
SOCIAL NETWORK ANALYSIS IN THE SUPPLY CHAIN OF A FRAMING COMPANY

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ABSTRACT

Organizations, in search of better operational performance and competitive advantage, have sought alternatives for identifying problems and opportunities for improvement in the context of supply chain management. In this context, Social Network Analysis, in conjunction with Graph Theory, emerges as one of the tools used for this purpose. Therefore, this article seeks to analyze the effects of relational and structural immersion in the logistics performance of an aluminum framing company from a case study. To obtain data and information, semi-structured interviews were conducted with the manager responsible for the purchasing sector. The results show that some suppliers have considerable influence on the supply chain, whether positive or negative. It can be positive, bringing the consolidation of partnerships between companies with a strong and reliable relationship and negative, for example, when the product suffers breakdowns or delays in the process. We also highlight the need for the company to establish logistics performance indicators in a better way to quantitatively assess the impacts of the chain on operational activities in order to assist in more assertive strategic decision-making.

Keywords: Social network analysis; Supply chain; Operational performance.

INTRODUCTION

Supply chain management is essential for all companies, as it is essential for achieving their goals and good competitive performance. Factors related to the cost of purchasing, storing, moving, and distributing materials account for a large portion of the cost of the product or service. The supply chain is broadly defined as a network generally composed of suppliers, producers, distributors, retailers, and wholesalers that is organized to produce and distribute the products involved in the chain in the correct quantity, in the right place, at the right time, and in the shortest possible time to reduce the costs added by the actors in the chain (Wagner and Netshat, 2010).

Colicchia and Strozzi (2012) define that the operational risks, the uncertainties of the business environment, and the supply network complexity in a supply chain increase the chances of loss in the company's performance. In turn, Hendricks *et al.* (2009) state that effective supply chain management is necessary to minimize the risks caused by the relationships between the actors, reducing the negative impact on performance and improving the stabilization of the chain.

In this context, studies concerning supply chain operations are fundamental, especially considering the analysis of the structure that makes up the supply chain as a network (Kim *et al.*, 2011). The relationship networks influence individual actors and organizations in how they are managed, developed, and sustained. Another indication of their influence is the way companies are starting to be analyzed, not only from an individual perspective but also from a more systemic viewpoint (Nelson, 2001; Silva and Heber, 2013).

One of the main tools for analyzing a supply chain is the Social Network Analysis (SNA) technique, through which some metrics can be assessed, verifying the performance, importance, and how these actors' behaviors influence the supply network (Kim *et al.*, 2011; Fortunato, 2010).

The SNA, along with the concepts of Graph Theory, enables identifying the relationships between the individuals that comprise the network, the way they are linked together, the types of connection, the flow of information, and the formation of other groups within the network itself. In supply chain management, one can highlight the presence of a network in which the vertices are companies that may be suppliers, producers, or even customers, while the edges configure the relationships between them, such as the exchange of supplies or finished products and information (Kim *et al.*, 2011).

Several studies can be found in the literature on how social relations affect organizations' economic actions. For example, in the study by Borgatti and Foster (2003), the idea of a much broader social context in the relationships between companies is addressed and has thus become a recurring study object for researchers. Uzzi (1996) has studied a range of objects through empirical research, especially survival in business, while Simsek *et al.* (2003) applied the tool regarding business behavior. Batenburg *et al.* (2003), in turn, applied it to the social identity of companies.

According to Zukin and Dimaggio (1990), two types of immersion in network studies stand out: relational and structural. The first is a vision of cohesion in the network and highlights the strength of the organization's immediate ties in the transfer of relevant information in the business process, enhancing the role of trust between both organizations (Gobbo, 2010). Differently, structural immersion is related to a positional view, i.e., it goes beyond the strength of the ties between organizations, considering how the company's structural position in the network allows it to have access to the most valuable information flow in the chain (Gulati, 2007; Sacomano and Truzzi, 2009).

