Contents lists available at GrowingScience

Uncertain Supply Chain Management

homepage: www.GrowingScience.com/uscm

Relationship between integration, readiness and innovative product performance in a Brazilian supply chain

Rodrigo Marques de Almeida Guerra[a*], Roberto Nascimento Peixe[a], Marcus Frantz Alberto[a] and Ana Paula Brum Zavarise[a]

[a]*UFSM - Federal University of Santa Maria, Brazil*

A B S T R A C T

Article history:
Received September 16, 2024
Received in revised format October 25, 2024
Accepted January 9 2025
Available online January 9 2025
Keywords:
Supply chain
Integration
Product innovation
Readiness
Dynamic capabilities

There are few studies addressing the mediating effect of readiness in supply chains in developing countries. We use the theory of dynamic capabilities to investigate the impact of integration (INT) on readiness (REA) and on innovative product performance (IPP) and to examine the mediating effect of REA on INT and IPP. We conducted a survey with a sample of 213 supply chain (SC) managers of machinery and equipment for transport and lifting heavy loads in Brazil. To this end, we used structural equation modeling to test the hypotheses and PROCESS macro to confirm the indirect effect. The empirical results indicate a significant effect between INT and REA and REA and IPP. However, the indirect impact of REA was compromised. The literature review demonstrates that the microfoundations of dynamic capabilities (Sensing, Seizing and Reconfiguration) strengthen supply chain links, particularly between INT, REA and IPP. This article helps managers understand the functioning of SC routines and operations. To this end, they should develop strategies that strengthen SC ties with INT, REA and IPP to face future crises. This paper advances the findings on integration, readiness, and innovative product performance in an SC. The findings provide insightful implications for managers to improve their strategies. In doing so, we theorize how the microfoundations of dynamic capabilities support the efficiency of supply chain operations.

1. Introduction

Although the supply chain (SC) theme has been extensively explored in previous research, there are still gaps that need to be addressed, especially in developing countries such as India, China, Russia and Brazil. Generally, these countries are territorially extensive and populous and require agricultural commodities and adequate infrastructure to transport and store grains, goods and products. The Brazilian SC manufacturing machinery and equipment for transporting and lifting heavy loads is strategic because it contributes to jobs, generates wealth through GDP (Gross Domestic Product) and boosts exports of goods and products. The main products manufactured are electric winches and hoists, lifting and transport components, freight elevators, material handling systems, overhead cranes and gantry cranes, lifting platforms etc. These equipment and machines assist in the heavy load-handling operations of any SC. In Brazil, companies in this SC are located in São Paulo, Santa Catarina, Rio Grande do Sul, Pernambuco, Minas Gerais and Paraná. In 2022, these companies generated 16,219 jobs with an average salary per worker of R$4,589.04 (almost US$842.03). Small companies employ 5,866 employees, 36.2% of all jobs generated (Rais, 2022; Sebrae, 2022). Periods of crisis harm SC operations (Wijaya, 2023; Ali & Mahmood, 2024). To this end, managers must integrate routines and increase collaboration with business partners to meet market demands (Williams et al., 2013; Bae et al., 2023). In addition, they must strengthen the orientation toward innovation and new product performance (Dahan and Levi-Bliech, 2024).

* Corresponding author
E-mail address guerra.rodrigo@ufsm.br (R. M. de A. Guerra)

ISSN 2291-6830 (Online) - ISSN 2291-6822 (Print)

doi: 10.5267/j.uscm.2025.1.002

Based on the above, we intend to answer two research questions:

RQ1: Is there a positive effect of integration (INT) on innovative product performance (IPP)?
RQ2: Readiness (REA) mediates the relationship between integration (INT) and innovative product performance (IPP)?

This paper has the objective of investigating the direct effect of integration (INT) on innovative product performance (IPP) and measuring the indirect impact of readiness (REA) on the INT and IPP of an Brazilian SC manufacturing machinery and equipment for transporting and lifting heavy loads. This paper has the following contributions. First, the manuscript will contribute to filling the research gap in supply chains in developing countries. Second, it aims to test the hypotheses of the empirical model, i.e., to assess the direct and indirect effects of INT, REA and IPP. Third, some SCs are intricate and complex and have dysfunctional operations regarding integration, readiness and innovative performance of products. Fourth, managers need to develop policies to mitigate losses caused by disruptions caused by unforeseen events, such as the COVID-19 pandemic, earthquakes, floods and uncertainty in customer demand. To this end, managers need to develop routines that adapt to adversity. Furthermore, we present a theoretical framework that demonstrates how the supply chain can utilize the microfoundations of dynamic capabilities. In addition to the introduction, the other sections are as follows: the next section presents the theoretical framework and hypotheses. The third section demonstrates the research method. The fourth section reveals the analysis of the results. The fifth section addresses the discussion of the hypotheses. Finally, the sixth section infers the conclusions and implications of the research.

2. Theoretical review and hypotheses

Importance of heavy lifting and transportation equipment for supply chain efficiency

In general, heavy load lifting and transportation equipment is essential for the efficiency of any supply chain. This equipment is present in all companies that need to move loads in various sectors, such as: mining, transportation, retail, metal mechanic, beverages, food and others. However, managers must use strategies to improve the efficiency and productivity of cargo handling equipment (Nguyen, 2024). Wanke *et al.* (2018) state that some of the stages in the supply chain may be sensitive to the movement of heavy loads, which requires greater operational efficiency from the company. Sarantakos *et al.* (2024) argue that port operations present several uncertainties, such as the arrival time of ships and the loading time of goods and products onto vessels. Thus, cargo handling equipment plays a vital role in the efficiency of a container terminal (Pham & Nguyen, 2022). Cargo terminals serve as product movement centers to prepare goods and products sold to customers in the domestic or international market (Nath & Upadhyay, 2024). (Bombelli & Fazi, 2022) highlight that air terminals serve to transport unusual products, such as perishable products, live animals, pharmaceuticals, electronic items and chemicals and may require special equipment for cargo movements.

2.1 Dynamic capabilities

Dynamic markets make the environment even more competitive. To adapt, firm managers need to develop dynamic capabilities (Ambrosini and Bowman, 2009; Eisenhardt and Martin, 2000). The dynamic capabilities framework analyzes the sources and methods for creating and capturing wealth in a rapidly changing environment (Teece et al., 1997). Teece (2007) defines microfoundations of dynamic capabilities as the distinction of skills, processes, procedures, structures, and rules that underpin the sensing, seizing, and reconfiguring capabilities. Teece *et al.* (1997, p. 516) state that “dynamic capabilities integrate, build and reconfigure internal and external competencies in a rapidly changing scenario". There are three main types of dynamic capabilities: sensing (understanding the search and exploration of activities), seizing (explaining how capabilities should be exploited) and transforming (how an organization can transform or restructure itself) (Teece, 2007). Eisenhardt and Martin (2000) suggest that dynamic capabilities are specific and distinctive processes that lead to a unique path in each company. Thus, supply chains with dynamic capabilities can improve their performance and competitiveness against competitors (Hinelo et al., 2024). However, they need to renew their resource base and reconfigure their routines to combat operational inertia and adapt to the changing environment (Helfat, 1997; Makkonen *et al.*, 2014). Nacchiero *et al.* (2024) emphasize that supply chains need to develop dynamic capabilities for the renewal and reconfiguration of capabilities, resources and competencies, aiming to adapt to the constant changes and interruptions suffered by supply chains. Gutierrez *et al.* (2022) postulate that the microfoundations of dynamic capabilities can maintain team readiness in response to environmental uncertainty. Thus, managers can select the appropriate combination of resources and capabilities to make the right decisions in periods of change. Therefore, supply chains must be resilient, agile and sustainable to overcome periods of vulnerability caused by uncertain and unexpected events (Akram et al., 2024). Specialized supply chains seek heterogeneity of resources to obtain strategic alliances. Opportunities may arise from competitors’ operational failures or inefficiencies (Steiner et al., 2017).

