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A Social Network-based Organizational Model for improving knowledge management in supply chains

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ABSTRACT

Purpose – This paper provides a social network-based model for improving knowledge management in multi-level supply chains formed by small- and medium-sized enterprises (SME).

Design/methodology/approach – This approach uses social network analysis techniques to propose and represent a knowledge network for supply chains. Empirical experience from an exploratory case study in the construction sector is also presented.

Findings – This proposal improves the establishment of inter-organizational relationships into networks to exchange knowledge among the companies along the supply chain and to create specific knowledge by promoting confidence and motivation.

Originality/value - This proposed model is useful for academics and practitioners in supply chain management to gain a better understanding of knowledge management processes, particularly for supply chains formed by SME.

Keywords: Social networks, knowledge management, supply chain management, small- and medium-sized enterprises

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1. INTRODUCTION

Knowledge is one of the most decisive factors capable of offering competitive advantages for supply chain partners (Crone and Roper, 2001; Cheng et al. 2008; Wu, 2008). However, economic systems based on small- and medium-sized enterprises (SME) are an important barrier for transitions from traditional economies to knowledge-based ones.

In the particular case of SME, it is important to consider the inherent difficulties of their size, and the difficulty of gaining access to either the same sources of external financing, such as large companies, or the appropriate sources of information to make adequate decisions. For these companies, cooperation with other similar sized or larger sized companies in their supply chain (SC) is a strategic alternative that enables them to obtain competitive advantages. Some authors (Gattorna and Walters, 1996; Christopher, 1998; Gunasekaran et al., 2001; Ozkul and Barut, 2009) recognize this need for cooperation and stress the establishment of closer, long-term relationships as a way to construct increasingly efficient and responsive supply chains. Indeed, collaboration between SC partners is receiving increasing attention in the SC literature (McCarthy and Golicic, 2002; Matopoulos et al., 2007). It is essential to base this collaboration on mutual trust, openness, shared risks and shared rewards to yield competitive advantages that result in better performance than to not consider collaboration (Hogarth-Scott, 1999). More and more companies collaborate in the SC because it offers market diversity, competitive pricing and shorter product life cycles (Soosay et al., 2008).

Malhotra et al. (2001) maintain that SC partners engage in interlinked processes that enable rich information sharing and building information technology infrastructures to process the information obtained from partners, a scenario that creates new knowledge. Most articles on SC collaboration typically focus on large multinational companies, while SME dominate the European industry to a great extent (Cadilhon and Fearn, 2005). For this

collaboration to take place in an SC formed by SME, an environment guaranteeing a series of factors that allows knowledge sharing among the participating companies is necessary. In this particular case of an SC formed by SME, the location of the companies in a given territory favors greater product specialization and better flexibility, and considerably increases competitiveness. Grouping in terms of a group of abilities, knowledge, technologies or markets can be a catalyst that impels innovative processes in companies. In this case, implicit knowledge in a given territory plays a vital role because it helps establish formal or informal collaboration and participation mechanisms (Capó-Vicedo et al., 2008).

The main contribution of this paper is the proposal of an organizational form based on Social Networks (SN) that takes full advantage of knowledge management benefits. This work uses the social networks analysis (SNA) techniques as a modeling tool to better understand knowledge management in a multi-level SC. The SNA perspective views any system as a set of interrelated actors or nodes. Actors represent entities at various levels of collectivity, such as persons, companies, countries, and so on (Borgatti and Li, 2009). Several authors propose SNA techniques (Boschma and Ter Wal, 2007; Borgatti et al., 2009) as appropriate to model business networks. In fact, there have been many previous works from supply chain management and logistics using these techniques (Carter et al. 2007; Mueller et al., 2007; Ozkul and Barut, 2009; Borgatti and Li, 2009; Choi and Wu, 2009; Bernardes, 2010). The findings of this paper provide useful insights into how supply chains formed by SME can reinforce their collaborative behaviors and activities to not only enhance their relationships, but to also achieve competitive advantages for the SC as a whole.

This paper starts by reviewing the literature on knowledge management (KM) at the inter-organizational level to study the particular case of the SC formed by SME and the importance of the network concept to improve the KM process at this level. Furthermore, this paper suggests a new organizational form based on SNA to gain a better understanding of the

KM process, and it also studies the case of a construction SC. Finally, this work presents the contribution and implications based on the findings, along with the limitations and further research identified.

2. THEORETICAL FRAMEWORK

There are different ways of understanding and classifying knowledge, and most focus on knowledge types: tacit, explicit, individual, organizational, etc. Nonetheless, there are many other factors to consider, among which the interdependence between knowledge and the organizational context stands out (Zheng et al., 2010). This is especially important because generation of new knowledge occurs in this context, and each context requires not only a different form of KM, but also different support systems.

With SCs it is necessary to form a relationship or deal with organizations with very different experiences, languages and contexts. This implies new organizational ideas, plus an environment of trust and collaboration between the enterprises in the SC which facilitates knowledge creation and distribution. To obtain advantages from knowledge sharing, it is of strategic importance that firms understand the factors affecting partners' knowledge sharing behaviors (Cheng et al. 2008).

