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Using SNA to Improve B2B Last-Mile in Industry Sector

Usando SNA para Melhorar a Última Milha de B2B no Setor Industrial

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ABSTRACT

Transportation systems remain a challenge for most supply chains. Delivery products in time, quantity, and location at once is not an easy task and this challenge is even amplified when we are dealing with Last-mile logistics. Despite business-to-business being less difficult compared to business-to-consumer distribution, there are still many operational logistics issues related to it. In this paper, we investigated a last-mile logistics from a Brewery Industry transferring supplier materials among its plants in São Paulo, Brazil. The aim is to identify the most important players in the network, offering the company a more effective view of the plants and their supply last-mile network. Therefore, we used the Social Network Analysis approach using the UCINET ©software. The results allowed the company to improve the efficiency of its last-mile B2B distribution for internal supplier materials.

Keywords. City Logistics. Urban Freight. Beverage Industry. Social Network Analysis. Complementary Material of Production.

RESUMO

Os sistemas de transporte continuam sendo um desafio para a maioria das cadeias de abastecimento. Ter entrega, produtos em tempo, quantidade e localização ao mesmo tempo não é uma tarefa fácil e esse desafio se amplia até quando se trata da logística do *last-mile*. Apesar do *Business-to-Business* ser menos difícil em comparação com a distribuição *Business-to- Consumer*, ainda existem muitos problemas de logística operacional. Neste artigo, investigamos uma logística de última milha de uma indústria de cerveja transferindo materiais de fornecedores entre suas fábricas em São Paulo, Brasil. O objetivo é identificar os players mais importantes da rede, oferecendo à empresa uma visão mais eficaz das fábricas e da rede de *last-mile* de abastecimento. Portanto, usamos a abordagem de Análise de Redes Sociais com o software UCINET ©. Os resultados permitiram à empresa aprimorar a eficiência da distribuição *last-mile* de materiais de fornecedores internos.

Keywords. City Logistics. Urban Freight. Indústria de Bebidas. Social Network Analysis. Materiais Secundários.

1 INTRODUCTION

For the last decades, several research projects and initiatives have been investigating solutions in order to improve transportation systems. Transportation is a need to the production process and logistics must be understood as an essential paradigm to supply chain management. Despite its relevance, last-mile logistics remains one of the main challenges in transportation (Altenried, 2019).

Last-mile can be defined as the final leg in a business-to-consumer (B2C) delivery service whereby the consignment is delivered to the recipient in-home or at a collection point (Gevaers et al., 2014). Despite the fact the last mile to be related to the end-user idea, it can be seen in the context of business-to-business (B2B) whereas the end-user may be an employee or a stakeholder. Moreover, in this case, last-mile represents the delivery process from the warehouse or a distribution center to the recipient (Lin et al.,2016).

The B2B last-mile is subject to the same issues as the B2C's in regards to the delivery window, local government intervention, complex network distribution, vehicle restrictions, and so on (Juhász & Bányai, 2018) (Faccio & Gamberi, 2015). According to Aljohani and Thompson (2020), although business-to-consumer (B2C) and consumer-to-consumer (C2C) deliveries account for a larger share of parcel deliveries in urban areas, business-to-business (B2B) deliveries still account for a noticeable share in the urban freight industry, they still argue that recent trends and operational challenges have driven a great deal of research, especially with a higher focus on B2C and C2C deliveries, due to the emergence of online shopping, crowd shipping and omnichannel retailing.

Most Industries are changing fast, part of the 4th Industry Revolution (Industry 4.0) according to Schwab (2018) solving our common challenges requires radical ways of thinking; technologies that replace human labor, severe climate changes, major concerns about inequality, and the prospects for economic insecurity are undermining the models and paradigms on which our society rests. It means all stakeholders should assume their responsibility to do something revolutionary or incremental to guarantee log term improvements. In this context those Industries face challenges to meet their customer and society expectations, Bonilla et al. (2018) argue that in this complex scenario of pressing global environmental (and other) challenges, Industry 4.0 emerges from the synergy of the availability of innovative digital technology and the demand by consumers for high quality

and customized products. Is clear that Industry 4.0 and its tools have a role on boosting productivity, revenue growth,and competitiveness.

