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Sustainable supply chain innovation and market performance: The role of sensing and innovation capabilities

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ABSTRACT

The involvement of supply chains in the creation of competitive advantages can drive change and innovation, particularly when considering the current need for sustainable practices in line with the demands of the consumer market. In this context, this study aims to investigate the impact of the dynamic capabilities of market sensing and innovation on sustainable innovation practices in supply chains and on market performance. For this, a survey was performed with 137 Brazilian experts in supply chain management using Structural Equation Modeling. We found a positive impact of the dynamic capabilities of market sensing and innovation on sustainable innovation practices in supply chains and on market performance. The investigation indicated paths for the adoption of a multilevel theoretical perspective based on the exploration of dynamic capabilities in line with marketing objectives.

1. Introduction

Organizations face pressure from stakeholders to implement sustainable practices. In this context, studies have focused particularly on sustainable innovation, based on the assumption that innovation should seek to provide competitive advantages to organizations, generate environmental benefits and social well-being (Cillo et al., 2019). There is also a growing interest in the literature in expanding the scope of the analysis of sustainable innovation to all stakeholders, looking deeper to sharing the responsibility for socio-environmental impacts between different organizations (Seuring and Müller, 2008).

Considering co-responsibility for materials and information's flows and socio-environmental impacts, the involvement of the supply chains' stakeholders in the creation of competitive advantages can drive change and innovation (Nilsson and Göransson, 2021), particularly when considering the current need for circular configurations (Govindan et al., 2016). This is especially true since organizations are not simply autonomous entities competing against each other, but members of interconnected networks that may generate or destroy value (Anderson et al., 1994).

Gao et al. (2017, p.1530) define supply chain innovation (SCI) as "an integrated change from incremental to radical changes in product, process, marketing, technology, resource and/or organization, which are associated with all related parties, covering all related functions in supply chain and creating value for all stakeholders. If the supply chain innovation results in balanced performance of economic, social and environmental dimensions [...] it is called a sustainable supply chain innovation (SSCI)". Tatham et al. (2017) and Aslam and Azhar (2018) defend the adoption of the theory of dynamic capabilities in studies on SSCI. According to Chowdhury and Quaddus (2021), organizations need to create dynamic capabilities to identify, adapt and respond to their stakeholders' sustainability requirements, as it helps mitigate the vulnerability caused by the risks involved in the lack of sustainable practices, such as consumer boycotts, reputational damage, financial losses and legal costs.

Nilsson and Göransson (2021) found that, despite the perceived relevance of all stakeholders, consumers and suppliers have not been explicitly considered, which indicates a need for investigations into the role of consumers in the adoption of sustainable innovation and on how innovation permeates supply chain links. Considering the lack of studies addressing SSCI based on the theory of dynamic capabilities (Tseng et al., 2019) and analyzing the role of consumers, Taghikhah et al. (2019) proposed the supply chains extension to consumers to achieve sustainability goals.

There is an expectation that SSCI practices will positively impact market performance resulting from an approach based on the consumer

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market. Chowdhury and Quaddus (2021) proposed a model to measure supply chain sustainability, defending that sustainability practices, together with the stakeholders' social, environmental, and economic requirements, are capable of positively affecting market performance. Furthermore, understanding the impact of these practices on market performance is relevant as some organizations are still wary of the acceptance of sustainable products, services and technologies by consumer markets (Gupta et al., 2020).

In this context, this study investigated the impact of the dynamic capabilities of market sensing on sustainable supply chain innovation and market performance. The findings broaden the paths for investigating SSCI using marketing theoretical perspectives based on the theory of dynamic capabilities, also benefiting organizations that face challenges in reconciling sustainability and performance.

2. Theoretical framework

2.1. Sustainable supply chain innovation (SSCI)

The concept of sustainable innovation is sometimes treated as a synonym for other terms, indicating a lack of consensus due to the presence of multiple areas of study analyzing the same topic, with most studies focusing on ecological and economic impacts, even though efforts have been made to include social aspects (Boons and Lüdeke--Freund, 2013).

For this study, sustainable innovation is seen as a broad concept encompassing the "introduction of products, production processes, management practices, or business methods, new or significantly improved, that bring economic, social, and environmental outcomes" (Neutzling et al., 2018, p.3449). Moreover, this study infers that the concept is in line with Sustainable Development and the Triple Bottom Line (TBL) approaches since it includes three dimensions of analysis: environmental; economic; and social.

The TBL approach was conceived in 1997 to measure business performance considering the environmental, economic, and social dimensions (Loviscek, 2021). Although TBL's concept is relevant for introducing sustainability to the business world, there are still challenges to reconcile performance in the three dimensions. Most organizations have measured performance in financial and operational terms, disregarding social well-being and the environment (Loviscek, 2021).

This study built on the SSCI practices advocated by Taghikhah et al. (2019): sustainable supplier selection, product recovery, waste management, sustainable design, sustainable transport, reverse logistics and network designs. According to the authors, the analysis of these practices is useful because people buy products not only based on their functionality or low price but also based on the way they are produced and delivered.

2.2. Consumer market and SSCI

Based on the idea that consumers evaluate the way goods are produced and delivered (Taghikhah et al., 2019), the historical difficulty of reconciling supply and demand must be considered. There is still interest in mitigating this difficulty, as seen in the push-pull approach to supply chains (Harrison et al., 2004), as well as in the customer-centered supply chain, which seeks to combine the strengths of supply networks to focus on the needs of each customer link in the chain, responding proactively to changes in demand (Madhani, 2019).

Regarding sustainable innovation, Horbach et al. (2012) and Liddle and El-Kafafi (2010) investigated the role of technological factors known as push and market demand (pull). They found that, overall, these factors must be analyzed inseparably, and that consumer requirements from the chain and the market are an important driver of innovation.

Svensson (2003, p.394) emphasized the concept of consumer driven value chain, proposing a holistic and bidirectional model that includes the creation of value for the consumer working "back from the ultimate consumer, not towards him as a final step". For Nilsson and Göransson (2021, p. 2), sustainable supply chain innovation has been addressed in terms of "silos, short-term thinking and profit-maximizing". They also found that, even though customers, suppliers, and other stakeholders are considered strong links in supply chains, most studies do not analyze them explicitly.

