TECHNOLOGY AND TECHNOLOGICAL CAPABILITIES IN SUPPLY CHAIN MANAGEMENT

TECNOLOGIA E CAPABILIDADES TECNOLÓGICAS NAS CADEIAS DE SUPRIMENTOS

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A B S T R A C T

The article aims to analyze the mediating effect of technologies and technological capabilities on the relationship between supply chain strategic orientation and chain performance and its impact on the target company performance. To collect data, a sample of 125 manufacturing companies sited in technological hubs in Brazil was used. The data, treated by modeling in structural equations, revealed that technology and technological capabilities mediate the relationship between the strategic orientation and the supply chain performance, in turn, impacts the focal company performance. Given these results, it was concluded that technology and technological capabilities are the best strategies to improve the relationship between the strategic orientation of the supply chain and performances for chain and company. The contribution of this paper was proof that technology and technological capabilities play an important role in performances both for the supply chain and the focal company.

K E Y W O R D S

Manufacturing capabilities. Supply chain management. Business performance. Technology. Technological capabilities

R E S U M O

O artigo objetivou analisar o efeito mediador das tecnologias e capabilidades tecnológicas na relação entre orientação estratégica da cadeia de suprimentos e desempenho da cadeia e seu impacto no desempenho da empresa foco. Para tanto utilizou-se de uma amostra com 125 empresas manufatureiras sediadas em polos tecnológicos do Brasil. Os dados coletados, tratados pela modelagem em equações estruturais, revelaram que a tecnologia e capabilidades tecnológicas medeiam totalmente a relação entre orientação estratégica da cadeia de suprimentos e desempenho da cadeia, o que, por sua vez, impacta no desempenho da empresa foco. Diante desse resultado concluiu-se que a tecnologia e capabilidades tecnológicas é a melhor estratégia para melhorar a relação entre orientação estratégica da cadeia de suprimentos e desempenhos (cadeia e empresa). O artigo deixa como contribuição dados para entender e melhorar, teórica e empiricamente, os desempenhos de cadeias de suprimentos e das empresas.

P A L A V R A S - C H A V E

Capabilidades de Manufatura. Gestão da Cadeia de Suprimentos. Desempenho dos negócios. Tecnologia. Capabilidades technologicas.

INTRODUCTION

Both globalization expansion and information technology revolution have come to be seen as factors that affect supply chain (SC) performance in recent decades. They have transformed the economy, by integrating Asia, especially China, into global value system, thereby marking the advent of data-driven instrial digitalization in order to increase competitiveness (Chen *et al*., 2019). Thus, changes are increasingly needed in the conduction of sales, data processing and processing capacity, and companies are required to respond more and more quickly to changes in customer and market behavior (Porter; Heppelmann, 2014).

The interaction easiness enhanced by digital technology among different SC agents has leds Supply Chain Management (SCM) to a critical function in the coexistence of strategic paradoxical strategical orientations, such as lean manufacturing and supply agility, called as "agile supply chain" (Ciccullo *et al*., 2018). Song, Di-Benedetto, and Nason (2007) add that in order to create economic value, sustainable competitive advantage and superior profitability, a company needs to manage technology and technological capabilities like any other activity.

However, what is becoming more and more visible is that technology and technological capabilities are factors that affect company's organizational structure (Martínez-Alonso; Martínez-Romero; Rojo-Ramírez, 2019). Adapting technology to organizational structure can provide greater dynamism to organizations and, consequently, business success (Gilson, 2010). Yet, technological advances, such as Internet, microprocessors, artificial intelligence and other innovations, involve increased sophistication in product, process and logistic technology. Kim, Jung, and Hwang (2019) found that technological advances can increase or destroy the innovation capabilities of organizational structures. Decision making about possible innovation strategies can affect company structures, in addition to making knowledge and skills highly valuable —or obsolete — depending on incorporations or technological changes in SCs (Bamgbade *et al.*, 2019). On the other hand, Hussain, Saud, and Md Isa (2015) argue that the impacts on performance are indirect and happen through technology and technological capabilities.

Therefore, this study aims to investigate the following question: do technology and their technological capabilities mediate the relationship between strategic orientation of SCM and the performances of both the chain and the individual company? Hence, the aim of the study was to examine the mediating effect of technology and technological capabilities on the relationship between supply chain strategic orientation and chain performance of the focus company.

LITERATURE REVIEW

Supply chain strategies and chain performance

Supply Chain Management can be defined in a number of ways. But careful analysis shows that almost all share the viewpoint and lines of thought. The Council of Supply Chain Management Professionals (CSCMP, 2019) emphasizes the importance of integrating functional areas activities, which should work as a single body. To that end, a close relationship with customers and suppliers is also essential, resulting in an efficient and effective SC.