Along these lines, Grant (2001) indicates that there are certain occasions involving collaboration with another enterprise that help achieve better integration and diffusion of knowledge than internal collaboration (e.g., the Toyota SC or in the SME networks of Northern Italy). The reason for this is that the creation of informal relationships usually takes place between different enterprises. These relationships are based on common interests and the will to share experiences, and are much more effective than the more formal enterprise processes used for knowledge integration and transfer.

Moreover, Levy et al. (2003) introduce the term "co-opetition" to show that both cooperation and competition can happen at the same time as, for instance, in the SME

grouped into clusters. This term includes knowledge transfer, which can be vital to achieve competitive advantages by using the knowledge gained by cooperation to compete in the market. These authors create a work context to analyze the transfer of the knowledge between organizations through the so-called “co-opetition”. This study centers on SME since this kind of enterprise is a good knowledge generator, but cannot or does not know how to use knowledge properly.

Kinder (2003) introduces the idea of value streams and flows, and illustrates with empirical evidence how and why supply networks are conduits of value and knowledge. This author argues that a closer analysis of supply networks reveals them to be important conduits of knowledge and, therefore, a significant component in any closer relationship among production, technology and knowledge.

The literature also indicates that SME are less able to harness the benefits of supply chain management (SCM) or to encounter greater obstacles when attempting to introduce SCM practices, mainly because larger customers manage them at arm’s length and they have to follow the norms stipulated by the buyer (Wagner et al., 2003; Arend and Wisner, 2005; Vaaland and Heide, 2007; Archer et al., 2008). Systems, tools and methods also represent significant differences between SME and larger companies; for example, in relation to the adoption of electronic interfaces between the actors in the SC. While larger companies have the resources and technical budgets to implement e-business and e-supply strategies, SME continue to face resource limitations. Finally, the expertise of larger companies and their ability to codify learning into transferable knowledge are other important facts that imply an important difference with SME. However, SME networks sustain a range of social relationships and benefits such as accumulations of tacit knowledge and know-how (Kinder, 2003).

The reasons for lack of implementation may also relate to existing structures in the

SC. These include resource structures and how collaborating actors link and share various assets. Effective knowledge creation is now a top priority in an SC (Wu, 2008). In order to create new knowledge, SC partners engage in interlinked processes that enable rich information sharing and building information technology infrastructures that allow them to process the information obtained from partners (Seggie et al., 2006).

With this in mind, Giannakis (2008) maintains that the successful management of supplier relationships can potentially enhance trading partners' productivity through knowledge diffusion, along with the implementation of good SC practices. This author also states that the potential of SC synergies to create and transfer useful knowledge is still to come about. The failure of many initiatives reveals a two-fold problem: there is great difficulty in generating and transforming knowledge into organizational action and, subsequently, it is even more difficult to transfer knowledge to supply chain partners.

Companies in an SC can use knowledge of social networks to identify internal collaboration opportunities (McGregor, 2006; Carter et al., 2007) and to obtain management improvements such as working together easier with the rest of the SC members, generate confidence between the companies in the SC and collaborative learning, among others. Therefore it is necessary to propose new models for improving the understanding of the generation and transfer of knowledge processes between the partners of an SC constituted by SME. These models should be approached at a network or multi-level SC, rather than in a dyadic SC (Chen and Paulraj, 2004; Mueller et al., 2007; Johnsen et al., 2008).

3. MODEL PROPOSAL

For the particular case of an SC formed by SME, KM is possible with a series of met conditions. These conditions come in two large groups: conditions relating to the industrial sector and conditions relating to each SC.

Regarding the conditions relating to the industrial sector, it is necessary to bear in

mind that the sector to which enterprises belong influences the form of knowledge management. This is because industrial processes can differ considerably for each sector, which implies certain differences in the nature of the knowledge transmitted. In fact, several authors in the literature deal with the particularities of KM in a specific industrial sector (Mentzas et al., 2006; Venters et al., 2005; Egbu et al., 2005; Newell et al., 2006; Fong and Kwok, 2009; Javernick-Will and Scott, 2010).

Regarding the specific conditions relating to each SC, the particular context in which enterprises operate has a strong influence on the KM carried out in it. As mentioned above, a series of met requisites are necessary to achieve positive interaction among the different enterprises in order to generate knowledge creation and an interchange process. This process demands a degree of similarity among the management systems, culture, language, objectives, etc., which is not always the case. In line with all this, several authors describe the influencing facts that achieve suitable knowledge generation and transmission throughout the SC. These characteristics become especially important in the case of an SC formed by SME because, if they do not exist, it is impossible to generate, acquire, transfer and combine knowledge among them; therefore, achieving customer satisfaction is also impossible.

In this sense, Teece (2001) points out that companies need to be entrepreneurial, imbued with dynamic capabilities, and organized in such a way that they are flexible and highly responsive to changes. He proposes the fulfillment of the following characteristics: flexible limits, strong incentives, nonbureaucratic decision-making processes that are decentralized and independent, flat hierarchical structures and the culture of innovation.

