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THE INFLUENCE OF TECHNOLOGY IN LOGISTICS: An Exploratory Study

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ABSTRACT
Advances in technology enable companies to collect and analyze previously inaccessible data to improve existing business processes or create new ones. The purpose of this study is to document the role and impact of technology in supporting business strategy with regard to logistics, addressing Social Network Analysis (SNA), Big Data Analytics (BDA) and the Internet of Things (IoT) in order to assist in the continuous improvement of the quality of services and respective costs. This study was elaborated from a literature review researched in the Scopus and Web of Science bases from where 56 articles were extracted, period 2000/2018, besides books and statistical consultations. The state of art has revealed that with the many possibilities that technology offers today, a better dynamics of logistics management can be achieved by storing data directly in the cloud that help to signal ideal times and places of purchase, inventory control, storage and displacement of the products, allowing to predict maintenance schedules and predictive and proactive movement. Despite the various benefits, it has been found that investment in technology in the logistics area is still quite high, observing that recently some companies are beginning to realize the benefits of this high investment in technology in the supply chain area. The findings of this research serve as a valuable example of how logistics can take advantage of the deployment of SNA, BDA and IoT technologies, assisting professionals, researchers and society in general.
Keywords: Logistics management; supply chain management; social network analysis; big data; Internet of things.

INTRODUÇÃO

The advent of logistics allowed access to the consumption of products out of season, or produced at long distances nationally or internationally, provided more variety of choice to consumers stimulating the supply which, in turn, leads to price reductions. It is no longer necessary to live near where the products are manufactured or produced (STATISTA, 2018).

The fundamental aspects of logistics are what separate production from

consumption: efficient and effective inventory management, storage, handling and transportation of goods allows production and consumption to occur in places very distant from each other. Its main intention is to serve the consumer, delivering the right product, at the right time and at the lowest price possible. This requires extensive communication where coherent information can be disseminated in a short period of time. (TRACEY; LIM; VONDEREMBSE, 2005). This has been achieved through new technologies that 4.0 industry has been providing with an essential communication tool.

Social media has revolutionized our societies. This has had a substantial impact on the way we work and live and is gradually becoming a key part of intelligent societies, revealing information about people and their space-time experiences around living environments. Big data and artificial intelligence technologies are helping to manage and analyze large amounts of generated data (SUGIMIYANTO et al., 2017).

People tend to post about everything, and this leads to the accumulation of a large amount of data generated, every day. According to Sugimiyanto et al. (2017), this enormous amount of published information leads to a great chance to explore information and obtain something to profit. Big data, social networks, internet of things can be used, explored and analyzed for insights and result in decision making. Every day the data is being generated very quickly, in large and multivariate quantities.

According to Zhou, Huang and Wang (2017), in the last decades, several online social networks have gone through a rapid development. One of the defining phenomena of modern times, which have reshaped the world as we know is the world's accessibility to the internet. Most of the World Wide Web is social media, which comes in many forms including blogs, forums, business networks, photo sharing platforms, games, microblogs, chat applications and finally social networks.

According to the Statistic Portal (STATISTA, 2018), the power of SN (social networks) is such that the number of users worldwide is expected to reach around 3.02 billion active users per month by 2021, about one third of the Earth's total population. Still, it is estimated that in 2022, 750 millions of these users come from China and about a third of a billion from India. The region with the highest penetration rate of SN is North America, where about 70% of the population has at least one public account. Popular SN like Facebook, Twitter, WeChat, Sina Weibo, etc. have drawn hundreds of millions of people to communicate with each other on their platforms.

Meanwhile, businesses related to this networking are also growing rapidly. For example, as reported by the 2017 Facebook annual report, its revenue in 2014 was 12.47 billion dollars and more than 90% of its revenue was advertising sales. The reason for such advertising value is that there are many users communicating actively on the platform. As a result, increasing the activity of its network is always an important priority for the daily logistics operation of companies (STATISTA, 2018).

This article analyzes, using a literature review, the relevance of the use of technology and its advantages in terms of logistics in a wide way. The objective of this research is to observe how technology is being used in the logistics sector to drive processes and performance improvement, highlighting the antecedents of the cross-functional

integration between the demand and supply functions in several networks now contemplating the technology.

Therefore, throughout this study, especially in the chapter of the literature review, we will try to confirm the importance of SNA, BD and IoT for logistics and its relevant contribution.

BIBLIOGRAPHIC REVIEW

This section presents a literature review on the concepts, definitions and practices of Logistics and Supply Chain Management, Social Network Analysis, Big Data and Internet of Things.

