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The supply chain management researches are now integrating the social network analysis concepts, since it allows a deep understand about the relationships between the firms that are part of the chain. In this paper we analyze the role of logistics service providers through the netchain concept, aiming to discuss how its position in the supply chain alters all others actors behavior. Doing so, we present some relational and structural propositions about logistics service providers considering the effects on the agent's centrality, the network subgroups identification and the nature of relationships between organizations. The goal is to better understand the importance of these companies through a new perspective. Keywords: supply chain; logistics service providers; social network analysis.

INTRODUCTION

The research in supply chain management (SCM) has become aware of the importance of the social network analysis in the last years, and many authors are working in this interdisciplinary, as: Galaskiewicz (2011), Borgatti & Li (2009), Choi & Kim (2008), Carter et al. (2007), Lazzarini et al. (2001) among others. This is because the chain term is considered an imperfect metaphor for dealing with supply chain (SC) relationships since it rarely has a linear behavior. Even though the supply chain term is the most used in literature, the appropriated term would be supply network, since it describes lateral relations, the reverse loop, exchanges in both directions and also it positions the focal firm as a reference point (LAMMING et al., 2000). The social network perspective is precisely concerned

about these relationships and its use in SCM researches improves the understanding scope of the chain structures and the business strategy.

One of the basic principles of network analysis is that the social relations structure determines the content of these relationships, i.e., where each actor is positioned in a social network will determine how its relation will be established. Thus, these actors are not independent but rather influence each other in the network context (MIZRUCHI, 1994). The social network analysis provides numerous tools to map the structure of relationships based on the recognition that network structure constrains and at the same time is shaped by actors' actions. But unfortunately this concept is not particularly concerned with vertically organized ties, but rather with horizontal relationships between firms belonging to a particular industry. Because of that, Lazzarini et al. (2001) presents the idea of netchains, an approach that intends to integrate SCM and network theory recognizing that complex interorganizational settings embody several types of interdependencies both horizontally and vertically. In their research, the authors pointed a series of practical uses for netchain concept and suggests that a development of their studies would include the role of chain service providers which are not direct participants in a netchain but contribute in the process of value creation by interacting with several layers.

Our proposal in this paper is just to analyze the role of Logistic Service Providers (LSP) in the context of a netchain, aiming to discuss how the position of these companies in the network can improve or decrease the supply chain results. In other words, we intend to analyze the structure of a netchain that has a LSP as an important actor as well as its relationships with the focal firms, with the firms in the same actuation layer and with all other companies that are part of the supply chain. As remembered by Mizruchi (1994), there are three areas that deserve special attention in social network analysis because of its theoretical relevance: 1) the effects on the agent's centrality; 2) the network subgroups identification and 3) the nature of relationships between organizations. Therefore, we consider these three relevant aspects in this analysis, specifically mentioning the LSP centrality (in the case of a 4PL) and the relationships between LSP and other firms. Thus, we were able to point out some propositions about the role of LSP in a given supply chain and the importance of its relationships to all other companies results,

following the concepts proposed by Borgatti & Li (2009), Lazzarini et al. (2001), Choi & Kim (2008) and Galaskiewicz (2011).

SUPPLY CHAIN MANAGEMENT AND SOCIAL NETWORK ANALYSIS

The SCM concept has gained academic prominence in the last years, especially because it brings the idea of integrated management of business process and information through the companies linked to the supply chain. Since the main goal of SCM is to reduce the total amount of resources needed to generate a desired level of customer service, it is clear that some level of coordination of activities and processes within and between organizations is necessary to achieve this objective (COOPER et al., 1997). In this sense, a collaborative supply chain is that one which two or more businesses (ties) work together to plan and execute supply operations, denoting interdependence.