Taghikhah et al. (2019) argued that, if consumers are motivated to change the way they consume, replacing a purely economic bias to include aspects such as the environment and social justice, these preferences reconfigure and feed back into the chains. In the opposite direction, they believe that organizations need to introduce sustainable practices along the chain, aiming to influence and motivate this behavior.

Paloviita (2010), analyzing how Finnish consumers perceive sustainable innovation in local food supply chains, found that the sustainability in the supply chain of food produced locally must be promoted and requires personal, direct relationships with local producers, education, and communication with consumers. In their social media analysis, Amirmokhtar Radi and Shokouhyar (2021) found that employing sustainable innovation practices along the supply chain of smartphones has been received positively by consumers and that the environment, materials, technology, and corporate social accountability are the main topics of interest.

SSCI can still affect organizational marketing results. Chowdhury and Quaddus (2021) proposed a model to measure supply chain sustainability, defending that sustainability practices, together with the stakeholders' social, environmental, and economic requirements, are capable of positively affecting market performance. In their study, market performance included market share growth, new market opportunities and favorable consumer attitudes. They found that market performance was especially affected in environments with superior sustainability governance through the reduction of sustainability risks arising from damage to Institutional image.

Gupta et al. (2020) argued that the lack of clarity on the requirements of consumers is a barrier for sustainable supply chain innovation, despite its potential benefits to meet the needs of the consumer market. The authors showed, for example, that there is still uncertainty regarding consumer acceptance of sustainable products and technologies and, for this reason, organizations seem unwilling to adopt sustainable innovations. As a strategy, they advocated promoting the benefits of sustainable products so that demand increases.

2.3. Dynamic capabilities and SSCI

Tseng et al. (2019) stated that there is a lack of studies about sustainable supply chain innovation based on the theory of dynamic capabilities, which are defined as the "ability to integrate, build and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997).

According to Zheng et al. (2011), the theory of dynamic capabilities considers how competitive advantages are renewed, which is particularly important in environments marked by instability, competition and innovation. From the perspective of studies on supply chain management, the approach may enable an understanding of how joint capabilities are formed among stakeholders. According to Tatham et al. (2017), the understanding of dynamic capabilities enables more efficient answers for the current competitive landscape, which is characterized by shorter lifecycles for products and technology, leading to a constant need for adaptations. Aslam and Azhar (2018), for instance, found that dynamic capabilities applied to supply chains have a positive impact on cost reduction, increased profitability, and customer satisfaction.

Dynamic capabilities are superior-level capabilities that channel other capabilities to maintain external aptitude, namely sensing, seizing, and transforming. Sensing activities involve the ability to 'scan' for complex and disordered information in the external environment, such as latent consumer demands, new technologies, and threats that could affect the business. Successful sensing enables an evaluation and processing of the information and involves decentralization, a collaborative culture, and other requirements. Once the information is obtained, seizing involves the ability to respond to potential opportunities such as investing in new technologies, projects, and business models. Lastly, transforming is the ability to maintain these new resources in line with the overall strategy, based on a new organizational design and structure, for instance (Teece, 2018).

An important sensing capability is market sensing, which includes all actions performed to enable proactive learning of the characteristics of the stakeholders, including consumers, competitors, and the entire business environment around a supply chain (Lee, 2004). According to Bayighomog Likoum et al. (2020), the market sensing capability provides organizations with the necessary flexibility to remodel their structure in a way that is cohesive with future changes in the market, based on efficient communications with other actors in the ecosystem.

Market sensing can also be related to innovation capacity. Innovation capacity is conceptualized by Weber and Heidenreich (2018) as a company's ability to acquire, assimilate and transmit new knowledge in order to develop new goods and services. It is therefore appropriate to understand whether organizations that are able to detect market needs are also better able to innovate and, even more so, whether this ability has a broader impact on the creation of more sustainable supply chains.

2.4. Research hypotheses

Previous studies found a positive effect of the market sensing capability on innovation (Alshanty and Emeagwali, 2019). Ardyan and Sugiyart (2017) found that the market sensing capability has a significant and positive effect on the quality of innovative products in the market. However, when it comes to innovation capacity within supply chains, Mendoza-Silva (2021) identified that previous studies have neglected the impacts of collaboration between companies, making studies that explore innovation capacity in supply chains essential. Therefore, the first hypothesis proposed in this study is.

H1. The market sensing capability has a positive relationship with the innovation capability.

In terms of sustainability, would the ability to detect the market have a positive impact on the ability to innovate sustainably, extending to supply chains? Hong et al. (2018) found that the seizing, market sensing and innovation dynamic capabilities mediate the relationship between sustainable practices in supply chains and economic, social and environmental performance.

Day (1994) established a market-based sustainability model in which organizational activities must be based on complex sets of abilities and knowledge within three dimensions. The outside-in dimension includes market sensing and anticipating external requirements; the spanning dimension includes efforts to integrate internal and external capabilities, crossing functional boundaries; and the inside-out dimension encompasses the internal transformation processes triggered by the market.

In the context of sustainable innovation, Weidner et al. (2020) identified market-based dynamic capabilities for sustainability, defining it as a type of outside-in capability related to the ability to reconcile customers' wishes with social, environmental and economic concerns of other stakeholders. They concluded that market-based sustainability is positively related to sustainable innovation.

Similarly, Lintukangas et al. (2019) found that innovation in supply chain management has a positive influence on the overall sustainability performance and argued that supply chain management must consider its role as a generator of sustainable ideas in markets through the perception capability. In a systematic literature review, Nilsson and Göransson (2021) proposed a model for sustainable supply chain innovation and argued that collaboration between stakeholders enables the development of the innovation capability and that, to this end, building dynamic capabilities for adopting new ideas is essential. Thus, considering that the literature shows that the combination of market detection capabilities between organizations can have a positive impact on innovation capacity, it is important to analyze whether these capabilities also have a positive impact on sustainable innovation within supply chains, raising the hypothesis that it remains to be seen whether this also applies to sustainable innovation in supply chains.