2.2 Relationship between integration and innovative product performance

Supply chains develop a link with several other companies to improve organizational performance (Kim, 2006). Overall, integration improves supply chain performance by providing greater collaboration and strategic coordination between the focal firm and its supply chain business partners (Williams et al., 2013; Bae et al., 2023). Basana et al. (2024) point out that integration with external supply chain partners can reduce the risk of disruptions in the product development process. Therefore, managers should develop close partnerships with external companies to maintain the quality of processes and innovative products. Furthermore, integration reduces information asymmetries and contributes to an environment of greater efficiency, process optimization, contributing to better service between the parties (Partyka, 2022; Basana et al., 2024). Integrated supply chains generate contacts between upstream suppliers and downstream customers (Vickery et al., 2003). Collaborative integration can occur between strategic partners, suppliers, customers and other links in the supply chain (Mentzer et al., 2001; Siagian et al., 2021) to reduce costs, provide better service and add value to the customer (Kamal et al., 2021). Furthermore, integrated supply chains must deliver innovative product performance (Kumar et al., 2020; Chen et al., 2023; Dahan and Levi-Bliech, 2024). Innovative performance occurs through the application of creativity or innovative ideas to improve products, processes and procedures, aiming to increase the importance, value and performance of a product or service (Chen et al., 2023; Feng et al., 2022). Based on the discussion above, we intend to investigate the following hypothesis:

Hypothesis H1a: There is a positive relationship between integration and innovative product performance.

2.3 Relationship between integration and readiness

In general, supply chains are exposed to events that affect their commercial operations and impact production, transportation and product distribution processes to the market. To this end, companies need to monitor risks and plan actions to anticipate the occurrence of potential catastrophes, disasters or unexpected events that impact supply chain operations (Das and Lashkari, 2015). Disruptions are unexpected events that can compromise the operational and financial level of the parties involved (Ponomarov and Holcomb, 2009; Ruel and El-Baz, 2023). Thus, a supply chain must be integrated and agile enough to restore its operations to the same state as before the disruption (Ponomarov and Holcomb, 2009). Given the above, we intend to test the following hypothesis:

Hypothesis H1b: There is a positive relationship between integration (INT) and readiness (REA).

2.4 Relationship between readiness and innovative product performance

Few studies use tools to measure readiness in supply chains (Musyarofah et al., 2023). Despite this, supply chains seek to create and develop solutions and products that meet customer needs at an efficient cost. Therefore, supply chain managers need to adapt their business models based on goals, key indicators and metrics to measure the performance of products and processes (Tolonen et al., 2017). Even with expensive products, some customers are willing to pay the premium to get responsibly manufactured products that meet sustainability standards (Ullah et al., 2024). Consumer awareness of environmental issues has led to greater agility and knowledge sharing among partner companies in the supply chain, improving the performance of innovative products and processes (Li, 2021; Demir *et al.*, 2023). Tolonen *et al.* (2017) point out that supply chain readiness can be an alternative to renewing processes to develop innovative products. For example, supply chains with greater readiness develop operations based on subprocesses and activities such as demand and supply planning, purchasing, production, order management, distribution and invoicing. Based on the theoretical framework, the aim is to test the following hypothesis:

Hypothesis H2: There is a positive relationship between readiness (REA) and innovative product performance (IPP).

2.5 The mediating role of supply chain readiness

Ponomarov and Holcomb (2009) proposed a conceptual model that integrates the main elements of supply chain resilience and its management. A resilient supply chain should incorporate preparedness for unexpected events, offer efficient responses and be able to return to the original state after disruptive occurrences. Arlbjørn *et al.* (2006) state that readiness for change requires time, as it requires the development of competence, technical concepts and mechanisms to execute readiness efficiently in the supply chain. Alsmairat (2022) emphasizes that organizational readiness is a mediating variable and a prerequisite for the success of the reverse supply chain. To this end, companies must develop internal capabilities, such as infrastructure, organizational policy, strategic direction, employee qualifications and management commitment. Internal capabilities are important for successful new product development, especially in developing countries (Duran et al., 2022).
Readiness contributes to managers' decision-making, reducing response time and supply chain recovery in adverse periods (Chowdhury and Quaddus, 2016). To this end, managers need to develop readiness strategies in the pre-disruption period, aiming to reduce the occurrence of unforeseen events (Ponomarov and Holcomb, 2009). Therefore, we will test the following hypothesis:

Hypothesis H3: Readiness mediates the relationship between integration and innovative product performance.

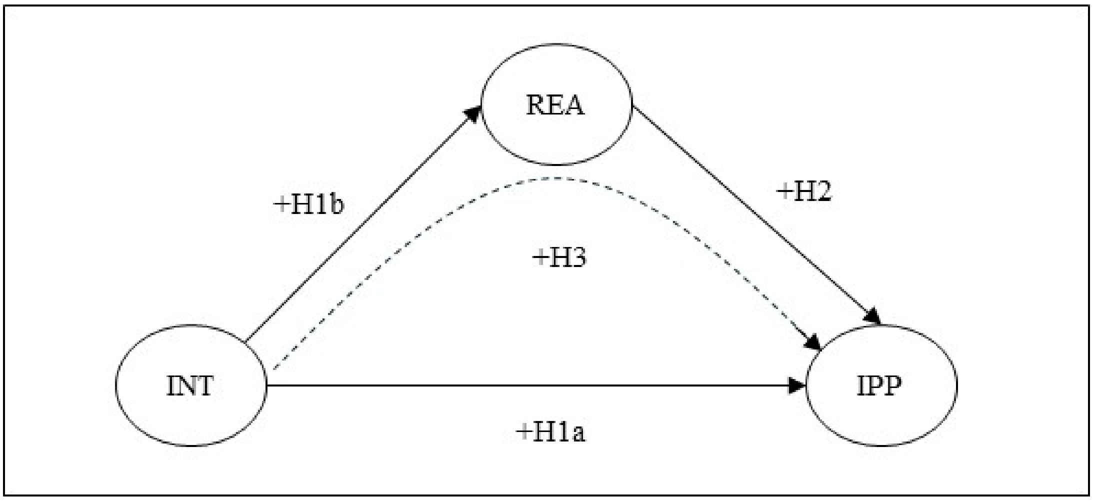

Fig. 1. Proposed theoretical framework

Source: Prepared by the authors
Note(s): INT = Integration. REA = Readiness. IPP = Innovative product performance

