

TECHNOLOGY CAPABILITY AND INFORMATION SHARING: EFFECTS ON THE SUSTAINABLE ENVIRONMENTAL PERFORMANCE OF INDUSTRIAL COMPANIES

CAPACIDADE TECNOLÓGICA E COMPARTILHAMENTO DE INFORMAÇÃO: EFEITOS SOBRE O DESEMPENHO AMBIENTAL SUSTENTÁVEL DE EMPRESAS INDUSTRIAIS

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ABSTRACT

Purpose – To analyze the impact exerted by the technological capability and the influence exercised by information sharing on sustainable environmental performance.

Design/methodology/approach – Quantitative research using sample with 148 industrial companies and application of multivariate analysis for verification of hypotheses.

Findings – The results indicate that technological capability has a direct and positive impact on environmental performance and information sharing has a significant moderating effect on this impact.

Research limitations/implications – The research investigates direct impact and moderation relationships, not extending the analysis to other types of relationships, effects and influences, which may be investigated in future research.

Practical implications – The simultaneous influence of technological capability and information sharing on sustainable environmental performance contributes to broadening the set of variables and relationships with potential to boost organizational performance.

Social implications – Managers of organizations can improve sustainable performance by building technological capability and encouraging the sharing of knowledge and information by their teams.

Originality/value – This study explores simultaneous effects of organizational variables with potential to drive sustainable environmental performance, adding new possibilities for analysis and identification of factors that can interfere with organizational performance.

Keywords - Sustainable environmental performance. Technological capability. Information sharing.

RESUMO

Objetivo – Analisar o impacto exercido pela capacidade tecnológica e a influência exercida pelo compartilhamento de informação sobre o desempenho ambiental sustentável.

Design/Metodologia/Abordagem – Pesquisa quantitativa utilizando amostra com 148 empresas industriais e aplicação de análise multivariada para verificação de hipóteses.

Resultados – Os resultados indicam que a capacidade tecnológica exerce impacto direto e positivo sobre o desempenho ambiental e o compartilhamento de informação tem efeito moderador significativo sobre esse impacto.

Implicações da pesquisa – A pesquisa investiga relações de impacto direto e de moderação, não ampliando a análise para outros tipos de relações, efeitos e influências, que poderão ser investigados em pesquisas futuras.

Implicações práticas – A influência simultânea da capacidade tecnológica e do compartilhamento de informação sobre o desempenho ambiental sustentável contribui para ampliar o conjunto de variáveis e relações com potencial para impulsionar o desempenho organizacional.

Implicações sociais – Gestores de organizações podem aprimorar o desempenho sustentável ampliando capacidades tecnológicas e encorajando o compartilhamento de conhecimento e informação por parte de suas equipes.

Originalidade/ valor – Este estudo explora efeitos simultâneos de variáveis organizacionais com potencial para impulsionar o desempenho ambiental sustentável, acrescentando novas possibilidades de análise e identificação de fatores que podem interferir no desempenho organizacional.

Palavras-chave - Desempenho ambiental sustentável, Capacidade tecnológica, Compartilhamento de informação.

1 INTRODUCTION

Economic criteria have prevailed in the analysis of company performance. This is despite the significant growth in the volume of research that has included aspects of environmental sustainability in the performance indicators (Das, 2017; Sarkis & Zhu, 2017). Recent research has broadened the debate on the contribution of environmental sustainability guidelines to the economic performance of companies, opening new horizons in the field of competitive strategies and sustainable development (Sachs, 2009; Teece & Linden, 2017). Overcoming the traditional view that the inclusion of sustainability guidelines in business would bring about a reduction in competitive performance, new challenges have been placed on business managers to incorporate new dimensions into the set of factors with potential to positively influence sustainable environmental performance (Zhu, Sarkis & Lai, 2013; Sarkis & Zhu, 2017).

Studies that addressed the relationship between environmental performance and technological capability did not provide a homogeneous view of the results. Das (2017) described the technological capability as an enabling factor of sustainability, providing greater adherence of productive and operational processes to the requirements associated with the preservation of the environment and social responsibility. Along the same line of argument, some studies characterized the technological capability among the factors that amplified the productive potential and intensified the inclusion of sustainability guidelines in the productive systems (Sachs, 2009; Raut, Narkhede & Gardas, 2017; Sarkis & Zhu, 2017). Other studies pointed out that technological capability had little influence on the effect of innovation on organizational performance (Esendemir & Zehir, 2017).

Despite the growing interest in the academic environment for the study of aspects associated with sustainable performance, there are still gaps in the examination of factors with the potential to influence this performance, especially the combined effects of these factors. In this sense, the following research question is taken as a starting point: What impact does technological capability have on sustainable environmental performance, and how does information sharing affect this? The



objective of this study is to analyze the impact of technological capability on sustainable environmental performance, and to consider the effect of information sharing on this impact.

2 LITERATURE REVIEW

The literature review includes a bibliographic survey, followed by analysis of the content of the recovered articles and the proposal of the hypotheses.

