Innovation capabilities for sustainability: a comparison between Green and Gray companies

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Abstract

Purpose – This paper aims to identify and compare the arrangements of innovation capabilities and their correlation with the socio-environmental responsibility of two groups: companies with less socio-environmental concern (Group Gray) and companies with greater socio-environmental concern (Group Green).
Design/methodology/approach – Descriptive and quantitative research with 1,322 Brazilian manufacturing companies was conducted. We analyzed (1) the actual arrangement of capabilities and (2) the ideal arrangement of capabilities with the greatest impact on innovation.
Findings – Results suggest that there is a difference in the arrangement of capabilities between the two groups. Also, there is a difference between the capabilities that effectively receive the companies' attention and the capabilities that should be valued and developed. Green companies must focus their efforts on Transaction capability, followed respectively by Management, Development and Operation capabilities. Gray companies must focus on Development capability, followed by Management, Transaction and Operation capabilities.
Originality/value – By identifying the ideal capability arrangement, this research provides important information that can guide managers in planning internal strategies for investments, prioritizing management efforts and rearranging capabilities to boost innovation for sustainability.

Keywords Capability, Sustainable innovation, Eco-innovation, Manufacturing industry, Socio-environmental responsibility
Paper type Research paper

1. Introduction

Given the climate change scenario and increasing loss of planet biodiversity, development cannot be conceived without alignment with a sustainable basis and innovation (Hofmann, 2019). Considering the business environment and social pressure influence, for startups, added to public policies and sector agreements, this alignment may be natural. However, incumbent firms are mostly built on a different techno-scientific paradigm, based on pillars that do not necessarily consider sustainability an essential part of technological development guidelines. Business and innovation strategies for sustainability imply changes in business management and operations to implement practices and solutions that lead to this goal (De los Rios and Charnley, 2017). Innovative solutions and actions that lead to sustainability

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require new skills such as holistic, systemic and transdisciplinary vision (Engert *et al.*, 2016; Pieroni *et al.*, 2019), new relationships vis-à-vis the value chains (Hofmann, 2019), new operating technologies (Lüdeke-Freund *et al.*, 2019) and changes in the products and processes (Del Río *et al.*, 2016). This diversity of innovative practices and actions is achieved through innovation capabilities. Thus, for companies to achieve business innovation for sustainability, they need different innovation capabilities.

Innovation capabilities are a set of tangible or intangible skills, experiences and resources that shape business routines toward innovation (Nelson and Winter, 1982) and are at the heart of the transformations that any company makes into its products, operations, management and transactions (Zawislak *et al.*, 2012). Indeed, innovation capabilities drive companies to achieve better innovative performance (Zawislak *et al.*, 2013) and outperform competitors (Bittencourt *et al.*, 2019). The firm's resources that shape capabilities need to be sensing, seizing and reconfiguring to innovation and new business opportunities, including environmental issues (Lynch, 2019). The link between innovation capabilities and sustainability is significant since it can leverage sustainable innovation development and adoption. However, studies analyzing companies' innovation capabilities from the perspective of sustainability are scarce (Fernando *et al.*, 2019). Such analysis is important because the lack of innovation capabilities is an obstacle for incumbent companies to innovate, focusing on socio-environmental actions both at the firm level and at the value chain (Gupta *et al.*, 2020).

There is a discussion on how incumbent companies can successfully innovate and compete in such a changing environment and market, aligning economic, environmental and social objectives (Lynch, 2019). It is possible to broadly identify two large groups of incumbent companies regarding sustainability (Kiron *et al.*, 2012). While one group includes socio-environmental responsibility in their strategic agenda and considers sustainability critical to their competitiveness (here named as Green companies), the other group is restricted to solely meeting legal socio-environmental responsibility obligations (here named Gray companies).

What remains unclear in academic literature is the difference in innovative capabilities arrangements between Green and Gray companies. Influenced by sectoral patterns, geographic location, size constraints, among other aspects, every company has the knowledge resources and assets organized in a unique arrangement of innovation capabilities. The positive correlation between innovative behavior, capabilities and performance is undeniable (Nelson *et al.*, 2018). Research on capabilities in the sphere of socio-environmental responsibility mostly focuses on external influences and drivers rather than paying attention to internal factors, such as the arrangement of capabilities (Del Río *et al.*, 2016). As all companies have four innovation capabilities —Development, Operation, Management and Transaction (Zawislak *et al.*, 2012, 2013)—, the correct arrangement of these capabilities is necessary to boost innovation performance for sustainability effectiveness (Reichert *et al.*, 2016). Thus, Gray companies' specificities may require a distinct arrangement of innovation capabilities that could be different from that of Green companies.