All the above-mentioned conditions can be combined as a single unit: SC enterprises must establish relationships to create a dynamic network that eliminates learning barriers to allow knowledge to flow freely throughout the network. The key to obtain competitive advantages lies in the capacity of the SME in the SC to acquire and absorb knowledge, to

exploit it to develop new products and processes, and to learn from the best business practices. To go about this, it is important to strengthen ties among SC members.

SME must change their mind-set and create a new business culture to encourage knowledge exchange in order to share and use the tacit knowledge possessed by their employees throughout the SC. This process uses cross-functional and cross-organizational groups, which come together regularly to address different operational issues, and to break down and overcome inter-company barriers (Soosay et al., 2008). Total implication from all the agents is also necessary to create a climate of collaboration and mutual confidence. This is only possible by means of more stable and durable relationships to establish equal relationships. Instead of the classical models of buyer-supplier relationships which assume a hierarchy wherein customers specify and demand suppliers to conform or acquiesce, new organizational forms are necessary like those based on transparency (Lamming et al., 2005; 2006) in order to exchange sensitive information and knowledge in an SC, or in the extended enterprise and social networking (Kinder, 2003) as conduits of knowledge. Therefore, an organizational structure that eliminates barriers is necessary for the creation, transfer and diffusion of knowledge (Kinder, 2003; Lamming et al., 2005; Walter et al., 2007). In this context, a Social Network (SN) should be created between the companies in the SC. The current definitions in the literature consider SN to be networks of collaborating companies (Carter et al., 2007; Borgatti and Li, 2009). Each company is a node that contributes what it knows best (its core competence) to the network. Each network member establishes good communication with not only other members, but also the environment beyond the network. For cooperation purposes, it is crucial to understand the activities of others as they provide a context for the node's own activity. The most important aspect of an SN is mutual trust among members. The need for flexibility and fast-changing organization implies information having to flow through the network nodes. All SN members must have access to information

to make the right decisions. Evidently, this reinforces the idea of collaboration; neither leaders nor followers exist.

The most representative nodes in a project must organize themselves to create a flexible, dynamic structure (SN) to allow the network to exchange and share knowledge. The fundamental requirements of this dynamic network are that its members are all equally important and that they all have access to the knowledge network.

Figure 1 depicts the proposed configuration represented with SNA techniques. The *initiator node* is the responsible for starting the network configuration; *operational nodes* provide the SN with a complementary core competence and, finally, the *integrator node* or *Project Manager Node* coordinates, unifies and manages the operational nodes. It comprises different members of all the other nodes and acts as an interface with the remaining nodes.

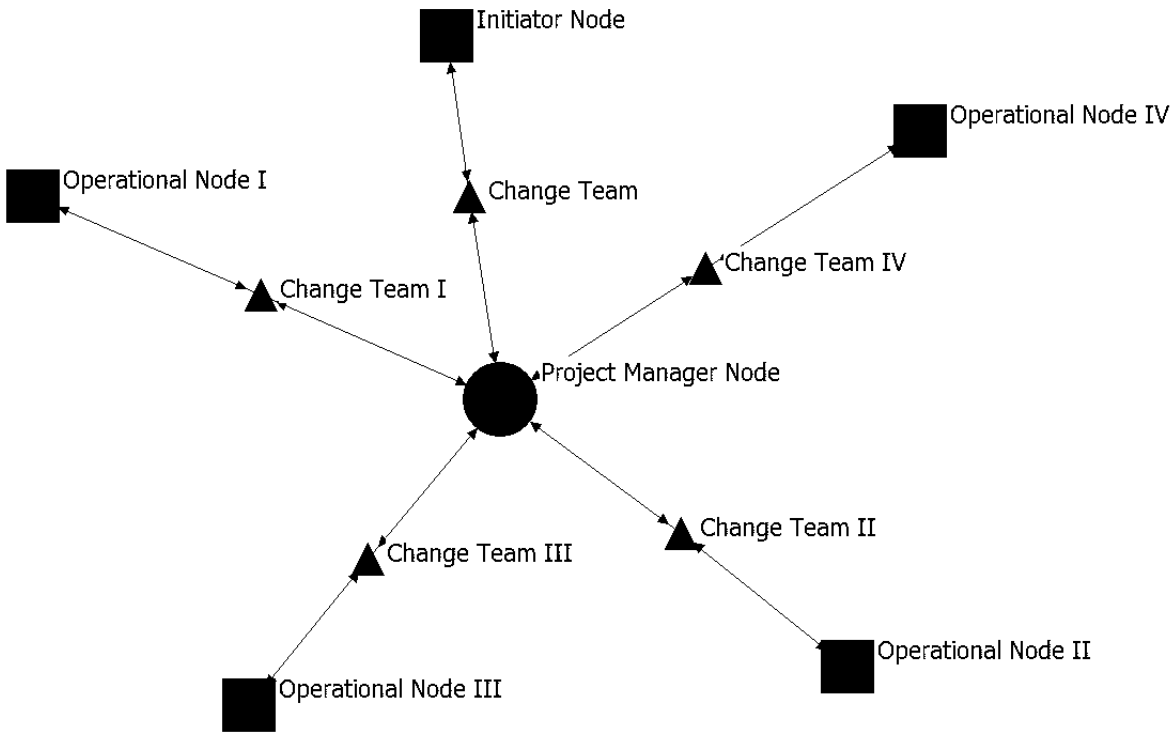


Figure 1. The principal nodes of the SN. Source: Authors’ own from Ucinet 6.0.

