Managing knowledge transfer across supply chain: a social network approach

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Abstract— *This paper analyses the theme of knowledge transfer in supply chain management. The aim of this study is to present the social network analysis (SNA) as an useful tool to study knowledge networks within supply chain, to monitor knowledge flows and to identify the accumulating knowledge nodes of the networks*

Keywords-component; Supply Chain Management, Social Network Analysis, Knowledge Transfer Process, Knowledge Networks.

I. INTRODUCTION

In contemporary supply chain management a firm's sustainable competitive advantage depends on its ability to manage, integrate and coordinate heterogenic knowledge flows and contingent characteristics of a complex network of relationships within the supply chain [1]. It is well recognized that information and knowledge transactions are a key component in building models of a supply chain [2]. In this paper we suggest that the problem of knowledge transactions deals with the problem of sharing "real-time" information, as already indicated in literature, but also with a problem of knowing where specific know-how is accumulated to foster a better knowledge transfer across supply chain networks. The knowledge transfer process involves considerable difficulties identified in the literature of knowledge management [3][4]. They are knowledge dispersion, knowledge fragmentation and the obsolescence of a part of the knowledge. For this reason an important aspect of managing knowledge in the supply chain is the evaluation of the trade off between knowledge creation and obsolescence, preservation and renewal. Equilibrium has to be found to create new knowledge starting from the existing one and based on sharing of different types of knowledge coming from each partner. We argue that knowing how to map knowledge flows, recognizing where important knowledge is accumulated and knowing how to share and integrate heterogeneous kinds of knowledge are all very important. In the other words how to identify and manage the firm's knowledge networks in order to increase its competitive advantage.

According to the resource-based view, the inimitability of competitive advantage is due to firm-specific resources, such as knowledge and competences [5] [6]. These are characterized by path-dependency and for this reason are difficult for competitors to imitate, and also difficult to replicate by the same management. This paper contributes to the understanding of knowledge transfer process and localized learning through the method of social network analysis (SNA). Specifically, resource-based view on competitive advantage is taken into consideration. Thus, in this paper, supply chain questions and knowledge management are combined for a better understanding and managing of knowledge transfer process. Besides, the methodology of SNA is proposed to map knowledge flows within the supply chain in order to identify where knowledge is created, where innovation takes place and how to foster knowledge diffusion among partners of the chain. The main purpose of this paper is twofold:

1) To propose the study of knowledge network as a determinant for improving knowledge transfer process. To this end the mapping of knowledge networks in the supply chain is proposed.

2) To present the methodology of SNA as an innovative tool for monitoring knowledge flow dynamics, managing them and for identifying the points of knowledge accumulation and facilitating knowledge transfer.

The paper is divided into four sections. Section 2 discusses the theoretical background of our research, identifies the research gaps, and outlines the features of SNA. Section 3 presents the methodology of SNA for knowledge network mapping and knowledge transfer. Finally section 4 concludes the paper, and highlights some implications for knowledge management activities.

II. THEORETICAL BACKGROUND

A. Supply Chain Network and Knowledge Transfer Process

High-tech market and knowledge intensive industry are characterized by fast-paced technological changes and extreme pressure of time-to-market. In order to gain sustainable competitive advantage, firms have to generate innovative products and services and reduce time-to-market. In the light of this, two questions have become very important. The first is the chance of reaching innovative knowledge, which leads to the second concerning with the chance of managing an effective knowledge transfer process. In fact, reduction of time-to-market is directly linked with effective knowledge transfer among parties. In order to develop new products or services

and launch into the market quicker, innovative knowledge is fundamental. It is widely recognized that one of the main ways to reach innovation is investing in R&D, but it has also become clear that another important source of innovation comes from firms' suppliers network [7] [8]. Therefore, managing suppliers, procurements, and the whole network effectively can increase the chance of gaining innovative knowledge, which result in higher competitive advantage.

In complex supply chain networks the main question is consistent with the re-engineering of the network in order to improve the overall value creation. In order to do this, suppliers, their specialized knowledge and their competences have to be integrated and coordinated in an ongoing process. The role of intangible resources, such as knowledge and competences, in gaining sustainable competitive advantage is well recognized in the resource-based perspective. Starting from Penrose's primary contribution [5], the resource-based framework has emphasized the role of firm specific resources in competitive advantage. The intangible resources can help to reach innovation, because of their inimitability by competitors.