Thus, it is possible to state that the way companies create mechanisms for competitiveness depends on strategies, structures and administrative mechanisms for integrating processes, suppliers, customers and stakeholders in order to create value (Porter; Heppelmann, 2014). Patel, Azadegan, and Ellram (2013) argue that SC implementation comprises the determination of two distinct and interdependent factors: strategic and structural orientation.

Krajewski, Malhotra and Riztman (2018) point out that poor performance of the SC can often be the exact result of a wrong strategy for products and services offered. Therefore, in formulating supply chain strategies, as Fisher (1997) suggested two models of SC: efficient supply chains for functional products and responsive supply chains for innovative products. Thus, adopted strategy must be focused on collaboration within and across each cluster, and based on the consensus of objectives. This will generate results across the network, in which economies of scale and efficiency will be subordinated to service, resilience and effectiveness (Stevens; Johnson, 2016).

Other studies also demonstrate the importance of strategy in supply chains. Mohammaddust *et al.* (2017), for example, investigated how SCs should be designed, and how risk mitigation strategies should be used to meet different performance objectives. Consideration of various risk mitigation strategies enables organizations to select and best combine these strategies to counteract the negative effects of risks. Gawankar, Kamble, and Raut (2016) highlighted the importance of measuring SC performance in the long term, which enables the implementation of operations strategies for the entire chain. In this sense, Boonsothonsatit (2017) believes that SC cost measures by sales and average order cycle time are critical factors in measuring SC performance, and that they are influenced by a root cause, that is, the size of the product batch. Thus, it is expected that:

H1: Supply chain strategies have a direct impact on chain performance

Supply chain strategies and technology and technological capabilities

Porter and Heppelmann (2014) stated that the level of technological investment can be treated as a political issue, and that companies with cost leadership usually invest aggressively in technology and technological capabilities. Zahra and Hayton (2008) conceptualized the types of technology policy decisions that organizations can make as: a) Aggressive technological posture: in this dimension, company uses technology proactively (Guo; GAO; CHEN, 2013); b) Automation and innovation process: this dimension is related to the level of automation of factories and facilities. These choices may show a strong inclination towards cutting edge process technology and; c) New product development: this dimension refers to the intensity of product development. Companies in this group tend to outperform their competitors in number and rate of introductions of new products. (Ghemawat, 2018).

The rapid progress of technology has turned these investment decision into a complex issue: companies must take into account that the state of the art in technology and technological capabilities becomes obsolete in a few years (Huisman, 2013). However, another factor to be addressed for this investment is the strategy implemented in SC. As pointed out by Marinagi, Trivellas, and Sakas (2014) in a survey of 76 organizations, cost, quality, delivery reliability, product innovation and time to market are no longer the only decisive sources of competitive advantage. In fact, technology used by companies have been shown to play a crucial role in establishing sustainable competitive advantages, especially in SCs. Hence, it becomes necessary to align chain's strategies with technological strategies. Qi *et al.* (2017) also corroborate this point by demonstrating that supply chain strategies are achieved through companies integration, which occurs mainly through technology. Thus, it is expected that:

H2: Supply chain strategies have a direct impact on technology and technological capabilities

Technology and technological capabilities and chain performance

Technology and technological capabilities play a dominant role in productivity growth of most nations, having provided companies with a competitive advantage. However, investing in technology and technological capabilities does not always mean reducing costs or increasing productivity. While SCM basic business processes remain the same, technology such as robots, drones, Internet of Things, Cloud Computing, Blockchain and others are making it possible for some companies to achieve levels of efficiency and responsiveness that were not previously possible (Hugos, 2018).

The benefits of adopting technology and technological capabilities include reduced labor, materials, inventory and maintenance costs, increased product variety and quality, shorter cycle times, more assertive information, timely collaboration and greater integration among chain links (Prajogo; Sohal, 2013).

A study by Reichert and Zawislak (2014) using a sample of 133 Brazilian industrial companies revealed the lack of evidence of a positive relationship between technological capability and company performance. The result was given by the Brazilian economic circumstances, considering that the country is an emerging economy in which most businesses are based on low and medium-low technology industries. Alternatively, Ortega (2010), using a sample of 233 Spanish companies in information and technological communication field, showed a positive impact of technological capabilities in relation to performance.