Logistics

Logistics is being recognized worldwide as a competitive determinant for companies. As such, the nature of Supply Chains and networks is changing at a rapid pace, presenting technological and social developments. These developments include advances in industrial automation (sensors, robotics, 3D printing and smart mobility), concerns about environmental deterioration (scarcity of natural resources, untidy carbon emissions), thereby bringing new business models (e-commerce). Incorporating new technologies into modern supply chain operations, while addressing environmental and social concerns, presents a major challenge for organizations and the world. Logistics is now becoming an indispensable factor for economic development as evidenced on the annual publication of World Bank Logistics (ZIJM et al., 2016).

Today, logistics has evolved, and the concept of Supply Chain Management is increasingly emphasized. Many companies, which did not care about the management of their suppliers and carriers that consequently did not follow the wholesaler that also did not understand how the retailer's operations worked, have recently begun to realize the importance of this management.

Logistics has been playing a crucial role in organizations and is increasingly identified as a central element in Supply Chain Management - SCM (SEZHIYAN; PAGE; ISKANIUS, 2011). Therefore, according to Min and Mentzer (2004), logistics may be understood as a respectable part of SCM that plans, executes, monitors and controls the essential cost and time of reverse flow and storage of goods, services and information within a company with the purpose of meeting the client's wishes.

In the last two decades, the initiatives related to this system have included several functions, such as inventory management, connection with the acquisition of customers, suppliers, transportation, warehousing, sales and marketing management, organization and planning of these activities (MUNUZURI et al., 2009; HONG; VONDEREMBSE, 2011)

The increasing global competition of today, reducing profit margins, changing customer preferences, etc., have led companies to emphasize their logistics (RAVI; SHARKAR, 2015).

Thus, a high level of logistics performance not only reduces costs (for example, by reducing inventory levels), but also contributes to customer satisfaction by acting as a competitive differentiator (TASCHNER, 2016).

Based on the Delphi study involving more than 55 executives from 20 US-based companies, Keebler and Plank (2009) also concluded that there are great opportunities for cost reduction in logistics and improved performance within companies using technology.

Logistics might be of three types – inbound, internal logistics (in-company) and outbound logistics (external) to manage the

flow and storage of materials and goods (DAUGHERTY et al., 2005).

Today, increasing supplier networks, distributors and outsourcing have forced organizations to not only try to improve their logistics operation (NGUYEN, 2013), but also to maintain economic business sustainability (LEE; WU, 2014).

In addition, logistics has also become an important channel for customer satisfaction and cost-effectiveness (QURESHI; KUMAR; KUMAR, 2009). Stock and Mulki (2009) described logistics as a likely market differentiator and profit center in the context of the organization.

However, from the point of view of business organization, the implementation and the execution of this linear system is subject to several challenges, such as the environment, customer preferences and individual requirements, market variability and changes, etc. (DÍAZ; SOLÍS; CLAES, 2011; MCFARLANE; GIANNIKASV; LU, 2016). This may justify the importance and necessity of adopting more methodological approaches such as technological ones to achieve effective management concepts (OJALA; ANDERSSON; NAULA, 2008).

According to the Council of Supply Chain Management Professionals - CSCMP (2018), logistics involves the planning, execution, control of flow and storage, in an effective and efficient way, of services, materials and products from the point of origin to the point of consumption, in order to meet the demands of the consumer.

As previously commented, logistics, also addressed by Tracey, Lim and Vonderembse (2005) is a process that guarantees the delivery of the right product in the right quantity at the right time in the right place at the right price.

Regardless of logistics being part of the process from supply (origin) to demand (consumption), its main functions are:

- Plan - flow/transport/mobility - of raw materials, products in preparation or finished and physical goods for the elaboration of services, transporting, manipulating and storing;
- Do - considering time, quality and costs;
- Control - maintaining efficiency and effectiveness.

Figure 1 shows an illustration of the logistics management process.