One of the Industries' supply chains that require effective planning their Supply Chain, especially last-mile logistics in the brewery sector. This kind of Industry requires many plants of distribution to fill up bars, restaurants, and supermarkets demands. In a continental country like Brazil, those challenges are even higher. However, it is not last-mile regarding the final customers that this particular supply chains need to control but they must be able to interconnect these plants to transfer resources among them. Those resources are complementary material of production, raw material, pieces of equipment, etc, extremely important to deliver the final product.

The company studied is the biggest beer producer in Brazil - a centenary company now part of an association with Belgium's and American's brewery companies. The company is responsible for around 60% of the internal market (Freitas, 2019). With plants throughout the country, the company manages the challenge to link their plants and distribution centers to share resources with the idea to reduce costs.

The present study analyzes the resources transferred among these plants and distribution centers in São Paulo state. A province with 20% of Brazilian inhabitants. The idea is to investigate this last-mile case using network metrics and graphics based on Social Network Analysis. The contribution of the paper is shed light to the discussion of last-mile problems and their importance for production management.

2 THEORETICAL REFERENCE

2.1 Social Network Analysis Approach

Social network analysis (SNA) is based on the premise that society is formed by relations and patterns (Marin & Wellman, 2014). Therefore, culture and nature are structured as a network of brains, organisms,organizations, economies, and consist in a way of thinking that focuses on attention on the relationships among the entities, actors, or nodes (Borgatti, 2018). Consequently, it is possible to study these structures based on graphics and metrics measures. The graphic theory provides a qualitative understanding that is hard to obtain quantitatively (Borgatti, 2018).

This way, we can identify the clusters and relations considering the alignment of the nodes, the number of entries and subgraphs.

On the other hand, SNA offers the chance to test the role of the nodes inside the network using quantitative metrics. Network analysis describes how the actor is linked in a relational network (Hanneman & Riddle, 2014).

Centrality, for instance, represents the structural importance of a node and is divide in threefold:

(1) Degree - which means the number of ties of a given type that a node has;

(2) Closeness - which means the sum of geodesic distances from a node to all others;

(3) Betweenness - which means how often a given node falls along the shortest path between two othernodes. Finally, another important measure is the k-core that consists of a subgraph in which every actorhas degree k or more with the other actors in the subgraph. It is a sub-graph present in each network (Borgatti, 2018). In the methodology section, we presented the application method of SNA and in theresults and discussion section our findings and analysis of the use of these measures.

3 METHODOLOGY

The current study uses a dataset of one of the biggest Brazilian Brewery companies to identify and analyze the flow of materials among plants in São Paulo state, Brazil.

A total of 5,483 deliveries within the ten most important plants for cargo volume were used. These plants are located in the cities of Agudos, Iracemápolis, Jacareí, Jaguariúna, Limeira, Lins, Ribeirão Preto, São Bernardo do Campo, São José dos Campos e São Paulo.

These figures volumes were processed using the Microsoft Excel © in order to establish a relationship between plants in kilos, Table 1. Figures may be used to illustrate the article always when it necessary.

Table 1 - Cities Dataset

CITIES	AGU	IRA	JAC	JAG	LIM	LIN	RIB	BER	JOS	PAU
AGU	0	0	9046	1124	68	0	0	39	12000	3783
IRA	821	0	0	0	0	0	3461	0	11586	21318
JAC	15806	0	0	14512	0	0	0	1	1020	4578
JAG	7453	0	349	0	10	0	1626	1	92	404
LIM	1188	0	7847	3829	0	0	47	0	0	47
LIN	1611125	0	2467006	1610084	0	0	112801	0	11228	271490
RIB	2342	0	1600	105	0	0	0	0	226	1357
BER	77187	0	79593	118187	0	0	161	0	44	2111
JOS	2835	0	4540	456	0	0	19	0	0	214
PAU	597926	0	1213467	351120	3	0	12404	0	169	0

Source: Authors (2020).