3. Method

3.1 Data collection and sampling

The research design emerged from the investigation of gaps obtained through floating readings. To this end, the researchers accessed the Scopus and Web of Science databases and analyzed research on supply chains from the last five years. Through the databases, we verified the theoretical relationship between the constructs and the absence of empirical models involving the INT, REA and IPP constructs and scales to measure them. A qualified bilingual professional back-translated the assertions (English-Portuguese-English) to ensure equivalence of meanings for the scale. We then applied a pre-test with 72 companies and corrected minor deviations in the translation. After the pre-test, we made minor adjustments to the translation (Douglas & Craig, 2007), which improved the respondents' understanding. Data collection was carried out through a self-administered online questionnaire developed with Google Forms. The questionnaire contained 13 specific questions on supply chain integration, readiness and innovative product performance adapted from Chowdhury and Quaddus (2017) and Prajogo and Ahmed (2006). We sent the survey link to the email addresses of 402 companies participating in the Brazilian supply chain to manufacture machinery and equipment for transporting and lifting heavy loads. Respondents also received a letter introducing the study, which included the study's objective and some guidance on answering the questions using a five-point Likert scale (1–strongly disagree; 5–strongly agree). The target audience for this research were managers who work on the front line of the Brazilian supply chain for manufacturing machinery and equipment for transporting and lifting heavy loads, as they are professionals familiar with complex operations and routines and have experience in team leadership. We obtained feedback from 219 participants and we excluded six questionnaires due to missing data, incorrect completion, or biased responses. Thus, the valid results were from 213 managers, which corresponds to a response rate of 52.98%. This response rate was due to email and telephone monitoring to motivate managers to respond to the survey. We obtained two waves of responses with a 15-day interval between waves. Data collection took place between January and March 2024.

3.2 Data analysis

After data collection, we performed the Common method variance (CMV) test and constructed reliability and validity tests. We assessed data normality using the asymmetry, kurtosis and Kolmogorov-Smirnov tests using IBM SPSS® (Statistical Package for the Social Sciences) software. After assessing distribution normality, we analyzed variable grouping, loadings and commonalities using EFA. To this end, we applied the orthogonal Varimax factor rotation method (Vieira & Ribas, 2011). Variable grouping was perfect and there was no need to exclude items.

In addition, we performed multiple linear regression to obtain the R^2 (Determination coefficient) and VIF (Variance Inflation Factors) values. All results were considered satisfactory and met the requirements of a survey (Hair Jr. et al., 2009). We verified the model's fit using the AFC (Confirmatory factor analysis) results and applied structural equation modeling (SEM) with the help of Amos® software (Marôco, 2010).

Finally, we analyzed the indirect effect of readiness using PROCESS macro, an extension coupled to IBM SPSS® software. PROCESS macro uses bootstrapping of 5000 resamples with a 95% confidence interval (CI) for $p<0.005$. This technique ensures greater precision in measuring indirect effects, such as moderation and mediation (Hayes & Rockwood, 2017).

3.3 Common method variance (CMV)

CMV is a common problem in research involving the area of administrative sciences (Fuller et al., 2016). To ensure the reliability of the CMV, we applied a protocol consisting of five steps (selection of companies, anonymous responses, questionnaire with easy and understandable language, absence of ambiguous questions and separate approach for dependent and independent constructs) (Podsakoff et al., 2003). The CMV assessed the occurrence of distortions in late and early responses. To this end, we applied the Hartman test based on the single-factor Exploratory Factor Analysis (EFA) using IBM SPSS® software version 21.0. The results confirmed that both waves were free of CMV because they had results greater than 0.5 (Armstrong and Overton, 1977; Podsakoff *et al.*, 2003).

3.4 Descriptive statistics and data preparation

Most of the interviewees were female (55.75%), aged between 31 and 40 years (32.74%), with completed higher education (53.98%) and decision-making (100%). The scope of the production chain is predominantly national (69.91%), concentrated in the states of Rio Grande do Sul (62.83%) and São Paulo (37.17%), mainly in the industrial sector (78.76%) and operating in small businesses (55.75%). In addition, most of the interviewees stated that the supply chain presents some level of innovation (80.53%), is considered resilient (74.34%) and is predominantly composed of suppliers (52.21%). Table 1 presents the results of descriptive statistics, such as minimum, maximum, mean, standard deviation, asymmetry and kurtosis for each variable analyzed. All items were considered satisfactory, that is, within adequate limits for quantitative research. The normality of the data was verified using the asymmetry, kurtosis (Table 1) and Kolmogorov-Smirnov tests. The results of asymmetry ($|sk|<3$) and kurtosis ($|ku|<10$) indicate the normality of the data distribution, as they oscillated within an acceptable range of values (Pestana & Gageiro, 2005).

Table 1
Descriptive statistics and Pearson Correlation

					Asymmetry		Kurtosis	
Variable	Min	Max	Average	Std. Dev.	Statistics	Error	Statistics	Error
INT	2.00	5.00	4.10	0.78	-0.63	0.28	-0.13	0.56
REA	1.00	5.00	3.84	0.82	-0.72	0.28	0.91	0.56
IPP	5.00	20.00	16.04	3.06	-0.96	0.28	1.27	0.56

Note(s): INT = Integration. REA = Readiness. IPP = Innovative product performance

The Kolmogorov-Smirnov test served as a robustness test to confirm the normality of the data. To this end, we used the categorical variable 'innovation in the supply chain' that supports the null hypothesis (H_0).

3.5 Measurement

We used a validated measurement model to ensure content validity. Initially, we identified validated constructs in the academic literature that corresponded to the research needs proposed by supply chain managers. We then adapted the questionnaire to the Brazilian reality and directed the instrument to three experts in international supply chains. The feedback helped to improve the questionnaire. In addition, we extracted the results of Cronbach's alpha, factor loadings, average variance extracted (AVE) and composite reliability (CR) from Chowdhury and Quaddus (2017) and Prajogo and Ahmed (2006). Table 2 presents the results of the validation and reliability of the constructs demonstrated by Cronbach's alpha, AVE, CR, factor loadings, mean and standard deviation for the variables integration, readiness and performance of innovative products in the supply chain. The measures corroborate the application of structural equation modeling (SEM).

Table 2
Construct validity and reliability

Variable/Items	Loading	Mean	SD
NT - Integration (Alpha = 0.85; AVE = 0.62; CR = 0.87)			
INT1 - We share information with supply chain partners.	0.81	3.79	1.15
INT2 - We have integration between the different departments of our company.	0.77	4.32	0.82
INT3 - We have a collaborative relationship with our supply chain partners.	0.83	4.28	0.77
INT4 - We have adopted ICT for the smooth flow of goods and information.	0.73	4.03	0.98
REA - Readiness (Alpha = 0.90; AVE = 0.63;CR=0.89)			
REA1 - We can quickly detect SC outages.	0.76	4.04	0.81
REA2 - We have preparedness training to overcome crises.	0.84	3.73	1.12
REA2 - We have preparedness training to overcome crises.	0.84	3.73	1.12
REA3 - We have resources to prepare ourselves during the crisis.	0.81	3.93	0.98
REA4 - We have early warning signs.	0.86	3.72	1.04
REA5 - We have forecasts to meet demand disruptions.	0.69	3.78	0.92
IPP - Innovative product performance (Alpha = 0.88; AVE = 0.67; CR = 0.89)			
IPP1 - Novelty level (novelty).	0.90	4.06	0.92
IPP2 - Use of the latest technology.	0.82	4.21	0.77
IPP3 - Product development speed.	0.83	4.17	0.87
IPP4 - Number of new products.	0.72	3.61	0.99

Note(s): INT = Integration. REA = Readiness. IPP = Innovative product performance. SD = Standard deviation. AVE = Average variance extracted. CR = Composite reliability. Alpha = Cronbach's alpha

Chowdhury and Quaddus (2017) analyzed the variables integration and readiness in the supply chain, suggesting satisfactory values for Cronbach's alpha ($\alpha \geq 0.7$), factor loadings ($\lambda \geq 0.6$), AVE (≥ 0.7) and CR (≥ 0.8). The results of Cronbach's alpha and CR validated the content of the constructs and the reliability of the questionnaire. Prajogo and Ahmed (2006) measured the variable innovative performance of products. The study provided consistent results for Cronbach's alpha ($\alpha \geq 0.8$), factor loadings ($\lambda \geq 0.7$) and good quality of fit indices of the structural model obtained by structural equation modeling (SEM): TLI (Tucker Lewis Index) = 0.96, NFI (Normed Fit Index) = 0.96, CFI (Comparative fit index) = 0.97, SRMR (Standardized root mean square residuals) = 0.04 and $p<0.01$. Thus, it is clear that the fit measures are adequate for the CFA.