This paper refers to a study at an aluminum framing company, a segment that presents a significant panorama in the country, especially in civil construction. The aluminum used in Brazil had an initial milestone of significant growth in the 1950s, especially in cities where it began to be produced on an industrial scale, such as Ouro Preto and Minas Gerais. Given the whole context of aluminum used in civil construction, replacing the systems most used until then, such as steel and wood frames, the country's production in the early 1980s began to exceed domestic consumption, becoming an exporter (De Farias Nunes *et al.*, 2018).

According to the Brazilian Aluminum Association (ABAL), Brazil is among the world's leading producers of primary aluminum. Lightness, together with strength and durability, contributes to aluminum's use in the production of frames, which are fundamental in the civil construction sector (Machado *et al.*, 2020).

Given the aforementioned, it is proposed that the logistical performance of the company under analysis is affected by the relationship with suppliers and customers. Thus, the goal is to analyze the effects of relational and structural immersion in the logistical performance in which it finds itself, through supply network analysis. To this end, the focal company of the case study is an aluminum framing company, while the other players compr-

sing the supply network are the first-tier suppliers, some of the second-tier, and the customers.

This study contributes not only in terms of interpretative content in inter-organizational analyses regarding relational and structural immersion but also in the internal relationship of the company in terms of impacts on logistics and financial performance from the emergence of operational performance problems arising from the supply chain relationship.

The article is structured into five sections, besides this first introductory section. The second section consists of the theoretical framework whose theoretical-empirical relationship is presented. In the third section, the methodological procedures adopted are exposed, followed by the results found and their discussion. Finally, section four presents the final considerations of the work.

THEORETICAL FRAMEWORK

Social Network Analysis in Supply Chains

A social network consists of points called vertices or actors that may be connected by lines called edges that signify some relationship between the connected vertices. Such vertices can be organizations, people, companies, or any element that is being observed from a network. The edges refer to the connection type between the vertices, which can be by affinity, information sharing, supplies, and documents (Wasserman and Faust, 1994).

In recent decades, there has been a growth in the use of Social Network Analysis and graph theory in representing and extracting information from different system networks (Fortunato, 2010). Recent studies involve the use of SNA and graph theory in enterprise supply chain management (Wagner and Netshat, 2010; Kim *et al.*, 2011).

According to Wagner and Netshat (2010), network modeling enables measuring actors' vulnerability within a supply chain. However, the authors point out that although there is a growth of empirical support, managers still need to be prepared to calculate and analyze chain indicators as a whole rather than just looking from the individual company's perspective.

Social network analysis has been widely employed in several areas by researchers. Van der Aalst and Song (2004) developed studies on business processes, where process analysis was improved from mining social networks. However, several researchers have advanced the application of SNA concepts in supply chain management

and logistics (Borgatti and Li, 2009; Ketchen and Hult, 2007).

The relationship between buyers and suppliers observed from the standpoint of a chain constitution can be relevant since, given the complexity of the network in which the company is inserted, some of the company's strategic or behavioral actions can be taken. Thus, through the interactions between buyers and suppliers, it is possible to verify the power of influence and significance of a given company in the network and its impact on material supply (Cox *et al.*, 2001; Choi and Kim, 2008).

Therefore, according to Carter *et al.* (2007), the analysis of the relationships between the players that make up the supply network can provide relevant information that would not be obtained through conventional research. Thus, the SNA is an essential tool that enables the visualization of obscure points that may be relevant to the strategic and operational actions of the company.

Positional immersion

Embeddedness refers, in essence, to an approach in which dyadic and economic relations are not considered in isolation (Baker, 1990). Embeddedness expresses the idea that social relations influence the decision-making processes of the actors within the network, adhering to aspects concerning trust and different exchanges as conditioning factors (Granovetter, 1985; Uzzi and Gillespie, 1999). According to Kim (2014), the context of immersion in supply chains is based on the company's relationship with the other actors that make up the network and how it is influenced. Thus, immersion characterizes the state of dependence of the company on its suppliers and customers (Choi and Kim, 2008).