The Integrator, or Project Manager Node, is connected with each node included in the network, through the corresponding Change Team Node, represented by a triangle. People at

different hierarchical levels and disciplines work as facilitators from the Change Team, thus allowing horizontal and vertical knowledge transmission. Each Change Team Node acts as a network broker because the interaction among all the agents occurs in this node, thus leading to the creation, transmission and utilization of knowledge. At the end of the project, the Change Teams will be the facilitators of a new equilibrium point of the network if they are able to turn the new tacit or explicit knowledge into organizational knowledge (Project-to-Business -P2B- transfer). These teams should work continuously to become used to the learning dynamics.

Figure 2 represents an entire SC where knowledge transmission to the rest of the Project Manager Nodes takes place. If time is the factor separating projects, the P2B transfer occurs and this new knowledge becomes organizational knowledge and is available for undertaking further projects.

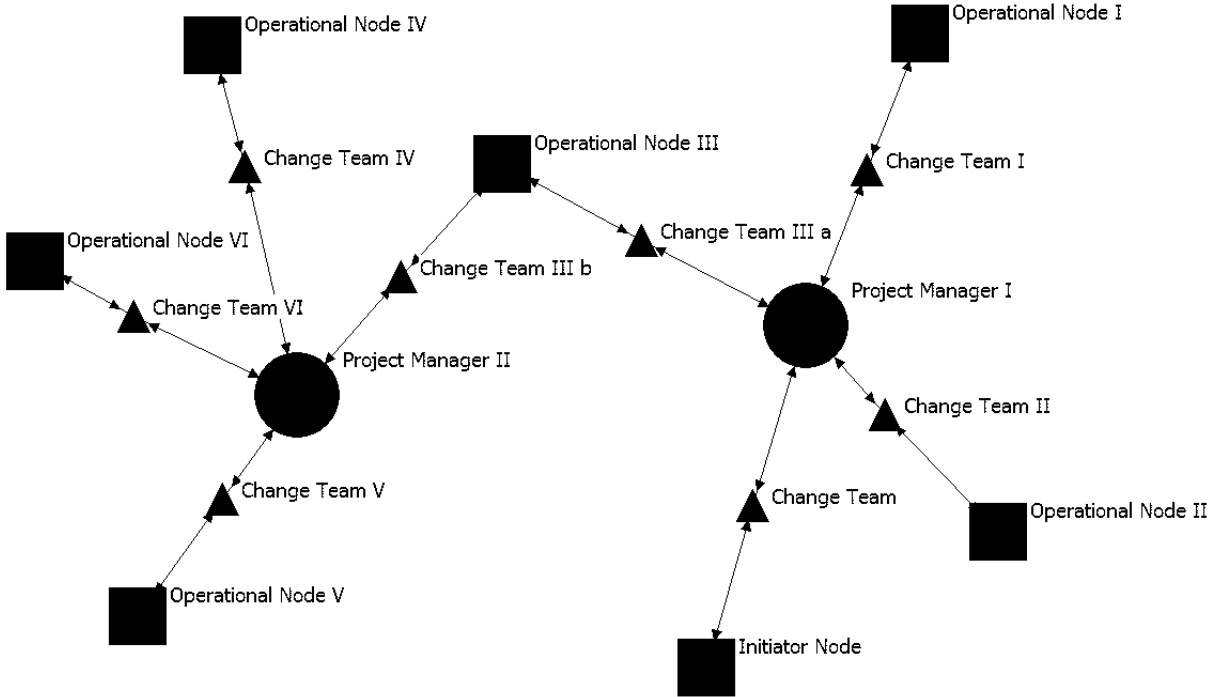


Figure 2. Knowledge transmission flows in the entire SC

4. EMPIRICAL STUDY

An empirical study of our proposal was carried out in a Spanish construction SC.

Many authors (Venters et al., 2005; Egbu et al., 2005; Newell et al.; Fong and Kwok, 2009; Javernick-Will and Scott, 2010) point out that knowledge and human capital management are especially relevant in the construction sector, which is characterized by projects considered to be prototypes based on multi-disciplinary teams and temporary organizational structures. They also indicate that experience is the basis of planning, decision-making and formalization of projects and companys' organizational structures.

In order to understand the KM concept in the construction industry context, it is necessary to better analyze the sector by identifying its peculiarities that distinguish it from other industries. Its production process corresponds to a project configuration. Despite using standard techniques for planning and controlling projects, each construction project is unique and different. Real added value depends on the capabilities of the people involved who need to adapt and be innovative to provide solutions to the specific circumstances that may arise. This implies intensive knowledge generation (explicit and tacit), which leads to an obvious competitive advantage. Construction firms have to assume the need to manage the complete knowledge generation process in order to correctly share and transfer knowledge project-to-project (P2P) and project-to-business (P2B). Indeed, the usefulness of models in generating management advice for SC feeding into a low volume or a one-off project environment like the construction industry has not been considered (Sanderson and Cox, 2008).