3.6 Ethical requirements

This research met the ethical requirements established by the Research Ethics Committee (CEP) based on Resolution 196/96 of the National Health Council (CNS). The data collection instrument was submitted to the Research Ethics Committee (CONEP) of the Federal University of Santa Maria (UFSM) before its final application. Respondents chose to participate in the study and could withdraw at any time without suffering any penalty. The registration number for this research is CAAE: 73715623.4.0000.5346.

4. Analysis of results

4.1 Exploratory factor analysis (EFA)

We used IBM SPSS® software to run the EFA. To this end, we used the Bartlett test ($p>0.001$), chi-square ($\chi^2=646.883$) and Kaiser-Meyer-Olkin test (KMO=0.868) by the Varimax method. In addition, the EFA ensured the perfect grouping of the analyzed variables (Table 3), with no need to exclude items. Table 3 presents the values of the factor loadings ($\lambda \geq 0.5$) and commonalities ($h^2 \geq 0.5$) that meet the requirements of the academic literature (Hair Jr. et al., 2009).

4.2 Confirmatory factor analysis (CFA)

Table 4 presents a summary of the CFA results that gathered the values of Cronbach's alpha, AVE and CR ($\alpha \geq 0.7$, AVE$\geq$0.5 and CR$\geq$0.7) based on theoretical assumptions (Hair Jr. et al., 2009). We achieved convergent validity through the results of the factor loadings and AVE ($\lambda \geq 0.5$ and AVE$\geq$0.5). Discriminant validity occurred because the square root values of the AVE were greater than those of the correlation between the constructs (Table 4) (Fornell & Larcker, 1981).

Table 3
Result of Exploratory Factorial Analysis (EFA)

			Factors			
Variable	Average	STD DEV	1	2	3	h^2
INT1	3.79	1.15	0.684			0.725
INT2	4.32	0.82	0.896			0.85
INT3	4.28	0.77	0.757			0.734
INT4	4.03	0.98	0.585			0.64
REA1	4.04	0.81		0.826		0.719
REA2	3.72	1.12		0.621		0.759
REA3	3.93	0.98		0.68		0.706
REA4	3.72	1.04		0.816		0.807
REA5	3.78	0.92		0.678		0.659
IPP1	4.06	0.92			849	0.82
IPP2	4.21	0.77			0.847	0.801
IPP3	4.17	0.87			857	0.801
IPP4	3.61	0.99			0.663	0.637

Note(s): INT = Integration. REA = Readiness. IPP = Innovative product performance. h^2 = Communality

Table 4
Alpha, AVE, CR and Pearson Correlation

Variable	Items	Alpha	AVE	CR	INT	REA	IPP
INT	4	0.85	0.62	0.87	0.786		
REA	5	0.90	0.63	0.89	0.742**	0.794	
IPP	4	0.88	0.67	0.89	0.575**	0.606**	0.820

Note(s): The values, in italics, of the main diagonal, indicate the square roots of the AVE
**p<0.01

4.3 Structural Equation Modeling (SEM)

We used the Amos® (Analysis of Moment Structures) software to run the structural equation modeling (SEM) using the Maximum Likelihood (ML) method. To this end, we met the following assumptions: sample >200 cases, use of a continuous scale to evaluate the observable variables and normality of the distribution (Hair Jr. et al., 2009). The structural model presented satisfactory results for SEM: χ^2 = 109.664; gl = 62; χ^2/df = 1.769; p-value <0.001; CFI = 0.923; GFI = 0.825; IFI = 0.925; TLI = 0.903; AGFI = 0.743; RMSEA = 0.104) (Figure 2). Table 5 presents the SEM results for each model tested.

Table 5
SEM Result

SEM results	Refernce	Complete model	Model 1 H_{1a}	Model 2 H_{1b}	Model 3 H_{1c}	Model 4 H_{1d}
χ^2	The smaller the better	109.664	34.294	59.383	31.45	110.472
gl	There is no reference	62	19	26	26	63
χ^2/gl	$2<\chi^2/gl\leq3$	1.769	1.805	2.284	1.21	1.754
GFI	>0.900	0.923	0.954	0.919	0.986	0.923
CFI	>0.900	0.825	0.901	0.865	0.912	0.823
IFI	>0.900	0.925	0.955	0.921	0.987	0.925
TLI	>0.900	0.903	0.932	0.888	0.981	0.905
AGFI	>0.850	0.743	0.812	0.766	0.847	0.745
RMSEA	0.05<RMSEA<0.08	0.104	0.106	0.134	0.054	0.103

Note(s): χ^2 = Chi-square; gl = Degree of freedom. GFI = Goodness-of-fit Index. CFI = Comparative fit index. IFI = Incremental Fit Index. TLI = Tucker Lewis Index. AGFI = Adjusted Goodness-of-Fit Index. RMSEA = Root Mean Square Error of Aproximation

4.4 Multicollinearity and homoscedasticity test

Levene's test was applied to test homoscedasticity (Kline, 2011; Hair Jr. *et al.*, 2009). Levene's statistic indicated no significant differences between the gender variable and INT, REA and IPP (range 0.725 to 2.374 and p>0.05).