This study is framed in the context of supply chain networks. It is worth noting that the phrase "supply chain networks" has been used to indicate the growing aspect of complex networks within the supply chain. As indicated in the literature the components of a supply chain are: network structure, business process and management [9]. The content of network structure has different implications. The network is one of the potential governance structures recognized in literature. The theme of governance structure has been addressed by transaction cost economics theory [10] [11], which is one of the dominant frameworks to study the supply chain. Indeed in accordance with transaction cost paradigm the high costs inherent in opportunistic behaviour can be alleviated with hierarchy governance structure. Subsequently many scholars addressed the same question with different findings. Powell [12] suggested network structure as the best form of governance to minimize transaction costs, thanks to many factors such as trust and co-ordination mechanisms. Today, in supply chain management, it is recognized that in supply chain management the issue regarding the best governance structure is linked to other important aspects for managing effective supply chain. In this paper, we focus the attention on the relationship between network governance and supply chain integration. In particular we address the process integration problem.

In fact, process integration is considered as one of the value drivers of an efficient supply chain strategy. Others are value maximization, responsiveness improvement, and cycle time reduction [13]. Supply chain integration is studied from many points of view.

As Lee [14] has outlined, the integration issue is not only a question of cost reduction, but also deals with information integration. The integration regards process as well as information and capabilities. As posited by Clark [15] capability integration is important in product development success. Capability integration is very different from information integration because knowledge and information is not the same thing. As Nonaka pointed out "information is a flow of messages, while knowledge is created and organized by the very flow of information" [16]. A high degree of integration is expected in markets with high competition and a supply chain with a low degree of dominance [17]. A low degree of dominance is the prerequisite of a network structure. In supply chain network structure the main decision in integrating and leveraging resources regards outsourcing strategies. Generally, the main motivation of outsourcing decision is cost efficiency so that firms can decide to outsource non-core activities. But, it has been recognized that the supplier's network can be a source of innovation, especially in today's fast-paced technological changes. For this reason, firms can also outsource innovative activities, such as R&D, to other business partners. In such case, the main motivation is gaining access to resources unavailable internally. Outsourcing of knowledge intensive activities also implies disadvantages. First of all, the dispersion of specialist knowledge and competences is highlighted, and secondly, the de-centralization of power. Thus, the challenge of knowledge transfer in supply chain is more difficult because it has to tackle the problem of dispersion of specialist knowledge. In fact, the lack of connections between actors can determine this dispersion. The risk of losing knowledge and competences, or abandoning them to obsolescence is inherent in the knowledge transfer process. Despite these difficulties, existing research shows that knowledge transfer among business actors, such as suppliers network or research centre is the basis of competitive advantage [18]. In the light of this, a growing literature in resource-based view and knowledge management [19] domain addresses the problem of how to foster knowledge transfer, and how to manage heterogeneous and dispersed knowledge in the supply chain [19].

In particular, many scholars in knowledge management field address the problem of what the most important knowledge management activities are. According to Chakravarthy et al. [20], knowledge management means the accumulation, protection and leverage of knowledge. These streams of literature also show the main difficulties in managing knowledge transfer process. The barriers to knowledge diffusion are highlighted. The barriers are due above all to knowledge characteristics. Indeed, it is known that firm specific knowledge is often tacit [21]. This kind of knowledge is extremely context bound, embedded in individuals or in groups where it is created. For these reasons tacit knowledge is very difficult to transmit through formal ties and codified communication. The tacit dimension of knowledge makes it transferable only through observation, imitation, and direct contacts. At the same time, it is embedded in behaviour and social relationships [22].