Qrunfleh and Tarafdar (2014) also corroborate this point by demonstrating that information systems, through their capacity for information agility, mediate the relationships between agile supply chains and their performance, meaning a positive influence. Liu, Prajogo and Oke (2016), in a survey of 202 Australian companies from seven manufacturing sectors (machinery, chemistry, food, beverages, tobacco, oil and ore) verified, among other hypotheses, the possibility of a positive relationship between the use of technology in SC and delivery performance of companies in that chain. The study proved this possibility, especially in companies with high levels of information sharing with SC partners. When accurate information is shared in the chain, technology used are proven to facilitate quick decision making that results in improved performance. So it is to be expected that:

H3: Technology and technological capabilities have a direct impact, which can be positive or null, on chain performance

Supply chain performance and company performance

Although measuring the performance of companies in joint operations is invaluable in achieving SC objectives, that has been a challenge for organizations since the early studies about SCM (Maestrini *et al.*, 2017). A number of metrics can be used to measure this performance, but various studies point to factors such as flexibility, integration and responsiveness to customer reuirements (Qrunfleh; Tarafdar, 2014; Fayezi; ZUTSHI; O'LOUGHLI, 2017).

Supply chain flexibility is an operational capability that allows chain partners to respond effectively to internal or external changes (Fayezi; ZUTSHI; O'LOUGHLI, 2017). Studies have been focused on several factors, such as that of Sanchez and Perez (2005), on flexibility, which identified that supply chain ability to adapt to changes positively impacts focal company ability to introduce and deliver the products expected by customers. More recently, Jin *et al.* (2014), in a survey of 198 North American companies, found that information sharing through technology is associated with flexibility in SC, which in turn is associated with focal company competitive performance. This finding suggests that a company should focus on supply chain flexibility to improve its performance.

Regarding integration, Ralston *et al.* (2015) pointed out that companies must align their supply chain integration strategies because they affect their ability to respond to customer demand, thereby improving their operational and financial performance. Ataseven and Nair (2017) also empirically demonstrated that internal integration, supplier integration and customer integration within the SC have a significant impact on a company's financial performance

Qrunfleh and Tarafdar (2014), among other hypotheses, tested in their work whether the SC's responsiveness was positively associated with company's performance. Through the analysis of data from 205 executives and senior managers in purchasing and SC functions of manufacturing companies in USA, the authors proved this association.

Likewise, Danese, Romano, and Formentini (2013) identified that integration practices in SC have a significant and positive impact on SC response capability, which, in turn, is beneficial to improve the company's response capability. According to Stevens and Johnson (2016), the role of supply chain and the SCM focus can be summed up as supporting companies to obtain competitive advantages especially through the focus on integration, flexibility and responsiveness. So it is to be expected that:

H4: There is a positive relationship between supply chain performance and focal company performance

Mediation role of technology and technological capabilities

If technology and technological capabilities are seen as mediators of the relationship between supply chain strategic orientation and chain performance, this means that they exercise total control of the phenomenon, that is, supply chain performance relies essentially on technology and capabilities. However, given that the terms technology and technological capabilities are confusing, it is necessary to know some definitions, or at least understand them, to facilitate their use in this study.

Technological capabilities refer to manufacturing processes, technology, new product development, production facilities and forecasting technological developments in industry. These skills are contained in the organization and are activated by the market, competitors, challenges and business opportunities. Thus, greater efficiency in production process can reduce costs and improve delivery systems and, therefore, competitiveness (Song; BENEDETTO; NASON, 2007). As can be seen from the descriptions, technology and technological capabilities can be defined in isolation or in association. The present study addresses technology and capabilities as a single concept.

Hussain, Saud, and Md Isa (2015) showed evidence about the mediating effect of technology and technological capabilities in manufacturing and industrial process companies in the United States and Malaysia, respectively. Peng *et al.* (2016) argue that companies should pay attention to functions such as coordination and optimization of SCs to improve performance, with Information Systems (ISs) helping companies in more complex operations that require faster resolution. Supported by technological capabilities, ISs help to improve business processes, with accurate information easily accessible to other departments and other companies participating in the chain (Modgil; Sharma, 2017). Qrunfleh and Tarafdar (2014) also demonstrated that supply chain ISs strategies, when used together, improve SC overall performance.

Integration of technology and technological capabilities is necessary for effective SCM, specifically by producing accurate and real-time information that improves efficiency and productivity of both companies and SCs and, consequently, customer satisfaction (Budiarto; PRABOWO; HERAWAN, 2017). Thus, it is expected that:

H1a: Technology and technological capabilities mediate the relationship between supply chain management strategies and chain performance

METHODOLOGIC PROCEDURES

Nature and Type of Research, Data Collection Instrument, and Subject of Research

The research consisted of a quantitative descriptive study, preceded by an exploratory study with 10 managers of technology companies associated with tech hubs in Brazil to study the phenomenon in greater depth and to become familiar with the research object. After that, it was proceeded to examine the mediating effect of technology and technological capabilities on the relationship among supply chain strategic orientation, chain performance, and focal company's performance from the perspective of Brazilian managers of technology hubs. Initially, categories identified in first stage were classified into the four constructs of the study: strategic orientation, technology and technological capabilities, chain performance and company performance. Each construct was associated with six measures, obtained from the interviewees' statements, thus totaling 24 observable measures. With that, was constructed a semi-structured questionnaire in a scale ranging from Totally Disagree (TD = 1) to Totally Agree (TA = 6). Before being sent to the field, the questionnaire was subjected to 10 pre-tests to assess the content, number of items, and time and degree of difficulty in answering the questionnaire.