The complex nature of construction projects (special event, time limited, closed goals, set resources) make them suitable for large companies because they prefer to reduce organizational complexities by acting in project-based supply networks (Kinder, 2003, Lamming et al., 2006). Yet SME have difficulties in managing this kind of projects because the learning and knowledge transfer processes are limited. In this case, knowledge creation mainly comes through the learning acquired by individuals when they either resolve problems or face new situations emerging from changes or innovation. The development of new

products is the central process of organizational knowledge creation (Nonaka and Takeuchi, 1995). In the specific case of construction, each project is a prototype as it completely differs from any other. Indeed each project team always finds a situation which implies the need to solve problems. So, learning occurs and, therefore, new knowledge creation takes place.

Generally, each construction project is made up of several stages, ranging from the design stage to undertaking an infrastructure integral maintenance plan. One or several companies can participate in all these stages. The present-day tendency of these companies is to become more and more specialized, particularly in construction process terms. This involves a large number of diverse agents (promoters, planners, project managers, constructors, subcontractors, industrialists, specialists, control laboratories, suppliers, proprietors and users). Therefore, it is essential to develop a means of coordination among them. The embodiment of this coordination may be the figure of a single person or a team (Construction Manager), which plays a key role in the organizational knowledge creation process. This coordination organization, its characteristics and competences, all depend on the way selected to manage each construction project.

Currently there are new alliances in the construction SC constituted by SME, mainly in the subsectors of residential or industrial construction. These alliances are networks made up of collaborative companies which act as network nodes where each contributes the best it knows (core business). They all operate with the client (promoter or property) as if dealing with a single company, and a new network appears each time a construction project arises. It is important to point out that each individual project shapes the SC in the construction sector. Each project involves the client's organization demand for infrastructure or building. According to the model proposed by Lambert et al. (1998), the central organizing element in this type of SC is the client, and the SC considers that the client can be the promoter or the property owner.

4.1. Sampling and data sources

According to the main trade association SEOPAN (Spanish Association of Construction Companies), in 2009 the construction industry in Spain accounted for 1.82 million employees, representing 10% of the total Spanish GDP. As a direct result of the today's economic crisis, this sector is facing serious problems.

We have analyzed the network of relationships between a construction company and the rest of the companies of its SC. Specifically, our work aims to analyze the role played by the central company in an SC in adapting the construction sector to the change period deriving from the new market scenario.

This work follows a previous research in which we carried out several work sessions with a panel of experts from the main agents belonging to the sector. These interviews allow us to collect information about the relational network of the sector before and after current economic changes. Collected information was completed from several secondary sources of internal and public reports and publication distributed by sector associations, universities, and of public financial and accounting data Spanish databases.

Table 1 presents the companies' main characteristics. Interviews took place from September to December 2009 in 13 companies belonging to three different levels of the SC with the managers indicated in Table 1.

Table 1. The main characteristics of the companies analyzed (2009)

Firm		No. employees	Operating income (€)	*PTOE (€)	Interviewee
Construction Manager	1	171	26,371,395	85,600	Director of Engineering
Contractors	1	14	2,138,115	83,198	Head of finances
	2	36	3,143,834	6,654	Manager
	3	19	1,905,365	59,811	Manager
	4	34	3,746,726	29,616	Director of Engineering
	5	4	259,777	13,374	Manager

Firm		No. employees	Operating income (€)	*PTOE (€)	Interviewee
Materials / Components Suppliers	1	12	3,163,412	20,221	Sales Manager
	2	5	272,644	4,504	Manager
	3	6	1,170,447	75,306	Sales Manager
Manufacturers	1	4	1,132,182	14,372	Manager
	2	40	5,200,507	80,617	Head of Production
	3	32	818,080	90,579	Head of Production
	4	169	97,079,000	6,434,000	Sales Manager

* Pre-tax operating earnings

4.2. Analysis techniques

The empirical study was based on a series of semi-structured interviews held with managers and executives of a construction firm and of the companies belonging to its SC (Table 1). We used the roster recall method (Giuliani and Bell, 2005; Morrison and Rabelotti, 2009) which entails presenting a list of the remaining agents to each interviewee and asking about relationships with any of them.

Interviews were designed to obtain information leading to the development of quantitative indicators of the relations among the companies in the SC at the knowledge network (KN) Level. The knowledge transfer related to technical problems has been considered based on the works of Giuliani and Bell (2005), Giuliani (2007), Morrison (2008), Morrison and Rabelotti (2009) and Ramírez-Pasillas (2010). This approach involves going beyond the mere transfer of information to which access can be easily achieved by other means (e.g., trade fairs, Internet, magazines, etc.)

All the collected data have been completed from secondary sources (publications and reports of the main trade associations and also from Spanish databases). The use of secondary sources improves the validity of all the data obtained (Yin, 1989).

Then we followed the SNA techniques and the UCINET 6 program (Bogartti et al, 2002) for the purpose of analyzing and representing the structure of the relationships or the

inter-organizational links, and the knowledge flows between them (Boschma and Ter Wal, 2007; Borgatti et al., 2009).