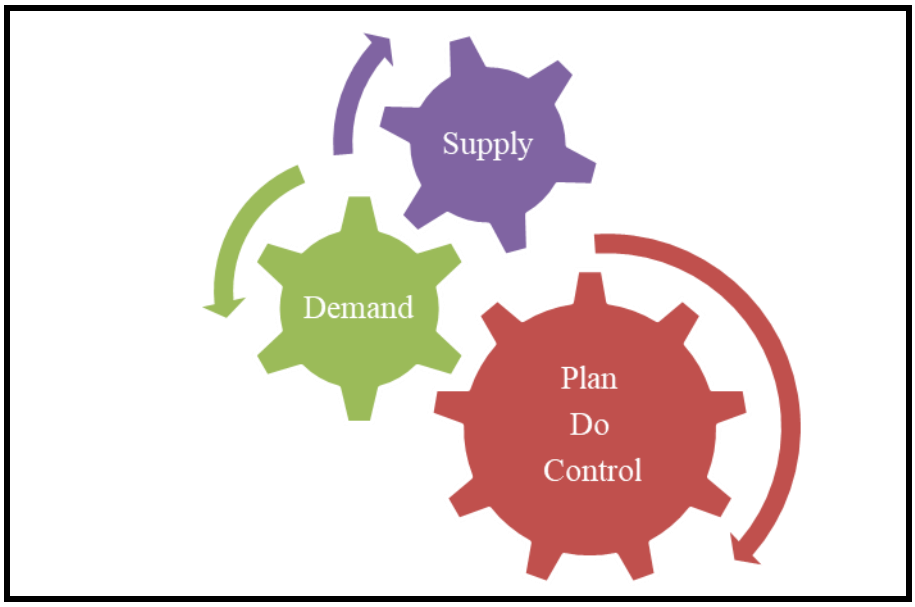

Figure 1: Logistics management process
Source: Authors, based on the researched literature (2018)

Logistics is a process of functions that are articulated to counterbalance supply and demand through the production of goods and services and, according to the CSCMP (2018) definition, SCM encompasses the planning and management of all functions involved in outsourcing, acquisition, conversion and all logistics activities. It includes coordination and collaboration with partners who can be suppliers, intermediaries, outsourced service providers and customers. SCM integrates supply and demand management within and across enterprises.

As for SCM this is an integration function, with the basic responsibility of linking the main logistics functions and their processes within and between companies into a cohesive and high-performance business model. The supply chain encompasses all logistics management activities, manufacturing operations and drives the coordination of processes and activities with and through marketing, sales, product design, finance and information technology. Therefore, logistics is the part of the SCM that plans, implements and controls the efficient and effective flow, reversing the mobility and storage of goods, services and related information between the point of origin and the point of consumption to meet requirements (CSCMP, 2018).

Social Network Analysis – SNA

The Social Network Analysis (SNA), emerged as a methodological technique in several contexts (FREEMAN, 2006). SNA has been used in studies on organizations (CARPENTER; LI; JIANG, 2012), tourism (RACHERLA; HU, 2010), social capital (LI, 2013) and innovation (DAHLANDER; GANN, 2010). In these studies, SNA sees relationships as "nodes" (denoting individual actors within the network) and "links" (denoting the relationship between individuals). Because the visual representation of networks can be a powerful way to convey complex information, SNA has been applied in innovative exploratory research on management-related issues. The potential application of SNA has gained significant importance in management and organization studies (KILDUFF; TSAI, 2003).

According to Philips and Philips (1998), Carter, Ellram and Tate (2007), Autry and Griffis (2008), several authors have demonstrated the advantages of the use of SNA in the area of logistics. For example, Philips and Philips (1998) point to SNA to track the flow of information between business and transport logistics, showing that the flow of information becomes more efficient, entities communicate directly with one another, and logistics and transport become more interconnected.

The SNA helps in the prediction of links that is still a problem of basic importance. How to conduct a comprehensive and principle-based prediction of links, considering various information of the network structure is of great interest (ZHOU; HUANG; WANG, 2017).

Borgatti and Li (2009) provided logistics researchers with the general concepts and mechanisms of SNA. Carter, Ellram and Tate (2007) highlighted the potential application of the SNA to the empirical research of logistics through the hypotheses related to informal and formal structures of influence within the context of a social network organization, providing guidance for future research in the field.

In the same way, Autry and Griffis (2008) studied the capital of the supply chain using SNA.

However, according to Yen-Chun et al. (2017) the literature found is not yet extensive in the deepening of the extension of collaboration between SNA and logistics management, we can say that the issue of logistics in e-commerce, which currently has great representativeness in terms of revenues for some companies, must be considered strategic, because it can generate the success or failure of an enterprise. This theme is paramount to e-commerce, as if not well-designed, it can put all work at risk. logistics in e-commerce is part of managing an online store in both planning and control as well as storage and flow of products. In e-commerce, logistics includes receiving and checking products, stocking products, shipping products for order preparation, shipping orders to the carrier, and finally tracking and tracking shipped orders. Regardless of the industry, most companies use e-commerce to expose their brand, products or services, and primarily as a sales tool to increase revenue (SOFIT Logistics Technology, 2017).