The interdependence between companies has an important role in SCM, which is facilitate the achievement of the typical benefits of vertical integration (incorporation of procedures for the SC via a merger, acquisition or growth) without the burden of asset ownership (PIRES, 2009). In order to facilitate this integration between the ties and also improve the flow of materials, the SCM has a set of practices and initiatives, e.g., VMI (Vendor Managed Inventory), ESI (Early Supplier Involvement) and CPFR (Collaborative Planning, Forecasting, and Replenishment). Actually, one of the most important practices in SCM is the logistics services outsourcing, i.e., the transfer of logistic activities to another company that becomes responsible for the flow of products and information in the supply chain. The companies that choose to outsource its logistics services are able to change their focus to the core business, reduce the costs associated with logistics services and increase the service level to their clients (FIGUEIREDO et al., 2003). These benefits are achieved because the logistics service providers bring their know-how to the buyer environment and may perform even coordination activities in the client supply chain (BALLOU, 2001).

Looking further we will realize that supply chains are indeed networks and not just an aggregation of supplier and customer relationships (BORGATTI & LI, 2009; BROOKES & SINGH, 2008; CARTER et al., 2007; CHOI & KIM, 2008;

GALASKIEWICZ, 2011). They may extend across international borders and what happens in one part of the network affects what happens in other parts of the network exactly as the influence of the LSP, which could be able to change all the relations and improve (or decrease, if not successful) information flows through their acts. For this reason, is natural the application of social network analysis in order to better understand the nature of the relationships in a given supply configuration. The concept sees the actors as being interdependent rather than independent and relational ties between them could be used to represent transfer or flow of resources. Also, it understands the network structures as providing opportunities for or constraints on individual decisions and actions (CHOI & KIM, 2008). This means that the structure of the SC, i.e., where the actors are positioned, could bring benefits, constrains or challenges to all other companies. This idea represents the concept of embeddedness, that highlights the fact that an actor decisions and outcomes are affected not only by it acts and relations, but by the structure of the overall network of relations within which the actor is inside (GRANOVETTER, 1985; UZZI, 1997).

Even the network itself could be embedded in a larger institutional context, such as social, political, or economic and the concept of structural embeddedness, when applied to SCM, identifies that a supplier's results depends on how it environs itself with other companies. This concept of social structures complements the idea of chain structures reported by Cooper et al. (1997). Therefore, Borgatti & Li (2009) remember that is necessary to consider the relationships among actors (also called nodes) that are linked into chains that vary in length and may indirectly connect all actors with all others to fully understand the supply chain features. The sparseness of a network or the number of structural roles¹ that it contains helps us to understand the density of this structure. For example, in certain kinds of ties dense networks could spread redundant information between the actors, since all of them are linked and receives the same information. The opposite, sparse networks, could have better information because not all actors are linked (it has a structural hole) and this could avoid

¹ Burt (1995) defines structural holes as the separation between nonredundant contacts, i.e., a relationship of nonredundancy between two contacts meaning that they are connected by this structural hole.

redundant information to flow. But it is important to understand that these characteristics depend on the type of flow being analyzed.

Bringing this example to the SCM, when the information exchanged is about interactions from suppliers with focal firm, such as prices paid, more structural holes bring benefits to this focal firm. But when the information is about integrating the outputs from the actors, structural holes could be negative to firm goals (BORGATTI & LI, 2009). It is also important to notice that, in the context of the social network, the density of a supply chain represents a quantitative measure about its level of complexity. Highly dense models may indicate large numbers of multi-tier interactions, while sparse models indicate linear supply chains (BROOKES & SINGH, 2008). In sum, network analysis helps to understand members or a set of member's relative strength in a structure of exchange relations. Privileged positions in the network structure may result in access to resources, information, raw materials, among others. In this sense, the network analysis helps to explain how the competition set up between chains rather than between individual firms (ALVES FILHO et al., 2004).

However, the network analysis is not particularly concerned with vertical integration, but rather with horizontal relationships between firms, i.e., the relations that a company has with other firms in the same level of activity. In order to approximate the network theory with the SCM features, Lazzarini et al. (2001) propose consider simultaneously all types of interdependencies that occur in a given interorganizational relation. They called this view as netchain, a set of networks comprised of horizontal ties between firms within a particular industry or group, and linked vertically in a given supply chain. This way, the netchain analysis differentiates horizontal ties, the transactions in the same layer, and vertical ties, transactions between layers, being able to mapping how actors in each layer are related to each other and to agents in other layers. This proposition is particularly useful in this paper because the LSP acts between horizontal layers and most of the flow of products and information pass through them. The netchain approach allows for a more complete picture of a supply chain structure, since it consider simultaneously the existence of sequential and reciprocal interdependencies. It is important to realize that the most relevant aspect to qualify a given tie in a netchain is the nature of interdependence between agents,

because even vertical transactions that typically exhibit sequential interdependencies can also embody reciprocal elements (LAZZARINI et al., 2001).