Our starting point is the observation that knowledge transfer process in supply chain network is inevitably affected by problems of knowledge dispersion, knowledge obsolescence and knowledge integration. The problem of knowledge transfer has become important in today's complex global market because organizations have to integrate and share different sources of heterogeneous knowledge. In our view, knowledge transfer, integration and dispersion/protection are intertwined process issues. The inherent problem with suppliers network is above all how to manage heterogeneous knowledge flows

within the network in order to reach innovative knowledge, integrate it and make it accessible to all actors of the network. Thus, in complex supply chain network, specific knowledge is dispersed along the supply chain, but it is embedded in behaviour, organizational routines and social context [23]. We argue that knowledge transfer process is complicated, in today's supply chain networks, due to the organizationally embedded nature of knowledge. In such conditions, management has to find a way to facilitate the process across a complex supply chain despite the barriers of boundaries of the firms and heterogeneity of knowledge. Despite these difficulties to co-ordinate knowledge dispersed along the supply chain, firms have to tackle this problem because in a knowledge-based perspective [24], the main goal of the firm is to integrate specialist knowledge of its members. Grant identified integration as the main role of the firm in the knowledge age. However, the more complex the knowledge is, the more difficulties firms have to integrate it.

Indeed, the source of competitive advantage is not only knowledge itself but the way this knowledge is integrated and applied [24]. For the same reason, management has to know how to manage diverse sources of knowledge. In order to reach innovation an important issue is knowing where innovative knowledge takes place and then improving its transfer process. In both cases, R&D investments, procurements decisions, technology and knowledge transfer become a key component in supply chain modelling. It is because when actors among supply chain started technology development or knowledge innovative activities they have to share this with others. Management has to know where such innovative knowledge activities take place. Grant [24] suggested a series of mechanisms to enhance the process of knowledge integration. He emphasized the importance of rules, directives, and routines. But, in the literature, other suggestions can be found, such as the providing of communication structures [25] or organizational tools for knowledge integration. The literature on the problem of knowledge transfer seems to find the main solutions to the problem in organizational dimension. In this paper we suggest the use of SNA methodology to tackle the problem of knowledge transfer, dispersion and obsolescence in the context of supply chain management. In order to build our argument on how to identify knowledge networks we refer to SNA methodology.

B. SNA and Its Applications

To our knowledge, the SNA has not been applied in supply chain knowledge management. Herein, we propose the use of SNA because it is a useful tool for practitioners and scholars to inquire into the relationships among a social network. Examples of a social network can be friendships among groups as well as business relations between companies. The main aspect in a social network is the existence of connections, ties, among actors or nodes of the network. In a business framework the social network perspective posits that all organizations are social networks, that the environment is a network of other organizations. In a supply chain network perspective, such interpretation of the context can provide new insights. Moreover, in the social network field, the study of the features of ties has many implications for the study of knowledge. Following Burt [26], ties can be studied for their access, timing, and referrals. Access deals with the chance given by certain network ties, to have influence on someone in the network. Timing regards the chance to save time in obtaining information through some connections. Referrals mean the opportunities given by some connections.

In social network studies, there are two main streams of research regarding information and knowledge access. One is consistent with the structural hole theory, the other with the social capital theory. According to the structural hole theory, emphasis is on the central nodes of the network because they have multiple connections and more chances to gain access to important knowledge and information than peripheral nodes. The important aspect to specify is that central nodes emerge after SNA. They do not dovetail with those indicated by formal structure. On the other hand, the social capital theory is more concerned with the social relationships in which actors are embedded. The main tenet is that social connections have a positive impact on individual growth. Mathematical studies and methods for modelling networks highlighted features of network structure [27] [28] and its statistical properties. The first property is "small-world", the second is clustering, whereas the third is the property of having a skewed degree distribution [30]. In recent years there has been a growing interest in SNA discipline and it emerges as an interdisciplinary domain and for this reason it has become very attractive for statisticians, mathematicians, sociologists and biologists. The first significant contribution in this field is by researchers of the School of Manchester. Thanks to their reflections, "network" is discussed, for the first time, as an analytical concept to which the mathematical theory of graphs can be applied.

