Domenek, Antonio Carlos; Giro Moori, Roberto; Vitorino Filho, Valdir Antonio
The mediating effect of operational capabilities on operational performance
Revista de Gestão, vol. 29, no. 4, 2022, October-December, pp. 350-366
Universidade de São Paulo
Brasil

Received 27 January 2021
Revised 2 June 2021
17 July 2021
15 December 2021
7 February 2022
Accepted 8 March 2022

The mediating effect of operational capabilities on operational performance

Antonio Carlos Domenek and Roberto Giro Moori
Social and Applied Sciences Center, Mackenzie Presbyterian University, São Paulo, Brazil, and
Valdir Antonio Vitorino Filho
Federal Institute of São Paulo, São Paulo, Brazil

Abstract

Purpose – Collaboration and operational capabilities are two strengths for managing supply chains to achieve operational performance. In this context, this study aims to analyze the mediating effect of operational capabilities on the relationship between collaborative supply chain management and operational performance.

Design/methodology/approach – The study design consisted of a theoretical framework to estimate the mediation paths by latent variable structural modeling methods. A survey of 138 respondents from Brazilian capital goods companies was conducted.

Findings – The study revealed that operational capabilities partially mediate the relationship between collaborative supply chain management and operational performance. The findings provide important guidance for managers to strengthen the relationship with suppliers to continuously improve operational capability.

Research limitations/implications – As the sample size was made up of 138 respondents, it was impossible to revalidate the theoretical–empirical model. New data need to be collected to re-evaluate the structural model and expand them to other economic segments.

Practical implications – By examining the theoretical insights and empirical findings, the study expanded knowledge about collaborative management and the understanding of the importance of operational capabilities in the relationship between collaborative management and operational performance for management practices.

Originality/value – The study developed a theoretical–empirical measurement model, reliable and statistically validated, to test the mediating effect of operational capabilities in the relationship between collaborative management and operational performance.

Keywords Operational capabilities, Collaborative supply chain management, Operational performance

Paper type Research paper

1. Introduction

Companies operating in a supply chain offer greater added value to their customers, with products of higher quality and lower cost, in addition to improving the performance of the company and the chain in the long term (Qrunfleh & Tarafdar, 2013).

The authors would like to thank the editors and the reviewers for their excellent guidance and valuable comments. This study was supported by Brazilian Agencies: Research Mackenzie Fund, National Council for Scientific and Technological Development, and Coordination for the Improvement of Higher Education Personnel.

Revista de Gestão
Vol. 29 No. 4, 2022
pp. 350-366
Emerald Publishing Limited
e-ISSN: 2177-8736
p-ISSN: 1809-2276
DOI 10.1108/REGE-01-2021-0016

The capital goods industry has always experienced technological changes, which led to integration in supply chains, to face international competition for providing low-cost and quality products and services to customers (Puga & Castro, 2018).

Companies have increasingly acknowledged that collaborative management practices in supply chains are essential to improve their strategies and meet their partners' performance (Wu & Chiu, 2018). Nevertheless, Narayanan, Narasimhan and Schoenherr (2015) argue that collaborative management has practical implications in establishing the right level between collaboration and performance, since it is a non-linear relationship.

Other studies indicate that many collaborations in the supply chain fail due to a corporate culture incompatible with the complexities involved (Zhang & Cao, 2018). Indeed, there is not a single combination of market, product or partner characteristics that drive the supply chain, but different combinations that can lead to collaborative management (Ellran & Cooper, 2014).

One of them is to use operational capabilities as a mediating factor or intermediation strategy in the relationship between collaborative management and operational performance. Swink, Narasimhan and Wang (2007), when testing the mediating effect of operational capabilities on the relationship between four types of integration activities and business performance, found that each type of integration activity had unique benefits and disadvantages.

Therefore, as the studies show, the relationship between the constructs of collaborative supply chain management, operational capabilities and operational performance is not evident. Given these gaps and uncertainties, this study aimed to answer the following question: do operational capabilities mediate the relationship between collaborative supply chain management and operational performance in Brazilian companies of the capital goods industry? We chose this sector because of its relevance in productive investments, knowledge transfer and diffusion of technical progress for its users.

We structured the article as follows. After this introduction, Section 2presents the theoretical framework and the hypotheses for estimating the theoretical and empirical model. Section 3 explains the methodology, Section 4, the results and discussion, and Section 5, the conclusions and suggestions for further research.

2. Theoretical framework and hypotheses

To examine the mediating effect of operational capabilities, we considered the basic causal chain involved in mediation (Baron & Kenny, 1986), shown in Figure 1.

Baron and Kenny's approach (1986) was adjusted by Iacobucci, Saldanha and Deng (2007), according to the assumption that there is some mediation of operational capabilities when the hypotheses of both paths [collaborative supply chain management → operational capabilities] and [operational capabilities → operational performance] are significant, i.e. H2 and H3 are not rejected. However, if either one is not significant, there is no mediation, and the analysis should end. To test and categorize the mediating effect of operational capabilities (if partial or total), we used the variance accounted for (VAF) test, because it is stronger (Hair, Hult, Ringle & Sarstedt, 2014) than the Sobel test (Baron & Kenny, 1986).

Figure 1 shows the theoretical support for testing the statistical significance of H1, H2 and H3, detailed below.

2.1 The influence of collaborative supply chain management on operational performance

The supply chain is a process that takes into consideration all companies involved, in both directions, upstream and downstream, from the first raw material supplier to the final consumer (Sukati, Hamid, Baharun & Yusoff, 2012). Supply chain management comprises a set of methods and techniques to improve the integration and management of all indicators in

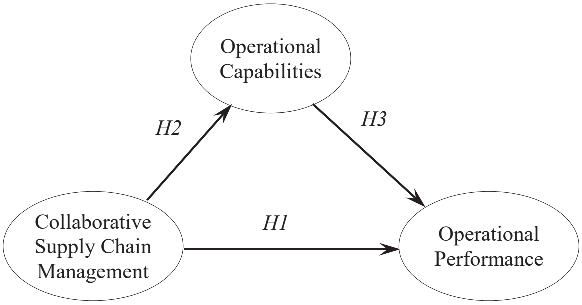


Figure 1.
Conceptual framework

the chain, such as transportation, inventories and costs (Moyano-Fuentes, Bruque-Camara & Maqueira-Marin, 2019).