In order to create a network, we input data in the Ucinet ©version 6.697 and using the module Netdraw© we created a network of plants taking into consideration the material indexed in kilos, Figure 1.

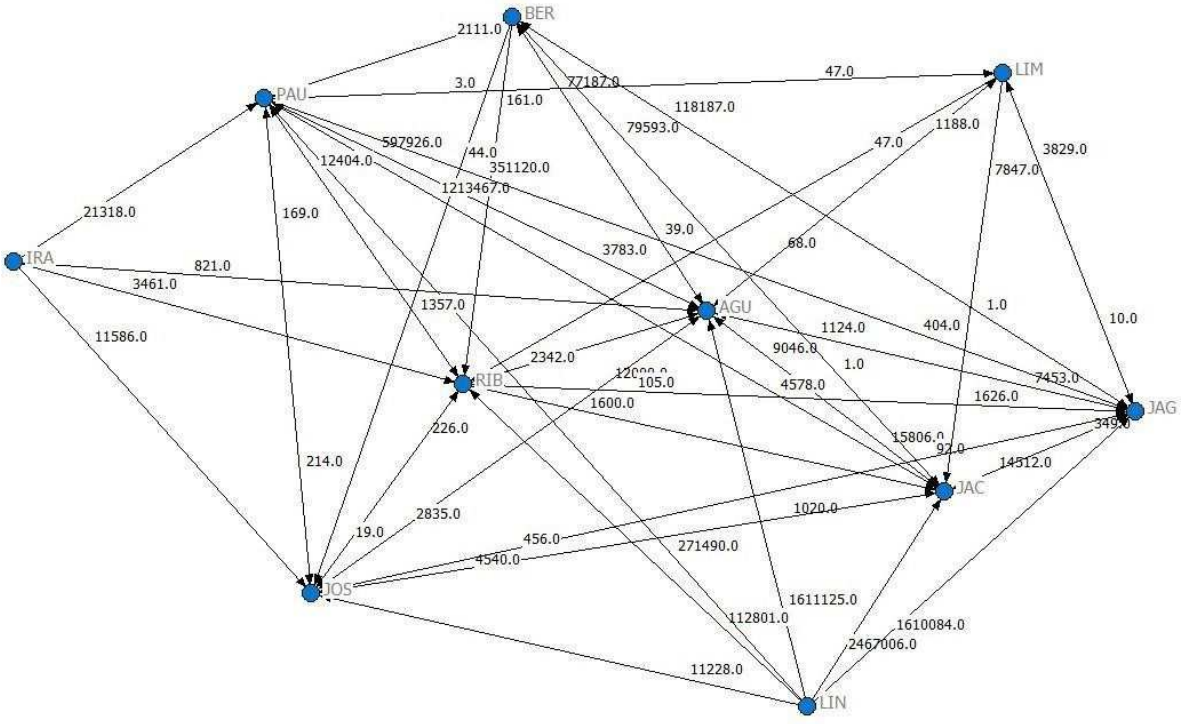
Finally, we analyzed the network metrics to understand the network relationships using network graphics and Social Network Analysis metrics. For a better understanding of the results, the explanation revolving around SNA metrics were included directly in the Results and Discussion section.

It is important to highlight that the aim of the paper is not generalized a model to be used in all the supply chains, but it shows the role of SNA in organizing and analyzing the relationship between different nodes, especially in this case brewery companies plants and distribution centers.

4 RESULTS AND DISCUSSION

Regarding the type of the material network, we could identify that the network is bidirectional, which means that it owes in both directions towards the players, indegree and outdegree, Figure 1.