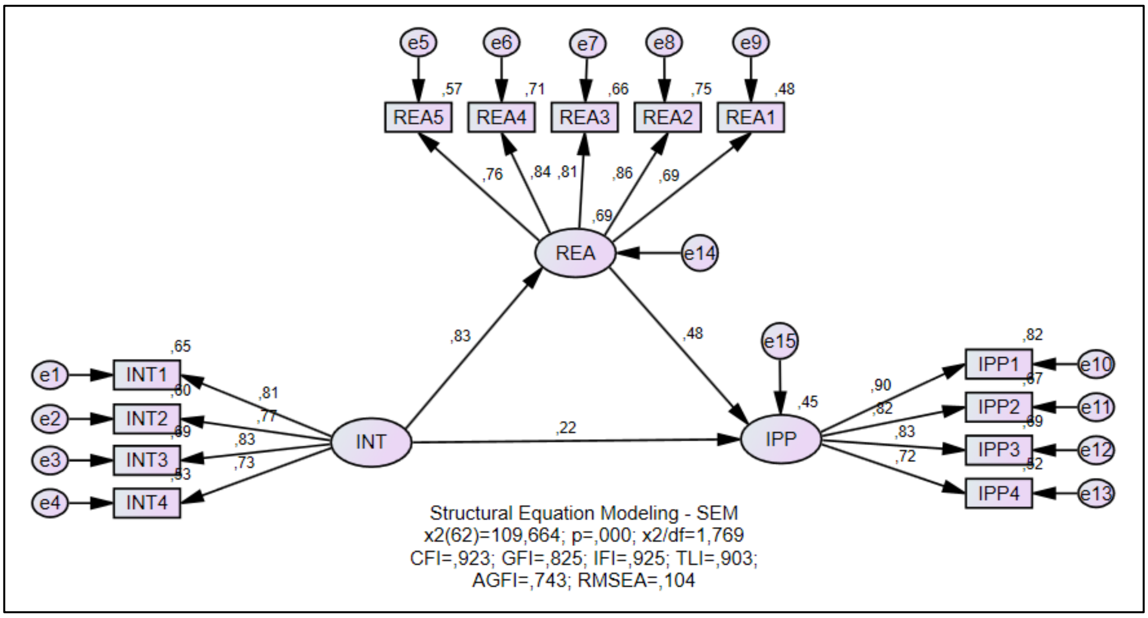

Fig. 2. Result of the mediation model

Note(s): χ^2 = Chi-square; gl = Degree of freedom. GFI = Goodness-of-fit Index. CFI = Comparative fit index. IFI = Incremental Fit Index. TLI = Tucker Lewis Index. AGFI = Adjusted Goodness-of-Fit Index. RMSEA = Root Mean Square Error of Aproximation

Multicollinearity exists when two or more variables present a high correlation between the residuals (Hair Jr. et al., 2009). For this purpose, we applied the tolerance (>0.1) and VIF (<5.0) tests (Field, 2009). The tolerance statistics ranged from 0.261 to 0.497, while the VIF statistics ranged from 2.013 to 3.955, confirming that multicollinearity was not a problem.

5. Discussion and implication

5.1 Main findings

Hypothesis H1a was rejected (β = 0.284, t = 0.928, p>0.05). Thus, it is possible to state that there is no significant relationship between INT and IPP in the SC investigated. In general, the association between INT and innovation in SC contributes to the performance of new products (Dahan & Levi-Bliech, 2024). However, the rejection of hypothesis H1a may demonstrate a dispersion of collaboration and strategic coordination between the focal firm and business partners to achieve new products (Williams *et al.*, 2013; Bae *et al.*, 2023; Chen *et al.*, 2023).

Lack of integration can aggravate SC disruptions due to the difficulty of sharing information between suppliers, customers and the focal company. Limited business partners can inhibit the development of new products, generate process inefficiencies, limit the provision of services to customers, increase SC operational costs and harm organizational performance (Siagian et al., 2021; Kamal *et al.*, 2021; Basana *et al.*, 2024).

Hypothesis H1b was accepted (β = 0.737, t = 5.206, p<0.001), demonstrating the positive effect of INT on REA. This result reinforces SC's commitment to avoiding possible interruptions in the production, transportation and distribution of products in the market. Operational agility is an example of how SC can integrate different departments collaboratively and act with REA, aiming to avoid sudden events (Das and Lashkari, 2015; Ponomarov and Holcomb, 2009; Ruel and El-Baz, 2023).

REA refers to the supply chain's ability to withstand the impact of unexpected events without interrupting its operations (Chang & Lin, 2019). A supply chain must develop strategies to mitigate possible mismatches in operations and provide agile and effective responses to partners and customers (Norris *et al.*, 2008; Knemeyer *et al.*, 2009).

Hypothesis H2 was accepted (β = 0.710, t = 2.013, p<0.05), demonstrating a positive relationship between REA and IPP. In general, SCs use metrics to measure the performance of innovative products and processes (Tolonen et al., 2017). SCs with a higher level of maturity share information and knowledge, develop innovative products quickly and replenish orders quickly (Chang and Lin, 2019; Li, 2021; Kayikci *et al.*, 2022).

Readiness suggests that supply chain subprocesses should be integrated to mitigate disruptive effects on demand, production, purchasing, supply, distribution and billing (Tolonen *et al.*, 2017; Demir *et al.*, 2023). To this end, contingency strategies should be developed to reduce the impacts of unexpected events that may negatively affect the IPP (Tolonen *et al.*, 2017; Chang and Lin, 2019).

Hypothesis H3 was rejected (β = 0.523, BootLLCI = 0.010, BootULCI = 2.222) and it is impossible to confirm the mediating effect of REA on INT and IPP. The multiplication of effect "a" by effect "b" generated effect "c′" (Table 6). Thus, it is possible to state that there is no mediation of REA on INT and IPP because effect "c" (c=0.284) is smaller than effect "c′" (c′=0.523).

Despite the rejection, the finding of H3 is relevant due to the scarcity of empirical research on the mediating effect of REA in SCs (Alsmairat, 2022). The results of this study are contrary to those obtained by Tran *et al.* (2023) and Hassan *et al.* (2023) because they consider REA as a mediating variable. Thus, new studies should be published to broaden the understanding of the mediating effect of REA in SCs. Hassan *et al.* (2023) point out that empirical research on the mediating effect of REA is limited, which justifies the development of new studies.

Table 6
Hypothesis test results

Model	Hypotheis	Relation	Effect	β	s.e.	t	p-value	R^2	Accept?
Model 1	H1a:INT→IPP	Direct	a	0.284	0.306	0.928	0.353	0.37	No
Model 1	H1b:INT→REA	Direct	b	0.737	0.142	5.206	<0.001	0.69	Yes
Model 1	H2:REA→IPP	Direct	c	0.710	0.353	2.013	<0.05	0.53	Yes
Model	Hypothesis	Relation	Effect	β	s.e.	BootLLCI	BootULCI	R^2	Mediation?
Model 4	H3:INT→REA→IPP	Indirect	c'	0.523	0.5408	0.010	2.222	0.45	No

Note(s): INT = Integration. REA = Readiness. IPP = Innovative product performance

Studies on REA indicate difficulty in measuring the effect of the construct. The application of REA requires time and refinement of skills, concepts and procedures that attest to efficiency in SCs (Arlbjørn *et al.*, 2006). Regardless of the level of maturity, companies' entry into SCs with readiness requires that the parties involved have acceptable levels of readiness (Kayikci *et al.*, 2022).

5.2 Theoretical and practical implications

This research has generated theoretical implications. First, the questionnaire was validated for the Brazilian context and can be replicated in future research. Second, research involving INT, REA and IPP in SCs is limited. To date, no studies have been published with the three variables together. This article contributes to the theoretical advancement of REA in SCs by using the construct as a mediating variable. The indirect effect of REA can strengthen the strength of two or more variables with a direct impact. SCs with REA are more resilient in periods of instability due to the dynamic capabilities applied. They aim to reconfigure their resources and redefine operations in an agile and efficient manner. Based on the revised theoretical framework, we define integration, readiness and innovative performance of products in SCs (Ponomarov and Holcomb, 2009; Chowdhury and Quaddus, 2017; Dahan and Levi-Bliech, 2024). INT raises the level of collaboration and improves the flow of information between the involved parties, reducing the risk of interruptions in operations. IPP contributes to new product launches and overall company performance. REA is the ability to detect interruptions and overcome adversities quickly. To this end, the SC must have the resources to face crises and develop forecasting systems to meet demand disruptions. Furthermore, the article brings practical contributions. First, the research involved companies in a developing supply chain. The companies that make up the SC investigated sell machinery and equipment for moving heavy loads to other SCs. The SC generates jobs, contributes to Brazil's GDP and stimulates the export of goods and products to other countries.