Among the possible strategies, collaborative management practices stand out in companies of the supply chain, which are based on interdependence and collaboration between them (Ellran & Cooper, 2014).

Collaborative supply chain management can be defined as a process of joint responsibility for decision-making among chain partners (Soosay & Hyland, 2015); the basic assumptions are forming partnerships, investing in resources and sharing information, rewards and responsibilities (Cao & Zhang, 2011).

The ability to plan and carry out tasks together with partners in the supply chain has enabled companies to integrate operations more efficiently (Soosay & Hyland, 2015). However, a multi-case survey conducted by Fawcett, McCarter, Fawcett, Webb and Magnan (2015) in the USA and Europe, with 15 companies, showed that the sociological and structural elements of resistance led to the failure of collaborative management initiatives.

For a collaborative supply chain management to effectively contribute to improve operational performance, companies must seek some factors (Wu, Melnyk & Swink, 2012), such as a mutual understanding of the goals of the companies participating in the chain, and their commitment to search solutions for common problems. The main focus of collaborative supply chain management is sharing information and similar values for achieving similar goals among the partners (Cao & Zhang, 2011); the exchange of information must be open and reciprocal (Vanpoucke, Vereecke & Muylle, 2017).

A study with 189 executives from different firms in Thailand found that "secure sharing of information" was the most important factor in fostering collaboration (Panahifar, Byrne, Salam & Heavey, 2018). Thus, we formulated H1:

H1. Collaborative supply chain management positively affects operational performance.

2.2 The influence of collaborative supply chain management on operational capabilities

Operational capabilities mean quality, flexibility and delivery, which a company needs to compete strategically (Vanpoucke *et al.*, 2017). They comprise distinct factors in operations' strategy (Wu *et al.*, 2012) and integrate a set of a company's skills (Teece, 2019; Zhang, Pawar, Shah & Mehta, 2013), to improve the outputs through a more efficient use of its productive capacities, technologies and material flow (Zhang *et al.*, 2013). They provide superior operational performance regarding its competitors (Ojha, Gianiodis & Manuj, 2013).

Collaboration must prioritize a long-term relationship among the companies participating in the chain and focus on increasing each company's operational capabilities (Wong & Wong, 2011). Integration between companies and suppliers improves operational capabilities (Abdallah, Obeidat & Aqqad, 2014) and is critical for achieving an impressive performance (Wu & Chiu, 2018). A systematic review conducted by Soosay and Hyland (2015) showed that dynamic capabilities are one of the organizational theories that support collaboration, which allows a company to access, change and leverage supply chain resources to respond to the evolution of a competitive environment.

Regarding quality, operational capabilities can be measured by the supply of better products and services (Nand, Singh, & Bhattacharya, 2014), by the production process, which ensures that the equipment and services follow customers' requirements, and by the manufacture of equipment whose performance exceeds customers' expectations (Avella, Vazquez-Bustelo & Fernandez, 2011). In a collaborative supply chain, sharing knowledge and experience contributes to develop a mutual understanding of the circumstances that affect companies and helps developing core capabilities to address common challenges (Herczeg, Akkerman & Hauschild, 2018).

For delivery-related operational capabilities, what stands out are the service performance indicators for all delivery terms agreed in purchase orders and contracts (Nand *et al.*, 2014). As for the specification flexibility, technical changes in the product during its production (Qrunfleh & Tarafdar, 2013), to adjust its delivery to customer's needs (Nand *et al.*, 2014) and for the supply flexibility, the ability to meet unexpected changes in supply (Malhotra & Mackelprang, 2012). Therefore, we developed H2:

H2. Collaborative supply chain management positively affects operational capabilities.

2.3 The influence of operational capabilities on operational performance

The activities carried out in a supply chain relate directly to operational performance (Prajogo, Huo & Han, 2012). Performance improvement is one of the most important goals for implementing a collaborative supply chain management (Ou, Liu, Hung & Yen, 2010).

Therefore, the concepts of competitive advantage and improvement in performance regarding competitors are crucial (Danese & Romano, 2011). Additionally, the collaboration itself can be a strategic resource or a capability that is unique, valuable and hard to replicate, thereby providing a competitive advantage (Fawcett *et al.*, 2015).

Operational capabilities represent how companies can achieve a better performance (Ralston, Grawe & Daugherty, 2013). They comprise improvement in the operational performance, in terms of more efficient production processes and productivity standards higher than market standards (Cao & Zhang, 2011); the search for reducing stops due to unforeseen production reprogramming (Lee, Kim, Hong & Lee, 2010); and reducing the total cost of logistics, with inventories, storage and transportation (Fawcett *et al.*, 2015).

Another important issue is the possibility of increasing the supply chain resilience, through operational capabilities arising from underlying and interdependent mechanisms within the supply chain, such as deliveries' speed, visibility of the material flow and flexibility of the production process (Scholten & Schilder, 2015). Wong, Lai, Cheng and Lun (2015) developed a study on information technology (IT) capabilities, with a sample of 188 Hong Kong wholesale trade companies. They found that an IT collaborative decision-making mediated the relationship between inter-organizational integration and customer service. That performance required a high level of IT infrastructure, which highlights the importance of information technology in collaborative decision-making for achieving performance benefits.

The operational capabilities that manifest themselves through product design and development, just-in-time and quality management efforts (Tan, Kannan & Narasimhan, 2007) are connected with dynamic capabilities, as shown by Cepeda and Vera (2007), in a sample of 107 Spanish companies in information and communication technology. However, Helfat and Winter (2011) observe that the borderline between dynamic and operational capabilities is not very clear.

The reduction of rework costs due to problems in materials, services and components, in addition to production costs lower than market standards (Wu *et al.*, 2012), was also mentioned in the literature as operational capabilities that influence operational performance. Thus, we developed H3:

H3. Operational capabilities positively affect operational performance.

2.4 Mediation of operational capabilities in the relationship between collaborative supply chain management and operational performance

The competitive market, globalized and in continuous change, requires products and services of low cost, better quality, with faster and more reliable deliveries (Thatte, Rao & Ragu-Nathan, 2013). Therefore, collaboration is a practice in the supply chain that can improve members' performance (Fawcett *et al.*, 2015).