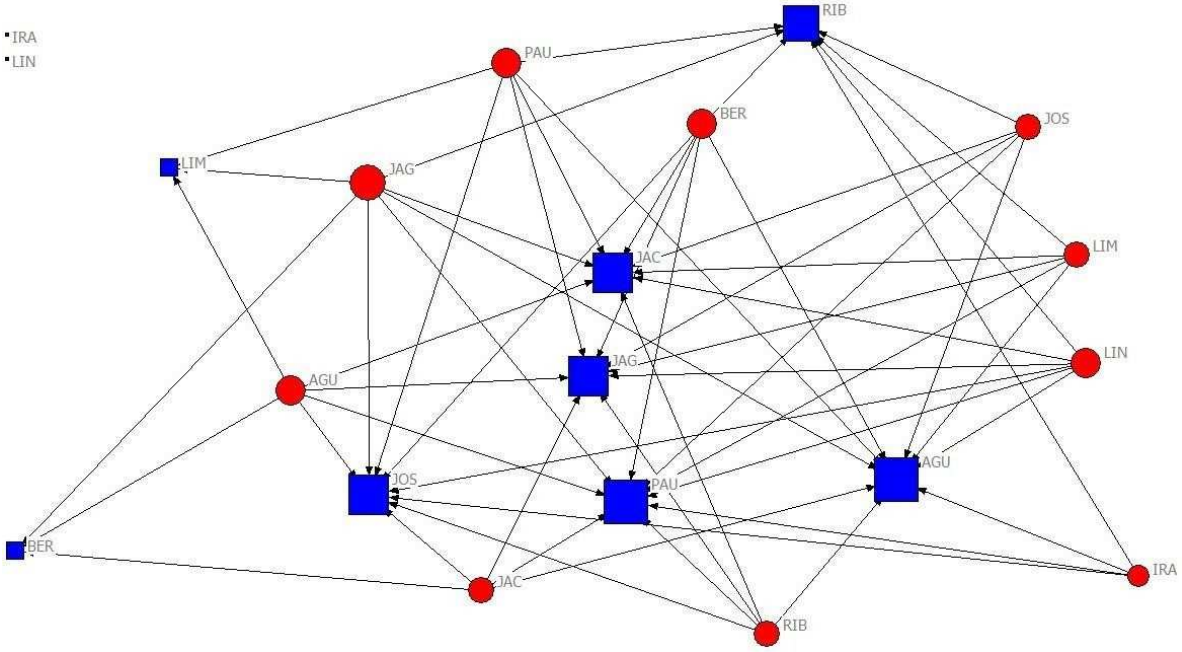
Figure 1 – Material distribution network



Source: Authors (2020).

The centrality degree measures the number of ties the network presents and it can be measured both as indegree, which is the measuring of many calls that an actor receives from another, indicating popularity or receptivity, and outdegree is the measurement of the number of connections that an actor establishes with other actors in this network, indicating expansiveness (Wassermann & Faust, 1994). The indegree and outdegree of the network can be seen in Figure 2.