5. EVALUATION OF RESULTS

This section provides some empirical insights from the analysis of a Spanish construction company and its SC in detail. From the clients’ (property) point of view, this company is a unique company or network. This company offers the property an all-round service for the construction of industrial plants. It acts as the network broker (Construction Manager) and plays two main roles (Simões-Costa and Rabelo, 2002): looking for new business opportunities and coordinating the process to select the most suitable consortium of enterprises for every opportunity that arises.

After selecting the project participants (Table 1), the network in charge of undertaking this project comes into being. The situation illustrated by Figure 3 emerges by following London and Kenley’s model (London and Kenley, 2000), which corresponds to a construction project showing the client’s perception of the entire SC as one company.

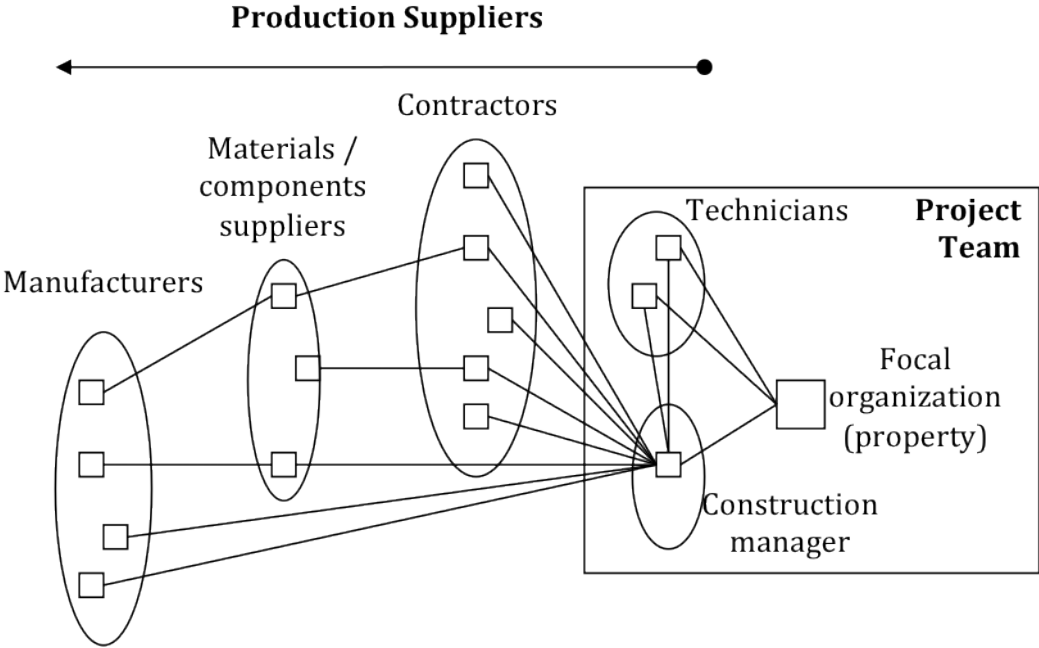


Figure 3. Network configuration to manage a construction project

While the project is underway, the studied company also acts as project coordinator and carries out activities in terms of controlling the execution of terms, qualities, coordination of information and the knowledge flows among the members, etc. The constitution of this network does not directly imply the constitution of the dynamic knowledge network (Social Network). In fact the construction firms examined face a series of problems to create a real Social Network (Table 2), and it is the Construction SME's culture that mainly motivates such problems.

Table 2. The problems arising while creating a Social Network in a construction SC.
Source: Authors' own

Identified problem
Participants in the construction project are not sure about the benefits they can gain from sharing knowledge and experiences
Belief they can lose competitive advantages
Dissimilar culture
Different objectives
Different standards and productive systems
Different language (jargon)
Existence of a relationship among SC members that presents certain rivalry and lack of confidence
Communication and information management problems due to insufficient coordination
The information available is mostly incorrect or insufficient. This can affect the tasks that depend on others
Low quality and failure to comply with terms as a result of a lack of understanding among the various parts of the SC
The organization of companies into departments creates internal barriers. This prevents them from obtaining a clear vision of their own processes, which means they are unable to concentrate on their client's needs and requirements

Most of the problems identified in Table 2 boil down to a lack of a collaborative culture and the cultural differences among the companies. Therefore, it is firstly necessary that potential participants in such alliances change their mind-set to then adapt to new forms of working to share information and knowledge where people work in a coordinated manner.

The solution to the above-mentioned problems depends mainly on achieving a cultural change of the companies participating in each network. The analyzed company operates in a well-defined geographic area; therefore the participants in each network are near each other. This fact, plus cooperation among them (different networks repeat most of them), help make

this cultural change easier. Thus, there is a real business ecosystem (Camarinha-Matos, 2002) among them and the Dynamic Knowledge Network (SN) emerges.

According to this cultural change, the broker company must work principally on three main facts, as shown in Hong-Minh et al. (1999): change of mind-set, orientation to a process management, and exchange of personnel and knowledge.