According to Wu *et al.* (2012), operational capabilities can foster improvements in the supply chain, such as increasing efficiency or creating higher added value for customers. Such capabilities comprise a set of skills, competencies, processes and routines that mitigate or solve problems by reconfiguring its operational resources. A supply chain with a high level of collaborative management practices, which can integrate its processes and share information, will achieve operational capabilities of flexibility, quality and delivery (Vanpoucke *et al.*, 2017).

Qrunfleh and Tarafdar (2013) checked the mediation relationship between the partnership with strategic suppliers and postponements, as practices and strategies of lean and agile chains, through the response capacity of the supply chain. Hsu, Tan, Kannan and Leong (2009) identified that operational capabilities, such as new product design, total quality management and just-in-time, mediate the relationship between collaborative practices in the supply chain and operational performance.

More recently, Vanpoucke *et al.* (2017) carried out a study with a global sample of 563 respondents in the industrial sector, to test a mediation framework for moderating upstream and downstream integration, which links integration tactics to operational performance. The results showed that the operational integration of the supply chain is indispensable to capture the benefits of information exchange, although the use of IT was stronger in upstream integration.

The operational capabilities manifested in innovation were the object of a study by Liao, Hu and Ding (2017), in a sample of 74 firms and 465 questionnaires, from the upstream, middle and downstream manufactures of Taiwan networking communication industry. The results showed that the relationship between supply chain collaboration value innovation, supply chain capability and competitive advantage can have a positive impact, and supply chain capability is a full mediator between supply chain collaboration value innovation and competitive advantage. Thus, we developed H1a:

H1a. Operational capabilities mediate the relationship between collaborative supply chain management and operational performance.

2.4.1 Control variables. We examined other factors in addition to the independent variables considered in the model of Figure 1 to assess if they affected the relationship response between independent and dependent variables. We tested ten elements as control variables: job title, respondent's position, higher education, time in current position, time in company, firm size, annual revenue, type of relationship, length of time with suppliers and purchase motivation factor, as shown in Table 1.

3. Methodology

3.1 Development of survey instrument and data collection

The study was descriptive, and we used a quantitative method to build, test and validate the theoretical and empirical models. Previously, we carried out an exploratory study with ten

Demographic dimension	Frequency	(%) of sample
1. Job title		
Director	25	18.1
Manager	72	52.2
Team leader	13	9.4
Others	28	20.3
2. Respondent position		
Supply chain management	16	11.6
Purchase	26	18.8
Production/manufacturing	22	15.9
Sales	59	42.8
Operations/logistics	15	10.9
3. Higher education		
Business management	39	28.3
Engineering	73	52.9
Economy	5	3.6
Others	21	15.2
4. Time in current position		
$\leq$ 2 years	15	10.9
2 $\leq$ years $\leq$ 5	26	18.8
$\geq$ 5 years	97	70.3
5. Time in company		
$\leq$ 2 years	8	5.8
2 $\leq$ years $\leq$ 5	26	18.8
$\geq$ 5 years	104	75.4
6. Firm size (n. of employees)		
$\leq$ 99 employees	61	44.2
100 $\leq$ employees $\leq$ 499	28	20.3
$\geq$ 500 employees	49	35.5
7. Annual revenue (R$m)		
$\leq$ R$90m	74	53.6
90 $\leq$ R$ million $\leq$ 300	17	12.3
$\geq$ R$300m	47	34.1
8. Types of relationship		
Alliance	92	66.7
Legal contract	14	10.1
Cash purchase	12	8.7
Trust collaboration	20	14.5
9. Time with suppliers		
$\leq$ 1 year	1	0.7
1 $\leq$ years $\leq$ 5	25	18.0
$\geq$ 5 years	112	81.2
10. Motivation for buying		
Innovation	87	63.0
Replacement	50	36.2
Tax incentives	1	0.7

Table 1. Respondents' demographic characteristics

managers of capital goods' companies to obtain additional data and assist in preparing the questionnaire statements. Later, we collected data through the questionnaire, which had two blocks, based on the theoretical framework. The first block referred to data from respondents and the company. The second referred to the constructs: collaborative supply chain management, operational capabilities and operational performance. In this block, we also asked respondents to mark the level of disagreement on a Likert-type scale, ranging from totally disagree (TD = 1) to totally agree (TA = 5) regarding the measure of the respective construct.

Before data collection, we submitted the questionnaire to a pre-test with ten respondents, to improve clarity and change unclear or unfamiliar words. Then, for ease of access, we chose a sample of member companies of the Brazilian Association of Machinery and Equipment Industry (ABIMAQ). We sent the questionnaires by e-mail to managers related to supply chain management, together with a letter of introduction explaining the research objectives. Next, we estimated the minimum sample size with the parameterized G*Power 3.1.9.4 application [effect size (f^2) = 0.15; α err prob = 0.05; power ($1 - \beta_{err}$ prob) = 0.80; number of predictors = 2], which indicated a sample size of 68. However, Ringle, Silva and Bido (2014) suggest using twice or triple this value, to have a more consistent model.

3.2 Data treatment

Initially, we examined the data to identify non-standard responses and missing data resulting from incomplete questionnaires. Then, we submitted data to factor analysis, to examine latent variables or relationships, due to the large number of variables used, and determine if the information could be summarized into a smaller set of factors or components. In this stage, we used the following tests:

(1) One-dimensionality given by Cronbach's alpha coefficient, whose minimum limit is 0.7;

(2) Composite reliability (CR), which has a fair value higher than 0.7 (Hair *et al.*, 2014);

(3) Content validity, in the exploratory study and pre-tests;

(4) Convergent validity, obtained by observing the average variance extracted (AVE), whose value should be higher than 0.5; and

(5) Discriminant validity, observed by comparing the square roots of AVEs values of each construct, with the correlations among the constructs.

The square roots of AVEs must be higher than the correlations between those of the constructs (Henseler, Ringle & Sinkovics, 2009). We did Harman's one-factor test by using exploratory factor analysis, to examine the possibility of a common method bias, since there was only one respondent for each questionnaire; there is a bias when the solution extracted from a single factor exceeds 50% (Podsakoff, MacKenzie & Podsakoff, 2003).