Bibliographic survey

The bibliographic survey was conducted through a search in SCOPUS, one of the most relevant international databases of scientific publications, initially using the general terms, focusing on the title, abstract and keywords - TITLE-ABS-KEY(“sustainable performance” or “technological capability” or “information sharing”), totaling 22,212 documents, followed by a specific search, with the combined terms – ALL (“sustainable performance”) and ALL (“technological capability”), resulting in 17 documents. The general and specific results showed that these are concepts of increasing interest in the scientific environment (Figure 1).

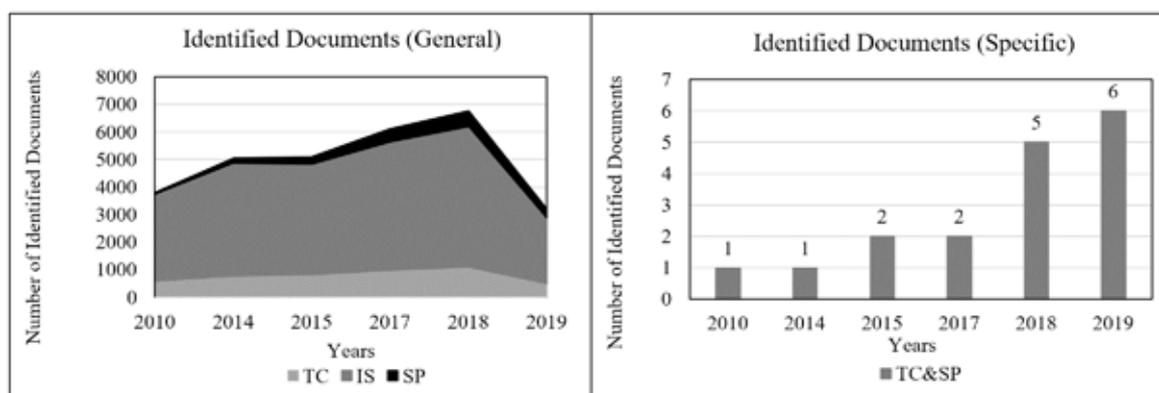


Figure 1 – Evolution of the number of published documents, general and specific.
Note: TC=Technological Capability; IS=Information Sharing; SP=Sustainable Performance.

In general terms, the documents identified show growth in the period highlighted in Figure 1 - the reduction for the year 2019 is due to the interval considered (only the first five months of the year). As for the specific documents (combined search terms), the number of documents identified is increasing when examining the 2010-2019 period. In terms of sources and areas of study of the specific documents identified, two publications stand out (*Sustainability* and *Journal of Cleaner Production*), as does the area of business, management and accounting. These results are presented in Figure 2.

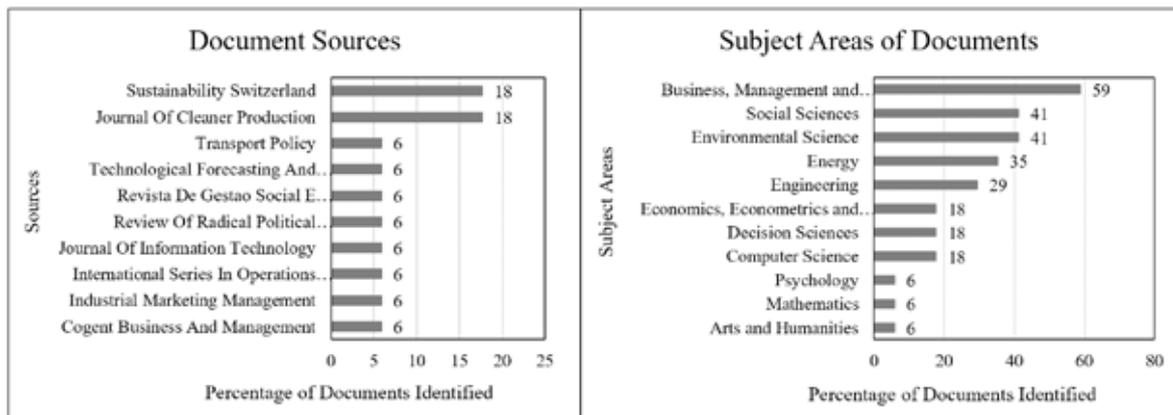


Figure 2 – Sources and study areas of the specific documents identified.

The terms used in this study appear in periodicals dealing with business sustainability as well as technological aspects. The business and management areas have received contributions from studies that address social, environmental, technological and economic aspects. This is reflected in the documents identified to compose the literature review for this study. Table 1 shows characteristics that indicate the relevance of the sources used in this study.

Table 1 – Characteristics of the sources associated with the documents identified in the search.