H2. The market sensing capability has a positive relationship with sustainable supply chain innovation.

Even before including the idea of sustainable innovation, some authors found in their studies that innovation itself is an antecedent of sustainability. Lai et al. (2015) found that corporate innovation strategies have an impact on sustainability results, and Nugraha et al. (2021) found that information-sharing behavior, organizational innovation initiatives, and innovation capability have a partial impact on compliance with sustainability goals. Wetering et al. (2017) argued that the innovation capability is an essential element to drive sustainable transformation, particularly when facilitated by information technology resources, which leads to the emergence of the third hypothesis of this study.

H3. The innovation capability is positively linked to sustainable supply chain innovation.

Sustainable innovation practices in supply chains may also be related to market performance. Chowdhury and Quaddus (2021) proposed a model to measure supply chain sustainability, defending that sustainability practices, together with the stakeholders' social, environmental, and economic requirements, are capable of positively affecting market performance. They found that market performance was especially affected in environments with superior sustainability governance by reducing image and reputation's harm. It remains to be seen whether the sustainable innovation practices analyzed in this study also have a positive impact on market performance. These studies led to the formulation of the fourth hypothesis.

H4. Sustainable innovation practices in supply chains are positively related to market performance.

3. Methods

3.1. Data collection and sample

This study used primary data collected through surveys with experts. We considered experts those working in organizations from different industries, in roles related to supply chain management, marketing, sustainability, innovation, or research and development (R&D). It included demographic questions and listed five constructs or latent variables based on the literature (Market sensing capability – MSC; Innovation capability – INC; Sustainable supply chain innovation – SSCI; and Market performance – MPERF), presented through 28 measurement items. Table I presents the descriptions and codes of this study's latent variables.

To measure MSC, we used the model proposed by Hong et al. (2018), who investigated the relationships between sustainable practices in supply chains, dynamic capabilities, and economic, social, and environmental performance. We added one item related to the MSC (MSC8): 'We know the demands of customers in the region(s) where we operate', as Choi et al. (2018) highlighted the importance of a business structure based on regional needs.

For INC, we used Hong et al. (2018)'s model, adding three extra items, based on the need to provide a general understanding of the different dimensions of product innovation (INC3, INC4 and INC7): 'We can change our products', 'We can launch new products in the market'' and 'We are pioneers in launching new products'

To measure SSCI, this study adapted the models by Taghikhah et al.

Table 1
Description and codes of the latent variables.

Latent variable	Code	Description
Market sensing capability (MSC)	MSC1	We can quickly learn from suppliers, customers and competitors
	MSC2	We often update outdated knowledge on consumers
	MSC3	We can quickly and effectively apply new knowledge to related products and services
	MSC4	We are able to keep abreast of changes in technology and products of our competitors
	MSC5	We are fully aware of the changes in customer demand
	MSC6	We are able to track the changes in technology and demand for alternatives
	MSC7	We are able to keep abreast of changes in the technology and products of our partners in the supply chain
	MSC8	We know the demands of the consumers in the region(s) where we operate
Innovation capability (INC)	INC1	We can quickly adapt our products, processes and technologies to meet local or regional market demands
	INC2	We can quickly adapt to new technologies
	INC3	We can change our products
	INC4	We can launch new products in the market
	INC5	We can adopt new management methods according to the environmental changes
	INC6	We implement new marketing methods to promote our products
	INC7	We are pioneers in launching new products
	INC8	We can quickly integrate resources to respond to changes in the environment, timely response to the company's objectives
Sustainable Supply Chain Innovation (SSCI)	SSCI1	The company I work for selects its suppliers and business partners based on criteria that include the social and environmental impact they cause
	SSCI2	The company I work for, with its suppliers and business partners, seek new ways to recover, reuse or recycle products that are damaged, defective or at the end of their useful life
	SSCI3	The company I work for, with its suppliers and partners, develop products with innovative design, designed to reduce the social and environmental impact in the supply chain activities (sustainable packaging, for example)
	SSCI4	The company I work for, with its suppliers and partners, develop products with innovative design, designed to increase their durability
	SSCI5	The company I work for, with its suppliers and business partners, seek new ways to facilitate the return of damaged, defective or end-of-life products
	SSCI6	I consider it important that the suppliers and/or business partners of the company I work for adopt innovative ways to reduce the waste generated during the processes of raw material purchase, production, distribution, and sale
	SSCI7	The company I work for, its suppliers and/or business partners, seek new environmentally sustainable ways of distributing its products (less polluting vehicles, for example)
	SSCI8	The company I work for, its suppliers and/or business partners, before installing new industrial plants or distribution centers, seek to evaluate the social and environmental impact caused in the local community
Market performance (MPERF)	MPERF1	Our products are perceived by consumers as more sustainable than those of our competitors
	MPERF2	The adoption of sustainable practices has increased our sales volume
	MPERF3	The adoption of sustainable practices has increased our market share
	MPERF4	The adoption of sustainable practices has been making it possible to enter new markets

Note. Source: the authors.

(2019), Calik and Bardudeen (2016), Baliga et al. (2019). The study by Taghikhah et al. (2019), with textual adaptation, was used to measure some practices: selection of sustainable suppliers, product recovery, waste management, sustainable design, sustainable transportation, reverse logistics, and sustainable network design.

Lastly, to measure MPERF, this study proposed a model based on Keszey (2020) and Chowdhury and Quaddus (2021). The following measurement items were defined after an adaptation to include SSCI practices: 'MPERF1: Our products are seen by consumers as more sustainable than those of our competitors', 'MPERF2: The adoption of sustainable practices has increased our sales', 'MPERF3: The adoption of sustainable practices has expanded our market share', and 'MPERF4: The adoption of sustainable practices has enabled our entry into new markets'.

The chosen measurement models were translated and retranslated from English into Brazilian Portuguese. A pre-test was performed with five experts (Hunt et al., 1982).