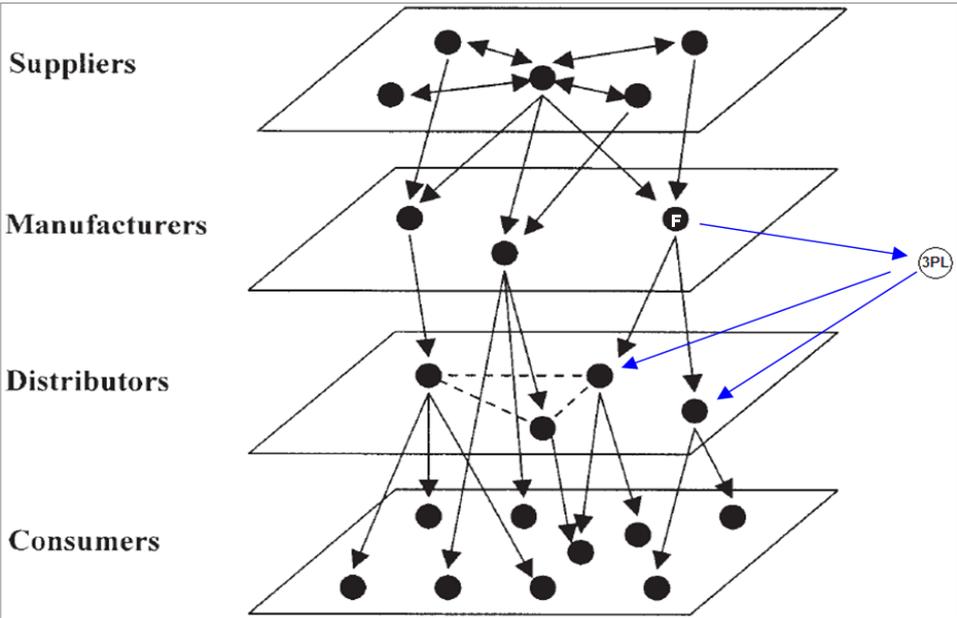
LOGISTIC SERVICE PROVIDERS AND ITS ROLE IN THE NETCHAIN

The LSP may be characterized as the company that conceives and implements logistics solutions for its customers, adding value to their products at all stages of the supply chain. These companies have great responsibility to minimize the supply chain risks, since they have the necessary expertise to perform delivery activities and usually have experience in management of logistic partnerships. Besides worrying about the logistics primary activities (transport and storage), the LSP should be focused on adding value to the customer's existing process whenever possible. Another important aspect about these firms is that most all information about supply and delivery activities passes through them (BALLOU, 2001). Since the correct flow of the information to all actors in the chain is one of the most important aspects to SCM success, it is clear why these companies have an important role in any given supply chain. The LSP companies may be divided in two kinds, related to the activities that it performs to the focal firm and the influence it has in the supply chain: Third-Party Logistics (3PL) or Fourth-Party Logistics (4PL).

1 THIRD-PARTY LOGISTICS (3PL) STRUCTURAL EMBEDDEDNESS

In a study aiming to discuss how the LSP change its relations in order to meet the market demands, Hertz & Alfredsson (2003) presents a segmentation model based in the level of adaptation and problem solving from these companies. In this research, the authors divide the LSP firms in four types: Services developer, Traditional LSP, Flexible LSP and Fourth-Party Logistics. The first three types are also identified as 3PLs and describe LSP companies that are concerned with basic logistics activities and could develop services to improve the supply chain, such as kit assembly, inventory, package and coordination services. It means that a 3PL is fully involved in the focal firm business and its role could combines physical services and management services. About its contacts in the

supply chain, a 3PL will have close relations with its contractor and the contractor clients. Even if some 3PLs could interact with suppliers of the focal firm or the final client, most of logistics outsourcing agreements defines the former scope as the actuation field for 3PL. Figure 1 exemplifies these relationships in the context of a netchain, i.e., shows a supply chain structure highlighting the 3PL actuation.