Several types of immersion can be found in the literature, such as that of Hess (2004), who addresses social, network, and territorial immersions. Meanwhile, Lechner *et al.* (2010) portray networks based on structural, relational, and cognitive immersions, while Zukin and DiMaggio (1990) consider structural and relational immersions.

Structural immersion

According to Choi and Kim (2008), the discussion about structural immersion has existed for some time, mainly in the fields of sociology, economics, and organization theory. Structural immersion goes beyond not only the sense of analyzing the immediate ties of organizations but also the importance of the informational or material flow provided by the structural position found in the net-

work (Burt, 1992). Therefore, depending on the structure of the network of relationships, it can positively or negatively affect the performance of an organization, i.e., different effects can occur due to the configuration of the relationships among the other actors in the network (Choi and Kim, 2008).

Several structural measures can be considered for analysis, such as centrality, density, cohesion, and size. The centrality measures developed by Freeman (1979) are the best known: the centrality of degree, closeness centrality, and intermediation centrality. The measure centrality of degree refers to the number of ties of a given actor with other network constituents. This indicator identifies how well the company is connected to others, characterizing access to information and resources from various sources (Abbasi *et al.*, 2012).

The centrality of proximity consists of easy access to information and communication control. It is based on a given actor's ability to independently access the other actors in the network without the need for intermediation. Therefore, an actor with low centrality of proximity is strongly dependent on other agents in the network to access the flow of information or resources. On the other hand, a vertex with a high degree of proximity can access the flow of information more quickly and share it more efficiently through the network (Abbasi *et al.*, 2012).

Regarding intermediation centrality, other actors intermediate access to information and resources, as it considers the number of times a vertex passes through geodesic paths between pairs of other points. Therefore, when a given actor mediates the relationship between two points occupying a central position, it can affect the network through the distortion of information between the actors (Freeman, 1979).

Another measure considered in social network analysis is network density, which is treated as the number of connections between network members and is a dimensionless value. According to Wasserman and Faust (1994), network density can be estimated from **Equation 1**.

$$D = \frac{2T}{n(n-1)}$$

Where:

network density [D]

number of ties the network has [T]

number of vertices [n]

Relational immersion

Relational immersion starts by combining characteristics such as time, intensity, and frequency. Although these concepts were originally developed for personal relationship studies, they are fully adaptable to the business context (Stanko *et al.*, 2007).

According to Tiwana (2008), relational immersion refers to the strength of ties. The relational ties between actors define the frequency degree that an organization shares knowledge, resources, or information (Gulatti, 1998; Choi and Kim, 2008). Thus, a weak-intensity tie is characterized by a low interaction frequency or relationship importance between actors, while actors who exchange valuable resources, knowledge, and information have more powerful tie strength between them (Khoja *et al.*, 2010; Simsek *et al.*, 2011).

It is important to highlight that tie strength or cohesion is a property of relational immersion, directly related to density since density is a variable of the overall structural immersion of the network, and cohesion is a property between two actors in the network, with cohesion being essential for the higher density of a network. In this sense, they should be treated simultaneously since the strength of the relationship (strong or weak) depends on the network structure, which can be classified as dense or diffuse (Rowley *et al.*, 2000).

McEvily and Tortoriello (2011) affirm that trust significantly weighs in the buyer-supplier relationship. Therefore, it is based on the strength of the tie between agents. Thus, cohesion, that is, the relational strength of ties, is one way to analyze relational immersion (Capioto *et al.*, 2019).