Second, the configuration of the validated empirical model is unique and should be understood comprehensively. Supply chain managers must develop dynamic capabilities to improve processes, enhance existing routines and create efficient management methods with business partners to achieve IPP. Rejecting hypotheses H1a and H3 may be the starting point to reinvigorate the association between INT, REA and IPP.

5.3 Contribution of dynamic capabilities to the supply chain

Dynamic capabilities enable the creation, implementation and protection of the organization's intangible assets to achieve superior long-term performance (Teece, 2007). For this purpose, managers must identify the links between the elements of a supply chain and establish connections with business partners through collaboration. Based on Teece (2007), we argue that dynamic capabilities strengthen the links between suppliers and customers. Thus, it is possible to make the supply chain ecosystem more robust and invigorated to face upstream and downstream disruptions.

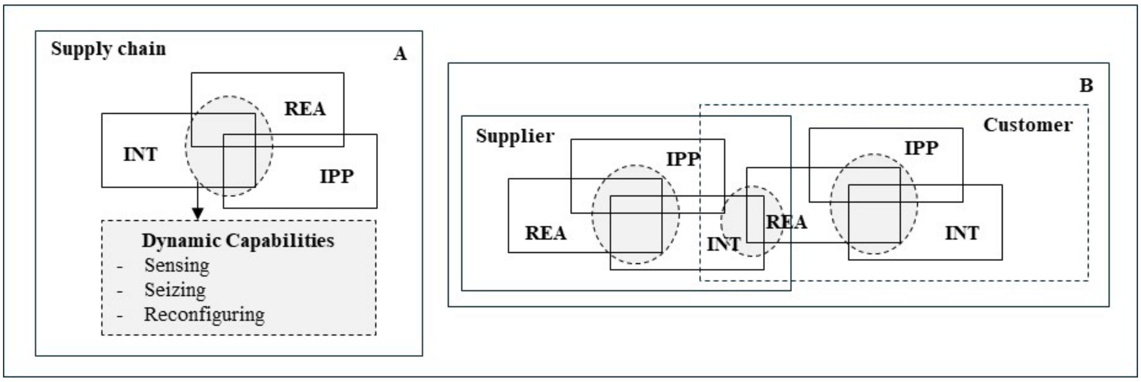

Fig. 3. SC connection and dynamic capabilities

Source: Prepared by the authors

Fig. 3-A illustrates the relationship between the three variables analyzed. The image allows us to infer that INT, REA and IPP have contact points that indicate opportunities for detection, seizure and reconfiguration of intangible resources between the links in the supply chain. Fig. 3-B presents connection points that indicate the microfoundations of dynamic capabilities. Teece (2007) defines microfoundations of dynamic capabilities as the ability to develop sensing, seizing and reconfiguring. Fig. 4 summarizes the fundamentals of dynamic capabilities applied to the supply chain.

	Sensing	Seizing	Reconfiguring / Transforming
Fundamentals of dynamic capabilities applied to the supply chain	Managers develop individual capabilities within their supply chain roles. Opportunities need to be filtered, shaped and calibrated.	Managers need structure, procedures and incentives to take advantage of opportunities with supply chain business partners.	Managers must align supply chain strategic objectives and reconfigure specific tangible and intangible assets.
	Integration ◄---► Readiness ◄---► Innovation ◄---► SC performance		

Fig. 4. Fundamentals of dynamic capabilities applied to the supply chain

Source: Prepared by the authors

Like Teece (2007), we argue that sensing occurs when supply chain managers develop individual capabilities that allow them to filter, shape and calibrate new partnership and collaboration opportunities for the supply chain. For example, a new business partner strengthens the supply chain's commercial relationship with new markets, accelerates the development of new products, reduces production operating costs, or can reinvigorate distribution channel links to new markets. Seizing brings together a set of structures, procedures and incentives so that managers can explore opportunities with business partners. Thus, the supply chain must have the necessary resources so that managers can take advantage of new market opportunities. For example, using a business partner's distribution channel can help with market penetration. Thus, the integration and collaboration strategy between supply chain links activates the readiness for innovative product performance in new markets.

Reconfiguring occurs when managers align strategic objectives across supply chain links through the use and transformation of specific tangible and intangible assets. The reconfiguration of distinctive resources should differentiate the supply chain from others. The pooling of resources associated with managers’ knowledge should be difficult to imitate and enable superior supply chain performance. For example, investing in the qualification and training of employees and managers contributes to improving operations and reducing dysfunctions in the supply chain. Integration and readiness can help managers change the mindset and efficiency of the supply chain.

6. Conclusion

This article had the dual objective of investigating the direct effect of integration (INT) on innovative product performance (IPP) and measuring the indirect impact of readiness (REA) on INT and IPP of a Brazilian SC that manufactures machinery and equipment for transporting and lifting heavy loads. This study contributes to a better understanding of the direct and indirect effect of the variables INT, REA and IPP in the supply chain of a developing country, such as Brazil.

The research findings reject the indirect effect of REA on INT and IPP and the direct effect of INT on REA. However, the study corroborates the direct effect of INT on REA and of REA on IPP. Despite this, it is possible to state that SC companies develop practices of collaboration, information sharing, integration between different departments and use of technology to accelerate the flow of information between companies. Furthermore, managers corroborate the level of novelty, speed of product development and the number of new products introduced into the market, indicating that they act with REA and IPP.

The rejection of REA as a mediating variable indicates that SC must develop deliberate strategies that reinforce REA through dynamic capabilities to mitigate disruptions. Actions must strengthen training, overcome periods of crisis, increase the levels of resources allocated to prevent disruptive events and develop warning mechanisms and forecasting systems that detect demand disruptions. Thus, it is possible to state that efforts need to be intensified to strengthen the indirect effect of REA on the investigated supply chain.

This study has some limitations. First, the research applied to managers of a specific SC limits the sample investigated. In general, operations in supply chains in developing countries are complex and present restricted routines and activities, making the findings relevant to the participating managers. We recommend that the proposed model be applied to other developing countries to test the robustness of the results. Second, the cross-sectional data collection limited the data collection to one time period. Thus, we encourage longitudinal research because it collects responses over some time. Third, the quantitative method uses a predefined (structured) questionnaire. New studies should conduct qualitative or mixed research and generate new insights into the variables investigated. Finally, further research should clarify the relationship between supply chain elements and the microfoundations of dynamic capabilities.

References

Akram, M. U., Islam, N., Chauhan, C., & Zafar, M. (2024). Resilience and agility in sustainable supply chains: A relational and dynamic capabilities view. *Journal of Business Research*, *183*, 114855. https://doi.org/10.1016/j.jbusres.2024.114855

Ali, A. A., & Mahmood, A. (2024). How Do Supply Chain Integration and Product Innovation Capability Drive Sustainable Operational Performance? *Sustainability (Switzerland)*, *16*(1), 1–20. https://doi.org/10.3390/su16010277

Alsmairat, M. A. K. (2022). the Nexus Between Organisational Capabilities, Organisational Readiness and Reverse Supply Chain Adoption. *Acta Logistica*, *9*(1), 31–37. https://doi.org/10.22306/al.v9i1.263

Ambrosini, V., & Bowman, C. (2009). What are dynamic capabilities and are they a useful construct in strategic management? *International Journal of Management Reviews*, *11*(1), 29–49. https://doi.org/10.1111/j.1468-2370.2008.00251.x

Arlbjørn, J. S., De Haas, H., Caspersen, R., Johansen, J., & Nørmølle, J. (2006). Improved change readiness through supply chain competency development. *Industrial and Commercial Training*, *38*(3), 128–136. https://doi.org/10.1108/00197850610659382