**Figure 1: Supply netchain highlighting the 3PL relationships
Based on Lazzarini et al. (2001)**

In Figure 1 we can identify that a 3PL firm receives the outputs from a focal firm (F), perform its activities and delivers its outputs to the clients of this focal firm. In other words, in this example the 3PL acts between the manufacturer horizontal layer and the distributor horizontal layer and can also be perceived as a new horizontal layer between them. Following the network analysis, we can presume that the relationships this firm has with others LSP could affect the role supply chain. This means that the structural embeddedness² of a 3PL can improve or complicate the vertical flows in the netchain and leads us to the first proposition about 3PL in a network analysis, which is in concordance with Choi & Kim (2008) study:

² Structural embeddedness refers to the state of company's dependence on its suppliers and customers in a supply network structure (CHOI & KIM, 2008).

Proposition 1: The quality and amount of the relationships that a 3PL has with other companies in the same layer of actuation could bring benefits to the supply chains that this firm is part of.

This proposition is considered a relational proposition that intend to discuss the strong or weak relationships, i.e., the amount of cooperation and integration between companies in SC (PIRES & SACOMANO NETO, 2010). If the 3PL is well connected in the market, has good and numerous relations with its pairs or is part of LSP associations, probably this company will be able to learn the best practices to improve its own business and, consequently, the role supply chain. The quality of the relationships (the strength of the tie) is important because is not always that a competitor will share its procedures and best practices to other companies. This will happen only when companies have an incentive for this, such as market development or association trades (PORTER, 1998). The quality mentioned, then, is related to the motivation to share information with other companies. In the opposite way, if a 3PL has not good relations with its pairs because is new in the business or because is geographically isolated, the supply chain that this 3PL is part could not achieve the best possible results. It is true also that the relationships that this 3PL has with other focal firms can lead to the same aspects cited above. If a company is part of other supply chains (providing services to others focal firms), this will enable more background to improve the supply chains result and its own interactions. But this aspect is not the main focus of this paper and could serves as a natural development of the presented research.

In figure 1 we can note also that the 3PL has few connections with other firms in the vertical layers. When this happen and also the 3PL has few connections with others in the same layer of actuation, we can identify a structural hole. The netchain is considered sparse and leads us to the second preposition:

Proposition 2: When a 3PL has few connections with other companies in its same layer of actuation and in the vertical layers, the supply chains that this firm is part of probably will not be integrated as good as possible.

This second proposition could be understand as a structural proposition since it focuses in the density of the netchain (PIRES & SACOMANO NETO, 2010). As noted by Borgatti & Li (2009), the sparseness caused by fewer 3PL relationships will bring benefits to the netchain especially because redundant

information will not be spread through the actors in the tiers. If all actors are connected, then the information that one possesses may also be possessed by others, which could suggest that a tie between them is redundant and unnecessary. Thus, a network with fewer ties among actors probably will deal with more non-redundant information. However, since the supply chain performance depends on the best possible actions of each company that is part of it, this case will likely lead to negative outcomes because the firms must integrate their outputs and each of them depends on the actions of the others. In this case, the density of the network is important to achieve supply chain goals and the structural hole identified could mean poor results (BORGATTI & LI, 2009). It is important to notice also that the model studied here would demonstrate a linear supply chain, with low complexity and where the 3PL has a more discrete role (BROOKES & SINGH, 2008). Therefore, even when performing management activities, the 3PL that is not doing its activities in the best way possible is not indispensable, i.e., the company could be replaced with few impacts to the other companies in the supply chain (PIRES, 2009). Thus, it is important to the whole supply chain that a focal firm knows and understands its 3PL relationships in the market, in order to achieve the best possible results and change it if necessary.