Next, to test the statistical significance of the dependency relationships and estimate a measurement model, as shown in Figure 1, we used the partial least squares-path modeling (PLS-PM) technique. We used Pearson's determination coefficient (R^2) to fit the data to the measurement model. According to Cohen (1988), for social and behavioral sciences, $R^2 = 2\%$ is considered a small effect; $R^2 = 13\%$ a medium effect; and $R^2 = 26\%$ as a large effect. We also used two other indicators of model fit quality: Relevance or predictive validity (Q^2), or Stone–Geisser indicator, whose criteria values of $Q^2 > 0$ are adopted (Hair *et al.*, 2014); and effect size (f^2), or Cohen's indicator, whose values of 0.2, 0.15 and 0.35 are considered small, medium and large, respectively (Hair *et al.*, 2014). To test and categorize the mediating effect, we used the VAF, given by: VAF c-cĔrroPadrão $= \left[\frac{\beta_{12}\ x\ \beta_{23}}{(\beta_{12}\ x\ \beta_{23}) + \beta_{13}}\right]$ → Equation (1), where: β_{12}, β_{23} and β_{13} are the structural coefficients captured from the relationship between the constructs [collaborative supply chain management and operational capabilities], [operational capabilities and operational performance] and [collaborative supply chain management and operational performance], respectively. The recommended values for variance accounting are: VAF > 80% means total mediation; VAF < 20%, there is no mediation; and 20% ≤ VAF ≤ 80% means a partial mediation (Hair *et al.*, 2014).

We chose VAF over the Sobel test, which is common in the studies by Baron and Kenny (1986) and Iacobucci *et al.* (2007) because Hair *et al.* (2014) consider that the Sobel test is insensitive for confirming the mediating effect. We used software SmartPls version 3.0 to handle the data.

3.2.1 Method limitation. The limitations of the research method were due to: (1) the sample size was 138 respondents, making it impossible to revalidate the theoretical–empirical model; (2) the operational capabilities construct comprised four practices, although there are other practices that we did not examine. However, regardless of the operational capabilities chosen for mediating a relationship between strategic collaboration integration and operational performance, the benefits do not seem to be universal, as shown by Swink *et al.* (2007). Because of this limitation, it is unclear if our findings could be applied to a broader set of operational capabilities.

4. Results and discussion

We collected data between 2015 and 2016. We sent 1,200 questionnaires to ABIMAQ. We received 138 answers, representing 11.5%, within the limit recommended by the G*Power 3.1.9.4 application (Ringle *et al.*, 2014).

4.1 Sample profile

The sample spans show a diversity of responses – senior managers, firm sizes and time of relationship with suppliers. Table 1 provides descriptive data of the sample.

4.2 Validation of the measures and scales of the constructs

The techniques of confirmatory factor analysis cleared the data collected from the 138 respondents in the Brazilian capital goods industry. Table 2 shows the results for factor loadings, α-Cronbach, AVE and CR.

Measurements showed factor loadings between 0.74 and 0.85. As for unidimensionality, all constructs had α-Cronbach values above 0.77, i.e. above the acceptability limit of 0.7 (Hair *et al.*, 2014). The CR presented values between 0.85 and 0.90, whose recommended limit is 0.7 (Hair *et al.*, 2014). Regarding the AVE, the values achieved were between 0.59 and 0.63, showing that the constructs had well-chosen characteristics, so the test measured the one it intended to, and not the underlying one (Hair *et al.*, 2014). As for the convergent validity, assessed by Fornell and Larcker's criterion, and given by the observations of the AVEs, the values were above the recommended minimum of 0.5. For the discriminant validity, we observed correlations among the latent variables smaller than the square root of the AVE (Henseler *et al.*, 2009).

Table 3 shows the bivariate correlation coefficients among the constructs and the square root of the AVE (diagonal of the matrix).

In addition, as shown in Table 3, the constructs' mean values ranged from 4.26 to 4.50, on a scale between 1 (totally disagree) and 5 (totally agree), and standard deviations ranged from 0.55 to 0.64. These values showed that the responses tended to agree with the questions. When debugging the collected data from the original numbers of 15 measurements, 13 measurements remained: five related to collaborative supply chain management, four related to operational capabilities and four related to operational performance. These measures were

Table 2.
Factor loadings for each measure of the measurement model

Construct/assertion	Factor loading	Construct statistics
Collaborative supply chain management		
Mutual understanding of goals among companies	0.78	α-Cronbach = 0.86
Organizations' commitment to find solutions to common problems	0.85	AVE = 0.63
Technical and organizational support to meet shared goals	0.80	CR = 0.90
Open and reciprocal information exchange among partners	0.72	
Alignment to meet common strategic goals	0.82	
Operational performance		
Productivity standards were higher than market standards	0.78	α-Cronbach = 0.77
Productive processes have become more efficient	0.79	AVE = 0.59
Production costs were lower, compared to market standards	0.74	CR = 0.85
Reduction of unplanned downtime due to production reprogramming	0.76	
Operational capabilities		
Provide superior quality products and services	0.77	α-Cronbach = 0.85
Manufacturing equipment with performance that exceeds customers' expectations	0.78	AVE = 0.90 CR = 0.86
The quality of the production process ensuring equipment and services according to customers' requirements	0.81	
Ability to quickly meet the needs for materials and services requested by customers	0.74	

Note(s): All measures were statistically significant at $p < 0.01$

lost due to their low factor loading. The bivariate correlation coefficients are all positive and significant for ($\alpha \leq 0.05$), showing structural relationships.

The control variables, managerial position and time in function, both have significant effects ($p < 0.05$, path coefficients of 0.22 and 0.23 to collaborative supply chain management and operational performance, respectively). These results show the importance of administrative management and operational employees that work in the factory floor, who can be relevant forces to achieve outputs, in addition to the independent variables considered in the study.

To assess the common method bias, we used Harman's single-factor test, which resulted in the solution of a single group from factor analysis, the total variance extracted from 41.82%, showing that there was no problem related to the common method bias.

In the sequence, we tested the statistical significance of the structural relationships of the model, using the SmartPls 3.0.

4.3 Evaluation of the structural model

For better understanding data analysis and results, we built two representative models of the study. The first model had no control variables, and the second included control variables, as shown in Figures 2a and b.