SNA involves a new point of view of social relationships. It abandons an atomistic perspective to look at the network of relationships among actors. The actor is no longer a point of interest in SNA perspective. This is the main reason to propose a social network approach in the study of knowledge transfer. Since knowledge transfer among different partners needs trust and common commitment, SNA appears a useful tool to identify where such characteristics exist among groups. SNA perspective emphasizes the importance of relationships, and above all, it looks at the informal connections. Generally the informal network, identifiable through SNA, seems the best place in which trust and therefore learning takes place [31]. In the literature SNA applications are used to improve flows of knowledge, to find lack of connections and to understand the nature of social ties and the degree of their intensity [32]. Indeed the main assumption is that knowledge passes more easily across informal ties than through formal links. If knowledge is embedded in a network of relationships, in the interaction of people, tools, and tasks SNA is a useful tool to inquire how the network is structured, who the more embedded nodes of the network are, and how to reach knowledge which is accumulated and embedded in those relationships.

First of all, SNA is a tool to visualize the map of knowledge flows. The main potential of SNA is its capacity to visualize relationships, and monitor information and knowledge flows [31]. SNA is able to represent the relationship structure through a graph on which it is possible to do

quantitative and qualitative analysis. The growing attention to the informal dimension of an organization is due to at least two factors. First, the evidence provided by many researchers that knowledge flows more easily through informal relationships than following formal organizational structure [33]. The second aspect is the extensive introduction of information and communication technologies (ICT) in the companies that have made their boundaries more permeable than before. Through ICT, communication and information pass across firm's boundaries allowing connections among people residing in different subunits of the same company, or even among units located far from the others. For all these reasons we propose SNA as a strategic tool for management in order to gain innovative inputs from firm strategic suppliers. Most of the applications of SNA in the management field deal with the comparison between formal organizational structure and the informal one, which emerges thanks to SNA application. Generally, the aim of the comparison is to reveal that individuals less considered in the

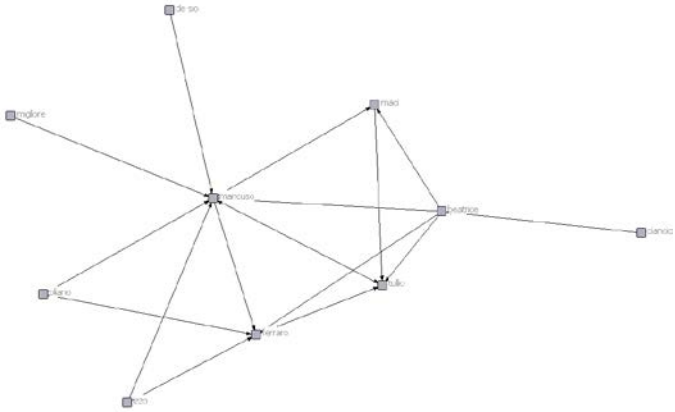

Figure 1 Example of an informal network

formal structure are, in contrast, central in the informal network of relationships. Fig. 1 shows an example of an informal network in which the person identified as the most central in the group is placed at the centre of the network. The central node is the node with most connection in the network.

SNA emerges as a set of methods for the analysis of social structures through a specific investigation of the relational aspects of these structures. The use of these methods, therefore, depends on the availability of relational rather than attribute data [35]. Relational data analysis is made by ordering the information in matrix: a framework in which each agent is listed twice (case-by-case matrix) once in the rows and once in the columns. The presence or absence of connections between a pair of agents is represented by "1" or "0" entries in the appropriate cells of the matrix. Then, the matrix describing the relations among actors can be converted into a graph of points connected by lines, called name sociogram, in which each line indicates the information link between two people; the arrow represents the direction of the relationship (incoming arrows show that the person is a source of information; outgoing arrows mean that the team member seeks information from the linked party). Other indications include a) Central people: who the most prominent people within a group are; b) Peripheral people: some people are only loosely connected to a network; c) Subgroups: groups within a group often arise along lines of location, function, hierarchy, tenure, age or gender.