2 FOURTH-PARTY LOGISTICS (4PL) AND BETWEENNESS CENTRALITY

The main difference between a 3PL and a 4PL is the change in focus. A 3PL is basically responsible for logistics operations, while the 4PL does this service and the development, implementation and maintenance of logistics projects for a given supply chain. A 4PL can contract and evaluate 3PL and other service providers and it performs huge management services such as financial services, payments, insurance and activities for end customers (STEFANSON, 2005). Chapman et al. (2003) argue that a 4PL is a redesigning of 3PL structures and relationships that enables the creation of a knowledge chain that facilitates and improves data, information and communication, as well as coordination, decision making and planning. These companies should synchronize activities between the agents of the supply chain, building strong relationships amongst the participants and developing the flexibility to deal with supply and

demand uncertainties (WIN, 2008). Through these definitions we can realize how important is the role of a 4PL in the chain and also we can verify that the most important activity that the company performs is the integration between the actors.

So, the relationships that a 4PL has with other members in the chain are the most valuable resource that this company has to be able to add value to the whole supply chain. Figure 2 exemplifies some of these relationships in the context of a netchain, following the given example for 3PLs.

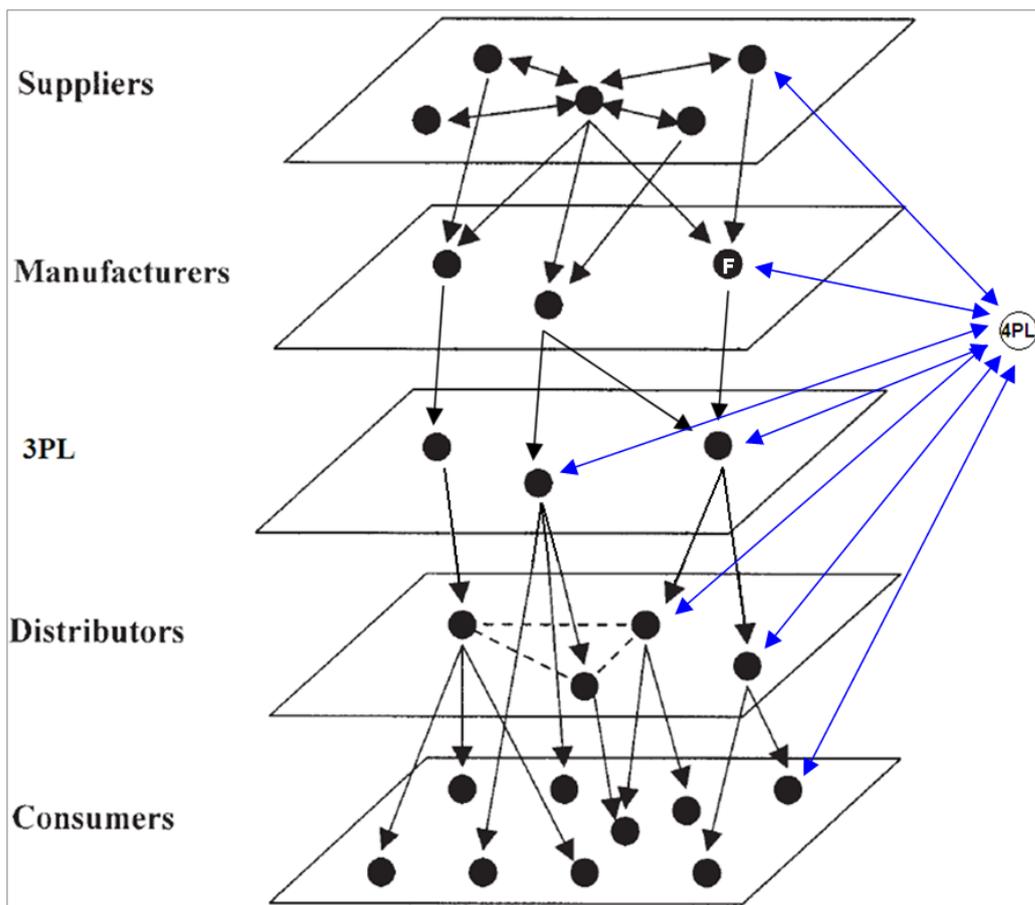


Figure 2: Supply netchain highlighting the 4PL relationships
Based on Lazzarini et al. (2001)