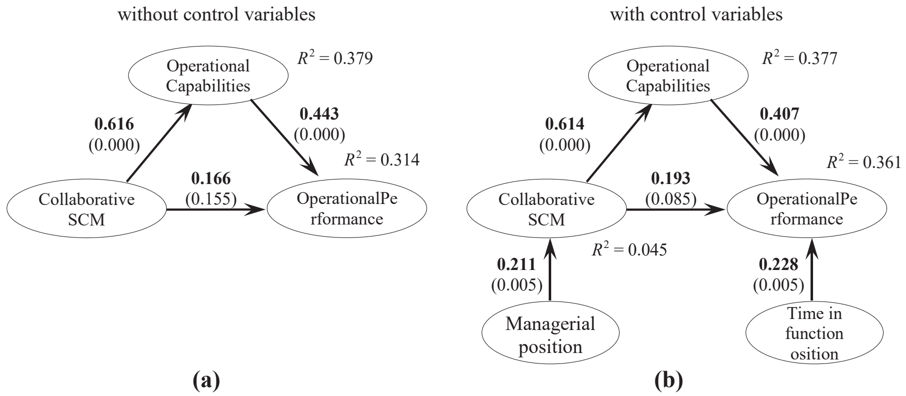
In Figure 2, we observe that Models 1 and 2 presented the structural coefficient for collaborative supply chain management ($\beta_1 = 0.166$, $p \leq 0.155$; $\beta_2 = 0.193$, $p \leq 0.085$), and neither model showed a problem of multicollinearity, as VIF had a value below 5, as seen in Table 4. Comparing the two models, the method bias was estimated at 0.027, i.e. despite an overestimation of the structural coefficient, this bias is small, and Model 2 represents the structural coefficient (0.193, $p < 0.085$) unbiased.

Therefore, being Model 2 unbiased, we assessed how much of the operational performance variance is explained only by operational capabilities. |To do this, the structural coefficient

Table 3. Mean, standard deviations, correlation, control variable and discriminant validation among the main variables

	Mean	Std. dev	CSC	OPF	OCP	1	2	3	4	5	6	7	8	9	10
Main variables															
Collaborative supply chain management	4.26	0.64	0.79												
Operational performance	4.27	0.63	0.40**	0.77											
Operational capabilities	4.50	0.55	0.58**	0.53**	0.77										
Control variables															
Managerial position	NA	NA	0.22**	0.01	0.03	1									
Respondent position	NA	NA	−0.08	0.03	−0.07	−0.15	1								
Higher education	NA	NA	−0.13	0.01	−0.04	0.09	−0.01	1							
Time in current position	NA	NA	−0.06	0.23**	0.07	−0.17*	0.16	0.03	1						
Time in company	NA	NA	−0.14	0.03	−0.05	−0.26**	0.15	−0.02	0.58**	1					
Firm size	NA	NA	−0.02	0.08	0.16	0.17*	−0.26**	−0.05	−0.04	0.05	1				
Annual revenue	NA	NA	−0.03	0.04	0.14	0.12	−0.25**	−0.07	−0.04	0.02	0.87**	1			
Type of relationship	NA	NA	−0.08	0.02	−0.10	−0.08	−0.01	−0.03	0.02	0.04	−0.11	−0.13	1		
Length of time with suppliers	NA	NA	0.04	0.09	0.01	−0.01	−0.10	0.05	0.16	0.09	−0.01	−0.01	0.01	1	
Purchase motivation factor	NA	NA	−0.06	−0.04	−0.12	−0.07	−0.06	0.01	−0.10	−0.01	−0.22**	−0.20*	0.21*	0.01	1
Original number of measures			5	5	5										
Final number of measures			4	5	4										

Note(s): The diagonal values of the matrix correspond to the square root of the AVE
**Correlation is significant at the 0.01 level (two-tailed)/*correlation is significant at the 0.05 level (two-tailed)
CSC = Collaborative supply chain management; OPF = Operational performance; OCP = Operational capability; NA = Not applicable



Note(s): 1 Model estimated by bootstrap with $n = 138$ and 5,000 repetitions
2 p-values for each standardized parameter are showed in brackets

Figure 2.
Comparison of theoretical–empirical models

	Model 1			Model 2			Difference
	β	p	VIF	β	p	VIF	$\beta1 - \beta2$
Respondent job title				0.211	0.005	1.000	
Time in current function				0.228	0.005	1.018	
CSC → OPF (H1)	0.166	0.155	1.612	0.193	0.085	1.626	−0.027
CSC → OCP (H2)	0.616	0.000	1.000	0.614	0.000	1.000	0.002
OCP → OPF (H3)	0.443	0.000	1.612	0.407	0.000	1.631	0.036
R^2		31.4%			36.1%		
$R_{2adjusted}$		30.4%			34.6%		

Note(s): CSC = Collaborative supply chain management; OCP = Operational capabilities; OPF = Operational performance

Table 4.
Structural models predicting operational performance

($\beta_2 = 0.407, p \leq 0.000$) of Model 2 was multiplied by the correlation (0.77), resulting in 24% of variance explained (Tenenhaus *et al.*, 2005).

Still, according to Figure 2, the determination coefficient had an average value of R^2 above 0.35 (except for position, which is a control variable), considered a large effect adjustment. In addition to examining R^2, we also checked the values of Q^2 and f^2 for collaborative supply chain management ($Q^2 = 0.027; f^2 = 0.398$), operational capability ($Q^2 = 0.177; f^2 = 0.307$) and operational performance ($Q^2 = 0.175; f^2 = 0.315$). Therefore, all Q^2 values were positive, showing a satisfactory predictive relevance, and values of f^2 were close to the large effect limit, indicating that the measurement model is accurate.

4.3.1 Hypothesis testing. The results of the hypothesis relationships (H1, H2, H3 and H1a) among the study variables are shown in Figure 2. The direct, indirect and total causal effects between the exogenous and endogenous variables can be seen in Table 5.

H1, linking collaborative supply chain management and operational performance, was not significant ($\beta_{12} = 0.193$, $p < 0.085$). The direct effect of collaborative supply chain management on operational performance was ($\beta_{13} = 0.193$, $p < 0.085$).

H2, linking collaborative supply chain management to operational capabilities, was significant ($\beta_{12} = 0.614$, $p < 0.000$), resulting in a direct effect on operational capability of 0.614.

H3, linking operational capability and operational performance, was significant (β_{23} = 0.407, p < 0.000), resulting in a direct effect on operational performance of 0.407.

In addition, we found estimates found for the indirect effects of collaborative supply chain management on operational capabilities (β_{12} = 0.614, p < 0.000), and of operational capabilities on operational performance (β_{23} = 0.407, p < 0.000), resulting in an indirect effect on operational performance of 0.250. The effect of the control variables on operational performance was 0.093 for managerial position and 0.228 for time in current position.