Source Title	Qualis	IF	ISSN
Cogent Business and Management	B2	n.i.	2331-1975
Industrial Marketing Management	A1	3,678	0019-8501
International Series in Operations Research and Management Science	A1	3,544	0025-1909
Journal of Cleaner Production	A1	5,651	0959-6526
Journal of Information Technology	n.i.	4,435	1466-4437
Review of Radical Political Economics	n.i.	0,579	1552-8502
Revista de Gestão Social e Ambiental	B1	n.i.	1981-982X
Sustainability Switzerland	A1	2,075	2071-1050
Technological Forecasting and Social Change	n.i.	3,129	0040-1625
Transport Policy	A2	2,512	0967-070X

Note: Qualis = 'CAPES/Qualis' Indicator; IF = 'Impact Factor' Indicator.

The sources of the documents identified recorded relevant quality levels, both the 'Qualis/Capes' indicator and the 'Impact Factor' indicator are indicators recognized by the academic community (CAPES, 2017, 2018). To these documents, the majority of articles (76%) were added. These dealt with methodological aspects and were referenced in the literature. From this literature base, the content relevant to this study was examined.

Sustainable environmental performance

Sustainable performance has received increasing attention in the literature dealing with sustainability. Sustainable performance is a concept that seeks to integrate economic, social and environmental dimensions in order to guide companies in conducting their business and operations (Sachs, 2009; Sarkis & Zhu, 2017). In this study, sustainable environmental performance is defined as a measure of the business effort involving environmental aspects, taking into consideration links to economic



and social aspects (Das, 2017). In his study, Das (2017) used specific variables to measure sustainable performance, including competitiveness, operating performance, social performance and sustainable environmental performance. Extending the detail of the concept of sustainable environmental performance, Raut, Narkhede and Gardas (2017) argue that this performance reflects a sustainability guideline that can be applied to the supply chain, having been highlighted as one of the most important business guidelines employed to obtain economic results. These guidelines simultaneously consider the reduction of risks and environmental impact and the promotion of social benefits.

In the current business scenario in which digital technology is being widely included in global production chains, it is essential to combine supply chain management with technological advances in order to provide the necessary conditions for the modernization of operations systems. Such systems are increasingly associated with intensive information flow and the need to deal intelligently with the various strategic challenges that face businesses. It is therefore essential for companies to develop their technological capabilities (Zhou & Wu, 2010; Voudouris, Lioukas, Iatrelli & Caloghirou, 2012; Esendemir & Zehir, 2017).

Technological capability and sustainable environmental performance

Technological capability comprises a multidisciplinary theme that is a part of the field of studies associated with techno-economic development and, specifically, with innovation-management guidelines and practices aimed at the use of organizational resources intended to promote innovation including innovation concepts, practices, processes, systems and routines (Schilling, 2013). The study of technological capability is part of a context of increasingly rapid and unpredictable changes, requiring priority attention from company executives (Teece & Linden, 2017). Technological changes have generated challenges for companies. On the one hand, they represent threats with accelerated obsolescence and the need for significant investment in modernization. On the other hand, they open new opportunities for business processes to be redesigned, digitized and increased, with new, more precise, reliable and scalable solutions, requiring decisions favorable to investment in innovation. These investments contribute to the development of important technological capabilities for the company to implement new technologies and increase the efficiency of its processes (Zhou & Wu, 2010; Wu, Lin & Chen, 2013). However, despite knowing the concrete possibilities of improvement in operational processes, companies find it difficult to implement projects aimed at inserting new technologies into the organizational context and promoting the necessary changes to convert innovation into results (Chamsuk, Fongsuwan & Takala, 2017).

Studies on this subject understand capabilities as sets of skills and knowledge accumulated by companies, allowing the coordination of activities for the appropriate use of their assets (Su, Peng, Shen & Xiao, 2013). In line with this definition, technological capability refers to the ability of the company to develop and use technological resources, involving the development of new products, the improvement of the production process, the development of technology and adaptation to technological changes occurring in the sector (Su et al., 2013). The opportunities for companies to adopt new technologies are relevant, and are estimated to have an impact on business (Zhou & Wu, 2010). These aspects drive companies to enter this broad process of digital transformation with determination. To be successful, they need, among the most necessary measures, to acquire technological capabilities both to plan and implement new projects successfully and to operate new information systems which can result in significant change in terms of information sharing, data storage capacity, and facilities for interconnection with external systems (Kim, Hwang & Rho, 2016; Teece & Linden, 2017). These challenges are complex and require specific measures from companies, either to define technological projects or even to redesign their business processes, including the supply chain.



Recent studies indicate that technological capability will be increasingly important in implementing the digitization of processes that are intensifying in companies, with implications for the sustainable performance of their production chains (Teece & Linden, 2017; Herrero, Bustinza, Parry & Georgantzis, 2017). The rapid change that is taking place in the technological environment, with the advance of new digital solutions such as 'Big Data' and 'Analytics' (Karre, Hammer, Kleindienst & Ramsauer, 2017), 'Cloud Computing' (Song, Zhao & Zeng, 2017), 'Artificial Intelligence', 'Mobile Internet' (Schniederjans, 2017) and the 'Internet of Things' (Mrugalska & Wyrwicka, 2017) have the power to transform the way companies run their basic business processes, including the supply chain. In this scenario, companies will need technological capabilities to adopt such technologies, develop projects to implement and modify their processes, operations systems and information systems. This will require the rapid acquisition of new knowledge, new skills and new competencies, both to operate these technological solutions and to generate new or improved products and services from them. Considering these developments in the relationship between technological capability and sustainable environmental performance, the following research hypothesis is proposed:

H₁: Technological capability has a positive impact on sustainable environmental performance.