Big Data – BD

There are many computational intelligence features to produce data such as, Internet of Things (IoT) of various sensors installed, microblogging, postings in social media, transactional data, video, digital images and more. All of this is called Big Data Analytics (BDA) which gives us a deep and comprehensive view and works because that large amount of data (of any type) taken every thousandth of a second is constantly clustered on machines with distributed systems. The main characteristics of the big data are the 5Vs (Volume, Variety, Velocity, Veracity and Value). By preparing this data and processing it, we can get an accurate and faster view of the subject in focus with greater ease and in record time (JESKE; GRÜNER; WEIß, 2013, p. 1) "Big Data has a lot to offer the world of logistics. This sophisticated data analysis can consolidate, with its new capabilities, the traditional fragmented logistics sector in pole position" (JESKE; GRÜNER; WEIß, 2013, p.1).

Even though all these advantages, on the other hand, a study by Accenture (2014,

p.7) concluded that "actual use of BDA is still limited." They found that, despite the recognized benefits of the BDA, most companies faced difficulties in adopting it, because they were concerned about the level of investment needed, security risks and the lack of business cases available for analysis.

Wang et al. (2016, p. 107) conducted a systematic review of Big Data in the context of logistics and supply chain management, and a "gap between academic theory and supply chain practices" was confirmed. Even today, academic examples describing case studies of the use of BDA in the logistics sector are scarce.

More recently, a KPMG report (2017) has described several examples of emerging cases that reveal how logistics operations are using Big Data solutions to reduce delivery delays through availability of GPS, traffic, and weather data.

Boyd and Crawford (2012, p 663) believed that Big Data can be defined from a multifaceted perspective, based on the interaction between technology, analysis and mythology. The technological perspective is related to the enormous computing capacity required to process and analyze large data sets, the analytical perspective is related to the potential value of the type of analysis performed in these large data sets, while the mythological perspective refers to the belief that, "... data sets offer a superior form of intelligence." In fact, the definition of Big Data is still evolving. The Business Intelligence and Analytics (BI & A) framework was developed in recognition of the evolution, applications and emerging research on Big Data (CHEN; CHIANG; STOREY, 2012).

The field has grown in recent times, as companies focus on rapid growth, acquisition and generation of data (ALEXANDER; HOISIE; SZALAY, 2011), typically originating from the following data sources:

• Transactional data: for many companies this is the traditional source of their structured data generated from their transaction processing systems, such as enterprise resource planning systems;
• Human data: A more recent source of data is unstructured data generated by humans using social media tools such as Twitter, Facebook, etc.;
• Sensor data: data is generated by sensor networks that are often referred to as the IoT. IoT applications can produce large amounts of data due to continuous monitoring of events (MISHRA; LIN; CHANG, 2014).

In addition, BDA is fundamental in helping to increase operational efficiency because it allows analyzing a massive volume of data, enabling the generation of knowledge about the most diverse operational aspects. Thus, it becomes possible to achieve operational efficiency, as the manager can have a solid foundation that contributes to process and performance improvement, quality improvement, error reduction and need of rework, among other optimizations that guarantee more efficient workflows. It applies to product and inventory as there is the possibility of monitoring operational information which allows controlling more critical flows such as the need for replacement, material loss and indicate which items are in greater demand in certain periods of the year, thus enabling the scheduling of distribution centers to increase movement, helping to avoid problems such as stock shortages and their consequent breakdown; helps identifying delivery patterns across regions and ensure greater fleet efficiency by combining logistics with data generated from routing software that provides information such as fuel consumption and distribution efficiency to

realize the need, for example, diversifying the fleet and improving route design, always focusing on efficiency; In the distribution area, based on the data of the deliveries made and the geographical location of the customers, it is possible to know which regions have the largest volume of shipments, identify demand patterns and the best networks to meet the flow of goods. Shipping, planning new distribution networks, making decisions that help increasing service agility and reduce operating costs (SOFIT LOGISTICS TECHNOLOGY, 2017).

Internet of Things (IoT)

This technology is a network of connected "things". In other words, it is a relationship between people-people, people-objects and object-objects.

Likewise, the Internet of Things (IoT) has also been predicted to play an important role in the future of the logistics industry as a growing number of objects begin to present bar codes, radio-frequency identification (RFID) tags and sensors, generating geospatial data that allow real-time accuracy, tracking of physical objects throughout the supply chain (ATZORI; IERA; MORABITO, 2010; MALIK et al., 2017; SWAMINATHAN, 2012).