After performing pre-tests, the questionnaires were sent by e-mail and by post to managers of 1,023 companies. With a total of 125 valid questionnaires considered, return rate is 12.22%.

Data treatments, Method Limitation and Study Delimitation

Initially, collected data were examined to assess missing data, atypical observations or extreme responses. Next, to define the underlying structure in a matrix of questionnaire responses, data were subjected to factor analysis technique to debug and establish the fundamental constructs or dimensions assumed to be inherent in the 24 original variables (Hair Jr *et al.*, 2014). Data adequacy for factor analysis was assessed by considering the main component method to predict a minimum number of variables necessary to explain the maximum part of the represented variance (Hair Jr *et al.*, 2014), an eigenvalue greater than or equal to one, Varimax rotation, and Kaizer normalization to improve constructs interpretation (Bagozzi; Yi, 2012)

To validate the measurement model, three steps were used. In the first, attention was paid to converging validities by using the Average Variance Extracted (AVE), according to Fornell and Larker criteria (Henseler; Ringle; Sinkovics, 2009), whose recommended minimum limit is 0.5. After guaranteeing convergent validity, the values of unidimensionality (or internal consistency) were evaluated, given by Cronbach's Alpha as well as those of composite reliability (CR). Cronbach's Alpha values above 0.6 or 0.7 are considered adequate in exploratory research, as well as values of 0.70 and 0.90 for CR. Finally, the discriminant validity was evaluated. In this case, Fornell and Lacker criteria (Bagozzi; Yi, 2012) were used, in which square roots of the AVE values of each construct were compared with (Pearson) correlations among the constructs.

To estimate the structural model, the partial least-squares technique was used. To that end, SmartPLS 3.0 software was used in the option 'Path Weighting Scheme', whose relationships among the constructs are linear regressions with model 'default' values, mean = 0 and standard deviation = 1, to read output values between 0 and 1, and bootstrap estimated significance for n = 125 and 5000 repetitions.

To assess the general fit of the structural model, Pearson's determination coefficients (R2) were used. R2 evaluate the portion of variance of endogenous variables, which is explained by the structural model, indicating adjusted model quality. For social and behavioral sciences area, Hair Jr *et al.* (2014) suggest that R2 = 2% be classified as a small effect, R2 = 13% as a mean effect and R2 = 26% as a large effect. In addition, the Goodness of Fit (GoF) model adequacy index was used, which is basically the geometric average between the average R2 (structural model adequacy) and the weighted average of the AVEs (Tenenhuaus *et al.*, 2005). To evaluate this indicator, Wetzels, Odekerken-Schroder, and Oppen (2009) suggest the value of 0.36 as appropriate for social sciences and behavior areas. In addition, two other indicators of model fit quality are used: relevance or predictive validity (Q2) or the Stone-Geisser indicator, and effect size (f2) or Cohen indicator (Hair Jr *et al.*, 2014).

To identify the nature of technology mediation and technological capability, it was used the variance accounted for (VAF) given by:

$$VAF = \left[\frac{\beta_{12}\, x\, \beta_{23}}{(\beta_{12}\, x\, \beta_{23}) + \beta_{13}}\right] \rightarrow \text{Equation [1]},$$

where: β12, β23 e β13 are the structural coefficients captured from the relationship among the constructs [Supply chain strategic orientation and Technology and Technological Capabilities], [Technology and Technological Capability and Chain Performance] and [Strategic supply chain orientation su and Chain Performance], respectively. The recommended values for variance accounting are: VAF> 80% means total mediation, VAF <20% does not exist mediation and 20% ≤ VAF ≤ 80% mediation is partial (Hair Jr *et al.*, 2014).

Limitations of the research method were that: a) collecting data about samples of companies in a probabilistic way was not an easy task. Research in Brazil usually uses convenient sampling; b) sample size for data analysis, using statistical technique and software, can reveal inconsistency or lack of convergence of the results. These limitations can be overcome by increasing sample size, using alternative or competing models, or alternative statistics to measure persistence, for instance, in such a way that results be convergent. Therefore, the inferences about evidenced results must be seen with reservations.

As for the study's delimitations, the main ones were: a) in terms of scope, the study was delimited to companies in technological centers in Brazil; b) regarding company's position in the chain for analysis, the work was limited to focus company, integrated with its immediate suppliers and customers (first tier or dyadic), and; c) as to the perspective, this is a transversal study, given that analysis was carried out on a sample taken only once.