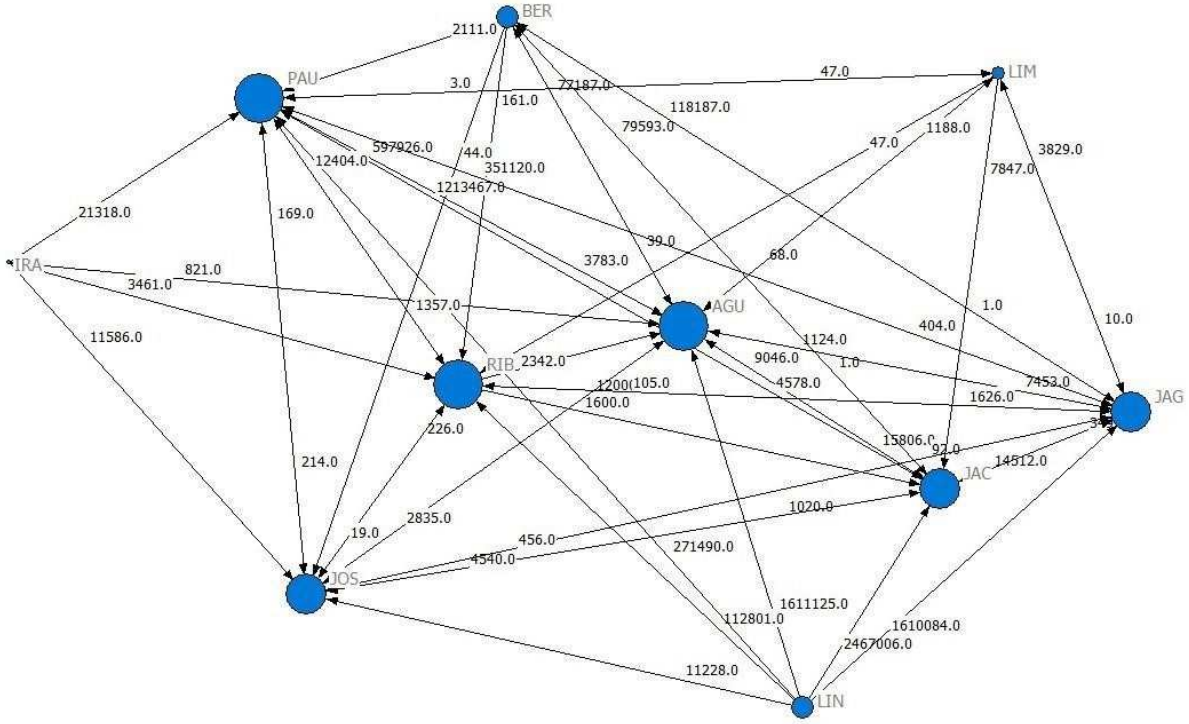
Figure 2 – Two-node network: indegree and outdegree



Source: Authors (2020).

Our outdegree network (circle) showed that plant of Jaguariuna (JAG) is the most important node to the delivery system connecting 86.44% of the nodes. Lins (LIN), São Paulo (PAU), São Bernardo do Campo (BER) e Agudos (AGU) are in second place connecting 67.00% of the nodes. Considering the outdegree network (square), São Paulo (PAU) and Agudos (AGU) link all the nodes, followed by Jacarei (JAC), Jaguariuna (JAG) and São José dos Campos (JOS) connected to 88.88%. Note that Lins(LIN) and Iracemápolis (IRA) are only outlets. Considering the indegree and outdegree indicators and the volumes, we plotted a degree centrality network, Figure 3.