The term IoT emerged in the late 1990s originating from the Auto-ID Center at MIT to describe RFID infrastructure work (SARMA; BROCK; ASHTON, 2000).

Then, it started to define a global network of infrastructure where "things", wireless transmissions and computing combine to form an information network (ATZORI; IERA; MORABITO, 2010; BOOS et al., 2013), allowing new channels of communication between people and things, and things and other things (VONGSINGTHONG; SMANCHAT, 2014). Examples of such things are sensors, actuators, pumps, motors, vehicles, thermometers, nuclear reactors, washing machines, air conditioners, scales, water meters, lights, RFID tags or surveillance cameras, (KOPETZ, 2011, KORTUEM et al., 2010, WORTMANN; FLÜCHTER, 2015; XIA et al., 2012), and IoT is responsible for linking these physical items to the digital world.

This is the potential of IoT that a recent global survey identified, in which 43% of respondent companies planned to implement IoT initiatives by the end of 2016 (GESCHICKTER; TULLY, 2016).

Logistics is an area where IoT is expected to have an extremely significant impact, transportation systems evolve and vehicles are equipped with an increased level of detection, network and communication capability, allowing vehicles to interact with each other and their environment (XU; HE; LI, 2014; ZHOU; LIU; WANG, 2012).

As sensing technology becomes increasingly sophisticated, vehicles are expected to interact with the environment, using a variety of sensors, cameras, maps and radar equipment to perform a variety of tasks, including driving, avoiding impacts and collisions, detecting pedestrians and animals, and even finding parking spaces (FAGNANT; KOCKELMAN, 2015, GERLA et al., 2014, JO; CHU; SUNWOO, 2012, KELLER et al., 2011; LOZANO-PEREZ, 2012). Possibilities for the logistics industry are obviously endless.

IoT and logistics are increasingly tightly connected and one of the approaches to defining IoT is almost derived from logistics as part of its function is to deliver "the right product at the right quantity, at the

right time and place, at the right condition, and at the right price "(UCKELMANN; HARRISON; MICHAHELLES, 2011, p.7).

Nevertheless, as with the BDA, there are still few cases that describe the actual use of IoT technologies in the logistics sector. As Sun (2012) discusses the role that RFID technology has in the future of IoT, from a supply chain context, however, there is a shortage of case descriptions.

Likewise, Bandyopadhyay and Sen (2011) discussed the potential of IoT to reduce ruptures, the logistic carbon trace and overproduction/underproduction, but also do not present a great profusion of new examples.

Logistics has many activities performed by automation, directly and indirectly and the internet of things can improve them in various practices such as:
In the case of the fleet whose tools allow to know the exact position of the vehicles during the trips and to identify exactly if they are operating, on, off, stopped or making the previously planned routes. In addition, there are also problems with knowing fluid and fuel levels or CO2 emissions. The IoT allows the incorporation of tools that reveal this information and transmit it via cellular network or wi-fi to an online platform that understands and analyzes it, obtaining important data for decision making;

Regarding the cargo being transported, IoT facilitates locating by ensuring and confirming that the required care parameters are being followed and that there are no changes between leaving the warehouse and arriving at the destination. In this way, IoT helps to ensure product arrival at destination by incorporating sensors, which make it possible to measure even the temperature of the product being transported, feel vibration in fragile goods, detect change in pressure, volume, among other relevant factors;

As far as the warehouse is concerned, IoT is also a big beneficiary, and the variety of uses and applications seems almost endless. Shelves equipped with weight and size sensors may warn if the pallet just placed corresponds to that location, if the operator has placed it incorrectly, if movement is required, if there is a risk of falling, etc.;

In the supply chain, sensor deployment and interconnection provide efficiency and reliability by promoting the Just in Time philosophy, which offers better demands for meeting deadlines that are becoming increasingly shorter with modernity.

Another and “new” option for using IoT is the so-called “last mile”. Use of solutions that automatically tell the carrier whether the person/customer (upon delivery) has left their home or through systems that inform the recipient of the approximate delivery time, considering the distribution assigned, their location and even the state of traffic. This is an extensive system that not only focuses on tracking but deepens the company's reach and represents a major leap in the level of service quality (SOFIT Logistics Technology, 2017).