RESULTS AND DISCUSSIONS

Data collected through questionnaires, in a total of 125 respondents, presented the following demographic profile:

a) Regarding respondents: 63.4% were company managers or directors; 34.1% worked in IT area, 23.6% in sales, and 16.3% in purchases and supplies; 59% had a college degree and 41% had a graduate degree; 32.2% were training in IT area and 38.7% in administration. In relation to time in the position, 31.5% had over five years in the job, and 32% had over five years in the company. Therefore, it was observed that respondents acted in areas that had an influence on SCM in the companies and were able to evaluate the central themes of the study;

b) In relation to companies: 66.9% had their business related to information technology; 31.1% of the companies were located in Campinas / SP hub; 37.7% at Belo Horizonte / MG hub; 7.2% at Blumenau / SC hub; 17.9% at Recife / PE center; 2.4% at Rio de Janeiro / RJ hub, and 3.7% at São José dos Campos / SP hub. 86.4% of the companies had up to 99 employees, and 91.2% had revenues of less than or equal to R $ 90 million reais in 2016. Therefore, the sample of companies that were part of the study was consistent with the population of companies in Brazil technological hubs.

Validation of Measurements and Model Structure Scales

Initially, data collected was examined and was found that constructs average were on the concordant side of the scal, with a minimum value of 4.25 and a maximum of 4.69. The construct with the highest average value showed the lowest standard deviation (or dispersion), equivalent to coeficent of variation of 0.17, while the one with the lowest average value, the standard deviation, was equivalent to the coeficent of variation of 0.27. These results denote the need to look more closely at the reasons for data dispersion, as well as the sample of companies or even a research protocol review.

After successive purifications, through application of factor analysis, it was defined a structural model composed of 19 variables, distributed in four constructs, as shown in Table 1. The data matrix, submitted to factor analysis, presented a KMO / MSA value equal to 0.84; Bartlett's sphericity test (Approx. Chi-Square) of 1647.44; 171 degrees of freedom, and significance of 0.000, which reinforces both that the data were adequate to carry out exploratory factor analysis and the presence of non-null correlations. It was also highlighted that all constructs had, at least, three variables, and that all variables exhibited a factor load above 0.50, meeting components' solidity criteria. To validate the measurement model, it was initially looked at convergent validities. AVE values greater than 0.5 were obtained. It was admitted, therefore, that the model converges to a satisfactory result (Bagozzi; Yi, 2012). After that, values of unidimensionality, given by Cronbach's Alpha, and CR, were evaluated. In both cases, values obtained for both Cronbach's Alpha and CR were higher than minimum recommended limits.

Table 1 - Factor load for each measure of the measurement model

CONSTRUCT / STATEMENTS			DSC	DSE	SSCM	TCapT
Chain Performance	$\bar{x}$ = 4.69; $\sigma_{\bar{x}}$ = 0.79; C_V = 0.17; α-C_R = 0.79; CC = 0.86; VME = 061; R^2 = 0.21					
	DC1	produces according to the technical specifications of the project.	**078**	0.22	0.10	0.37
	DC2	produces with quality in design and finish.	**0.78**	0.36	0.36	0.42
	DC3	produces according to the customer's need.	**0.80**	0.32	0.22	0.38
	DC4	produces according to promised delivery times.	**0.76**	0.62	0.10	0.27
Company Performance	$\bar{x}$ = 4.58; $\sigma_{\bar{x}}$ = 0.93; C_V = 0.20; α-C_R = 0.88; CC = 0.92; VME = 0.74; R^2 = 0.27					
	DE1	produces with high employee productivity.	0.60	**0.90**	0.30	0.28
	DE2	produces with low rates of rework and scrap.	0.40	**0.86**	0.26	0.33
	DE3	has technical assistance performance targets.	0.38	**0.89**	0.20	0.27
	DE4	has goals to reduce processing times and tool changes.	0.29	**0.78**	0.34	0.23
SSCM	$\bar{x}$ = 4.25; $\sigma_{\bar{x}}$ = 1.13; C_V = 0.27; α-C_R = 0.92; CC = 0.94; VME = 0.77					
	SC1	plans, with supply chain partners, promotional events.	0.21	0.31	**0.87**	0.49
	SC2	develops market forecasting with partners in the supply chain.	0.31	0.31	**0.91**	0.52
	SC3	manages the entire inventory with partners in the supply chain.	0.14	0.20	**0.93**	0.42
	SC4	plans with the supply chain partners, the variety of products.	0.15	0.19	**0.90**	0.42
	SC5	works with supply chain partners to find solutions.	0.25	0.36	**0.76**	0.35