There are two ways to study the network. One is called egocentric, while the other one is bounded [31]. In the first type, the egocentric, the researcher starts to collect data from one person. This person identifies the other people who are important for the specific purpose in building network. The purpose can be to identify the most central node of the informal network, or the leader of the team group and so on. According to Cross et al. [31] the main advantage of an egocentric network analysis is that it can uncover all the important relationships for the person taken into account. Generally it is based on short surveys. On the other hand the bounded network approach implies the identification of a network of interest. It can be a division, such as the R&D group or quality control department of a firm. In this case the researcher has to survey each person of the group about his relations with the others of that group. In the case of a supply chain network application, the use of a network bound approach can help the researcher to identify the most peripheral groups within supply chain, in terms of their connections with the others of the same chain. The SNA measures can be divided into two categories: group measures and individual measures. The first are density and cohesion. Following Freeman [35] network density can be considered as the actual number of ties in a network as a ratio of the total maximum ties that are possible with all the nodes of the network. In a fully dense network such measure has the value of 1. This indicates that all nodes are connected to each other. While, when the value is near 0 it indicates that it is a sparsely-knit network. It is defined as [35]:

$$D = \frac{2Nt}{N(N-1)}$$

where D is density, N represents the nodes and N_t the ties. In Fig. 2, a fully connected and a fully disconnected networks are shown.

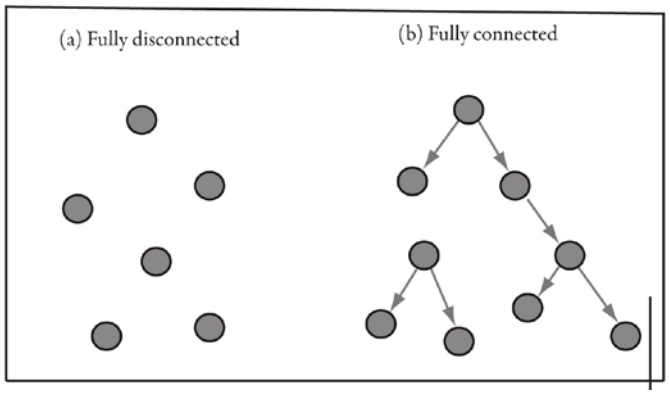

Figure 2 Degree of connectedness

Cohesion is the average of the shortest paths between every pair of people in the network [31]. Among the individuals, we can find many measures, including centrality, centralization, and betweenness. According to Nieminen [36], we distinguish among local and global centrality. Intuitively, the concept of centrality deals with the most connected node of the network. The point with the highest number of direct ties is the central.

But this approach ignores the role of indirect ties so that we distinguish among local and global centrality. Local centrality deals only with direct ties. A general measure of centrality has been elaborated by Bonacich [37], and it can be defined as:

$$c_j = \sum_j r_{ij}(\alpha + \beta c_j)$$

where c_i is the centrality of point j, r_{ij} is the value of the line connecting point i and point j. While centrality is referred to as the idea of point centrality [34], centralization deals with the graph structure as a whole, and it is defined as:

$$r = \frac{\sum_{i=1}^{g} [\max(Di) - Di]}{(g-1)(g-2)}$$

where, r is the centralization, Di is the number of people in the network that are directly linked to person i, and g represent the number of actors. Density and cohesion are measures used in analysis of the groups. Density and centralization are complementary because the former explains the general level of connectedness and the latter explains the extent to which the connectedness is focused around a particular node. Betweeneess shows the extent to which a particular node lies between the others of the network. It can be defined as:

$$b(i) = \sum_{jk} \frac{gjik}{gjk}$$

where g_{jik} is the number of the shortest paths from node j to node k (j, $k \neq i$), g_{jk} is the shortest paths from node j to node k passing through node j. In the past there was one problem in analyzing social network data. It was related to the difficulty of testing statistically hypotheses. This was due to the auto-correlated nature of data that violated the assumptions of independence. Today, permutation tests and random graph models enable non-independence to be overcome. We argue that SNA can be a useful tool in the management of supply chain network through the investigation of knowledge networks among actors of the supply chain.

III. Network Approach

A. Knowledge Network Mapping

The network approach is well utilized to study new economic phenomena, such as the proliferation of research alliances among firms and research centres or the diffusion of innovation [38]. Generally, these kinds of phenomena were studied through the classic economic theory that now seems inadequate.

1) What is a knowledge network?