A non-probability sample was adopted for convenience. This was considered viable for this study since the goal was to evaluate the relationships between each variable, not to make inferences for the general population. The minimum sample was obtained through the software GPower®. According to Ringle et al. (2014), the latent variable is used with the highest number of predictors in the model, and the sample size is calculated based on the selection of test significance and effect size.

Considering the latent variable SSCI with two predictors, the software recommended a minimum sample of 68 observations. Following the recommendation of Ringle et al. (2014), the double was used in this study, establishing a minimum of 136 respondents.

3.2. Data analysis techniques

The first step was the preparation of the database. Since the questions in the measurement instrument were mandatory, there was no missing data. Regarding atypical observations, each case was evaluated considering the observations outside the confidence intervals (Hair Jr. et al., 2014).

After the database preparation step, descriptive statistical analysis was performed to describe the sample and calculate the mean and standard deviation of the variables. The next step was the explanatory

Table 2
EFA criteria.

Measurement/test	Criteria
KMO test	Between 0.5 and 0.7: average; Between 0.7 and 0.8: good; Between 0.8 and 0.9: great; Above 0.9: excellent
Bartlett's test of sphericity	$p < 0,05$
Explained variance	Higher or equal to 60%
Factor loadings	n = 50: loads >0,75; n = 100: loads >0,55; n = 150: loads >0,45 n = 250: loads >0,35; n equal or higher than 350: loads >0,30
Communalities	Higher or equal to 0,5, according to the researcher's judgment

Note. Source: the authors based on Hair Jr. et al. (2014).

factor analysis (EFA), which was followed by structural equation modeling (SEM). For the EFA we verified the criteria presented in Table II. Regarding the rotation method, we opted for VARIMAX rotation, which seeks maximum simplification of the factor model.

The estimation method used in the SEM was partial least squares. This method makes no assumptions about the normality of the sample, which is useful for studies in social sciences since it is not possible to follow a normal distribution. In addition, it allows for more complex analyses, including mediating and moderating relationships, and for a considerable number of equations, obtaining global fit measures in smaller samples (Wong, 2013).

The steps taken were: (1) specification of the measurement model, (2) specification of the structural model, (3) data collection, (4) evaluation of the measurement and structural models, (5) comparison between the proposed and respecified models. Once the measurement objects were validated, an evaluation of the structural model was performed to understand the consistency between the model and theoretical expectations (Hair Jr. et al., 2014). The evaluation analysis parameters are in line with Ringle et al. (2014), as shown in Table III.

4. Results

4.1. Sample description and descriptive statistical analysis

The collection process resulted in 144 respondents, with 137 valid – seven observations were removed from the database: four respondents stated they did not work in one of the related areas, and three had incoherent responses with the confidence interval (all responses given corresponded to a single Likert scale item).

Demographic results show that most of the respondents resided in the Southeast region of Brazil (82.5%). Regarding age, there was a homogeneous distribution between age groups and an average of 36 years old. As for educational level, 94.2% indicated they had at least a college education, with 35% indicating they had a graduate education. In terms of income level, 61.5% indicated a monthly income between three and twelve times the minimum wage; 21.9% between six and nine times the minimum wage. In addition to demographics, some occupational characteristics were collected. Most of the experts have a major in Business Administration (32.1%) or Engineering (28.5%) and work in areas related to supply chain management (50.4%) and sustainability (27%). The business sectors in which their companies operate included commerce and distribution (14.6%), food and beverages (10.9%), transport (7.3%), construction and engineering (6.6%), information technology and communication (6.6%), agribusiness (6.6%), and telecommunications (5.1%). In addition, most of them work in management (43.3%) or support (48.2%) positions.

There was a homogeneous distribution for time in position, with 30.7% of respondents having spent from one to five years in the current position, 32.1% from five to ten years, and 28.4% for more than ten years. In addition, 23.4% indicated they had been in the same company for less than a year, 37.2% from one to five years, 23.4% from five to ten years, and 16.1% for more than ten years.

The analyses of the demographic and occupational characteristics were followed by the analysis of the mean and standard deviation values of the responses obtained for each latent variable.

Regarding variables MSC and INC, the analysis of the mean and standard deviation values indicate that the experts believe their organizations have business sensing and innovation capabilities, with means above three.

The evaluation of the SSCI variable also indicated means above three for all items. In general, this latent variable had less significant means than the other constructs, demonstrating more indifference by the respondents regarding the adoption of SSCI practices.

Lastly, the analysis of the mean and standard deviation for the market performance latent variable were developed. There were three mean values close to three in all measured items, with a more significant value for MPERF4 and MPERF3. The mean values obtained for MPERF1 and MPERF2 indicated a higher indifference regarding the increase in sales volume provided by these practices in relation to the company's reputation.

Table 3
Indicators for evaluating measurement models.

Indicator	Objective	Parameter
Factor loadings	Convergent validity	≥0,5
Extracted variance	Convergent validity	≥0,5
Confiability	Convergent validity	≥0,7
VIF (Variance inflation factor)	Convergent validity	VIF <5
Fornell-Larcker	Discriminant validity	Square roots of variance extracted > correlation
Student t-test	Nomological validity	$t >$ 1,96 (*bootstrapping*)

Note. Source: the authors based on Hair Jr. et al. (2014).

4.2. Explanatory factor analysis

Table IV shows the EFA results for each latent variable in the analyzed sample.

For reliability analysis purposes, all Cronbach's Alpha values obtained were higher than the minimum level indicated in the literature. Bartlett's test of sphericity demonstrated the adequacy of choosing the EFA method, with significant values at 95% (Sig. <0.05).

Regarding the KMO test, satisfactory values were obtained for the MSC, INC and SSCI latent variables, considered good (from 0.7 to 0.8) or great (from 0.8 to 0.9). In addition to this analysis, the anti-image matrix was evaluated as a measure of sample adequacy.