The most common problems are rivalry among SC members and a low level of confidence among them. In order to solve these problems, the broker must coordinate its efforts and attempt to work together to achieve end client satisfaction. It starts by determining clients' needs by transferring them to certain product requirements and by finally establishing how to deliver the end product to the client. This whole process must go through each construction stage. The broker promotes this relationship among SC members, and this relationship is based not only on confidence, mutual understanding, knowledge and acceptance of each member's particular expectations, but also on information and knowledge exchange. Thus, product delivery is on schedule and with the right levels of quality, leading to end client satisfaction and implying high internal levels of satisfaction, very few conflicts, etc.

Particular with regard to SME, the construction sector is well inclined to configurations by departments. This may prove to be a problem because companies cannot concentrate on the client. This kind of organization is too rigid as all activities are performed in sequence from one department to another by following hierarchical lines; so decision making becomes a slower, more complicated task. Despite concentrating on clients' requirements not being a new concept for construction companies, they do not usually pay the attention deserved to the client's value in their processes. Orientation by processes increases the company's efficiency; therefore, the client feels more satisfied, lead times are reduced and levels of quality are high. The main goal must be the end client; therefore, we must look for ways which offer the client as much value as possible, and not just in terms of price, quality

or deadlines. It is easier if the whole company focuses on the same goal (customer satisfaction) than several departments or sections attempting to achieve different goals. Once the company works in this way, it is easier to work together with the remaining SC members.

Exchanging personnel among the companies in the SC is a sign of a good relationship and of orientation by processes. This helps generate confidence between a company and its providers, and between a client and other companies. It also shows that the company wants to learn from others and is willing to share knowledge and technology. The broker promotes personnel exchanges when developing a new construction project to share human resources, experience and knowledge. Therefore, each company not only focuses on its own processes, but can also view the global process of the entire network working as a single body. They can compete against other SC and satisfy their clients' needs. This personnel exchange allows for personal and physical communication among the people of the various SC companies, thus creating a Social Network. The level of interaction is high and, therefore, tacit knowledge transmission among the companies takes place (Nonaka, 1994).

Table 3 summarizes the main operations performed by the broker to solve the problems shown in Table 2 and they can successfully constitute a Social Network in the SC.

Table 3. Solutions for the problems identified when creating a Social Network in the SC

Solution proposed	Result obtained
Select companies located near each other	Better cooperation among them to facilitate cultural change
Determine clients' needs and establish how to deliver the end product to them by promoting knowledge and information exchange among SC members	Product delivered on time and with the right levels of quality End client satisfaction High internal levels of satisfaction, very few conflicts
Promote process-orientation in the SC	Easier working together with the remaining SC members.
Exchanging personnel among the companies in the SC	Sharing human resources, experience and knowledge Generate confidence between the companies in the SC, and between clients and the SN. Learning from others, and sharing knowledge and technology. Each company not only focuses on its own processes, but also views the global process of the entire SN working as a single body. Improving personal and physical communication among the people of the various SC companies, thus creating a "social network". Transmission of tacit knowledge

Next, the general model proposed in Figure 2 has been adapted to this particular case study in Figure 4. The application of this SNA model is a powerful tool that allows managers to map networks of knowledge and information flows, and to obtain the improvements identified in Table 3.