Figure 3 – Degree centrality network

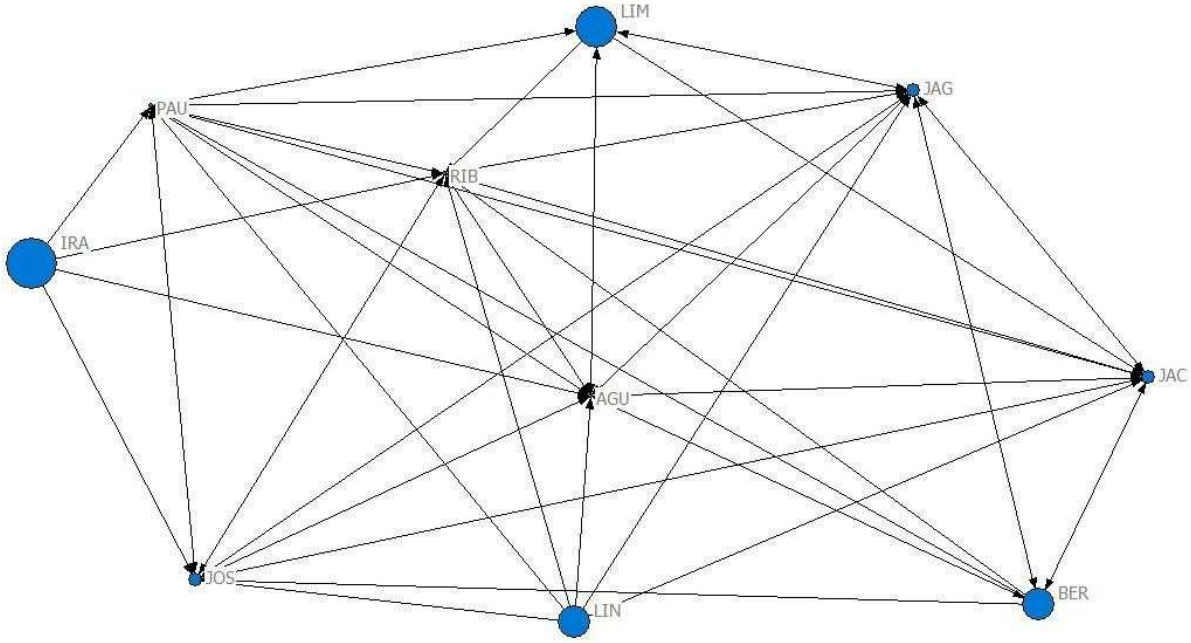


Source: Authors (2020).

Note that São Paulo (PAU), Agudos (AGU), Ribeirão Preto (RIB), Jacarei (JAC) and Jaguariuna (JAG)are the most central players of the network. Interesting to note that Ribeirão Preto does not have the biggest indegree and outdegree, but consolidating both linked to the volume this situation changes. This result justifies this further analysis. Another important centrality measure in a network is betweenness and closeness, represented in Figures 4 and 5. A node can lie between a pair of non-adjacent nodes, either along with their material ow or contractual relationship. In graph theory, betweenness is developed mainly as a metric, studied using the shortest path in a connected graph (Changat et al., 2019). In our research, São Bernardo do Campo (BER), Limeira (LIM), Iracemápolis (IRA), and Lins (LIN) have the highest degree of betweenness that means they are the most important nodes to the connection of the network.

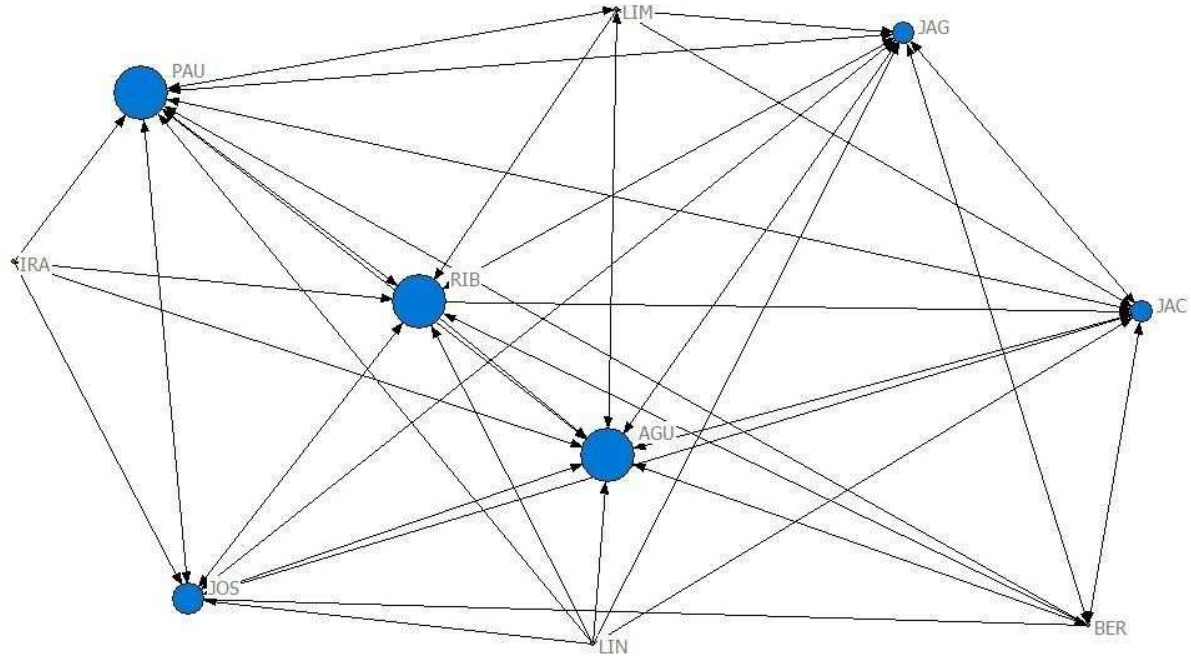
Closeness centrality is an index de ned in terms of a distance, it is the shortest distance in between the nodes in the network (Brandes et al., 2016). In this case, São Paulo (PAU), Ribeirão Preto (RIB) and Agudos (AGU) are presented as the most important nodes in the network. Figure 6.