In the factor loadings analysis, a significantly low value was found for the items SSCI6 (0.365) and SSCI8 (0.511). Therefore, these two items were removed. A new round of EFA was performed after the removal. The new round of EFA was considered satisfactory, with factor loadings above 0.55, an increase in explained variance from 42.2% to 51.5%, and an increase in Cronbach's Alpha to 0.809.

4.3. Structural equation modeling

Results for the PLS algorithm demonstrated a measurement item with value below 0.6 in the variable INC6 ('We are capable of innovating in our marketing initiatives'), with external loading equal to 0.570, indicating the need to analyze the possibility of removing this item to fulfill the remaining parameters.

To determine the convergent validity and the reliability of the measurement models, the values for Cronbach's alpha, composite reliability, and average variance extracted (AVE) were calculated. The AVE value for the latent variable INC was less than 0.5; therefore, the items with the lowest factor loadings were removed one by one until the AVE value became greater than 0.5 in a respecified model. Fig. 1 indicates the respecified model with external loadings greater than 0.6.

Reliability and convergent validity analysis for the respecified model were calculated and the parameters were met for the four latent variables, with Cronbach's alpha and composite reliability values greater than 0.7, and AVE greater than 0.5. These results enabled the next steps involving the discriminant validity assessment. The variance inflation factor (VIF) showed a maximum value of 1.702, which was considered adequate based on the criterion of Maroco (2010).

Results of the discriminant validity assessment through the Fornell-Larcker criterion in the latent variables indicate the fulfillment of the discriminant validity criterion for the respecified model.

The T values must be greater than 1.96 for measurement models to have nomological validity, considering a 95% significance level. The

Table 4
Explanatory factor analysis.

Latent variable	Item	Factor loading	Variance %	KMO	Barlett	Cronbach's Alpha
Market Sensing Capability (MSC)	MSC1	0.786	52.5	0.843	Sig. 0.000	0.868
	MSC3	0.780				
	MSC6	0.770				
	MSC2	0.759				
	MSC4	0.746				
	MSC5	0.730				
	MSC7	0.601				
	MSC8	0.599				
Innovation Capability (INC)	INC4	0.786	44.5	0.756	Sig. 0.000	0.816
	INC3	0.726				
	INC8	0.688				
	INC5	0.668				
	INC7	0.653				
	INC2	0.628				
	INC1	0.598				
	INC6	0.562				
Sustainable Supply Chain Innovation (SSCI)	SSCI3	0.769	42.2	0.788	Sig. 0.000	0.801
	SSCI2	0.747				
	SSCI1	0.731				
	SSCI5	0.699				
	SSCI4	0.641				
	SSCI7	0.633				
	SSCI8	0.511				
	SSCI6	0.365				
Market Performance (MPERF)	MPERF1	0.836	57.8	0.624	Sig. 0.000	0.751
	MPERF2	0.723				
	MPERF3	0.724				
	MPERF4	0.704				

Note. Source: analysis of research data

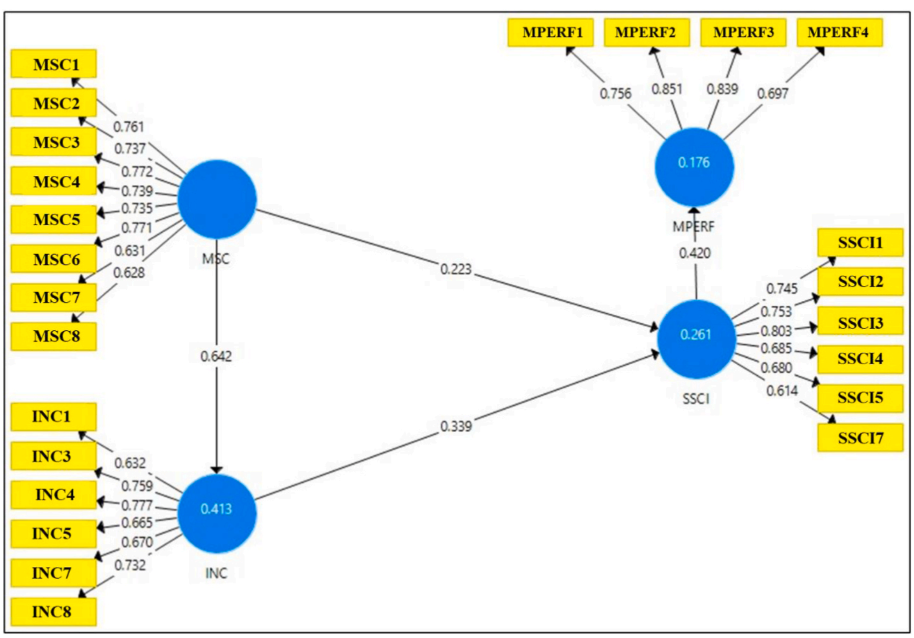

Fig. 1. Respecified Model.
Note. Source: analysis of research data.

results demonstrated that the values of the relationships between the measurement items and their respective latent variables meet this requirement, indicating their validity.

Subsequently, Pearson's coefficients of determination (R^2) were used as the first criterion for evaluating the structural model. R^2 and adjusted R^2 values for the respecified model were determined. The results refer to the magnitude of the effect, which was obtained from bootstrapping based on 5000 subsamples with a 0.05 significance level and showed that 41.3% of the variance in INC was explained by MSC which makes it a variable with large effect. In addition, innovation capability explained 26.1% of the variance in SSCI, which makes it also a variable with large effect based on the literature (R^2>13%). The predictor variables explained 17.6% of the variance in market performance, which is considered a medium effect by Hair Jr. et al. (2014).

Regarding the values found for the T-statistic and for the path coefficients, which are considered significant based on p-values lower than 0.05 and t-values greater than 1.96, there was a significant relationship between the market sensing capability and the innovation capability, which indicates that MSC is a strong predictor of INC.

In addition to these coefficients, the study also analyzed the Q^2

(Stone-Geisser) and f^2 (Cohen) values to determine how close the model came to what was expected of it, as well as the relevance of the latent variables for the model formation. The values were obtained from the blindfolding module of SmartPLS.