This paper aims to identify and compare the arrangements of innovation capabilities and their correlation with the socio-environmental responsibility of two groups: Green and Gray companies. It compares the arrangement of innovation capabilities between companies that are more (Green) and less (Gray) prone to socio-environmental concerns in their strategic guidelines and their correlation with performance to understand the innovation capabilities for sustainability. To achieve this goal, we analyzed a database consisting of 1,322 Brazilian manufacturing firms from 22 sectors. We analyzed the innovation capabilities of these groups in two aspects: (1) the actual arrangement of capabilities and (2) the ideal arrangement of capabilities with the greatest impact on innovation, according to a model generated by linear regression, based on Zawislak *et al.* (2012).

In the research context, Brazil is a useful environment to study differences between firms' arrangements of capabilities, performance and socio-environmental responsibility. It is a prominent country among the emerging economies, showing leading indicators of manufacturing and significant innovative activity in Latin America (Olavarrieta and Villena, 2014). Furthermore, Brazil has a strategic place in the climate change discussion due to its nature and biodiversity. Since Brazil has an export-oriented economy based on commodities, which may lead to a lower innovative rate, Brazilian firms are exposed to international regulatory policies, especially regarding the environmental areas (Frank *et al.*, 2016). This requires greater efforts to understand firms' innovation capabilities and correctly arrange them to drive innovation for sustainability in such an emerging economy.

Therefore, our research findings can help companies, especially in emerging economies, to be more innovative for sustainability, demonstrating if Green and Gray companies' innovation behaviors are suitable to drive the development of sustainable innovations or need a new configuration, i.e. an ideal arrangement of capabilities. This study advances scientific knowledge on the interrelation between innovation capabilities and sustainability, an under-explored relationship in the innovation and sustainability literature. Furthermore, managerial and policy implications are also pointed out, allowing better management of innovation for sustainability and, consequently, sustainable development improvement.

2. Literature background

This section begins with a brief discussion about sustainability and innovation. Then, we discuss companies' innovation capabilities and their relevance to sustainability.

2.1 Sustainability and innovation

There is a growing concern about sustainability and increasing pressure to transition toward a more sustainable society. As a result of public policies and regulation, consumer and social pressure and business opportunities (Lynch, 2019), companies have placed sustainability on their management agenda. The question is no longer if companies will embrace sustainability or not, but how they will do it. The challenge is to compete in such a dynamic environment with ever-changing markets, perform successfully and contribute to sustainable development at the same time (Kiron *et al.*, 2012; Klewitz and Hansen, 2014). Companies must find the right balance between environmental protection and social equity while increasing benefits for the stakeholders (Dyllick and Hockerts, 2002; Klewitz and Hansen, 2014).

Previous studies found that firms deal with sustainability through Corporate Social Responsibility (CSR), which requires firms to consider their environmental and social impacts in concert with their economic objectives (Rashid *et al.*, 2014). CSR can be seen as the pathway to sustainable development, by which firms voluntarily integrate social and environmental concerns in their operations and interactions with stakeholders (Branco and Rodrigues, 2006). Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (WCED, 1987, p. 54). On an organizational level, companies may contribute to sustainability by systematically making technical and managerial changes and efforts to balance environmental, social and economic goals.

Not all firms have found a way to profit from sustainability efforts, but those that have shared some interesting characteristics. Some firms have high commitment levels to sustainability, understanding it as critical to their competitiveness. Kiron *et al.* (2012) designated these types of firms as "harvest" (henceforth Green companies), while the ones that do not have such a level of commitment are designated as "non-harvest" (henceforth

Gray companies). Generally, these "Green" companies present concrete business cases for sustainability and tend to have: (1) a distinctive organizational mindset and design that supports sustainability; (2) a stronger CEO commitment to sustainability; (3) separate sustainability reports; (4) separate function for sustainability; (5) links between sustainability performance and financial incentives; (6) a clear communication of responsibility of sustainability; and (7) key-performance indicators related to sustainability (Kiron *et al.*, 2012).

To achieve that, innovation is key: sustainability is hinged on innovation (Kusi-Sarpong *et al.*, 2019). Interest in sustainable innovation has grown in recent years, both in academia and in practice (Oduro *et al.*, 2021). As a matter of fact, if sustainable endeavors request important techno-organizational changes under the optics of the previous paradigm, innovation is the way out.

Innovation for sustainability is about more or less significant improvements compared to a prior or other entity (Hansen and Große-Dunker, 2012; Klewitz and Hansen, 2014) and requires different types of innovation (Globbe, 2012). Therefore, innovation is used as a process or direction toward sustainability, which calls for deliberate management. By becoming successful in the marketplace, such innovations create more sustainable products, production methods, business models, market structures and consumption patterns (Eccles *et al.*, 2012; Hansen and Große-Dunker, 2012; Klewitz and Hansen, 2014). Therefore, innovation for sustainability is one of the main concerns of manufacturing companies (Weigt-Rohrbeck and Linneberg, 2019).