CONSTRUCT / STATEMENTS			DSC	DSE	SSCM	TCapT
Technology and technological capabilitites	$\bar{x}$ = 4.55; $\sigma_{\bar{x}}$ = 0.80; C_V = 0.18; α-C_R = 0.87;CC = 0.90; VME = 0.61; R^2 = 0.26					
	TC1	uses electronic tools to relate to customers.	0.39	0.30	0.32	**0.76**
	TC2	uses electronic tools to understand different markets	0.29	0.30	0.43	**0.83**
	TC3	uses electronic tools to assist the sales team.	0.24	0.25	0.40	**0.74**
	TC4	has skills for efficient after-sales.	0.35	0.30	0.43	**0.78**
	TC5	able to reconcile several innovation projects in parallel.	0.38	0.15	0.38	**0.81**
	TC6	able to coordinate R&D, marketing and production.	0.45	0.23	0.42	**0.75**

NOTE 1: ALL MEASURES WERE MEASURED ON A DISAGREEMENT / AGREEMENT SCALE RANGING FROM TOTALLY DISAGREE (TD = 1) TO TOTALLY AGREE (TA = 6)
NOTE 2: ALL MEASURES WERE STATISTICALLY SIGNIFICANT FOR (A ≤ 0.01).
NOTE 3: X̄ = AVERAGE: σ_X̄ = STANDARD DEVIATION; CV = COEFFICIENT OF VARIATION; □-CR = CRONBACH'S ALPHA; CR = COMPOSITE RELIABILITY; AVE = AVERAGE VARIANCE EXTRACTED; R2 = COEFFICIENT OF DETERMINATION.
SOURCE: RESEARCH DATA

Finally, discriminant validity was evaluated. As shown in Table 2 diagonal, written in italics, square roots of AVEs are greater than correlations between constructs, denoting that constructs are independent of each other (Hair Jr *et al.*, 2014).

Table 2 - Bivariate Correlation and AVE Square Root

VARIABLES	Dis-Chain	Dis-Company	SSCM	TCap-T
Chain Performance	*0.78*			
Company Performance	*0.52***	*0.86*		
SSCM	*0.25***	*0.32***	*0.88*	
TCap-T	*0.46***	*0.32***	*0.51***	*0.78*

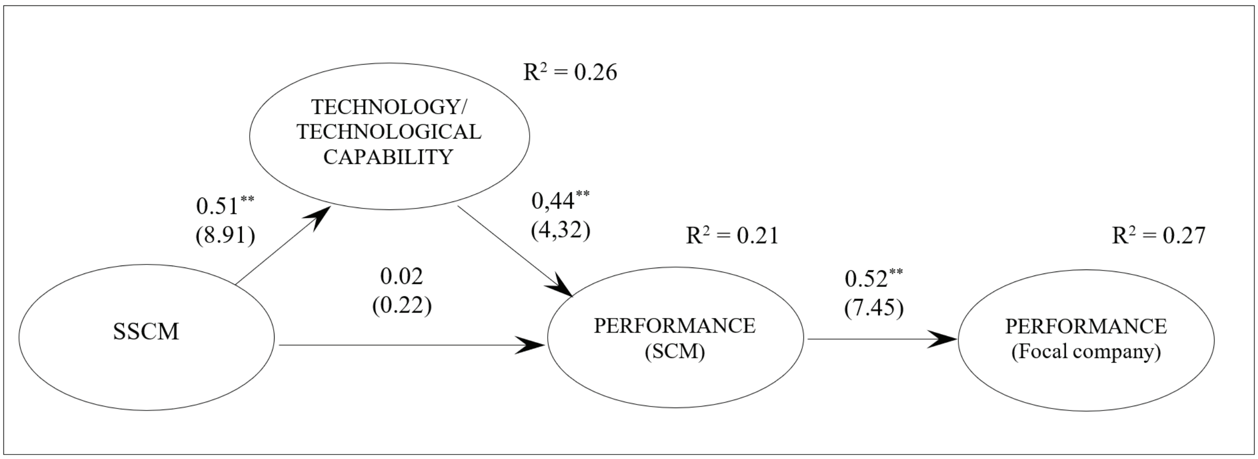
NOTE: ** INDICATES THAT THE CORRELATION COEFFICIENT IS STATISTICALLY SIGNIFICANT AT THE 1% LEVEL.
SOURCE: RESEARCH DATA

After validating measures and scales of data matrix underlying structure, it was verified statistical significance of the dependency relationships, simultaneously, of the constructs and established basis of modeling in structural equations.

Structural Equation Modeling

Applying SmartPLS 3.0 software, measurement model and respective values were generated graphically, as shown in Figure 1.