Information sharing and sustainable environmental performance

Information sharing is a multidisciplinary research topic and is included in a diverse number of study areas. It is approached, in conceptual terms, by the Information Science area and, in conceptual, practical, strategic and managerial terms, by the Information Technology (IT) area, connected to practically all knowledge areas. The IT Management area brings together studies associated with models, architectures, systems, processes, resources and facilities that enable the use of IT in the organizational context (Rossetti & Morales, 2007). Given the inevitable march forward of the digitalization of business processes, it is essential that the processes associated with the supply chain also adopt digitalization in all instances, from relations with suppliers, through production, operations, storage and logistics activities, to the services available to customers and consumers of products (Herrero et al., 2017). Since the investment necessary for such measures to be implemented is large, the commitment of the top management of the companies involved in the collaboration network becomes critical. In addition, top management must be articulate and seek to synchronize strategic plans, corporate governance structures and projects related to integration in the value chain (Cheng & Chen, 2016; Gosling, Jia, Gong & Brown, 2017).

In this context, systems that promote the exchange of information are essential, as well as aspects that provide the integration and connectivity of the technological infrastructure that can support the intensive exchange of information throughout the collaborative network, creating synergy and promoting synchronized actions (Gunasekaran, Subramanian & Rahman, 2015; Teece & Linden, 2017). Information sharing is defined as the extent to which information is made available to members of a supply chain (Hsu, Kannan, Tan & Leong, 2008). Recent studies show that information sharing has a significant influence on supply chain performance (Luo, Sha & Huang, 2013). Companies that recognize the importance of information exchange in the supply chain and adopt measures for effective realization are more likely to obtain competitive advantages (Luo et al., 2013). This is a time when new models are being discussed, where information sharing is no longer simply oriented to the company's internal units but also integrates global supply chains (Zhu, Sarkis & Lai, 2013). An institutional breakdown is underway, where the necessary availability of information becomes a reality, where systems and databases are connected in order to ensure that information about customers, processes and operations is available to the entire network. This new model requires that



information is shared in large databases and can be accessed and retrieved by any network partner (Teece & Linden, 2017). The various databases alone hold valuable data about customers and operations, representing strategic assets that could be useful to the entire network. Connecting partners in a network is not an easy task, rather, it is full of challenges. Systems must be integrated and operate on a continuous basis, without the need for people to interfere with perform procedures. Communication protocols need formatting that allows information exchange and interoperability standards are necessary for systems to be integrated (Herrero et al., 2017).

Although it is recognized that information sharing is a prerequisite for supply chain integration, there is still no willingness from companies to proceed with these projects. On the contrary, recent studies point out the timid adhesion of companies to the digitalization process of their business processes, including processes associated with the supply chain (Teece & Linden, 2017). Some of this behavior is associated with the companies' difficulties in obtaining sufficient financial resources to support the high investments required for the projects to be carried out (Teece & Linden, 2017). Other equally important issues are related to the lack of qualified professionals to carry out such projects, the economic and technological risks in implementing solutions that have not yet been fully assimilated by all companies, not to mention the unpredictability of the regulatory, tax and legal environment conditions which increase the risk associated with any movements that companies may initiate in order to modernize their operations. Based on this discussion, the following research hypothesis is proposed:

H₂: Information sharing has a positive influence on the relationship between technological capability and sustainable environmental performance.

Proposed conceptual model for research

This study is part of an interdisciplinary approach, involving the areas of Information Technology Management, Knowledge Management, Innovation Management and Sustainability. From each of these areas, variables were identified with the potential to integrate a theoretical model focused on the examination of factors prior to sustainable environmental performance. Variables identified from the literature review, as well as the relationships reproduced in the proposed model, were admitted for empirical verification during the research. Figure 3 shows the conceptual model presented to support the research. The constructs (latent variables) are represented by elliptical figures with their respective names inside, the continuous line represents the direct effect, the dashed line represents the moderating effect, the arrows indicate the directions of the effects, the hypotheses are named with the capital letter H and its respective number, the sign in brackets represents the positive direction of the effect.

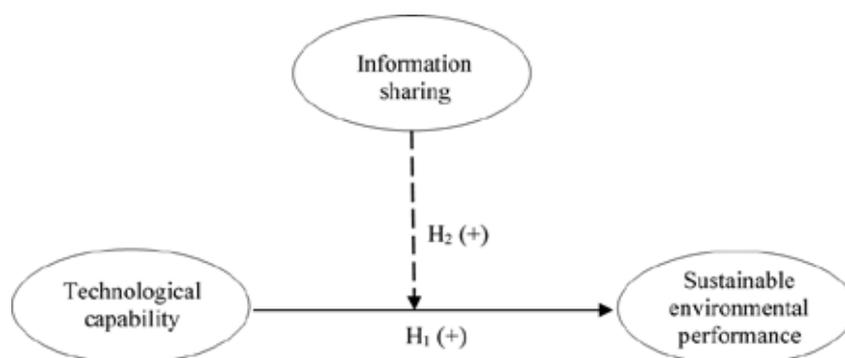


Figure 3 – Conceptual model proposed for the research.