Armstrong, J. S., & Overton, S. T. (1977). Estimating Nonresponse Bias in Mail Surveys. *Journal of Marketing Research*, *14*(3), 396–402. https://mpra.ub.uni-muenchen.de/81694/%0D

Bae, H. sung, Grant, D. B., Banomyong, R., & Varadejsatitwong, P. (2023). Investigating the impact of the strength of supply chain integration on cost and responsiveness. *International Journal of Logistics Research and Applications*, *26*(1), 58–76. https://doi.org/10.1080/13675567.2021.1931827

Basana, S. R., Malelak, M. I., Suprapto, W., Siagian, H., & Tarigan, Z. J. H. (2024). The impact of SCM integration on business performance through information sharing, quality integration and innovation system. *Uncertain Supply Chain Management*, *12*(1), 435–448. https://doi.org/10.5267/j.uscm.2023.9.008

Bombelli, A., & Fazi, S. (2022). The ground handler dock capacitated pickup and delivery problem with time windows: A collaborative framework for air cargo operations. *Transportation Research Part E: Logistics and Transportation Review*, *159*, 102603. https://doi.org/10.1016/j.tre.2022.102603

Chang, W. S., & Lin, Y. T. (2019). The effect of lead-time on supply chain resilience performance. *Asia Pacific Management Review*, *24*(4), 298–309. https://doi.org/10.1016/j.apmrv.2018.10.004

Chen, H., Amoako, T., Quansah, C. E., Danso, S. A., & Jidda, D. J. (2023). Assessment of the impact of management commitment and supply chain integration on SMEs' innovation performance: Moderation role of government support. *Heliyon*, *9*(5). https://doi.org/10.1016/j.heliyon.2023.e15914

Chowdhury, M. M. H., & Quaddus, M. (2016). Supply chain readiness, response and recovery for resilience. *Supply Chain*

Management, *21*(6), 709–731. https://doi.org/10.1108/SCM-12-2015-0463

Chowdhury, M. M. H., & Quaddus, M. (2017). Supply chain resilience: Conceptualization and scale development using dynamic capability theory. *International Journal of Production Economics*, *188*(September 2015), 185–204. https://doi.org/10.1016/j.ijpe.2017.03.020

Dahan, G., & Levi-Bliech, M. (2024). Assessing supply chain management's impact on new product performance: the mediating role of marketing innovation orientation during COVID-19. *Journal of Strategy and Management*, *17*(2), 297–321. https://doi.org/10.1108/JSMA-08-2023-0226

Das, K., & Lashkari, R. S. (2015). Risk readiness and resiliency planning for a supply chain. *International Journal of Production Research*, *53*(22), 6752–6771. https://doi.org/10.1080/00207543.2015.1057624

Demir, S., Gunduz, M. A., Kayikci, Y., & Paksoy, T. (2023). Readiness and Maturity of Smart and Sustainable Supply Chains: A Model Proposal. *EMJ - Engineering Management Journal*, *35*(2), 181–206. https://doi.org/10.1080/10429247.2022.2050129

Douglas, S. P., & Craig, C. S. (2007). Collaborative and iterative translation: An alternative approach to back translation. *Journal of International Marketing*, *15*(1), 30–43. https://doi.org/10.1509/jimk.15.1.030

Duran, H., Temel, S., & Scholten, V. (2022). Drivers and barriers of new product development success: evidence from an emerging economy setting country-Turkey. *International Journal of Innovation Science*, *14*(1), 97–120. https://doi.org/10.1108/IJIS-12-2020-0277

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, *21*, 1105–1121. https://doi.org/10.1002/1097-0266(200010/11)21:10/11<1105::AID-SMJ133>3.0.CO;2-E

Feng, L., Zhao, Z., Wang, J., & Zhang, K. (2022). The Impact of Knowledge Management Capabilities on Innovation Performance from Dynamic Capabilities Perspective: Moderating the Role of Environmental Dynamism. *Sustainability (Switzerland)*, *14*, 4577. https://doi.org/doi.org/10.3390/su14084577

Field, A. (2009). *Finding using SPSS statistics* (2nd ed.). Artmed.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, *18*(1), 39. https://doi.org/10.2307/3151312

Fuller, C. M., Simmering, M. J., Atinc, G., Atinc, Y., & Babin, B. J. (2016). Common methods variance detection in business research. *Journal of Business Research*, *69*(8), 3192–3198. https://doi.org/10.1016/j.jbusres.2015.12.008

Gutierrez, L., Lameijer, B. A., Anand, G., Antony, J., & Sunder M, V. (2022). Beyond efficiency: the role of lean practices and cultures in developing dynamic capabilities microfoundations. *International Journal of Operations and Production Management*, *42*(13), 506–536. https://doi.org/10.1108/IJOPM-02-2022-0086

Hair Jr., J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2009). *Análise multivariada de dados* (6th ed.). Bookman.

Hassan, M. F. A., Ngah, A. H., & Tio, M. B. Y. (2023). Third-party logistics intention to provide cold transportation services. The mediating effect of top management support and organizational readiness in TOE framework. *Opsearch*, *60*(4), 1603–1625. https://doi.org/10.1007/s12597-023-00683-8

Hayes, A. F., & Rockwood, N. J. (2017). Behaviour Research and Therapy Regression-based statistical mediation and moderation analysis in clinical research : Observations , recommendations , and implementation. *Behaviour Research and Therapy*, *98*, 39–57. https://doi.org/10.1016/j.brat.2016.11.001

Helfat, C. E. (1997). Know-how and asset complementarity and dynamic capability accumulation: the case of R&D. *Strategic Management Journal*, *18*(5), 339–360.

Hinelo, R., Seri, L., Putra, W., & Ratnaningtyas, S. (2024). Uncertain Supply Chain Management Investigating the role of supply chain management on sustainable performance and dynamic capabilities : An empirical study on logistic organization. *Uncertain Supply Chain Management*, *12*, 1739–1746. https://doi.org/10.5267/j.uscm.2024.3.008

Kamal, A., Azfar, R. W., Salah, B., Saleem, W., Abas, M., Khan, R., & Pruncu, C. I. (2021). *Quantitative Analysis of Sustainable Use of Construction Materials for Supply Chain Integration and Construction Industry Performance through Structural Equation Modeling (SEM)*. *13*(2), 522. https://doi.org/10.3390/su13020522

Kayikci, Y., Kazancoglu, Y., Gozacan-Chase, N., Lafci, C., & Batista, L. (2022). Assessing smart circular supply chain readiness and maturity level of small and medium-sized enterprises. *Journal of Business Research*, *149*, 375–392. https://doi.org/10.1016/j.jbusres.2022.05.042

Kim, S. W. (2006). Effects of supply chain management practices, integration and competition capability on performance. *Supply Chain Management*, *11*(3), 241–248. https://doi.org/10.1108/13598540610662149

Kline, R. B. (2011). *Principles and Practice of Structural Equation Modeling* (3th ed.). New York: The Guilford Press.