We have different definitions of the knowledge network. Communities of scientists, software developers are, among others, examples of such knowledge networks. We take into account the Hansen [39] work on knowledge networks in multinational corporations (MNCs). To him, the existence of relationships among members of different units in MNCs is the reason for which some of them are able to benefit from knowledge even if it is located in another business unit. Hansen's work [39] is focused on the way in which knowledge is integrated across geographically dispersed units. As in the case of Hansen's work on MNCs subunits, a growing body of research exists on intra-organizational network, such as those comparing formal and informal networks within the firm [33]. In contrast, the study of the inter-organizational dimension is more focused on the formal ties among network industries. These kinds of research deal with the study of the strategic alliances among firms, inquiring into the effect of such partnerships in developing new products. However, we argue that a focus on informal networks, even in the inter-organizational dimension, is needed. Hansen underlines the role of the related knowledge in MNCs and proposes the study of knowledge networks to discover why some units are able to benefit from knowledge residing in other parts of the firm, while the others are not [39]. But the role of knowledge accumulation is not taken into consideration. Learning and knowledge are inevitably localized so that management has to discover where this takes place. Knowledge creation happens, starting from the existing knowledge background. Thus, the challenge of knowledge integration has to be viewed intertwined with that of knowledge monitoring and knowledge accumulation. In both cases, it is a problem of how the network of relationship among business partners can be studied. We suggest that in supply chain networks it is possible to study the informal dimension of knowledge relationships (knowledge network) both at the intra and inter firm level. The study of knowledge networks and their informal dimensions appears important because the barriers to knowledge diffusion exist both within the same firm, among inter-unit of MNCs geographically dispersed and among different suppliers. There are barriers to internal knowledge diffusion in supply chain networks related to the position of the firm geographically dispersed, and with different knowledge and technical background of each member of the chain. The concept of knowledge network and its informal dimension allows the boundaries of the firms, formally defined, to be overcome.

2) Why knowledge network mapping?

It is recognized that social factors such as reciprocal commitment or trust can positively influence learning and knowledge transfer among supply chain [40] [41]. We focus the attention on knowledge network mapping because it is important to understand "who knows what", and which kind of competences is needed, assumes a considerable importance in management supply chain because suppliers are often involved in developing innovative products and services in short time, as mentioned above. Since knowledge is localized and accumulated according to the specific requirements of the firms, management has to know where it is accumulated and who the innovative people of the firm's knowledge networks are. At the same time it is embedded in specific organizational routines and operating procedures. The firm-specific knowledge is not context free, it is context bound. The importance of mapping the actual knowledge flows is due to the localized character of knowledge accumulated. The particular circumstances under which knowledge and learning take place lead to localized forms of knowledge accumulation. The map of knowledge network allows the monitoring of knowledge flows, the identification of innovative nodes of the

network. The nodes can be an individual as well as a group or an entire organization. Through the visualization of knowledge networks, it is possible to identify where important knowledge is accumulated in order to operate the main activities of a knowledge management process.

The map of the knowledge network is important both on intra and inter firm levels within the entire supply chain network. While the main advantage in terms of knowing where knowledge and competencies are accumulated appears clear at the intra level. At the inter level it becomes useful to evaluate how some relationships are maintained and which degree of intensity in information sharing characterizes the network among firms. If we consider the case of knowledge intensive industry, such as pharmaceutics and biotech, we already know that when knowledge is transmitted through formal agreement, geographic and spatial proximity does not matter [42]. At the same time, we know that scientists tend to prefer working with other scientists in doing research so that previous links among researchers can be the source of an agreement later. For this reason, the study of the informal relations among firms, research centres, universities and others nodes of the chain can be useful to understand future dynamics.