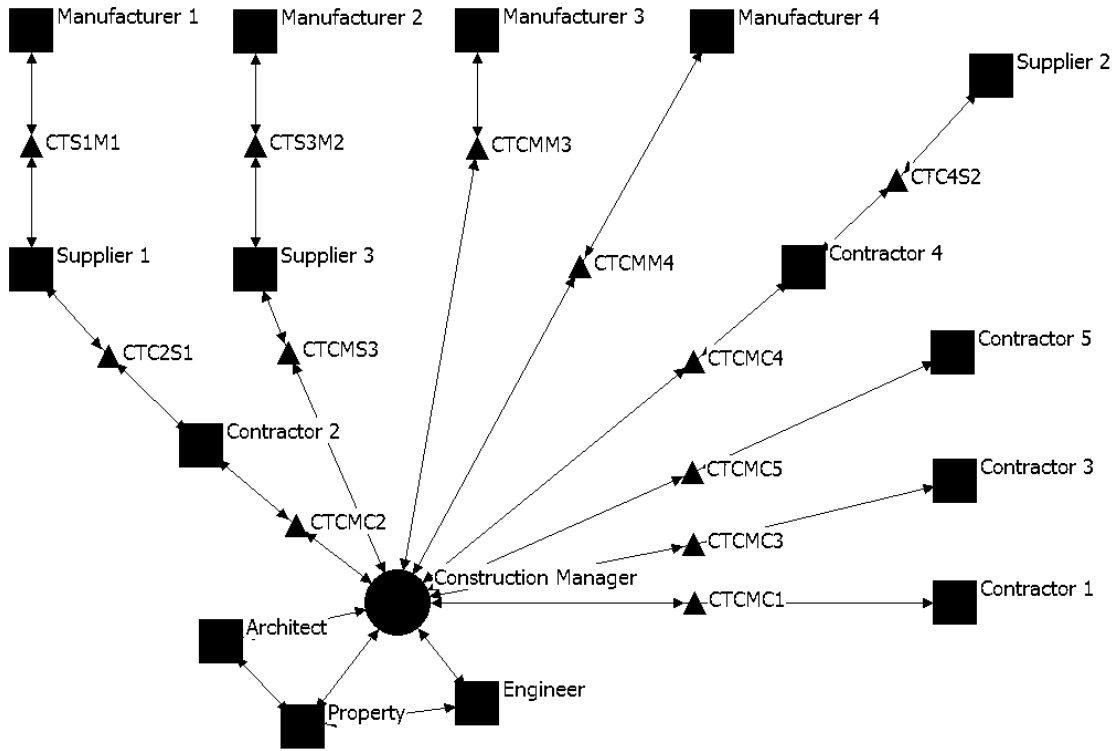


Figure 4. The social network corresponding to a construction SC

Figure 4 shows how the Construction Manager node transmits the knowledge generated in the operational part of the network to the Property and the technical nodes. At the same time, knowledge can flow in the opposite direction, that is, from the Property and the technical nodes to the network operational core. The social network is comprised of an *initiator node* (property), thirteen *operational nodes* (suppliers, manufacturers, contractors) and an *integrator node* (Construction Manager).

It is necessary to highlight the importance of the creation of the twelve Change Team Nodes in order to efficiently manage the knowledge flows along the entire supply chain. Each change team should be formed by people at different hierarchic levels inside each company

and at different discipline levels along the SC. They will work as facilitators of the knowledge flows by allowing the transmission of knowledge horizontally at the same hierarchic level by eliminating communication barriers, and vertically among the companies at each SC level. Project leadership will be exercised by different Change Team Nodes depending on the project phase. The aim is to obtain a balance of authority and control among the nodes. The advantage of this configuration is that a different network (with different people) will be created for each new constructive project on the basis of the nodes' characteristics. The high-performance team's competitiveness is assured as is, therefore, the constant creation of new knowledge.

Each network node has to transform itself into a learning organization. The Change Team has to be carefully selected for leading the transformation inside them. They will facilitate the steps needed to promote the continuous change inside their own organization and in the network. One same language has to be used to share data, information and knowledge. Each network node has to transfer individual knowledge into organizational knowledge by identifying the appropriate tools that will help the total process, and by choosing the indicators required to evaluate system efficiency.

When new knowledge is created in the constructive project's framework, the knowledge level of the network will vary. Nevertheless, it does not necessarily implicate that the network reaches a new equilibrium point. In fact, a new position can be temporary if each Change Team Node member is not able to transfer that knowledge to its respective node (Project-to-business knowledge transfer, P2B) when the constructive project finishes.

Having finished the constructive project, each change team will become the facilitator of a new equilibrium point of the network, provided they are able to turn that new tacit or explicit knowledge into organizational knowledge. If a node is involved in more than one constructive project at the same time, or some constructive projects are separated in time and

P2B transference is successful, then this new knowledge is already organizational knowledge and P2P transference will take place automatically.

6. CONCLUSIONS

This paper analyzes the knowledge generation process in a multi-level SC formed by SME. It suggests a new organizational form based on Social Networks to make the creation, transfer and sharing of knowledge possible in this particular case. Finally, it proposes a knowledge network model represented within SNA techniques to gain a better understanding of the knowledge creation and transfer process.

The first stage is to look at the main conditions and requisites to achieve real KM in the specific case of the SC formed by SME. One conclusion drawn is that collaboration is essential between SC members, which comes in the form of inter-organizational networks to encourage knowledge exchange and creation. Some fundamental factors are mutual confidence among members, a similar way of thinking, etc.

To verify these conclusions, this paper studies the particular case of the construction sector with one specific Spanish construction company acting as an SN broker in a construction SC. This work identifies the main problems arising when constituting the SN and analyzes the solutions adopted.

Another conclusion drawn is that each company not only focuses on its own processes, but also views the global process of the entire SN working as a single body. They can compete against other SNs and satisfy clients' needs. This personnel exchange allows for personal and physical communication among people in the various SC companies, thus creating a social network.

This paper shows how establishing these inter-organizational relationships into networks leads to knowledge exchange among the companies under study, and to the creation

of new specific knowledge by promoting confidence and motivation and by establishing alliances, team spirit and better coordination and communication among the enterprises involved. This implies a higher degree of innovation, fewer losses, improved efficiency in transactions and in production itself, and to increased competitiveness among the companies concerned.

We have identified some potential extensions of this work as further research: (1) further research of this proposal in other supply chains of similar or different sectors is forthcoming; (2) an additional quantitative analysis to reinforce the validity of the data and results could be integrated; (3) complementary conceptual modeling tools, such as flow charts and IDEF models, could be used as communication tools among SC users; (4) a decision system incorporating the SNA models could be developed. Finally, and considering the social capital concept for the explicatory model of the SME networks, we propose a research work that focuses on the distinction between simple relationships and more intense relationships which imply social components such as trust (Bernardes, 2010). In this sense, it would be interesting to propose variables to measure the relationships between agents not only as dummy variables, but which also take into account the degree of intensity in the relationship.

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