The values obtained for Q^2 were greater than zero, indicating that the model came close to the expectations, and the f^2 values demonstrated that the MSC variable was relevant for the model fit, with values greater than 0.35. The remaining variables had a medium effect on the model fit.

Based on the results obtained for the values of the path coefficients, T-values and p-values, and considering the study hypotheses, it follows that.

- The market sensing capability has a positive relationship with the innovation capability ($T = 12.966$; $\beta = 0.642$; $p = 0.000$);
- The market sensing capability has a positive relationship with SSCI practices ($T = 2.002$; $\beta = 0.223$; $p = 0.045$);
- The innovation capability has a positive relationship with sustainable supply chain innovation ($T = 2.763$; $\beta = 0.339$; $p = 0.006$);
- Sustainable innovation practices in supply chains are positively related to market performance ($\beta = 0.420$, $t = 5.943$; $p = 0.000$).

5. Discussion and conclusions

This study investigated the impact of the dynamic capabilities of market sensing and innovation on sustainable innovation practices in supply chains and on market performance, confirming an important predicting role of these capacities.

5.1. Hypothesis assessment

H1. The market sensing capability has a positive relationship with the innovation capability.

The hypothesis was confirmed, showing that the capacity for proactive learning of stakeholders' characteristics and the business environment favors the capacity for innovation, intending to apply this learning in changes or the development of new products and services. It is worth remembering, however, that improving this capacity requires decentralization and a collaborative culture (Teece, 2018).

The confirmation of this hypothesis is in line with previous studies such as Bayighomog Likoum et al. (2020), Alshanty and Emeagwali (2019) - these studies found a relationship between market sensing capability on innovation in small and medium enterprises, and Ardyan and Sugiyart (2017), who found that the market sensing capability has a positive and significant effect on the quality of innovative products.

H2. : The market sensing capability has a positive relationship with sustainable supply chain innovation.

This hypothesis confirms that learning about the socio-environmental requirements of the business environment, resulting from the market sensing capacity, benefits the adoption of sustainable innovation practices in the supply chain as a whole. Recovering Weidner et al. (2020), it is about reconciling consumers' desires and needs with the socio-environmental and economic concerns of other interested parties. Similarly, the confirmation of this hypothesis reiterates that organizations need to create dynamic capabilities in order to identify, adapt and respond to their stakeholders' sustainability requirements, mitigating the vulnerability caused by the risks involved in sustainable practices (Chowdhury and Quaddus, 2021). In summary, in this study we confirm that the market sensing capability is a predictor of the SSCI practices mentioned by Taghikhah et al. (2019): selection of sustainable suppliers, product recovery, waste management, sustainable design, sustainable transportation, reverse logistics and sustainable network design.

H3. The innovation capability has a positive relationship with sustainable supply chain innovation.

The confirmation of this hypothesis led us to conclude that organizations need more than detecting market information, they have to be able to assimilate and transform this information into new or modified products, services or technologies. As a consequence, a beneficial effect on SSCI practices is expected, a likely result of the greater ability to share information and the ease brought by new technologies (Nugraha et al., 2021; Wetering et al., 2017).

This finding is in line with Lai et al. (2015), who found that corporate innovation strategies have an impact on sustainability results; Nugraha et al. (2021), who found that the innovation capability affects compliance with sustainability goals; and Wetering et al. (2017), who argued that innovation capability is an essential element to drive sustainable transformation.

The confirmation of this hypothesis ratifies the assessment of Bhutta et al. (2021): in order to achieve sustainability in supply chains, organizations must adopt a holistic approach integrating the innovation capability while considering innovations in marketing, processes, products, clean production, and relationship with stakeholders.

H4. Sustainable innovation practices in supply chains are positively related to market performance.

These findings are also compatible with the literature, reinforcing the idea that adopting sustainable practices in production, distribution and other activities that permeate the links in a supply chain may help improve an organization's reputation with the consumer market, increase market share, increase profits, and find new markets. This result is in line with Keszey (2020) and with Chowdhury and Quaddus (2021).

In general, the study demonstrated the positive impact of aligning SSCI practices with consumer market demands, through the creation and improvement of market detection and innovation capabilities. These results represent an advance in the literature, in which there is a predominance of intra-organizational theoretical approaches that do not include the perspective of the consumer market (Tebaldi et al., 2018).

Empirically, the study proposes that organizations should turn their attention to their ability to read the business environment and adapt their offers to the requirements of the consumer market and stakeholders. As a consequence, a solid basis is created for improving SSCI practices, which, as demonstrated, has a positive impact on market performance. That is, uncertainty about consumer acceptance of sustainable products and technologies, highlighted by Gupta et al. (2020), can be mitigated by creating and improving these capabilities.

5.2. Limitations, future studies, and implications

As limitations, we can mention the use of a non-probability sample, since it prevents a generalization of the findings for the entire population. However, the study presents relevant theoretical and empirical contributions, indicating paths for the adoption of a multilevel theoretical perspective based on the exploration of dynamic capabilities in line with marketing objectives.

The theoretical contributions include the analysis of supply chains from a multilevel perspective that is not focused on dyadic relationships or the study of specific cases, which are considered limiting approaches according to Tebaldi et al. (2018). Furthermore, the study will help fill a gap in the literature by addressing the role of consumers and other stakeholders, as defended by Kusi-Sarpong et al. (2019), Nilsson and Göransson (2021) and Russo et al. (2019).

Empirically, the findings of this study may be useful for experts and managers working in different sectors and seeking to assist organizations with the successful adoption of SSCI practices, targeting customers who have increasing demands for the adoption of sustainable practices and providing knowledge for organizations to reflect on their dynamic capabilities for market sensing and innovation, which are important predictors of these practices.

Its conclusions will allow future studies to expand the proposed model, furthering the analysis of predictors and requirements for the market and innovation dynamic capabilities and seeking to analyze the factors that facilitate or hinder the development of these capabilities, as well as the human, material and financial resources needed.

The structural model we tested could also be applied to organizations in different industries, seeking to evaluate the results in market performance as well as financial and operational performance. In addition, there could be analyses focusing on the moderating effect of company size, sector or specific links in supply chains.