H1a attended the Iacobucci *et al.* (2007) approach, because H2 and H3 were supported. Thus, we found the presence of mediation supporting H1a. Hence, we sought to check the category of the mediating effect (partial or total) by using the VAF. From Table 5, we extracted data for the parameters β_{12} = 0.614, β_{23} = 0.407 and β_{13} = 0.193. Replacing these values in equation (1), we obtained VAF $= \frac{0.614 \;\; x\; 0.407}{(0.614\; x\; 0.407) + 0.193} = 0.564$. The value of 0.564 shows that mediation is around 20%.

Finally, these findings suggest that operational capabilities may produce "synergistic" mediating effects, which could extend their overall effects on outcome variables.

5. Conclusions

Examination of the empirical and theoretical models revealed, at the level of significance ($\alpha \leq 0.05$), the direct influence of collaborative supply chain management on operational performance (H1 was not supported), and, indirectly, through the [collaborative supply chain management → operational capabilities] and [operational capabilities → operational performance] paths (supported H2 and H3, respectively). Furthermore, the partial effect of operational capabilities' mediation on the relationship between collaborative supply chain management and operational performance was highlighted (H1a was supported). These results have theoretical and practical implications for administration and management practices, as described below.

5.1 Theoretical implications

The analysis of the mediation between the constructs of collaborative supply chain management, operational capabilities and operational performance in capital goods' companies enabled a better knowledge of the environment by organizations. Revealing that operational capabilities partially mediate the relationship between collaborative supply chain management and operational performance shows the strength of its construct. By being present in the theoretical and empirical models, operational capabilities assume a causal relationship between collaborative supply chain management and operational performance (Hsu *et al.*, 2009). Its importance lies in the dynamics of the fast movements of the competitive environment, where the vision of competitive advantage must evolve from the exclusive and valuable internal resources of the company to its operational capabilities, to improve and develop them continuously, as dynamic capabilities. For Teece (2019), understanding how some companies develop capabilities, grow and create competitive

Constructs	Operational performance Indirect	Direct	Total
Collaborative supply chain management	0.614*0.407 = 0.250	0.193	0.443
Operational capabilities	0	0.407	0.407
Managerial position	0.211*0.614*0.407 = 0.053	0	0.093
	0.211*0.193 = 0.041	0	
Time in current position	0	0.228	0.228

Table 5. Direct, indirect and total effects on operational performance

advantage, which leads to higher profits (and higher wages) above a perfectly competitive level, is essential for comprehending capitalism and the modern economy. Hence, there is an unanswered question, leading to an assumption of homogeneity, or almost homogeneity, of companies, whose macroeconomic environment lacks structures capable of providing them with helpful advice for decision-making on resource allocation, or for public policymakers to study firms and design results for society. Despite the relevance of capabilities for corporations' performance, managers still lack a consistent theory. For instance, operational capabilities are sometimes used as a synonym for competitive priority (Tan *et al.*, 2007), or are considered the result of dynamic capabilities deployment, because the value of dynamic capabilities lies in the configuration of the operational capabilities they create (Cepeda & Vera, 2007). However, the challenge of a consistent theory starts by identifying the drivers of operational capabilities in the supply chain context. Jasti and Kodali (2015), in a literature review on lean production that had operational capabilities as core aspects, such as just in time and total quality management, found several elements belonging to lean production, where around 30% of the articles concentrated on value stream mapping, setup time reduction, kaizen and Kanban. An interesting result is that they consider lean elements as a group, instead of individual factors, which applies to operational capabilities as well.

Teece (2019) still suggests developing a new theory of business capabilities, based on uncertainty, innovation and implementation of intangible assets, since the current dynamic capabilities' structure incorporates a business theory that has developed from a more primitive initial state than that assumed in most economic models. Therefore, managers must overcome the uncertainties of demand and time by using technology (Dong, 2020) and develop markets before preferences and prices attract competitors.

5.2 Implications for management practices

Once we showed the importance of the operational capabilities' construct as a mediator of the relationship between collaborative supply chain management and operational performance, collaborative supply chain management must embed these relationships, both in the company and in the chain partners, to achieve results, from a closer collaboration with their suppliers. Although there is no concept for operational capabilities, companies must be more agile and responsive than their competitors and add significant value to their stakeholders. Perhaps the only reason is that there is no theory of economics capabilities, thus making assumptions underlying existing theories (Alvesson & Sandberg, 2011). For the capital goods' companies investigated in this article, they need to adopt consistent collaborative practices, especially of a strategic nature, to achieve a better operational performance. Hence, firms should look for developments in capabilities such as quality, flexibility and delivery, which affect operational performance and recognizing that even with exceptional operational capabilities, the best performance will come through a collaborative supply chain management. However, operational capabilities are complex routines that determine the efficiency with which companies develop inputs into products (Teece, 2019). Amoako-Gyampah, Boakye, Famiyeh and Adaku (2020) also observe that capabilities allow configuring and implementing a company's assets, resources or processes better, increasing its competitiveness and superiority over competitors. In this specific case, the improvement of operational capabilities, especially the flexibility of terms and specifications, were essential factors for achieving better results in the supply chain of capital goods' companies.

Therefore, given the results attained, the theoretical implications, and practical applications in the sector studied, we consider that the main attributes of this supply chain are sharing of information, resources and objectives. We also conclude that operational capabilities still need to improve, to achieve a better operational performance for both the company and the supply chain.

As contributions, our findings suggest that operational capabilities must be continually strengthened to become an element of integration between collaborative supply chain management and operational performance. According to the resource-based view (Barney, 2001), internal resources that are valuable, difficult to imitate, rare and not replaceable are the reasons for competitive advantage. They need to be continuously re-evaluated, transformed, enhanced and adapted to the dynamics of the economic environment.

Nevertheless, managers must be careful when transferring operational capabilities from one workstation to another, due to the halo effect, which consists of analyzing success or failure just by results, jumping to conclusions and missing opportunities to continuously improve production processes or innovation processes (Rosenzweig, 2014). Hence, collaborations in the supply chain are important to avoid waste and quality problems.

5.3 Study delimitation

The main delimitation was to use a sample of companies from the machinery and equipment industry. In this study, most of the companies in the sample were first-tier supply chain members. Thus, there was a more collaborative relationship between the focus company and these suppliers (first tier) than with suppliers from more distant tiers.