Socio-environmental issues were considered sources of strategic change (Aragón-Correa *et al.*, 2008) and drivers for innovation strategies (Noci and Verganti, 1999). For instance, sustainable product innovation can improve companies' performance (Tariq *et al.*, 2019). To implement such practices, companies need to have different capabilities (Annunziata *et al.*, 2018), especially in terms of innovation (Gupta *et al.*, 2020). The appropriate way to understand the firm's behavior regarding innovation is through the understatement of its innovation capabilities. Thus, it is important to understand and identify the innovative behavior of firms facing sustainability practices.

2.2 Innovation capabilities for sustainability

Every firm has specific capabilities that they create and use strategically to identify market gaps to be filled with new offerings of value. Capabilities are based on learning and are path-dependent on specific actions and processes (Hart, 1995; Teece *et al.*, 1997). Such capabilities may be operational and dynamic, varying their purpose and intended outcomes (Winter, 2003). Innovation capabilities refer to how the firm organizes and develops technical and organizational efforts for change (Yam *et al.*, 2011; Del Río *et al.*, 2016), encompassing "the ability to absorb, to adapt and to transform a given technology into specific management, operations and transaction routines that can lead one firm to Schumpeterian profits, i.e., innovation" (Zawislak *et al.*, 2012, p. 15).

Innovation capabilities shape the company's ability to transform specific and applied resources into innovative outcomes and are responsible for adding value to goods and services through novel abilities (Lawson and Samson, 2001; Kafetzopoulos and Skalkos, 2019). They are important in acquiring market knowledge and transform it into technological innovations (Aydin, 2020). Innovation capabilities also help companies be ambidextrous, facilitating simultaneous exploitative and explorative innovation practices (Tajudeen *et al.*, 2021). There are many definitions and models for innovation capabilities in the innovation literature (Iddris, 2016; Weber and Heidenreich, 2018). In this sense, we adopted the model proposed by Zawislak *et al.* (2012), which comprises four innovation capabilities: Development, Operation, Management and Transaction. This model can be

used to identify and detail how firms behave, organize and arrange their capabilities to achieve superior innovation performance (Zawislak *et al.*, 2013). We chose this model because it is comprehensive and, at the same time, easily practical in both research and managerial action. Each capability corresponds to one type of innovation: development for product innovation, operation for process innovation, management for managerial innovation and transaction for commercial innovation (marketing), covering the four types of innovation advocated by Schumpeter (1942). Furthermore, it has already been applied and validated in distinct research with companies from different industries and segments, such as manufacturing (Alves *et al.*, 2017), service (Daniel *et al.*, 2017), agribusiness (Oliveira *et al.*, 2019), digital technologies (Schiavi *et al.*, 2020) and water innovation (Mvulirwenande and When, 2020). Table 1 summarizes the four capabilities and definitions, based on Zawislak *et al.* (2012).

The model assumes that every firm has different arrangements of development, operation, management and transaction capabilities, which helps to explain the uneven innovative performance among firms, sectors and countries, as shown in recent studies (Hartono and Sheng, 2016; El-Awad *et al.*, 2017; Guichardaz *et al.*, 2019; Raghuvanshi *et al.*, 2019). For example, Reichert *et al.* (2016) used this model to analyze the arrangement of innovation capabilities of low-technology companies, indicating the ideal arrangement (as an innovation success recipe) to improve innovation performance. Such arrangements can even assist in the development of the capabilities (Shu, 2019).

The model was used herein to identify and compare the arrangements of innovation capabilities and their correlation with socio-environmental responsibility. As capabilities

Capability	Definition	Outcomes
Development	The ability that any firm must have to interpret the current state of the art, absorb and eventually transform a given technology to create or change its operations capability and any other capability aiming to reach higher levels of technical-economic efficiency	Product innovation. This capability is responsible for creating new products or improving existing ones in the company. It is based on Research and Development (R&D), allowing technological innovations on machines, equipment, new productive materials, among others
Operation	The ability to perform the given productive capability through the collection of daily routines that are embedded in knowledge, skills and technical systems at a given time	Process innovation. This capability is responsible for the company's operational processes. It enables the company to innovate in the technological sphere about internal procedures, productive capability, efficiency, quality and effective control of manufacturing actions
Management	The ability to transform the technology development outcome into coherent operations and transaction arrangements	Management innovation. This capability is responsible for the business strategy, strategic planning, decision-making and orchestration of the other capabilities inherent to the company's organizational conjecture
Transaction	The ability to reduce its marketing, outsourcing, bargaining, logistics and delivering costs; in other words, transaction costs	Commercial innovation. This capability creates, improves and drives marketing and logistics actions and strategies. Thus, it makes it possible to increase the brand reputation, the quality of logistical actions and assists in the prospecting of better suppliers and potential consumers (improving the value chain)

Table 1.
Innovation capabilities and definitions

represent the ability to redesign and adapt company activities to ensure alignment with sustainability-oriented strategy (Gelhard and Von Delft, 2016), the adequate arrangement of innovation capabilities can lead to the creation of effective sustainable innovations. Companies need to integrate economic, environmental and social performance for sustainability while also reaching competitive advantages (product differentiation, operational cost reductions, managerial efficiency, marketing position, consumer preference, among others). Thus, proactive socio-environmental practices reflect organizational resources and capabilities as enablers that link technological development, corporate sustainability practices and organizational performance (Annunziata *et al.*, 2018). This can be done well through innovation capabilities and their arrangements.