Figure 1 - Theoretical-Empirical Model



NOTES: VALUE IN PARENTHESES REPRESENTS T VALUE OF THE STATISTIC (T> 1.96 - SIGNIFICANT FOR (*) (A ≤ 0.05) LEVEL; T > 2.58 – SIGNIFICANT FOR (**) X (A ≤ 0.01) V.
SOURCE: RESEARCH DATA

Figure 1 shows that model regression coefficients between model constructs showed positive relationships with different output values between 0 and 1. Furthermore, all the path coefficients of the linear regressions were statistically significant at the level (α ≤ 0,01), except for the path coefficient of linear regression between constructs [SSCM-SCM], which was not statistically significant.

In terms of structural model adjustments, Pearson's determination coefficients (R2), the endogenous constructs, obtained values equal to 0.26; 0.21 and 0.27. Based on average value of R2, result was equal to 0.25, which can be considered as effect from mean to large. However, Tenenhuaus *et al.* (2005) proposed an overall GoF index. Thus, when performing calculation, the value of 0.41 was obtained, indicating that model has an adequate adjustment. As for the two indicators of model fit quality, relevance or predictive validity (Q2) or Stone-Geisser indicator and Effect Size (f2) or Cohen indicator, results are shown in Table 3.

Table 3 - Values of predictive validity (Q2) and effect size (f2) indicators

CONSTRUCT	CV RED (Q^2)	CV COM (f^2)
SSCM	0.64	0.64
TCap-T (Chain)	0.14	0.44
Chain Performance	0.10	0.34
Company Performance	0.16	0.50
Reference values	$Q^2 > 0$	f^2 = 0.02- smal effect; 0.15- mean effect, and 0.35- large effect

CV RED = CROSS-VALIDATED REDUNDANCY; CV COM = CROSS-VALIDATED COMMUNALITY
SOURCE: RESEARCH DATA

Results interpretation, according to Table 3, shows that (Q2) indicator exhibited positive values, which reinforced that model approached what was expected of it, or the quality of the model's prediction or the accuracy of the adjusted model. Hair Jr *et al.* (2014) suggest that a perfect model would have (Q2) = 1, which denotes that model reflects reality, that is, without errors.

With regard to (f2) indicator, it exhibited large effect values, which denotes how much each construct was useful for adjusting the model (Hair Jr *et al.*, 2014). Specifically, for (f2) indicator, related to construct Technology and Technological Capability (TCap-T), the value of 0.34 was obtained, approximately, in the upper limit of mean effect. In summary, both values of (Q2) and (f2) indicated that the model is accurate and that the constructs were important for adjusting the model.

Next, Table 4 shows the statistical significance of the relationships among model constructs, the 'bootstrapping' module of the Smart PLS 3.0 software defined for n = 125 and 5000 repetitions.

Table 4 - Structural coefficients and hypothesis test

STRUCUTURAL RELATIONSHIP	STRUCTURAL COEFFICIENTS	STANDARD DEVIATION	T VALUE	HYPO THESIS	DECISION
Dis-Chain→ Dis-Company	0.52	0.07	7.45	H4**	Supports
SSCM → Chain Performance (β13)	0.02	0.11	0.22	H1	Not Suport
SSCM → TCap-T (β12)	0.51	0.06	8.91	H2**	Supports
TCap-T → Chain Performance (β23)	0.44	0.10	4.32	H3**	Supports

NOTA: (**) < 0.01: LEVEL OF SIGNIFICANCE (T > 2.58); (*) < 0.05: LEVEL OF SIGNIFICANCE (T > 1.96)
SOURCE: RESEARCH DATA

It is observed, therefore, that at levels of statistical significance ($\alpha \leq 0,01$), the correlations and regression coefficients are significant, thus supporting hypotheses H2, H3 and H4. However, for hypothesis H1 it can be inferred that there is insufficient evidence regarding the direct impact of [SSCM] on [Chain Performance]. This result shows the mediating nature of the [TCap-T] factor in relationship between [SSCM] and [Chain Performance].

Previous studies have explored the relationship between chain performance and company performance (Sanchez; Perez, 2005; Danese; ROMANO; FORMENTINI, 2013). The main argument is that if the SC works well, that is, if it achieves integration with customers and suppliers, it becomes flexible and ready to respond to customers, directly benefiting focal company in terms of improving price performance, quality and delivery times of its products (Ataseven; Nair, 2017; Qrunfleh; Tarafdar, 2014; Stevens; Johnson, 2016). Hence, hypothesis H4 is significant because it relates supply chain performance to focal company performance.

To further explore the impact of strategic supply chain orientation on chain and focal company performance, it was examined the mediating effect of technology and technological capabilities on the relationship between strategic orientation and chain performance, which in turn, impacts focal company performance. To better understand the mediation, Table 5 shows the direct, indirect and total effects of exogenous constructs on the endogenous constructs in the measurement model.