The 4PL needs to maintain strong relationships with almost all actors in the chain, serving as a hub to all participants. This means that almost all information and flows will pass through a 4PL as demonstrated in Figure 2. The firm can even achieve the end customer being responsible for the information interface between the client and the focal firm or through delivery services. Notice also that the 3PL firms are represented as a new layer, as mentioned earlier, and that the 4PL will

interact with these companies too, hiring them and managing their services. Therefore, a 4PL will interact with all layers in a netchain since it gives and receives (represented for double arrows) outputs from all actors, meaning that the 4PL has short paths with them because all actors need to interact with it even interacting with other firms in the chain. The first two propositions made in this paper about 3PL are also possible to be true with 4PL, since this company can perform some of the activities of a 3PL. But due to the other responsibilities and activities that this kind of firm has, we can propose other development to them based on social network theory and that can be perceived as structural propositions according to Pires & Sacomano Neto (2010):

Proposition 3: A 4PL company has a huge level of betweenness centrality in a supply chain that it is part of and, because of that, its integration level will affect the results of the whole supply chain.

Differently from a 3PL, that can be changed without big impact, the SC that has a 4PL interacting with all actors will strongly depend on this firm, meaning that the 4PL integration level will define the supply chain results. This is because, as noted by Borgatti & Li (2009), when we have short paths, nodes (in this case the 4PL) that lie along many short paths are structurally important nodes that are well positioned to (1) control and possibly filter information flows and (2) become bottlenecks that slow the network down. This is a type of centrality of an actor that social theory describes as betweenness, i.e., a node has high betweenness when it lies along many shortest paths between pairs of others. Thus, this node controls the short paths between all pairs of others or there are no other equally short paths that bypass this node (FREEMAN, 1979). Applying the concept to the SCM theory, given a netchain a company will have high betweenness when all of the shortest chains from suppliers to end consumers pass through that firm. These firms are structurally important to the supply chain and can be considered as key players that need to be healthy for the rest of the network to be healthy, including the focal firm (BORGATTI & LI, 2009). Therefore, a 4PL is highly embedded in the supply chain, almost all the actors will interact with it and its betweenness centrality highlights its importance to the success of the supply chain.

It is certain that the most important and strong relation that a 4PL has in the network will be with the focal firm, since it is this company that hired the 4PL to improve its chain. This perception leads us to the last proposition about 4PL:

Proposition 4: The relationship between the 4PL firm and the focal firm represents a huge level of edge betweenness and, for this reason, must be well-configured in order that all other firms in the chain are able to achieve good results.

The concept of edge betweenness refers to the betweenness of a tie rather than the betweenness of a node and measures the value of a tie to the general shortness of paths throughout the network. In the SC context, edge betweenness represents a very important supplier-buyer relationship. If one removes high betweenness ties from a network it will do more damage to the transmission capabilities of the network than does removing low betweenness ties (BORGATTI & LI, 2009). This is the case of the relationship between the focal firm and the 4PL as noted by Simatupang & Sridharan (2002) that argue that a collaborative SC needs that the companies work together in a high level of integration. In order to achieve this level of collaboration is extremely necessary trust between the parties and a relationship of partnership designed to achieve the common goals of SC. For a focal firm that hires a 4PL to redesign its SC and let this firm be the manager for SCM strategies, this relationship must rely more than in a contract but in a partnership relationship that shares the advantages and challenges of SCM. For this reason, the two parts must make sure that all duties and responsibilities are well known and must have a strong engine to share information in a quick and efficient way (PIRES, 2009). The relationship between the focal firm and the 4PL represents a strong tie in the sense of providing access to valuable resources that in this case are the benefits arising from 4PL know-how and relationships.