RESEARCH METHOD

The article presents a case study of a supply chain of aluminum frames, contextualizing the entire chain and its environment, aiming to understand the chain and the relationships between its links, and analyzing the relationships and behavior of the chain. It is characterized as a case study because it has an empirical nature that investigates a phenomenon in its actual context and environment and includes benefits such as increasing understanding of real and contemporary events and developing new theories (Miguel and Souza, 2012).

Data collection was carried out using an interview structured from a fixed list of questions, which functions similarly to a script. The interview was conducted with the company's manager, who mainly follows up on the

purchasing and production planning and control (PPC) processes. During the interview, the manager’s answers and observations were written down. There were two formal interviews: the first aimed to contextualize the aluminum frame supply chain, and the second sought to deepen the relationship between the company and the chain. Both interviews concerned suppliers and customers.

During the interviews, the focal company rated the importance of the items, especially the commercial partnership relationship with the suppliers. Thus, first-tier suppliers were evaluated on a scale of 1 to 3 based on their interaction with the company. Scale 1 represents a low interaction level, characterizing a strictly commercial relationship. Scale 2 characterizes a moderate interaction, meaning that there is better communication and trust, in some cases characterized by a partnership between the focal company and the supplier. Scale 3 represents the strongest relationship, in which there is a cooperative relationship between company and supplier, and there may even be the development of new products.

According to the matrix proposed by Kraljic (1983), weights of 1, 2, and 3 were established for the companies supplying products or services considered leverageable items, bottleneck items, and non-critical, strategic items, respectively. **Chart 1** shows the matrix used to define the weights and subsequent classification.

Table 1 presents the company’s response on the classification of each supplied item and its degree of interaction of the company and suppliers.

Table 1. Supplier classification

Supplier	Item classification	Interaction
S1	Strategic Items	3 – High
S2	Leverageable Items	1 – Low
S3	Leverageable Items	1 – Low
S4	Non-critical items	2 – Moderate
S5	Bottleneck items	2 – Moderate
S6	Leverageable Items	1 – Low
S7	Non-critical items	1 – Low
S8	Non-critical items	1 – Low
S9	Leverageable Items	1 – Low

Source: Prepared by the authors (2020)

Also, during the interviews, the focal company classified the customers into five sales regions. The sales target for these regions is based on the company’s planning. The regions’ customers were classified on a scale of 1 to 3, from low to high importance, respectively. High-importance customers were those representing sales of more than 25%. The regions with moderately important customers represent 15% to 25% of revenue. Customers of low importance are those impacting less than 15% of sales.

Table 2 presents the company’s answer about the classification of each customer and its billing.

	Low Purchasing Volume	High Purchasing Volume
Great opportunity and high risk	Bottleneck items	Strategic items
	difficult substitution	strategically important
	monopolized markets	difficult substitution
	high entry barriers	lack of alternative suppliers
	critical geographical or political situation	important in the overall context of company purchasing
Low opportunity and low risk	Non-critical items	Leverageable Items
	proper availability	proper availability
	standardized specification	availability of alternative suppliers
	possible replacement	standard pricing
		possible substitution

Chart 1. Kraljic Matrix

Source: Elaborated from Kraljic (1983)

Table 2. Customer classification

Customer	Billing	Importance
C1	Above 25%	3 – High
C2	Above 25%	3 – High
C3	15% to 25%	2 – Moderate
C4	Below 15%	1 – Low
C5	Below 15%	1 – Low

Source: Prepared by the authors (2020)

In the study, the aluminum frame supply chain was drawn using the results obtained from the structured interviews with the aid of the Gephi 0.9.2 software, in which the chain indicators that are discussed later (structural and relational immersion) were also generated. Furthermore, it is emphasized that for this study, the graph is non-directed since the informational relations between the players are a set of data exchanges between pairs of edges representing the companies.

Supply chain characterization

The players that make up the supply network analyzed consist of nine first-tier suppliers, that is, those who are immediately linked to the focal company and whose relationships consist of information exchange and the flow of materials needed for the manufacture and assembly of aluminum frames.