Table 5 - Direct, Indirect and Total effects of the constructs in the measurement model

CONSTRUCTS	PERFORMANCE			
	SCM			Focal company
	Direct Effect	Indirect Effect	Total Effect	Direct effect
SSCM	0.02	0.22(*)	0.24	-
TCap-T (Chain)	0.44	-	0.44	-
SCM performance	-	-	-	0.52

NOTE(*) 0.51 * 0.44 = 0.22]
SOURCE: RESEARCH DATA.

Table 5 shows that, with the insertion of Technology, the total effect of 0.02 was increased to 0.24, denoting the mediating effect of Technology variable in the relationship between supply chain strategic orientation and chain performance. To check the nature of the mediating effect, whether total or partial, it was applied Accounting Variance (VAF) test, presented in [Equation 1], whose parameters were extracted from Table 4, with values for $\beta 12 = 0.51$; $\beta 23 = 0.44$ e $\beta 13 = 0.02$, obtaining : $VAF = \frac{0.51 \ x \ 0.44}{(0.51 \ x \ 0.44) + 0.02} = 0,92$. The value 0.92, according to Hair Jr *et al.* (2014) approach, shows that VAF> 0.80 and, therefore, mediation effect was considered total. Consequently, hypothesis H1a was fully supported by the assessment of the variance accounted for (VAF) proposed by Hair Jr *et al.* (2014).

Table 5 also shows that the direct effect of [Chain Performance] construct on [Focals Company Performance] is 0.52. This means that by increasing the exogenous construct [Chain Performance] by 1 unit, the endogenous construct [Focal Company Performance] increases by 0.52 units, which is undeniably a good effect.

CONCLUSIONS

The study revealed that technology and technological capabilities mediate the relationship between supply chain strategic orientation and chain performance, which, in turn, impacts the performance of the focal company. This result provides theoretical and managerial implications, as discussed next.

Theoretical implications

The result contributes to the theory by enhancing the understanding of the associations among technology, technological capabilities, strategic orientation and SC and focal company performances. The last link in a SC is the final consumer, the only one who has the real currency. When making a purchase, this consumer will trigger productive actions and transfer portions of the real currency to companies located up the chain. In disputes over these portions of the real currency, intense relations of cooperation and conflict among companies will be established. Thus, the individual success will depend on how much value a company will be able to add to the SC.

According to Krajewski, Malhotra, and Riztman (2018), technology, among factors that drive increased competition between SCs, is perhaps the most important resource for a company to add value to its SC. Companies that invest in new technology and implement them generally have more solid financial conditions than those that do not. However, relationship between technology and competitiveness is often not understood. Technology and technological capabilities in themselves do not always represent the best option. They may not create competitive advantage, they may not be economically justified, they may not adapt to desired profile of competitive priorities or they may not increase company's fundamental skills. Investments in new technology generate new technological capabilities, new administrative needs or even new business models, which must go together.

The basic relevance of the mediating variable, as well as the antecedent one, is the fact that any asymmetric relationship between two variables is an abstraction made from an endless causal chain and, the greater the understanding about the links in that chain, the better the understanding of their relationship. In this sense, scientific explanations show their scope and limits. Theoretical contribution of this study was to prove the relevance of technology and technological capabilities as a mediating effect between supply chain strategy and chain performance, directly influencing companies results.

Implications for managers

The result, for management practices, provides administrators with useful information about the adoption of technology and technological capabilities under different levels of supply chain strategic orientation. It was demonstrated that technology and technological capabiities play an important role in performances both for the supply chain and the focal company.

Although each process and information technology is a powerful tool in itself and can be adopted separately, its benefits grow exponentially when they are integrated into each other.

In this new environment of using digital technology, administrators must be able to interpret the information that comes from the equipment, apply it creatively and find ways to add value. This is obviously not an easy task. Information or manufacturing processes technology are allies, as long as individuals be willing to learn from them.

To increase productivity and compete globally, a company's decision makers are unlikely to succeed if they only consider, naively, transposing electro-mechanical technology to digital formats. Technology generates new management models, thereby requiring attention to technological capabilities associated with workforce competency, so as not to have an asset that does not add value to the company. The fact that Brazilian productivity is low is an indicative that companies in the country poorly invest in process, information and training technology to adapt to the necessary skills required by the full use of the technology capacities.

Thus, given the results of this research, it can be concluded that technology and technological capabilities are important resources for productivity and competitiveness. For companies that operate in supply chains, being more successful means being able to minimize the risks of investments in technological resources (technology and technological capabilities).

Finally, it is suggested that future researchers: a) conduct longitudinal studies in which data collection could be focused on a smaller number of companies, but with greater representativeness; b) develop a computational model that uses different simulation rounds in order to evaluate the effect of changes on the model's control variables, and c) develop scenarios of moderation, or even mediation, of technology and technological capabilities.

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