Figure 4 - Betweenness centrality



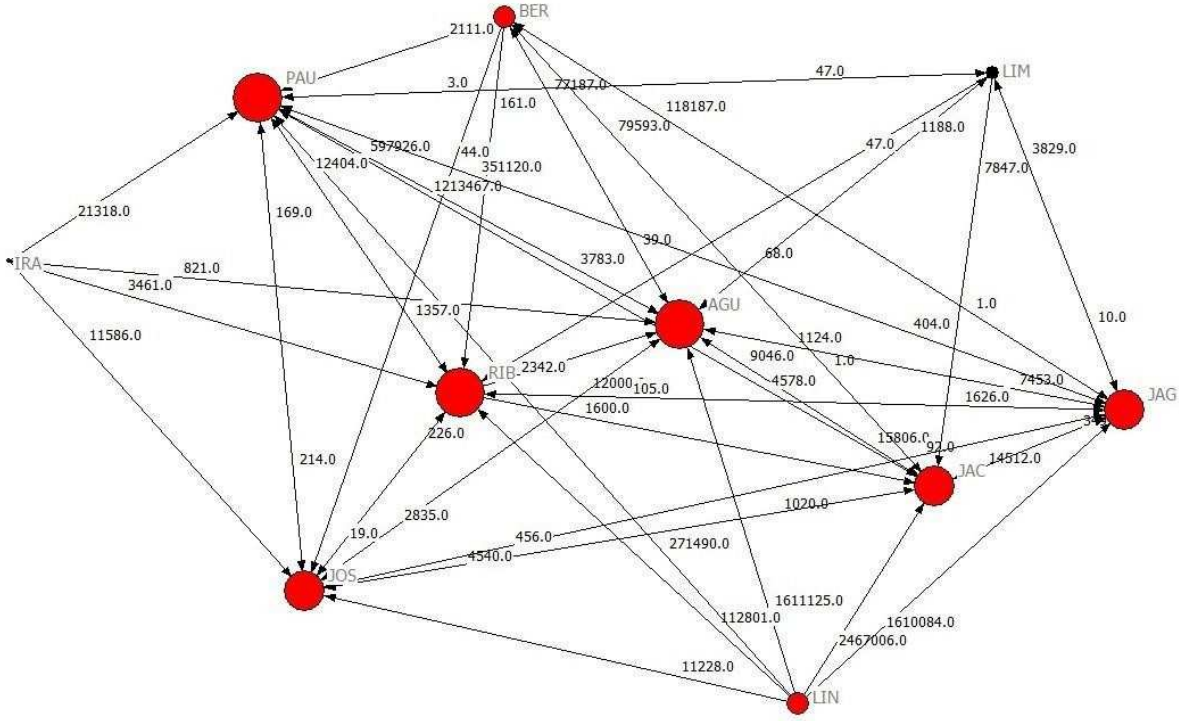
Source: Authors (2020).

Figure 5 - Closeness centrality



Source: Authors (2020).

Figure 6 - K-core



Source: Authors (2020).

According to IBM, the k-Core is a measurement that can help identify small-interlinked core areas on a network (IBM, 2020). Our network displayed homogeneity of relationships apart from Limeira (LIM) and Iracemápolis (IRA).

5 CONCLUSION

This study presents different social network analysis measures to analyze a B2B material last-mile distribution of a Brewery Industry in Brazil. The results show the relevance of SNA in evaluating the structure of a network in order to help industrial planning to make better decisions.