B. Knowledge Accumulation

The attention for the knowledge accumulation is due to the characteristics of knowledge, especially tacit type of knowledge. It is extremely embedded in social relationship, routines, and tools. In addition, it has a strong localized character. It is difficult to replicate or transmit. Even when it is transmitted, the risk of scattering some of it is very high. For this reason, a map of knowledge flows can be very useful to locate them, and to foster their transferring and integration. The creation of new knowledge is a very important aspect of any knowledge management process. New knowledge is created on the accumulation of previous knowledge. A cognitive association, between actions and their consequences, is the basis for developing new knowledge [43]. This kind of circumstance is more similar to an insight than to an observable phenomenon. While knowledge creation is so difficult to observe, knowledge accumulation can be studied offering useful suggestion in predicting the knowledge creation. In complex supply chain networks the main problems associated with knowledge accumulation could be monitoring knowledge flows with their intrinsic dynamism and managing growing flows of knowledge with the risk of loosing some of them. As mentioned above, knowledge transfer process deals with some problems such as knowledge dispersion and knowledge obsolescence. In order to preserve accumulating knowledge and to better understand the creation of the new knowledge an effort has to be made to monitor knowledge flows. The advantage of identifying accumulating nodes is twofold. We expect the identification to have a positive impact on fostering knowledge transfer, and allowing knowledge protection among parties of the supply chain. The importance of identifying accumulating nodes is due to the localized character of knowledge and learning. Both knowledge (the content) and learning (the process) are not easy to replicate in different contexts and conditions. As mentioned above knowledge is socially embedded in context specific relationships. Therefore, effective knowledge transfer depends on the extent to which each one is able to know where important knowledge is located and the sharing of knowledge and information. For this reason it is important to know who knows what. Equilibrium has to be found between knowledge creation and knowledge obsolescence, preserving the existing knowledge.

In this paper we propose a particular application of SNA, of which the flowchart is shown in Fig. 3. The first step is to conduct surveys to identify the most important network based on manager's suggestions and researcher observation. Data have to be analyzed to build the matrix. In this phase the use of software for SNA is very useful. Using the SNA software we can identify the direction of knowledge flows and of the most important nodes. They possess specific and tacit knowledge within the chain. This stage can be improved through a set of in-dept interviews conducted with some people among these nodes identified. In this phase centrality, betweens, density and cohesion measures are very useful. While in a small network, the most central nodes can be studied as the accumulating nodes, while in very large networks, such as supply chain, the only identification of the most central node can be difficult and useless. Quantitative analysis looks at the group as a whole and study how people are embedded in the network [31]. For this reason, we propose another way to identify the knowledge area based on the study of vectors between nodes. According to the two most important nodes, emerged from phase one, it is possible to determine the area generated by the vector. The two nodes can be people as well as groups or departments. This is shown in the Fig. 4(a) where A, B, C, etc. are the nodes. The arrow represents the vector among the nodes. The knowledge area, identified as a Euclidean space, can be seen as an attractor in accordance with the set mathematics theory. Indeed, an attractor can be a point as well as curve or a space. Thus, we obtain a new network area generated by vector among nodes E and A. All nodes important in building specific knowledge used by E and A compose this area. Thus, the area obtained, and visualized, is a cluster of knowledge accumulating nodes.