METHODOLOGY

In order to meet the objective of the study, a bibliometric systematic literature review of a qualitative nature was adopted. It aims to explore and document the practical results and contributions of the application of SNA, BDA and IoT technologies in logistics, investigating case examples of organizations (ZIJM et al., 2016) that have successfully implemented or not, initiatives in this area through the state-of-the-art analysis.

In many business sectors, including retail, it is noted that increasing the

complexity of business strategies needs to be addressed more efficiently in product delivery, requiring integration between the supply and demand functions of the company.

Figure 2 shows the graph that illustrates the researched material found in the Scopus and Web of Science databases, according to the keywords used, making a total of 638 documents. Several combinations of words were used as can be seen in Figure 2, most combinations associated to the word logistics, because separately, these keywords did not return the necessary and expected results. After reading and analyzing the titles and abstracts, we selected only the articles that addressed the technologies related to Logistics, studied in this research. Finally, 56 articles were selected and used.

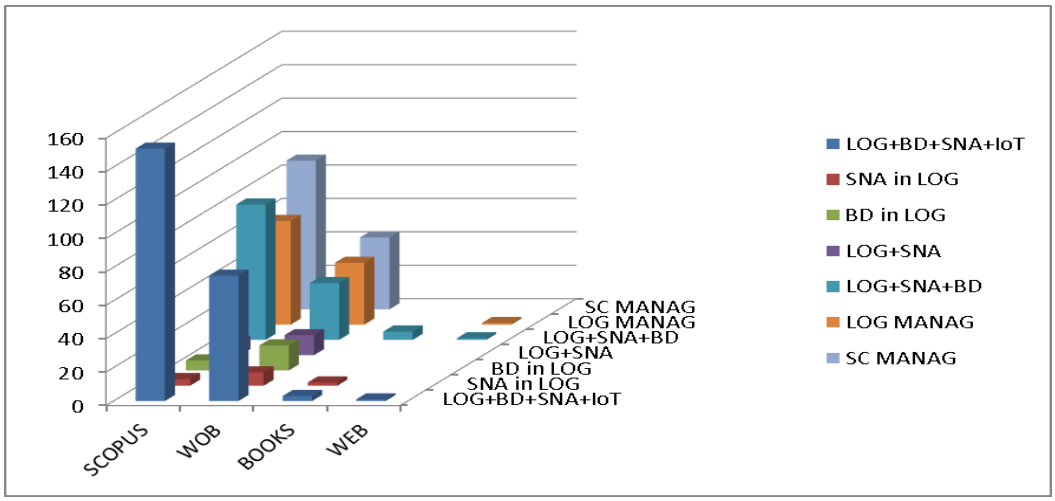

Figure 2: Articles addressing the theme, founded in the Scopus and Web of Science (WOB) bases, according to the keywords tried
Source: Authors (2018)

The research, based on Scopus and Web of Science, was made between October 3rd and 22nd, 2018, using various combinations of key words such as "Logistics", "Big Data", "Social Network Analysis" and "Internet of Things" (LOG + BD + SNA + IoT); "SNA in Logistics" (SNA in LOG) and "Big Data in Logistics" (BD in LOG); "Logistics and Social Network Analysis" (LOG + SNA) and "Logistics", "Social Network Analysis" and "Big Data" (LOG + SNA + BD); "Logistics Management" (LOG MANAG), "Supply Chain Management" (SC MANAG), covering the periods between 2000 and 2018. These surveys resulted theoretically, a priori, in a total of 638 documents.

Table 1 shows all the literature cited from the documents found and selected on the CAPES platform. In addition to these articles, four books, papers and statistics were also used as explained below.