According to the diagram shown in Figure 3, the variable 'sustainable environmental performance' (SP) acts as a dependent, the variable 'technological capability' (TC) acts as an independent, the variable 'information sharing' (IS) acts as a moderator. Thus, the conceptual model represents the direct impact of the 'technological capability' on the 'sustainable environmental performance' and the moderating influence of the 'information sharing' on this impact. The proposed conceptual model seeks to represent direct effects and interactions of independent variables (TC and IS) on the dependent variable (SP), aiming to support the analysis of the moderating effect on sustainable environmental performance.

3 METHODS

Considering the need to examine the influence of information sharing and technological capability on sustainable environmental performance, a quantitative research method was used to verify the impact of technological capacity on sustainable environmental performance and the moderation of information sharing on this impact. In order to achieve this objective, a literature review was performed. A bibliographic survey identified relevant publications associated with the research theme. This was followed by an analysis of the content of the selected articles. From this analysis, the research hypotheses were proposed and the conceptual model of support was defined. Procedures were adopted for the identification and delimitation of the population and sample, the structural components of the data collection instrument were defined, and a validity and reliability analysis were performed based on the variables, latent and observed, used in the research model.

The collected data were transcribed and statistically processed using criteria that enabled the examination of their validity and reliability. After statistical processing, the data were analyzed and could contribute to the discussion in the light of existing theories in the scientific context relevant to the theme of this study. Multivariate analysis methods with support from the IBM SPSS Statistics software, were used for statistical analysis of the data and verification of the hypotheses. The data used for such tests were obtained through a questionnaire, prepared from the original specifications in their respective surveys (Das, 2017; Su et al., 2013; Hsu et al., 2008). These data were collected by presenting statements to respondents belonging to company management. Their responses were collected, and their functional scope and previous knowledge of the subject was taken into consideration.

The questionnaire was based on previous studies, the scales of which were validated and used in empirical surveys. The collection instrument was structured with 15 items, five of which were associated with the 'sustainable environmental performance' construct, four associated with the 'technological capability' concept and six associated with the 'information sharing' concept.

Das (2017) identified technology as an enabler of sustainability, believing that the choice of technology, specifically sustainable technology, has an influence on the three dimensions of sustainability. Environmental, social and economic indicators need to be taken into account when choosing sustainable technology. The 'sustainable environmental performance' construct was the specific focus of research by Das (2017). This research developed and validated a scale to measure 'sustainable environmental performance', involving industrial companies and suggesting the application of this construct in applied research. Multivariate analysis was used to investigate different relationships and dimensions of variables associated with environmental, social and operational performance.

Su, Peng, Shen and Xiao (2013) analyzed the role of technological capability in driving competitive performance under turbulent conditions, identifying that technological and marketing capability are complementary and, under conditions of technological turbulence, only the technological



capability rises consistently. The ‘technological capability’ construct had its scale developed through research involving product development, manufacturing processes and technological development in the industrial sector. The research suggested the use of multivariate analysis to investigate relationships between technological capability and turbulence.

Hsu, Kannan, Tan and Leong (2008) investigated the effect of information sharing capacity on the relationship between buyers and suppliers, as well as its influence on the competitive performance of industrial companies. They identified the positive effect of organizational capacity to share information on competitive performance, stimulating operational improvement in the relationship between buyers and suppliers in a supply chain. They used the multiple linear regression technique to analyze data from companies in the United States, Europe and New Zealand. The ‘information sharing’ construct was designed to capture the use of information to articulate supply chain processes and provide feedback from end users and customers of the services provided.

In compliance with the number calculated for the sample size and in accordance with the criteria and procedures established for this type of survey (Hair, Black, Babin & Anderson, 2010), a total of 148 companies were contacted. Questionnaires were collected between March and October 2018. Those considered complete and therefore acceptable for use in the preparation of data and statistical checks, corresponded to 40.1% of valid responses after exclusion due to errors and omissions (Corrar, Paulo & Dias, 2017).

The constructs used in the survey were measured with five-point Likert scales, adapted from previously defined and statistically validated scales (Table 2).

Table 2 – Description of the latent variables used in the elaboration of the questionnaire.