Our conclusions is that São Paulo (PAU), Agudos (AGU) and Ribeirão Preto are the main players of the network and the main attention of the Industry needs to be focused on these plant, in order to taking measures to reduce costs of last-mile distribution.

The importance of using different SNA measures is to avoid the industrial managers make decisions based only in the evidence that one node presents more relevance in the network. As presented in this study, some plants portrayed in one analysis but inconsistent when considered all the measures. This study is an attempt to provide a technical perspective to industrial decision-makers using the approach of network analysis.

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REFERENCES

Aljohani, K., & Thompson, R. G. (2020). An Examination of Last Mile Delivery Practices of Freight Carriers Servicing Business Receivers in Inner-City Areas. Sustainability, 12(7), 2837. https://doi.org/10.3390/su12072837

Altenried, M. (2019). On the last mile: logistical urbanism and the transformation of labour. Work Organisation, Labour & Globalisation. JSTOR, 13(1), 114-129.

Bonilla, S., Silva, H., Terra da Silva, M., Franco Gonçalves, R., & Sacomano, J. (2018). Industry 4.0 and Sustainability Implications: A Scenario-Based Analysis of the Impacts and Challenges. Sustainability, 10(10), 3740. https://doi.org/10.3390/su10103740

Borgatti, S.P., Everett, M.G., Johnson, J.C. (2018). Analyzing social networks. Sage.

Brandes, U., Borgatti, S.P., Freeman, L.C. (2016). Maintaining the duality of closeness and betweenness centrality. Social Networks 44, 153-159.

Changat, M., Narasimha-Shenoi, P.G., Seethakuttyamma, G. (2019). Betweenness in graphs: A short survey on shortest and induced path betweenness. AKCE International Journal of Graphs and Combinatorics 16(1), 96-109.

Faccio, M., Gamberi, M. (2015). New city logistics paradigm: From the last mile to the last 50 mile sustainable distribution 7(11), 14873-14894.

Freitas, C.F. (2019) Infográfico. Market share de vendas de cerveja no brasil em 2019.

Gevaers, R., Van de Voorde, E., Vanelslander, T. (2014). Cost modelling and simulation of last-mile characteristics in an innovative b2c supply chain environment with implications on urban areas and cities 125, 398-411.

Hanneman, R.A., Riddle, M. (2014). Concepts and Measures for Basic Network Analysis. In: The SAGE Handbook of Social Network Analysis, SAGE Publications Ltd, 1 Oliver's Yard, 55 City Road, Lon-don EC1Y 1SP United Kingdom, 340-369.

IBM. (2020). K-core. Retrieved from https://www.ibm.com/support/knowledgecenter/en/SSXVXZ_2.2.0/com.ibm.i2.anb.doc/about_k_core.html

Juhász, J., Bányai, T. (2018). Last mile logistics: an integrated view 448, reporter: IOP Conference Series: Materials Science and Engineering, 1-10.

Lin, J., Chen, Q., Kawamura, K. (2016) Sustainability SI: Logistics cost and environmental impact analyses of urban delivery consolidation strategies 16(1), 227-253.

Marin, A., Wellman, B. (2014). Social Network Analysis: An Introduction. In: The SAGE Handbook of Social Network Analysis. SAGE Publications Ltd, 1 Oliver's Yard, 55 City Road, London EC1Y 1SP United Kingdom, 11-25.

Schwab, Klaus. Shaping the fourth industrial revolution. São Paulo: EDIPRO, 2018. ISBN 978-85-521-0024-9.

Wasserman, S., & Faust, K. (1994). Structural analysis in the social sciences.Social network analysis: Methods and applications. Cambridge University Press. https://doi.org/10.1017/CBO978051181547

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2) análise e interpretação dos dados.	X	X	X
3) elaboração do rascunho ou na revisão crítica do conteúdo.	X	X	X
4) participação na aprovação da versão final do manuscrito.	X	X	X