Supplier S1 is from the aluminum industry, and its main product is aluminum profiles for the civil industry. Supplier 2 is from the plastic industry and supplies the company with plastic resin. S3 is a mold company that services the focal company with plastic resins. S4 is a company that supplies sealing products used in the final product. S5 is a hardware company that supplies finishing hardware to the focal company. S6 is an exporter and importer of fasteners, mainly screws and nuts. Supplier S7 is in the civil construction sector and supplies rubber trim and sealing. Supplier S8 is a carrier that provides services for the focal company. Finally, S9 provides painting services for the focal company.

Suppliers S2 and S3 have an interesting business relationship with the focal company. This is because supplier S2 provides the plastic resin as a raw material that is purchased by the focal company and delivered to S3. S3 is considered a service provider for the focal company because it also performs the transformation of the plastic resin, which is later sent to the focal company as raw material for its production.

Suppliers S8 and S9 have a joint relationship with the focal company. Supplier S8 is a carrier that does the transportation between the focal company and S9. Company S9 does the painting for the focal company and then returns the product through S8. S8 is contracted by the focal company and is only responsible for transportation. Company S9 has a trust relationship with the focal company because, although there are other options with a similar service and price in the market, the focal company prefers to keep S9 as a supplier to maintain the quality and standard of the product.

The network has three third-tier suppliers. T1 and T2 are raw material suppliers and supply aluminum to supplier S1. The focal company is also considered S1's supplier because the leftovers of the production process from the use of aluminum profiles go back to S1. T3 manufactures fasteners and has a relationship with S6, which buys the fasteners, bolts, and nuts from the company for import and export.

The network also includes a reseller (R), who sells all over Brazil and transfers the orders to the factory. Such communication is essential since the product's production is tailored to the customers' needs, i.e., according to the orders placed by customers to the reseller, who passes them on to the focal company. The customers are C1, C2, C3, C4, and C5, considering the division made by the customers' company in terms of sales per region in Brazil. **Figure 1** shows the network of the company studied.

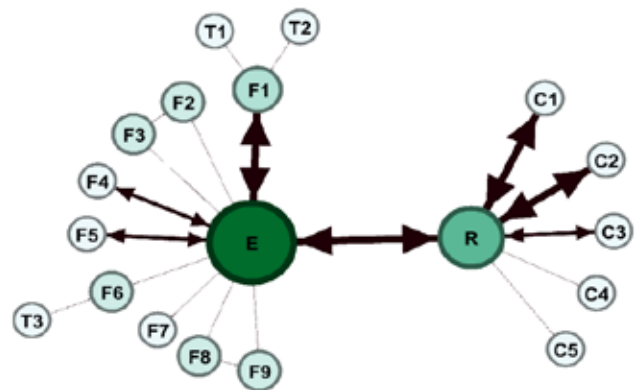


Figure 1. Supply network
 Source: Prepared by the authors (2020)

$$D = \frac{2 * 20}{19(19 - 1)} = 0,117$$

Where:

Second-tier suppliers [T];
First-tier suppliers [F];
Focal company [E];
Reseller [R];
Customers [C].

The graph was assembled based on the collected table, with the edges indicating the weight of the relations and the diameter of the node being proportional to the degree of centrality. The thickness of the edges refers to the degrees attributed to each relationship. That is, the greater the thickness, the stronger the relationship between the actors involved, and this relationship is characterized by the cohesion degree that varies from 1 to 3.

RESULTS AND DISCUSSION

This section describes the results obtained from the case study, explaining the analysis of the supplier network mapping and the relationship between structural and relational immersion with the logistics problems identified.

Structural and relational immersion

By filling in a relationship matrix and then using the software Gephi 0.9.2, besides generating the network visually, it is also possible to obtain some indicators that can help to analyze the previously mapped network. **Table 3** presents the values obtained for the selected indicators.