Sources	Latent Variables	Cronbach's Alpha	Indicators	Factorial Loads
Das (2017)	Sustainable environmental performance	0.901	Reduction of effluent treatment costs Reduction of disposal of toxic materials Reduction of environmental accidents Reduction of accidents in the production line Protecting biodiversity in the surroundings	From 0.554 to 0.923
Su, Peng, Shen and Xiao (2013)	Technological capability	0.860	Capability to generate new products Ability to improve production Ability to develop technology Ability to adapt to changes	From 0.760 to 0.880
Hsu, Kannan, Tan and Leong (2008)	Information sharing	0.758	Informal partner information Formal informational agreements Communication of strategies to partners Supply chain integration Partner compatible systems Feedback from end users	From 0.627 to 0.723

First, statistical tests were carried out to examine the research model, then checks were made on the proposed hypotheses.



4 RESULTS

A test sequence was used to measure the validity of this research. At first, this study estimated the reliability of internal consistency using Cronbach's alpha. According to Hair et al. (2010), a value of 0.70 or higher is adequate for the reliability coefficient. Table 3 shows that the alpha values for all constructs were higher than the base value of 0.70. Hair et al. (2010) recommend KMO (degree to which constructs can describe variations in indicators) higher than 0.70 and, in this survey, all values of the constructs exceeded this level.

Table 3 – Validity of constructs.

Construction Indicators	FL	Mean	Standard deviation	KMO	Bartlett's test			Cronbach's alpha
					χ^2	df	Sig.	
Sustainable environmental performance				0.896	504	10	0.00	0.901
D1: Reduction of effluent treatment costs	0.872	3.54	0.999					
D2: Reduction of waste toxic materials	0.883	3.56	0.991					
D3: Reduction of environmental accidents	0.865	3.48	0.986					
D4: Reduction of industrial line accidents	0.872	3.46	0.965					
D5: Protection of biodiversity in the surrounding area	0.861	3.53	0.944					
Technological capability				0.788	241	6	0.00	0.860
T1: Capability to generate new products	0.794	3.64	0.738					
T2: Capability to improve production	0.836	3.68	0.801					
T3: Ability to develop technology	0.855	3.67	0.820					
T4: Ability to adapt gears	0.822	3.73	0.830					
Information sharing				0.878	435	15	0.00	0.758
I1: Informal partner information	0.796	3.86	0.825					
I2: Formal information agreements	0.782	3.87	0.794					
I3: Communication of strategies to partners	0.802	3.86	0.762					
I4: Supply chain integration	0.811	3.91	0.755					
I5: Partner compatible systems	0.806	3.92	0.778					
I6: Feedback from end users	0.795	4.00	0.825					

Note: KMO=Kayser-Meyer-Olkin Measure; FL=Factorial Loads.

Factorial loads for the three first order constructions were evaluated. The results indicated that all factor loads exceeded the minimum of 0.70 on their respective constructions. With the data presented in this section, the fulfillment of the requirements of reliability and discriminant validity are verified in accordance with the guidelines of Hair et al. (2010).

Once the statistical tests using the sample data were concluded, the results were summarized in Table 4. Two statistical models were used to establish comparability of the power of explanation of the behavior of the dependent variable (R^2). The initial model configures a direct relationship between technological capability and sustainable environmental performance, and is used to verify the H_1 research hypothesis. The model with the moderating variable configures this same direct relationship with the addition of the moderating variable designated by the information sharing, and is used to verify the H_2 survey hypothesis. The structure of the analysis follows recommendations made by Vieira and Faia (2014).

Table 4 – Results of statistical processing of data.

Variables	Statistical Models			
	Initial Model*		Model with Moderator Variable**	
	Coeff.	Sig.	Coeff.	Sig.
Constant	-1.743E-17	1.000	-0.1107	0.1458
Technological capability	0.661	0.000	0.7188	0.0000
Information sharing			-0.0293	0.7651
Moderating variable			0.1494	0.0155
R ²	0.437	0.000	0.4651	0.0000
ΔR ²			0.0281	

Note: *Data processing in SPSS; **Data processing in SPSS/PROCESS.

The results shown are in line with the Initial Model and indicate a positive and significant association between the intensification of technological capability and the level of sustainable environmental performance acquired by the company ($\beta = 0.661$, $p < 0.05$), with an acceptable power of explanation of the behavior of the dependent variable ($R^2 = 0.437$, $p < 0.05$). This, therefore, supports hypothesis H_1 . The Model with Moderator Variable demonstrates the positive moderating effect played by information sharing in the association between technological capability and sustainable environmental performance. This initially presents itself at a lower level ($R^2 = 0.437$, $p < 0.05$), evolving to a higher level when the moderating effect is inserted in the model ($\beta = 0.1494$, $p < 0.05$; $R^2 = 0.4651$, $p < 0.05$), producing a positive variation ($\Delta R^2 = 0.4651 - 0.437 = 0.0281$). This supports the H_2 hypothesis, with a small effect on the dependent variable. For Hair, Hult, Ringle and Sarstedt (2014), values of $R^2 = 0.02$ suggest a small effect on the dependent variable, $R^2 = 0.13$, a medium effect, and $R^2 = 0.26$, a large effect. Figure 4 is used to support the explanation of the results found.