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CRediT authorship contribution statement

Lucas Silva Barreto: Writing – review & editing, Writing – original draft, Investigation, Formal analysis, Data curation. **Vérica Freitas:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Formal analysis, Conceptualization. **Verônica Angélica Freitas de Paula:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

References

Alshanty, A.M., Emeagwali, O.L., 2019. Market-sensing capability, knowledge creation and innovation: the moderating role of entrepreneurial-orientation. J. Innovation Knowledge 4 (3), 171–178. https://doi.org/10.1016/j.jik.2019.02.002.

Amirmokhtar Radi, S., Shokouhyar, S., 2021. Toward consumer perception of cellphones sustainability: a social media analytics. Sustain. Prod. Consum. 25, 217–233. https://doi.org/10.1016/j.spc.2020.08.012.

Anderson, J.C., Håkansson, H., Johanson, J., 1994. Dyadic business relationships within a business network context. J. Market. 58 (4), 1–15. https://doi.org/10.1177/002224299405800401.

Ardyan, E., Sugiyart, G., 2017. Market sensing capability and product innovation advantages in emerging markets: the case of market entry quality and marketing performance of batik industry in Indonesia. Dlsu Business Econ. Rev. 27, 1, 1.

Aslam, H., Azhar, T.M., 2018. Dynamic capabilities and performance: a supply chain perspective. Pakistan J. Comm. Soc. Sci. 12 (1), 198–213.

Baliga, R., Raut, R., Kamble, S., 2019. Sustainable supply chain management practices and performance. Manag. Environ. Qual. Int. J. 31 (5), 1147–1182. https://doi.org/10.1108/meq-04-2019-0079.

Bayighomog Likoum, S.W., Shamout, M.D., Harazneh, I., Abubakar, A.M., 2020. Market-sensing capability, innovativeness, brand management systems, market dynamism, competitive intensity, and performance: an integrative review. J. Knowl. Econom. 11, 593–613. https://doi.org/10.1007/s13132-018-0561-x.

Bhutta, M.K.S., Muzaffar, A., Egilmez, G., Huq, F., Malik, M.N., Warraich, M.A., 2021. Environmental sustainability, innovation capacity, and supply chain management practices nexus: a mixed methods research approach. Sustain. Prod. Consum. 28, 1508–1521. https://doi.org/10.1016/j.spc.2021.08.015.

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007.

Calik, E., Bardudeen, F., 2016. A measurement scale to evaluate sustainable innovation performance in manufacturing organizations. Procedia CIRP 40, 449–454. https://doi.org/10.1016/j.procir.2016.01.091.

Choi, S., Cho, I., Han, S.H., Kwak, Y.H., Chih, Y.-Y., 2018. Dynamic capabilities of project-based organization in global operations. J. Manag. Eng. 34 (5), 04018027 https://doi.org/10.1061/(asce)me.1943-5479.0000621.

Chowdhury, H.M.M., Quaddus, M.A., 2021. Supply chain sustainability practices and governance for mitigating sustainability risk and improving market performance: a Dynamic capability Perspective. J. Clean. Prod. 123521 https://doi.org/10.1016/j.jclepro.2020.123521.

Cillo, V., Petruzzelli, A.M., Ardito, L., Del Giudice, M., 2019. Understanding sustainable innovation: a systematic literature review. Corp. Soc. Responsib. Environ. Manag. 26 (5), 1012–1025. https://doi.org/10.1002/csr.1783.

Day, G., 1994. The capabilities of market-driven organizations. J. Market. 58 (4), 37–52. https://doi.org/10.1177/002224299405800404.

Gao, D., Xu, Z., Ruan, Y.Z., Lu, H., 2017. From a systematic literature review to integrated definition for sustainable supply chain innovation (SSCI). J. Clean. Prod. 142, 1518–1538. https://doi.org/10.1016/j.jclepro.2016.11.153.

Govindan, K., Seuring, S., Zhu, Q., Azevedo, S.G., 2016. Accelerating the transition towards sustainability dynamics into supply chain relationship management and governance structures. J. Clean. Prod. 112, 1813–1823. https://doi.org/10.1016/j.jclepro.2015.11.084.

Gupta, H., Kusi-Sarpong, S., Rezaei, J., 2020. Barriers and overcoming strategies to supply chain sustainability innovation. Resour. Conserv. Recycl. 161, 104819 https://doi.org/10.1016/j.resconrec.2020.1048.

Hair, Jr., Sarstedt, M., Hopkins, L., Kuppelwieser, V.G., 2014. Partial least squares structural equation modeling (PLS-SEM): an emerging tool in business research. Eur. Bus. Rev. 26 (2), 106–121. https://doi.org/10.1108/ebr-10-2013-0128.

Harrison, T.P., Lee, H.L., Neale, J.J., 2004. The practice of supply chain management: where theory and application converge. In: International Series in Operations Research & Management Science, ISOR, 62. https://doi.org/10.1007/b138860.

Hong, J., Zhang, Y., Ding, M., 2018. Sustainable supply chain management practices, supply chain dynamic capabilities, and enterprise performance. J. Clean. Prod. 172, 3508–3519. https://doi.org/10.1016/j.jclepro.2017.06.093.

Horbach, J., Rammer, C., Rennings, K., 2011. Determinants of eco-innovations by type of environmental impact: the role of regulatory push/pull, technology push and market pull. Ecol. Econ. https://doi.org/10.2139/ssrn.1805765. Discussion Paper No. 11-027.

Hunt, S.D., Sparkman, R.D., Wilcox, J.B., 1982. The pretest in survey research: issues and preliminary findings. J. Market. Res. 19 (2) https://doi.org/10.2307/3151627.

Keszey, T., 2020. Environmental orientation, sustainable behaviour at the firm-market interface and performance. J. Clean. Prod. 243, 118524 https://doi.org/10.1016/j.jclepro.2019.118524.

Kusi-Sarpong, S., Gupta, H., Sarkis, J., 2019. A supply chain sustainability innovation framework and evaluation methodology. Int. J. Prod. Res. 57 (7), 1990–2008. https://doi.org/10.1080/00207543.2018.1518607.