Table 1: Articles researched and consulted as part of the study

AUTHORS	TITLE	JOURNAL	YEAR
Hopkins and Hawking	Big data analytics (BDA) and internet of thins (IOT) in logistics: a case study	The International Journal of Logistics Management	2018
Zhou, Huang and Wang	A dynamic logistic regression for network link prediction	Sci China Math	2017
Sugimiyanto et al.	Enabling next generation logistics and planning for smarter societies	Procedia Computer Science	2017
Malik et al.	Data compatibility to enhance sustainable capabilities for autonomous analytics in IoT.	Sustainability	2017
Wang et al.	BDA in logistics and supply chain management: certain investigations for research and applications	International Journal of Production Economics	2016
Geschickter and Tully	Survey analysis: early adopters of IoT poised to make 2016 the year of the customer	Gartner Review	2016
Mcfarlane, Giannikas and Lu	Intelligent logistics: involving the customer	Computers in Industry	2016
Taschner	Improving SME logistics performance through benchmarking	Benchmarking: An International Journal	2016
Wortmann and Flüchter	Internet of Things	Business & Information Systems Engineering	2015
Hannah et al	The role of social mechanisms in demand and Supply integration: an individual network perspective	Journal of Business Logistics	2015
Fagnant and Kockelman	Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations	Transportation Research: Policy and Practice	2015
Ravi and Shankahou	Survey of reverse logistics practices in manufacturing industries: an Indian context	Benchmarking: An International Journal	2015
Accenture	BDA in supply chain: hype or here to stay?	Accenture Global Operations Megatrends Study, Dublin	2014
Xu, He and Li	IoT in industries: a survey	IEEE Transactions on Industrial Informatics	2014
Lee and Wu	Integrating sustainability performance measurement into logistics and supply networks: a multi-methodological approach	The British Accounting Review	2014
Vongsingthong and Smanchat	IoT: a review of applications & technologies	Suranaree Journal of Science & Technology	2014
Gerla et al.	Internet of vehicles: from intelligent grid to autonomous cars and vehicular clouds	IEEE World Forum on Internet of Things	2014
Mishra, Lin and Chang	A cognitive oriented framework for IoT big-data management prospective	IEEE International Conference on Communication Problem-Solving	2014
Boos et al.	Controllable accountabilities: the IoT and its challenges for organizations	Behaviour& Information Technology	2013
Gubbi et al	IoT: a vision, architectural elements, and future directions	Future Generation Computer Systems	2013
Jeske, Grüner and Weiß	Big data in logistics: a DHL perspective on how to move beyond the hype	Customer Solutions & Innovation	2013

AUTHORS	TITLE	JOURNAL	YEAR
Li	Social network and social capital in leadership and management research: a review of causal methods	The Leadership Quarterly	2013
Nguyen	Critical factors in e-business adoption: evidence from Australian transport and logistics companies	International Journal of Production Economics	2013
Sun	Application of RFID technology for logistics on IoT	AASRI Procedia	2012
Boyd and Crawford	Critical questions for big data: provocations for a cultural, technological, and scholarly phenomenon	Information, Communication & Society	2012
Carpenter, Li and Jiang	Social network research in organizational contexts: a systematic review of methodological issues and choices	Journal of Management	2012
Chen, Chiang and Storey	Business intelligence and analytics: from big data to big impact	Business Intelligence Research	2012
Jo, Chu and Sunwoo	Interacting multiple model filter-based sensor fusion of GPS with in-vehicle sensors for real-time vehicle positioning	IEEE Transactions on Intelligent Transportation Systems	2012
Zhou, Liu and Wang	Design and research of urban intelligent transportation system based on the internet of things	Internet of Things, Springer	2012
Xiaet al.	IoT	International Journal of Communication Systems	2012
Swaminathan	The effects of big data on the logistics industry	Profit Oracle	2012
Alexander, Hoisie and Szalay	Big data	American Institute of Physics	2011
Bandyopadhyay and Sen	IoT: applications and challenges in technology and standardization	Wireless Personal Communications	2011
Díaz, Solís. and Claes	Improving logistics and supply chain management in Spain: an analysis of current practices and future requirement	International Journal of Logistics Systems and Management	2011
Hong and Vonderembse	Global logistics strategies and experiences: the case of Korea express	International Journal of Logistics Systems and Management	2011
Keller et al.	Active pedestrian safety by automatic braking and evasive steering	IEEE Transactions on Intelligent Transportation Systems,	2011
Sezhiyan, Page and Iskanius	The impact of supply effort management, logistics capability, and supply chain management strategies on firm performance	International Journal of Electronic Transport	2011
KPMG	How big data is shaping the supply chains of tomorrow	Supply Chain Big Data Series	2011
Uckelmann, Harrison and Michahelles	An architectural approach towards the future internet of things	Architecting the Internet of Things	2011