Based on the equations calculated and representative data, a representative graph was made of the behavior of the variables (independent, dependent and moderator). Figure 4 shows the influence of factors on the sustainable environmental performance, where the technological capability triggers a direct impact on this performance and the sharing of information acts indirectly on the same performance, acting on the mentioned impact.

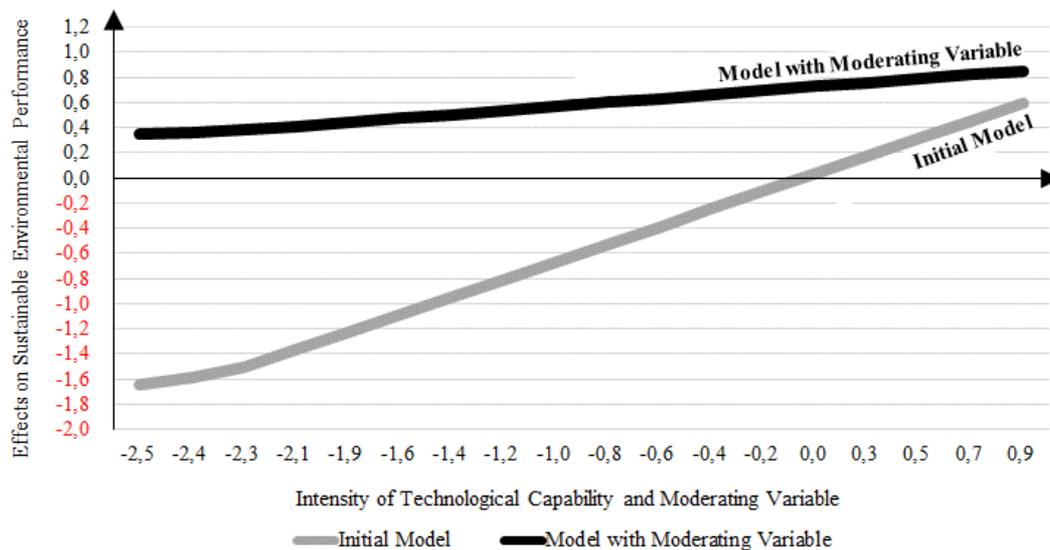


Figure 4 – Representative chart of the effects on sustainable environmental performance.



The Figure 4 displays a graphical representation of the effect that the technological capability and the sharing of information have on sustainable environmental performance, considering. First, the impact of the technological capability on sustainable environmental performance is shown (line grey), followed by the positioning of information sharing as a moderator in the association of the technological capability with sustainable environmental performance (line black). As visualized in Figure 4, the technological capability is able to influence the sustainable environmental performance, but in a reduced manner. By adding information sharing combined with technological capability, the power to explain the behavior of sustainable environmental performance is increased. However, when information sharing is repositioned to exercise the function of moderating the relationship between the two variables initially established in the model, there is an increase in the combined effect of technological capability and information sharing on sustainable environmental performance. The trajectories of the effects on sustainable environmental performance tend to cross at a certain future point, a fact that can be understood as a moderation that positively affects the initial impact during a certain interval, after which the moderating effect is annulled and then becomes negative, i.e., it attenuates the initial impact. In this sense, the greater the intensity of information sharing, the greater its effect on the impact of technological capability on sustainable environmental performance. However, at a given moment, the increase in this intensity produces no effect and, continuing its elevation, produces a negative effect, i.e., from a given moment, the greater the sharing of information, the smaller the impact exerted by technological capability on sustainable environmental performance.

5 DISCUSSION

Sustainability guidelines have been advocated by organizations with a global reach; the United Nations (UN) is one of the most relevant voices.

The efforts of nations, academics, institutions and researchers to address the issue of sustainability in business have been remarkable. Issues addressed include reflecting on definitions, determinants of success in sustainable initiatives, component factors, consequences of their application, mechanisms for implementation and dissemination of sustainability guidelines and guidelines in products, processes, services and business models. All over the world, the industrial sector has been moving towards adopting sustainability guidelines (Sarkis & Zhu, 2017). However, despite a valuable, vigorous and progressive effort, there is still a long way to go before the sustainability guidelines are absorbed by companies, particularly industrial companies. In Brazil, this effort has been relevant. However, economic and political difficulties, of which the main problem is legal insecurity, are still factors that receive priority attention of companies. This means that the adoption of sustainability guidelines can be postponed or even discontinued. The Costa study (2020) analyzes the critical factors involved in management decisions on investments, identifying legal insecurity as a restrictive factor. It turns out that international pressures and the growing awareness of Brazilian society have generated questions and situations, which although small, are capable of moving companies towards sustainability. Reflecting on this configuration, its challenges and opportunities, specifically for the industrial sector, represents a relevant contribution to conscious and determined progress to value balanced aspects of economic development.