Lastly we can identify that, differently than a 3PL, the relationships that a 4PL has in the network denote a dense network with few structural holes. As discussed earlier, this feature will denote that the SC demonstrated in Figure 2 will likely to have more redundant information flowing between the actors. Although it can be considered as a way to decrease the SC performance and also that it can denote that some of the ties are unnecessary, we understand that this is not the case. As noted by Borgatti & Li (2009) the SC needs that some redundant information flows through the actors because if the information in question is, for

example, manufacturing knowledge, sharing may lead to syntheses the result in a larger pool of knowledge that all the actors can handle and take advantage of. Therefore, in SCM case there is a different view on the value of structural holes.

DISCUSSION

The Supply Chain Management concept enables that companies meet its customer requirements in a quick and less expansive way. It integrates a set of companies through a common goal, aiming to improve the necessary processes that transforms raw material in end products. But the concept has yet great possibilities for development, especially when integrating the social network analysis in its researches. The network analysis enables the understanding of the relationships and structures of the companies that are part of a SC and how its position in the chain could influence the operation of all others firms. It means that the network structure, i.e., the interpersonal relationships and individual positions occupied by companies in a network influences individual or collective behavior and results (LAZZARINI et al., 2001).

In this paper we analyzed specifically the role of LSP firms in the netchain context and discuss some relational and structural propositions based in three areas from social network analysis: 1) the effects on the agent's centrality; 2) the network subgroups identification and 3) the nature of relationships between organizations (MIZRUCHI, 1994). The LSP companies are important because it develop and implement a set of logistics solutions for its customers, passing from physical services to reconfiguration processes and adding value to products in all stages of the SC. This way, these companies are divided into Third-Party Logistics (3PL) or Fourth-Party Logistics (4PL) based in its level of adaptation and problem solving (HERTZ & ALFREDSSON, 2003). About 3PL we propose that the relationships that this company has with other companies could bring benefits to the whole supply chain. This view is in concordance with Choi & Kim (2008) studies that proposes that the focal firm must understand a supplier's relationships in order to establish supplier management policies regarding that supplier. The authors defends that this occurs because the relationships that a supplier has with other companies could improve or decrease the results of the other companies in

the chain. Following this analysis, we propose that if a 3PL has few connections in the network, the SC that this firm is part of will decrease its integration level. The few relationships that this firm has represent a structural hole in the network (greater sparseness) and even the network literature defending that this could be better to the actors, we understand that this is not the case for the supply chain. Although redundant information is not being spread because of this structural hole, in the network this could be negative since these data will not consolidate processes and common understandings.

Looking for 4PL companies, we believe that the propositions made to 3PL firms are also true to them, but since this firm has a complementary and more relevant role to the SC it is necessary to add some propositions. This way, we theorize that a 4PL company has a huge level of betweenness centrality and its integration level will define the SC results. The betweenness centrality indicates the distance between tiers of interaction and its measure means that this node has a high level of interaction and those interactions are with very close tiers of the supply chain. This shows a risky situation because there will be minimal lag along the particular supply chain paths to counteract the effects of any disruption at the actor node (BROOKES & SINGH, 2008). Therefore, because of its interactions with almost all layers and its relevant activities, when a 4PL is not performing in the best way possible this could bring problems to the SC. Since the most important relationship that a 4PL has in the supply chain is with the focal firm, we can theorize also that this relation represents a great level of edge betweenness and it must be as best as possible to the healthy of the SC. The edge betweenness concept refers to the betweenness of a tie rather than the betweenness of an actor.

It is important to realize that different networks can have very different structures, and may have different logics and implications for the actors (BORGATTI & LI, 2009). While the network structure that has only a 3PL is considered sparse, the network structure that has a 4PL as one of the actors is considered dense. As we have discussed earlier, the dense network is better for SCM purposes. In this sense, Uzzi (1997) pointed out that a smart network strategy is to have a collection of both strong and weak ties because the strong ties are firms you can count on and the weak ties give access to new ideas and

alternatives. This is why a SC with a 4PL has probably more advantages than a SC with only 3PL acting, as demonstrated in this paper. We have here outlined some propositions that demonstrate the LSP importance for SCM strategies based in network analysis. It is true that these propositions require now empirical investigation to verify their utility to SCM researchers, but we believe they serve as good start point to deeply understand the LSP role in the supply chain.

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