Considering the degree centrality indicator, the focal company E, or hub, is better positioned in the chain (0.250) than the other actors. Moreover, the retailer R comes next as being a high degree centrality actor with 0.150. This means that both of them have a more substantial number of nodes connected to them and thus have notable importance in the network for the flow of resources and information.

Regarding the intermediation centrality, the E R nodes have a higher value. Therefore, these nodes mediate the exchanges performed in the network between the actors involved. Regarding proximity centrality, it is observed that the focal company and the reseller present the smallest distances compared to the other nodes of the network, both being essential for the execution of the activities performed by the supply chain actors.

The eigenvector centrality shows the influence of a node in the network. According to the results, the focal company E has full influence in the network as a whole,

followed by the dealer R with a moderate influence, and then the suppliers S2, S3, S8, and S9.

The clustering indicator refers to the actor's ability to form partnerships with another actor in the network. According to the results, the pair of suppliers (S2 and S3) and (S8 and S9) have a relationship that can be beneficial to establishing more consistent partnerships and can enhance both their power in the network.

Another indicator, which is of fundamental analysis, is the supply chain density. The calculation can be obtained according to **Equation 1**.

It can be observed that the network density value is relatively low. This is due to the low connection of the ties between the agents since the actors have mostly a single relationship with the other agents in the chain, given the various possibilities of interaction, which can strongly influence the chain in terms of the flow of information and resources.

As for relational immersion, some studies conceptualize it from some particular viewpoints, mainly the direct bond and the strength of interaction and cohesion (Kim, 2014). In this perspective, the focal company presents a good direct bond with its suppliers and with trust, mainly in terms of service standardization and quality assurance, always focusing on maintaining the quality standard for the final customer.

The company works with 2-year contracts, and according to the interviews, there have been no cases of supplier replacement in the last three years, which shows a good bond, stability, and trust in the relationship between the company and suppliers.

Interaction strength varies slightly depending on the supplier's product type and the relationship between the company and the supplier. Supplier S1 has the highest interaction strength because it supplies its principal raw material, aluminum profiles, which is the most strategic product for the company. Contact between the company and the S1 supplier is inevitable since any problem with the supplier can impact the production and quality of the final product.

Suppliers S4 and S5 have a relationship considered moderate because the company does not consider their items to be strategic. However, it considers its relationship with these suppliers strong and without problems on both sides. The other suppliers had low cohesive strength because, besides having fewer strategic items, their bonds were not considered strong.

Table 3. Indicator results

Name	Proximity Centrality	Intermedia-tion Centrality	Degree Cen-trality (un)	Degree Cen-trality	Own Vector Centrality	Weighted Degree	Clustering
S1	0.462	0.128	6	0.075	0.343	10	0.000
S2	0.429	0.000	4	0.050	0.387	4	1.000
S3	0.429	0.000	4	0.050	0.387	4	1.000
S4	0.419	0.000	2	0.025	0.280	4	0.000
S5	0.419	0.000	2	0.025	0.280	4	0.000
S6	0.439	0.066	4	0.050	0.308	4	0.000
S7	0.419	0.000	2	0.025	0.280	2	0.000
S8	0.429	0.000	4	0.050	0.387	4	1.000
S9	0.429	0.000	4	0.050	0.387	4	1.000
T1	0.321	0.000	2	0.025	0.100	2	0.000
T2	0.321	0.000	2	0.025	0.100	2	0.000
T3	0.310	0.000	2	0.025	0.088	2	0.000
E	0.692	0.514	20	0.250	1.000	32	0.044
R	0.545	0.292	12	0.150	0.510	26	0.000
C1	0.360	0.000	2	0.025	0.150	6	0.000
C2	0.360	0.000	2	0.025	0.150	6	0.000
C3	0.360	0.000	2	0.025	0.150	4	0.000
C4	0.360	0.000	2	0.025	0.150	2	0.000
C5	0.360	0.000	2	0.025	0.150	2	0.000

Source: Prepared by the authors (2020)

Cohesion can be related to the intensity, frequency/interaction, and duration of the relationship. In this case, cohesion is linked to the strength of interaction because it encompasses the intensity of the relationship between the focal company and the suppliers. Thus, S1 is the supplier with the highest cohesion, followed by S4 and S5. The degree of cohesion between the company and suppliers S2, S3, S6, S7, S8, and S9 is deemed low by the company.