Faced with the objective of studying influences on sustainable environmental performance, the relationships between technological capability, information sharing, and sustainable environmental performance were analyzed. The results obtained with the statistical processing of the data show the direct and positive impact of the technological capability on sustainable envi-



ronmental performance, in accordance with the findings of Das (2017). Das found significant relationships between practices supported by technologies and environmental performance, expanding them to achieve social, operational and competitive issues. Su et al. (2013) identified a positive impact caused by technological capability on the competitive performance of firms, stating that this capacity may be directed to expand the integration of firms in the context in which they are inserted, especially when these firms face turbulent business environments. This research expands the vision of Su et al. (2013) to engage the business challenge of incorporating environmental aspects into their performance and identifies the positive influence of technological capability on sustainable environmental performance.

Another result found in this research concerns the role of information sharing acting as a moderator in the relationship between technological capability and sustainable environmental performance. Hsu et al. (2008) studied the role of information sharing as a driver of competitive performance of companies. They identified that this sharing is effected through the integration of decision systems and business processes, but did not consider the positioning of information sharing as a variable that interferes with the relationship between other variables, noting that the quality and availability of information can contribute to improve the performance of other factors in the organization. This research presents evidence that information sharing contributes to increase the intensity of a relationship between two variables, such as the impact of technological capability on sustainable environmental performance. The study by Cheng and Chen (2016) identified that institutional guidance contributes to improve behavior and collaboration within the organization, stimulating the development of relevant skills. This result is in agreement with the results found in this study, which considers the sharing of information as a relevant measure to be observed by companies to stimulate organizational collaboration, as well as the improvement of skills.

It is observed that the intensity of the effect produced by the sharing of information presents a variation along the trajectory portrayed in this study. Initially, when the maturity of the organization is on the rise, this sharing positively influences the impact of technological capability on sustainable environmental performance, i.e., the greater the intensity of information sharing, the greater the impact caused by technological capability on sustainable environmental performance. However, as can be observed in the trajectories recorded in the graph (Figure 4), these tend to intersect, implying that from a certain intensity, the effect of information sharing is cancelled out and then becomes negative, i.e., it starts to negatively influence the impact such that from this point on, its effect will mitigate the impact of technological capability on sustainable environmental performance. From the performance point of view, there is an effect of technological capability that increases with the intensity of information sharing, followed by a stage in which the sharing starts to act in order to mitigate the intensity of the referred impact. Such an effect can be understood as the moment at which the excess of information or the treatment of information ultimately reduces the positive impact that the technological capability has on the sustainable environmental performance, that is, the excess of shared information becomes counterproductive to the performance, requiring measures by the managers to be controlled in order to avoid such excess. This finding may reveal a new research front that aims to identify and delimit more precisely these moments, contributing to the implementation of stimulus and contraction measures in the information management process in the organizational context.



6 CONCLUSION

This study aimed to analyze the impact of technological capability on sustainable environmental performance, as well as to examine the moderating effect of information sharing on this impact. Two research hypotheses were established, and a conceptual model was designed to carry out the research; both hypotheses were confirmed with significant results. Statistical tests showed that technological capability is positively and significantly related to sustainable environmental performance, i.e., the greater this capability, the greater the performance. The tests also showed that knowledge sharing can affect this impact, both positively and significantly, i.e., the greater the knowledge sharing, the greater the impact of technological capability on sustainable environmental performance.

In terms of theoretical implications, this study contributes to the addition of new knowledge related to factors with the potential to influence the performance of companies, in this specific case, to increase the sustainable environmental performance of companies. Sustainability has been a relevant field of study, contributing to the balanced development of economic activity, with environmental and social impacts discussed and new ideas being continuously launched. Thus, this study seeks to contribute to this set of knowledge, striving to promote sustainable development.

As for the practical implications, this study can be used by managers, both public and business, to incorporate strategic measures for the development of technological capabilities as a way to boost their sustainable environmental performance, and to implement processes to improve information sharing, both within the organizational space and in the external context, in order to positively influence performance. These efforts have the potential to increase the competitive performance of companies and ensure that sustainability fundamentals are integrated into their competitive strategies. Non-governmental organizations can use the results of this research to develop their models and proposals in order to improve economic growth, combined with social development and environmental preservation.

One limitation of this study is that a non-probabilistic sample was used. This prevents the expansion of the results beyond the limits of the sample, and also prevents estimates about the population from which the sample was extracted. In addition, in this study, only impact and moderation relations were considered, disregarding mediation relations or conditional effects. Future research may explore this same conceptual model with the support of probabilistic sampling. This would open up the possibility of expanding the sample and population inferences. Other possibilities, such as studies of sector groupings or specific segments of economic activities, as well as longitudinal studies to verify the behavior of variables over certain periods of time, may further expand knowledge of the relationships and impacts of variables focused on the management of industrial enterprises.

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1. Definition of research problem	√	√		
2. Development of hypotheses or research questions (empirical studies)	√	√		
3. Development of theoretical propositions (theoretical work)				
4. Theoretical foundation / Literature review	√	√		
5. Definition of methodological procedures	√	√		
6. Data collection	√	√		
7. Statistical analysis	√	√		
8. Analysis and interpretation of data	√	√		
9. Critical revision of the manuscript	√	√		
10. Manuscript writing	√	√		
11. Other (please specify)				