Lai, W.H., Lin, C.C., Wang, T.C., 2015. Exploring the interoperability of innovation capability and corporate sustainability. J. Bus. Res. 68 (4), 867–871. https://doi.org/10.1016/j.jbusres.2014.11.043.

Lee, H.L., 2004. The triple-A supply chain. Harv. Bus. Rev. 82 (10), 102–113.

Liddle, S., El-Kafafi, S., 2010. "Drivers of sustainable innovation push, pull or policy," World Journal of Entrepreneurship. Manag. Sustain. Dev. 6 (4), 293–305. https://doi.org/10.1108/20425961201000022.

Lintukangas, K., Kähkönen, A.-K., Hallikas, J., 2019. The role of supply management innovativeness and supplier orientation in firms' sustainability performance. J. Purch. Supply Manag. 25 (4), 100558 https://doi.org/10.1016/j.pursup.2019.100558.

Loviscek, V., 2021. Triple bottom line toward a holistic framework for sustainability: a systematic review. Revista de Administração Contemporânea 25 (3). https://doi.org/10.1590/1982-7849rac2021200017.en.

Madhani, P.M., 2019. Building a customer-centric supply chain strategy: enhancing competitive advantages. IUP J. Business Strat. 16 (2), 28–42. Available at: SSRN: https://ssrn.com/abstract=3424669.

Maroco, J., 2010. *Análise Estatística Com Utilização Do SPSS*, Edições Silabo. Lisboa.

Mendoza-Silva, A., 2021. Innovation capability: a systematic literature review. Eur. J. Innovat. Manag. 24 (3), 707–734. https://doi.org/10.1108/EJIM-09-2019-0263.

Neutzling, D.M., Land, A., Seuring, S., do Nascimento, L.F.M., 2018. Linking sustainability-oriented innovation to supply chain relationship integration. J. Clean. Prod. 172, 3448–3458. https://doi.org/10.1016/j.jclepro.2017.11.091.

Nilsson, F., Göransson, M., 2021. Critical factors for the realization of sustainable supply chain innovations - model development based on a systematic literature review. J. Clean. Prod. 296, 126471 https://doi.org/10.1016/j.jclepro.2021.126471.

Nugraha, A., Irwansyah, Purwadi, 2021. How digital knowledge sharing affects innovation work behavior and organizational innovation capability in term of sustainability development goals. IOP Conf. Ser. Earth Environ. Sci. 716 (1), 012058 https://doi.org/10.1088/1755-1315/716/1/012058.

Paloviita, A., 2010. Consumers' sustainability perceptions of the supply chain of locally produced food. Sustainability 2 (6), 1492–1509. https://doi.org/10.3390/su2061492.

Ringle, C., Silva, D., Bido, D.S., 2014. Modelagem de Equações Estruturais com utilização do SmartPLS. Revista Brasileira de Marketing 13 (2), 54–71.

Russo, I., Confente, I., Scarpi, D., Hazen, B., 2019. From trash to treasure: the impact of consumer perception of bio-waste products in closed-loop supply chains. J. Clean. Prod. 208 (1), 966–974. https://doi.org/10.1016/j.jclepro.2019.02.044.

Seuring, S., Müller, M., 2008. From a literature review to a conceptual framework for sustainable supply chain management. J. Clean. Prod. 16 (15), 1699–1710. https://doi.org/10.1016/j.jclepro.2008.04.020.

Svensson, G., 2003. Consumer driven and bi-directional value chain diffusion models. Eur. Bus. Rev. 15 (6), 390–400. https://doi.org/10.1108/09555340310500578.

Taghikhah, F., Voinov, A., Shukla, N., 2019. Extending the supply chain to address sustainability. J. Clean. Prod. 229, 652–666. https://doi.org/10.1016/j.jclepro.2019.05.051.

Tatham, P., Wu, Y., Kovács, G., Butcher, T., 2017. Supply chain management skills to sense and seize opportunities. Int. J. Logist. Manag. 28 (2), 266–289. https://doi.org/10.1108/ijlm-04-2014-0066.

Tebaldi, L., Bigliardi, B., Bottani, E., 2018. Sustainable supply chain and innovation: a review of the recent literature. Sustainability 10 (11), 3946. https://doi.org/10.3390/su10113946.

Teece, D.J., 2018. Dynamic capabilities as (workable) management systems theory. J. Manag. Organ. 24 (3), 359–368. https://doi.org/10.1017/jmo.2017.75.

Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strat. Manag. J. 18 (7), 509–533. https://doi.org/10.1002/(sici)1097-0266(199708)18:7<509::aid-smj882>3.0.co;2-z.

Tseng, M.L., Lim, M.K., Wu, K.J., Peng, W.W., 2019. Improving sustainable supply chain capabilities using social media in a decision-making model. J. Clean. Prod. 227, 700–711. https://doi.org/10.1016/j.jclepro.2019.04.202.

Weber, B., Heidenreich, S., 2018. When and with whom to cooperate? Investigating effects of cooperation stage and type on innovation capabilities and success. Long. Range Plan. 51 (2), 334–350.

Weidner, K., Nakata, C., Zhu, Z., 2020. Sustainable innovation and the triple bottom-line: a market-based capabilities and stakeholder perspective. J. Market. Theor. Pract. 1–21. https://doi.org/10.1080/10696679.2020.1798253.

Wetering, R.V., Mikalef, P., Helms, R., 2017. Driving organizational sustainability-oriented innovation capabilities: a complex adaptive systems perspective. Curr. Opin. Environ. Sustain. 28, 71–79.

Wong, K.K.K., 2013. Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. Market. Bullet. 24 (Technical Note 1), 1–32. http://marketing-bulletin.massey.ac.nz/.

Zheng, S., Zhang, W., Du, J., 2011. Knowledge-based dynamic capabilities and innovation in networked environments. J. Knowl. Manag. 15 (6), 1035–1051. https://doi.org/10.1108/13673271111179352.