5.4 Suggestions for further research

For future studies, we recommend:

(1) To continue investigating operational capabilities, since productive technologies will always be a great good. Indeed, they are important, and they include people, who lead a virtuous cycle of continuous improvement, with higher quality and lower cost products;

(2) To develop studies, using insights for appointing the significant bivariate correlations among the control variables;

(3) To revalidate the theoretical and empirical models, through replication, in the same sector or in other sectors of the country's economy; and

(4) To conduct longitudinal research for investigating operational capabilities and their mediating effect over a time series, thus generating comparative analysis over time.

References

Abdallah, A. B., Obeidat, B. Y., & Aqqad, N. O. (2014). The impact of supply chain management practices on supply chain performance in Jordan: The moderating effect of competitive intensity. *International Business Research*, *7*(3), 13–28. doi: 10.5539/ibr.v7n3p13.

Alvesson, M., & Sandberg, J. (2011). Generating research questions through problematization. *Academy of Management Review*, *36*(2), 247–271. doi: 10.5465/amr.2009.0188.

Amoako-Gyampah, K., Boakye, K. G., Famiyeh, S., & Adaku, E. (2020). Supplier integration, operational capability and firm performance: An investigation in an emerging economy environment. *Production Planning and Control*, *31*(13), 1128–1148. doi: 10.1080/09537287.2019.1700570.

Avella, L., Vazquez-Bustelo, D., & Fernandez, E. (2011). Cumulative manufacturing capabilities: An extended model and new empirical evidence. *International Journal of Production Research*, *49*(3), 707–729. doi: 10.1080/00207540903460224.

Barney, J. B. (2001). Resource-based theories of competitive advantage: A ten-year retrospective on the resource-based view. *Journal of Management*, *27*(6), 643–650. doi: 10.1177/014920630102700602.

Baron, R., & Kenny, D. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173–1182. doi: 10.1037//0022-3514.51.6.1173.

Cao, M., & Zhang, Q. (2011). Supply chain collaboration: Impact on collaborative advantage and firm performance. *Journal of Operations Management*, *29*(3), 163–180. doi: 10.1016/j.jom.2010.12.008.

Cepeda, G., & Vera, D. (2007). Dynamic capabilities and operational capabilities: A knowledge management perspective. *Journal of Business Research*, *60*, 426–437. doi: 10.1016/j.jbusres.2007.01.013.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). New York: Psychology Press.

Danese, P., & Romano, P. (2011). Supply chain integration and efficiency performance: A study on the interactions between customer and supplier integration. *Supply Chain Management*, *16*(4), 220–230. doi: 10.1108/13598541111139044.

Dong, J. Q. (2020). Technological choices under uncertainty: Does organizational aspiration matter? *Strategic Management Journal*, *42*(5), 898–916. doi: 10.1002/smj.3253.

Ellran, L. M., & Cooper, M. C. (2014). Supply chain management: It's all about the journey, not the destination. *Journal of Supply Chain Management*, *50*(1), 8–20. doi: 10.1111/jscm.12043.

Fawcett, S. E., McCarter, M. W., Fawcett, A. M., Webb, G. S., & Magnan, G. M. (2015). Why supply chain collaboration fails: The socio-structural view of resistance to relational strategies. *Supply Chain Management*, *20*(6), 648–663. doi: 10.1108/SCM-08-2015-0331.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2014). *Primer on partial least squares structural equation modeling (PLS-PM)*. Los Angeles: SAGE Publications.

Helfat, C. E., & Winter, S. G. (2011). Untangling dynamic and operational capabilities: Strategy for the (n)ever-changing world. *Strategic Management Journal*, *32*(11), 1243–1250. doi: 10.1002/smj.955.

Henseler, J., Ringle, C. M., & Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Advances in International Marketing*, *20*(1), 277–319. doi: 10.1108/S1474-7979(2009)0000020014.

Herczeg, G., Akkerman, R., & Hauschild, M. Z. (2018). Supply chain collaboration in industrial symbiosis networks. *Journal of Cleaner Production*, *171*, 1058–1067. doi: 10.1016/j.jclepro.2017.10.046.

Hsu, C. C., Tan, K. C., Kannan, V. R., & Leong, G. K. (2009). Supply chain management practices as a mediator of the relationship between operations capability and firm performance. *International Journal of Production Research*, *47*(3), 835–855. doi: 10.1080/00207540701452142.

Iacobucci, D., Saldanha, N., & Deng, X. (2007). A meditation on mediation: Evidence that structural equation models perform better than regression. *Journal of Consumer Psychology*, *7*(2), 139–153. doi: 10.1016/S1057-7408(07)70020-7.

Jasti, N. V. K., & Kodali, R. (2015). Lean production: Literature review and trends. *International Journal of Production Research*, *53*(3), 867–885. doi: 10.1080/00207543.2014.937508.

Lee, B. C., Kim, P. S., Hong, K. S., & Lee, I. (2010). Evaluating antecedents and consequences of supply chain activities: An integrative perspective. *International Journal of Production Research*, *48*(3), 657–682. doi: 10.1080/00207540802425377.

Liao, S. H., Hu, D. C., & Ding, L. W. (2017). Assessing the influence of supply chain collaboration value innovation, supply chain capability and competitive advantage in Taiwan's networking communication industry. *International Journal of Production Economics*, *191*, 143–153. doi:10.1016/j.ijpe.2017.06.001.

Malhotra, M. K., & Mackelprang, A. W. (2012). Are internal manufacturing and external supply chain flexibilities complementary capabilities?. *Journal of Operations Management*, *30*(3), 180–200. doi: 10.1016/j.jom.2012.01.004.

Moyano-Fuentes, J., Bruque-Camara, S., & Maquera-Marin, J. M. (2019). Development and validation of a lean supply chain management measurement instrument. *Production Planning and Control*, *30*(1), 20–32. doi: 10.1080/09537287.2018.1519731.

Nand, A. A., Singh, P. J., & Bhattacharya, A. (2014). Do innovative organisations compete on single or multiple operational capabilities?. *International Journal of Innovation Management*, *18*(3), 144001. doi: 10.1142/S1363919614400015.

Narayanan, S., Narasimhan, R., & Schoenherr, T. (2015). Assessing the contingent effects of collaboration on agility performance in buyer-supplier relationships. *Journal of Operations Management*, *33*, 140–154. doi: 10.1016/j.jom.2014.11.004.