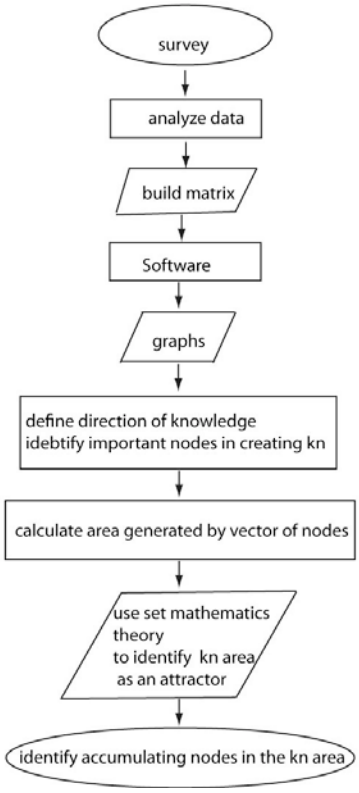

Figure 3 Flow chart of the SNA

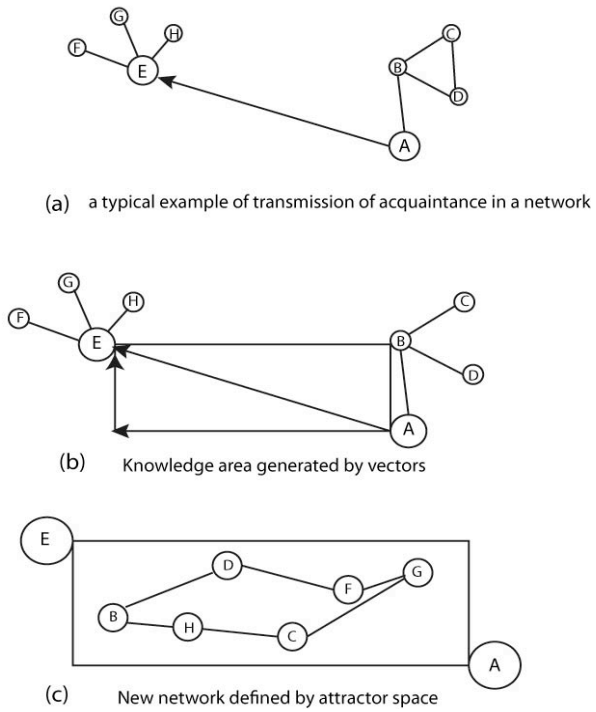

Figure 4 Steps of the SNA

B. Knowledge Transfer

As mentioned earlier, knowledge itself cannot be the only basis of competitive advantage. As the resource-based view indicates the firm's ability to manage and integrate knowledge, is more important to gain higher competitive advantage. Moreover in the knowledge-based perspective the competence to integrate specialist knowledge of the members is considered as the reason for existence of the firm. The competences for an effective knowledge management process are more important than exclusive knowledge. Thus considerable efforts have to be made in order to improve knowledge transfer, knowledge sharing and integration within complex supply chain networks. In this paper we argue that visualization of knowledge networks allows identification of knowledge area and accumulating nodes. This appears an important aspect because it can be useful to enhance knowledge sharing and knowledge diffusion. Monitoring of knowledge flows and identifying accumulating nodes constitute the basis for effective knowledge management transfer. The advantage given by this visualization tool represents an instrument for managers. It gives to them knowledge about who the most innovative persons are or which groups is determinant within the supply chain. Visualization of knowledge network constitutes an immediate and intuitive knowledge about where common and related knowledge is located. This becomes very important in project organization case. Knowing the role of persons as well group and communities of practice at work, is useful to evaluate if they are in the right position, to encourage them to foster knowledge creation and exploitation.

IV. CONCLUDING REMARKS AND FUTURE RESEARCH DIRECTIONS

A core theoretical contribution of our study is to study how informal networks management affects knowledge transfer and organizational performance in supply chain networks. Knowing knowledge networks can enhance organizational learning. Also, we contribute to the understanding of application of SNA method to supply chain. SNA provides a visual tool to identify the structure of the knowledge network. The monitoring of knowledge flows through the map of knowledge network is an attempt to better understand the firm-specific conditions under which learning and competitive advantage take place. The main aim of such activity is due to the fact that an effective and efficient knowledge transfer has a positive impact on cost and time reduction, and value adding.

The main advantage of identifying knowledge networks is the chance to know where firm-specific knowledge is located and to foster its transfer within the chain. A better knowledge transfer process is expected to have a positive impact of supply chain knowledge integration. The aim of an improved transfer and integration process is time- to-market reduction. This can have theoretical as well as managerial implication. From a theoretical point of view, the paper sought to contribute to a better understanding of how supply chain management works at the informal level. While from a managerial point of view, our study offers the chance for monitoring knowledge flows to discover where the determinant knowledge creation takes place.

A. *Future Research Directions*

In this paper, we have offered some testable propositions. Future application of SNA in supply chain can highlight many other aspects. Firstly, an effort has to be made to test our hypothesis. The analysis of multiple case studies, in which SNA can be applied, can provide a deeper understanding of the relationship between informal network, at the inter-level dimension of the supply chain, and the integration problem. Future research on monitoring knowledge flows will deal with the dynamics character of knowledge. Knowledge and its flows cannot be considered a static phenomenon. Therefore a static picture of knowledge network can be a limit of a SNA. Dynamics software, such as SONIA [44], already exists. It allows an on going monitoring of dynamics networks, but it involves a more complex data analysis. Thus future researches can address the problem of innovative way to collect data in a dynamics context.

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