AUTHORS	TITLE	JOURNAL	YEAR
Atzori, Iera and Morabito	The IoT: a survey	Computer Networks	2010
Dahlander and Gann	How open is innovation?	Research Policy	2010
Kortuem et al.	Smart objects as building blocks for the Internet of Things	IEEE Internet Computing	2010
Racherla and Hu	A social network perspective of tourism research collaborations	Annals of Tourism Research	2010
Borgatti and Li	On social network analysis in a supply chain context	Journal of Supply Chain Management	2009
Munuzuri et al.	Logistics management systems: an approach for the evaluation, integration and improvement of logistics processes	International Journal of Procurement Management	2009
Keebler and Plank	Logistics performance measurement in the supply chain: a benchmark	Benchmarking: An International Journal	2009
Qureshi, Kumar and Kumar	Framework for benchmarking logistics performance using fuzzy AHP	International Journal of Business Performance and Supply Chain Modelling	2009
Stock and Mulki	Product returns processing: an examination of practices of manufacturers, wholesalers/distributors, and retailers	Journal of Business Logistics	2009
Autry and Griffis	Supply chain capital: the impact of structural and relational linkages on firm execution and innovation	Journal of Business Logistics	2008
Ojala, Andersson, and Naula	Linking to global logistics value chains: an imperative for developing countries	International Journal of Technological Learning, Innovation and Development	2008
Carter, Ellram and Tate	The use of social network analysis in logistics research	Journal of Business Logistics	2007
Tracey, Lim and Vonderembse	The impact of supply-chain management capabilities on business performance	Supply Chain Management: An International Journal	2005
Daugherty et al.	Reverse logistics: superior performance through focused resource commitments to information technology	Transportation Research Logistics and Transportation Review	2005
Min and Mentzer	Developing and measuring supply chain management concepts	Journal of Business Logistics	2004
Sarma, Brock and Ashton	The networked physical world	Auto-ID Center White Paper	2000
Philips and Philips	A social network analysis of business logistics and transportation	International Journal of Physical Distribution and Logistics Management	1998

Source: Authors (2018)

In addition to the 56 articles cited in Table 1, four books of classical authors (FREEMAN, 2006;KERLINGER; LEE, 2000; KILDUFF; TSAI, 2003, ZIJM et al., 2016) dealing with the subject in question, which summarized from the development of SNA and BDA, between the XX and XXI centuries, information on computer statistical software,

multivariate statistics, ethics research, social networks and their implication in organizations, IoT providing an accessible introduction to theory and practice of network analysis in the social sciences offering a clear and official guide to the overall structure of network analysis, explaining the basic concepts, technical measures and reviewing the available computer programs.

In addition to the articles and books cited, consultations were made on the WEB, on CSCMP (2018), STATISTA - The Statistics Portal (2018) and SOFIT Logistics Technology (2017).

FINAL CONSIDERATIONS

In the last decades, the Logistics Management (LM) has generated a global attention in the Supply Chain of companies (SC), showing that an organized and properly documented logistics management, with accurate information, might improve efficiency and effectiveness in organizations business.

The motivation for this research was, therefore, to gain better understanding of how SNA, BDA and IoT are, currently, being leveraged in logistics. The examples are still scarce on the subject in the form of relevant case studies. However, we conclude that, as several authors suggest and prove, the aid of technology in logistics may be very important.

The importance of the use of a multi-methodological approach on the logistics field and SCM in the measurement of economic and environmental performance was observed in the review. Considerations have been woven reflecting on the digital universe and its expansion without limits.

We have found approaches on the cultural, technological and academic phenomenon that rests on the interaction of technology, analysis and mythology that provokes extensive utopian and dystopian rhetoric, that is big data and much is said about its contribution to the world and the high expectations of entrepreneurs in relation to the use of the tool in the supply chain, however, noting that companies still find it difficult to adopt it (in the order of approximately 80% to 20% of implementation) due to the difficulty of operationalization and the high initial investment.

About the IoT, it has been observed that the main factor that makes this promising paradigm possible is the integration of various communication technologies and solutions. It is analyzed in the state of the art, a facilitator of new forms of communication between people and things and between things. Its content includes the strengths and limitations of IoT-based applications in logistics, transportation, healthcare, the environment and disasters. One notes the tremendous increase in interest in the IoT and how this can be a real business opportunity. There is evidence of annual investments by organizations in millions of dollars in developing their supply chains, developing concepts based on social network and economy literatures including suggestions for capital investments in the supply chain field and pointing out future directions for research in the network area of the supply chain.

In addition, an overview of the theory of SNA and its potential applications for logistics and SCM research is also observed. It explores how the intellectual structure of the SCM discipline has been shaped over the

past 20 years, identifying the most important challenges faced by SCM theory and practice for the new decade.

The purpose of this study is to benefit logistics professionals and academic researchers, thus contributing to fill the gap between theory and practices of the supply chain.

It is suggested that, in future works, researches must be developed presenting a greater variety of case studies in the area of organizational logistics, as well as empirical research to verify the application of the technologies addressed in this study in the logistics different segments of Brazilian companies.

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