Ojha, D., Gianiodis, P. T., & Manuj, I. (2013). Impact of logistical business continuity planning on operational capabilities and financial performance. *International Journal of Logistics Management*, *24*(2), 180–209. doi: 10.1108/IJLM-06-2012-0049.

Ou, C., Liu, F.-C., Hung, Y. C., & Yen, D. C. (2010). A structural model of supply chain management on firm performance. *International Journal of Operations and Production Management*, *30*(5), 526–545. doi: 10.1108/01443571011039614.

Panahifar, F., Byrne, P. J., Salam, M. A., & Heavey, C. (2018). Supply chain collaboration and firm's performance: The critical role of information sharing and trust. *Journal of Enterprise Information Management*, *31*(3), 358–379. doi: 10.1108/JEIM-08-2017-0114.

Podsakoff, P. M., Mackenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. doi: 10.1037/0021-9010.88.5.879.

Prajogo, D., Huo, B., & Han, Z. (2012). The effects of different aspects of ISO 9000 implementation on key supply chain management practices and operational performance. *Supply Chain Management*, *17*(3), 306–322. doi: 10.1108/13598541211227135.

Puga, F. P. and Castro, L. B. (Orgs) (2018). *Visão 2035: Brasil, país desenvolvido: Agendas setoriais para alcance da meta*. Rio de Janeiro: BNDES. Available at: https://web.bndes.gov.br/bib/jspui/handle/1408/16040.

Qrunfleh, S., & Tarafdar, M. (2013). Lean and agile supply chain strategies and supply chain responsiveness: The role of strategic supplier partnership and postponement. *Supply Chain Management: An International Journal*, *18*(6), 571–582. doi: 10.1108/SCM-01-2013-0015.

Ralston, P. M., Grawe, S. J., & Daugherty, P. J. (2013). Logistics salience impact on logistics capabilities and performance. *The International Journal of Logistics Management*, *24*(2), 136–152. doi: 10.1108/IJLM-10-2012-0113.

Ringle, C. M., Silva, D., & Bido, D. S. (2014). Structural equation modeling with the SmartPLS. *BJM – Brazilian Journal of Marketing*, *13*(2), 54–71. doi: 10.5585/remark.v13i2.2717.

Rosenzweig, P. (2014). *The halo Effect … and the Eight other Business Delusion that Deceive Managers*. New York: Simon and Schuster.

Scholten, K., & Schilder, S. (2015). The role of collaboration in supply chain resilience. *Supply Chain Management*, *20*(4), 471–484. doi: 10.1108/SCM-11-2014-0386.

Soosay, C. A., & Hyland, P. (2015). A decade of supply chain collaboration and directions for future research. *Supply Chain Management*, *20*(6), 613–630. doi: 10.1108/SCM-06-2015-0217.

Sukati, I., Hamid, A. B., Baharun, R., & Yusoff, R. M. (2012). The study of supply chain management strategy and practices on supply chain performance. *Procedia: Social and Behavioral Sciences*, *40*(1), 225–233. doi: 10.1016/j.sbspro.2012.03.185.

Swink, M., Narasimhan, R., & Wang, C. (2007). Managing beyond the factory walls: Effects of four types of strategic integration on manufacturing plant performance. *Journal of Operations Management*, *25*(1), 148–164. doi: 10.1016/j.jom.2006.02.006.

Tan, K. C., Kannan, V. R., & Narasimhan, R. (2007). The impact of operations capability on the firm performance. *International Journal of Production Research*, *45*(21), 5135–5156. doi: 10.1080/00207540600871269.

Teece, D. J. (2019). A capability theory of the firm: An economics and (strategic) management perspective. *New Zealand Economic Papers*, *53*(1), 1–43. doi: 10.1080/00779954.2017.1371208.

Tenenhaus, M., Vinzi, V. E., Chatelin, Y., & Lauro, C. (2005). PLS path modeling. *Computational Statistics and Data Analysis*, *48*(1), 159–205. doi: 10.1016/j.csda.2004.03.005.

Thatte, A. A., Rao, S. S., & Ragu-Nathan, T. S. (2013). Impact of SCM practices of a firm on supply chain responsiveness and competitive advantage of a firm. *The Journal of Applied Business Research*, *29*(2), 499–530. doi: 10.19030/jabr.v29i2.7653.

Vanpoucke, E., Vereecke, A., & Muylle, S. (2017). Leveraging the impact of supply chain integration through information technology. *International Journal of Operations and Production Management*, *37*(4), 510–530. doi: 10.1108/IJOPM-07-2015-0441.

Wong, C. W. Y., Lai, K. H., Cheng, T. C. E., & Lun, Y. H. V. (2015). The role of IT-enabled collaborative decision making in inter-organizational information integration to improve customer service performance. *International Journal of Production Economics*, *159*, 56–65. doi: 10.1016/j.ijpe.2014.02.019.

Wong, W. P., & Wong, K. Y. (2011). Supply chain management, knowledge management capability, and their linkages towards firm performance. *Business Process Management Journal*, *17*(6), 940–964. doi: 10.1108/14637151111182701.

Wu, I. L., & Chiu, M. L. (2018). Examining supply chain collaboration with determinants and performance impact: Social capital, justice, and technology use perspectives. *International Journal of Information Management*, *39*, 5–19. doi: 10.1016/j.ijinfomgt.2017.11.004.

Wu, S. J., Melnyk, S. A., & Swink, M. (2012). An empirical investigation of the combinatorial nature of operational practices and operational capabilities. *International Journal of Operations and Production Management*, *32*(2), 121–155. doi: 10.1108/01443571211208605.

Zhang, M., Pawar, K., Shah, J., & Mehta, P. (2013). Evaluating outsourcing partners' capability: A case study from the pharmaceutical supply chain. *Journal of Manufacturing Technology Management*, *24*(8), 1080–1101. doi: 10.1108/JMTM-02-2012-0023.

Zhang, Q., & Cao, M. (2018). Exploring antecedents of supply chain collaboration: Effects of culture and interorganizational system appropriation. *International Journal of Production Economics*, *195*, 146–157. doi: 10.1016/j.ijpe.2017.10.014.

Corresponding author
Roberto Giro Moori can be contacted at: roberto.g.moori@gmail.com