Knemeyer, A. M., Zinn, W., & Eroglu, C. (2009). Proactive planning for catastrophic events in supply chains. *Journal of Operations Management*, *27*(2), 141–153. https://doi.org/10.1016/j.jom.2008.06.002

Kumar, V., Jabarzadeh, Y., Jeihouni, P., & Garza-Reyes, J. A. (2020). Learning orientation and innovation performance: the mediating role of operations strategy and supply chain integration. *Supply Chain Management: An International Journal*, *25*(4), 457–474. https://doi.org/10.1108/SCM-05-2019-0209]

Li, G. (2021). The impact of supply chain relationship quality on knowledge sharing and innovation performance: evidence from Chinese manufacturing industry. *Journal of Business and Industrial Marketing*, *36*(5), 834–848. https://doi.org/10.1108/JBIM-02-2020-0109

Makkonen, H., Pohjola, M., Olkkonen, R., & Koponen, A. (2014). Dynamic capabilities and firm performance in a financial crisis. *Journal of Business Research*, *67*(1), 2707–2719. https://doi.org/10.1016/j.jbusres.2013.03.020

Marôco, J. (2010). *Análise de Equações Estruturais: Fundamentos teóricos, Software & Aplicações*. ReportNumber.
Mentzer, J. T., Keebler, J. S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Journal of Business*, *22*(2), 1–25. https://doi.org/10.1002/j.2158-1592.2001.tb00001.x
Musyarofah, S. A., Tontowi, A. E., Masruroh, N. A., & Wibowo, B. S. (2023). Developing supply chain readiness measurement tool for the manufacturing industrial estates. *Journal of Open Innovation: Technology, Market, and Complexity*, *9*(1), 100019. https://doi.org/10.1016/j.joitmc.2023.100019
Nacchiero, R., Massari, G. F., & Giannoccaro, I. (2024). Supply chain transformative capabilities and their microfoundations for circular economy transition: A qualitative study in Made in Italy sectors. *Business Strategy and the Environment*, *May*, 1–21. https://doi.org/10.1002/bse.3939
Nath, P., & Upadhyay, R. K. (2024). Reformation and optimization of cargo handling operation at Indian air cargo terminals. *Journal of the Air Transport Research Society*, *2*, 100022. https://doi.org/10.1016/j.jatrs.2024.100022
Nguyen, L. H. (2024). The influence of management functions on the productivity of yard cargo handling equipment in container terminals. *Maritime Business Review*, *9*(2), 128–144. https://doi.org/10.1108/MABR-06-2023-0046
Norris, F. H., Stevens, S. P., Pfefferbaum, B., Wyche, K. F., & Pfefferbaum, R. L. (2008). Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *American Journal of Community Psychology*, *41*(1–2), 127–150. https://doi.org/10.1007/s10464-007-9156-6
Partyka, R. B. (2022). Supply chain management: an integrative review from the agency theory perspective. *Revista de Gestao*, *29*(2), 175–198. https://doi.org/10.1108/REGE-04-2021-0058
Pestana, M. H., & Gageiro, J. N. (2005). *Análise de dados para ciências sociais: a complementariedade do SPSS* (4th ed.). Sílabo.
Pham, H. T., & Nguyen, H. N. (2022). An Investigation of Cargo Handling Equipment Performance in Vietnam Container Terminals. *Logistics*, *6*(44), 757–762. https://doi.org/10.1007/978-981-99-2345-8_78
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. https://doi.org/10.1037/0021-9010.88.5.879
Ponomarov, S. Y., & Holcomb, M. C. (2009). Understanding the concept of supply chain resilience. *The International Journal of Logistics Management*, *20*(1), 124–143. https://doi.org/10.1108/09574090910954873
Prajogo, D. I., & Ahmed, P. K. (2006). Relationships between innovation stimulus, innovation capacity, and innovation performance. *R&D Management*, *36*(5), 499–515. https://doi.org/https://doi.org/10.1111/j.1467-9310.2006.00450.x
Rais. (2022). *Relação Anual de Informações Sociais*. Http://Www.Rais.Gov.Br/ Accessed on: 14 Jun 2024.
Ruel, S., & El-Baz, J. (2023). Disaster readiness' influence on the impact of supply chain resilience and robustness on firms' financial performance: a COVID-19 empirical investigation. *International Journal of Production Research*, *61*(8), 2594–2612. https://doi.org/10.1080/00207543.2021.1962559
Sarantakos, I., Nikkhah, S., Peker, M., Bowkett, A., Sayfutdinov, T., Alahyari, A., Patsios, C., Mangan, J., Allahham, A., Bougioukou, E., Murphy, A., & Pazouki, K. (2024). A robust Logistics-Electric framework for optimal power management of electrified ports under uncertain vessel arrival time. *Cleaner Logistics and Supply Chain*, *10*. https://doi.org/10.1016/j.clscn.2024.100144
Sebrae. (2022). *Serviço Brasileiro de Apoio às Micro e Pequenas Empresas*. Https://Sebrae.Com.Br Accessed on: 15 Jun 2024.
Siagian, H., Tarigan, Z. J. H., & Jie, F. (2021). Supply chain integration enables resilience, flexibility, and innovation to improve business performance in covid-19 era. *Sustainability (Switzerland)*, *13*(9), 1–19. https://doi.org/10.3390/su13094669
Steiner, B., Lan, K., Unterschultz, J., & Boxall, P. (2017). Applying the resource-based view to alliance formation in specialized supply chains. *Journal of Strategy and Management*, *10*(3), 262–292. https://doi.org/10.1108/JSMA-06-2016-0040
Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *1350*(August), 1319–1350. https://doi.org/10.1002/smj
Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533. https://doi.org/10.1142/9789812796929_0004
Tolonen, A., Haapasalo, H., Harkonen, J., & Verrollot, J. (2017). Supply chain capability creation – The creation of the supply chain readiness for a new product during product development process. *International Journal of Production Economics*, *194*(September), 237–245. https://doi.org/10.1016/j.ijpe.2017.09.007
Tran, T. H. U., Lau, K. H., & Ong, C. E. (2023). Mediating role of internationalization readiness in the adoption of social sustainability practices: Evidence from Vietnamese handicraft companies. *Business Strategy and Development*, *6*(2), 241–256. https://doi.org/10.1002/bsd2.236
Ullah, S., Ahmad, T., Kukreti, M., Sami, A., & Shaukat, M. R. (2024). How organizational readiness for green innovation, green innovation performance and knowledge integration affects sustainability performance of exporting firms. *Journal of Asia Business Studies*, *18*(2), 519–537. https://doi.org/10.1108/JABS-02-2023-0056
Vickery, S. K., Jayaram, J., Droge, C., & Calantone, R. (2003). The effects of an integrative supply chain strategy on customer service and financial performance: An analysis of direct versus indirect relationships. *Journal of Operations Management*, *21*(5), 523–539. https://doi.org/10.1016/j.jom.2003.02.002
Vieira, P. R. da C., & Ribas, J. R. (2011). *Análise Multivariada com uso do SPSS*. Ciência Moderna Ltda.

Wanke, P., Nwaogbe, O. R., & Chen, Z. (2018). Efficiency in Nigerian ports: handling imprecise data with a two-stage fuzzy approach. *Maritime Policy and Management*, *45*(5), 699–715. https://doi.org/10.1080/03088839.2017.1410588

Wijaya, O. Y. A. (2023). The role of supply chain management in entrepreneurial activities and product innovation on SMEs performance. *Uncertain Supply Chain Management*, *11*(2), 443–450. https://doi.org/10.5267/j.uscm.2023.3.005

Williams, B. D., Roh, J., Tokar, T., & Swink, M. (2013). Leveraging supply chain visibility for responsiveness: The moderating role of internal integration. *Journal of Operations Management*, *31*(7–8), 543–554. https://doi.org/10.1016/j.jom.2013.09.003