Considering that there were no changes to suppliers in the last three years, the interaction between the company and suppliers was considered good in their evaluation. Cohesion is based on the intensity of the relationship between actors, which thus considers the intensity, frequency, and type of product or service supplied.

Supply chain effects

According to the interviews with the manager, the main supplier, S1, is located geographically close to the focal company. Therefore, there are no problems regar-

ding the delay in receiving the aluminum profile since, from the moment the product is requested from the supplier, the product is received by the company within 24 hours, ready to be used. Thus, the significant trust of the focal company in the S1, represented by the greatest bond strength or cohesion, stands out, as it can be seen in the supplier network, especially since it is the base input for the frames.

One of the problems highlighted regards the shipping of products from the focal company to customers, corresponding to the states of São Paulo and Rio de Janeiro, due to state regulations that prevent trucks from circulating during business hours, causing delivery delays for customers. In addition, there are operational problems in which the customer refuses to receive the product outside the predetermined hours, causing dissatisfaction on the part of customer C5. Another problem is the material damage with the carrier F8 because it often delivers products painted with scratches or dents, thus making it impossible to use the material.

Although price is also considered, the establishment of partnerships is based essentially on product quality, and the relationship is established through supply contracts. Moreover, the contracts are commonly renewed since there are no problems regarding the quality of the products. Therefore, there is no constant change of suppliers, and consequently, a relationship of trust is developed.

Some implications must be considered in the context presented. According to Rossoni *et al.* (2014), high trust will not always result in performance gains for the focal company, which means that it is necessary to jointly consider the mechanisms of relational and structural immersion so that one enhances the other.

The problem with supplier F8 corroborates the effects cited by Uzzi (1996), in which there is a significant increase in problems related to third parties, leading to higher costs.

As the focal company does not have practices to measure logistics performance, a group of logistics indicators is necessary to allow monitoring of the performance achieved to establish goals that help achieve better operational performance and identify how the relationship with the other actors in the supply chain has impacted the results. Therefore, since this is not the scope of this work, the development and proposition of the evaluation indicators and their assessment after adopting these indicators can be developed in future research using this study as a starting point.

FINAL CONSIDERATIONS

As has been pointed out, the complexity of supply chains can contribute to the operational and logistical performance of companies. This fact suggests the need for a greater understanding of managers so better decisions can be made. Social network analysis applied to the business environment can be an essential tool to support the establishment of strategies and actions that allow more substantial competitive performance.

The practical implications of this study reinforce the insights about the use of social network analysis to study the impact of the supply chain on business performance. This assessment provides significant findings at the inter-organizational levels and how such relationships can impact positively or negatively on the organization.

The results of the measurement and analysis of the indicators suggest the need for the focal company to properly determine the key operational performance indicators to identify strategic and operational actions that

can best provide competitive gain. Thus, in future studies, we will highlight the proposition of logistics performance indicators and the subsequent evaluation of the results obtained with a new supply chain analysis and the way the network impacts the company. Additionally, it is suggested that these studies address quantitative indicators such as the average clustering coefficient, stability, and absorption capacity in the supplier network, which can be confronted with the performance measurement system of the companies to be researched.

The absorptive capacity, for example, may provide relevant information about how the transfer of material and informational resources is performed between companies in the same supply chain, where the effectiveness of this transfer will depend on the measurement of the suppliers' absorptive capacity, which will point out the main deficiencies in the information flow between them and the focal company.

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