Studies demonstrate that capabilities can leverage corporate sustainability (Lai *et al.*, 2015; Tseng *et al.*, 2019), such as improving sustainable product innovation (Dangelico *et al.*, 2017). Moreover, the proper arrangement of innovation capabilities could be important to achieve better sustainability results, but this is not discussed in prior literature. Therefore, it is necessary to identify whether the same arrangement of innovation capabilities by Green companies should (or should not) be followed by Gray companies. One must also analyze whether the actual arrangement is sufficient to drive sustainable innovation or a new "ideal" arrangement is necessary for both Green and Gray companies.

3. Method

3.1 The data set

The study database is from a survey conducted by the Innovation Research Center (NITEC) of the Federal University of Rio Grande do Sul (UFRGS), Brazil, in 2015 (NITEC, 2015). 1,322 Brazilian manufacturing firms from 22 industrial sectors participated in the survey. About 75% of the sample companies are from the low-tech intensive sectors and can be considered low or medium-low technology-intensive according to OCDE's technology intensity indicators (NITEC, 2015).

The instrument was developed and applied in Portuguese, based on the Zawislak *et al.* (2012) capabilities model, and was structured in two sections. According to each capability surveyed, the first section presented questions divided into four blocks: Development, Operation, Management and Transaction. The second sought to measure change and innovation, and the results allow us to analyze innovation performance by variable means. Categorical and interval questions were used, and the intervals were measured using a Likert Scale of five points. Data was collected through telephone interviews with online help for the questionnaire. Experienced and trained researchers performed the interviews. The research participants were the firm's owners, presidents, directors or top managers.

3.2 Statistical analysis

All tests were performed using IBM SPSS software for Windows, version 20. Validation of the internal consistency of the constructs was performed using Cronbach's alpha test. The analyzed database has a normal distribution. The scale as a whole and its dimensions presented Cronbach's alpha superior to 0.7, which is considered a high consistency (Malhotra and Birks, 2007). The Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) and Pearson correlations were performed, and validity and adequacy were verified.

Subsequently, the sample was classified into two groups from the results of question 27 of section 1 of the questionnaire: "Your company includes socio-environmental responsibility in the strategic agenda". The question was measured on a five-point Likert scale, with 1 disagreeing totally and 5 agreeing totally. A large amount of firms responded with numbers 4

and 5 (mean = 4.19; std. dev. = 0.892). Figure 1 shows the distribution of the answers to the question.

In order to separate the sample into groups with significant statistical differences, based on the mean and variance of the set, the *Z*-score test was applied. As a result, two groups with significant statistical differences were successfully obtained. From the results of the *Z*-test, responses with a *Z* score less than zero correspond to one group, and those with a *Z* score greater than zero correspond to another group. In the result of the *Z*-score application, zero corresponds to the mean of the sample responses.

Group 1 met the companies whose answers were between numbers 1 to 4 of the scale. They were considered the group that represented the companies of the sample with less socio-environmental concern and named, for this research, Group Gray. Group 2 met the companies that responded with number 5, the maximum score of the scale. Considered for purposes of this research as the group that presents the companies with the highest socio-environmental concern, they were named Group Green. Table 2 shows the scores after the *Z*-score test.

3.3 Sample characterization

After having the two groups defined and statistically validated, it was possible to verify their characterization vis-à-vis industrial sectors, size and management model, in order to identify differences and similarities. Table 3 shows sample characterization.

In order to characterize the companies according to their sizes, a revenue criterion of the Brazilian Development Bank was applied (BNDES, 2019). Firms from chemicals, metallurgy, automotive, non-metal products and metal products sectors represent most of the sample (60.14%). Regarding revenues, the largest sample portion is micro- and small-sized companies (86.76%). The sample was also characterized by the firm's management model. The highest percentage of firms in the sample is characterized by a management model centered on the figure of the owner(s) (36.31%), followed by firms with family executive positions (28.52%) and professional family organization (23.00%). Firms with corporate governance were the exception in the sample (1.06%).

Gray firms can be characterized as micro- and small-sized firms, with a management model centered on the figure of the owner(s) or organization with family executive positions.

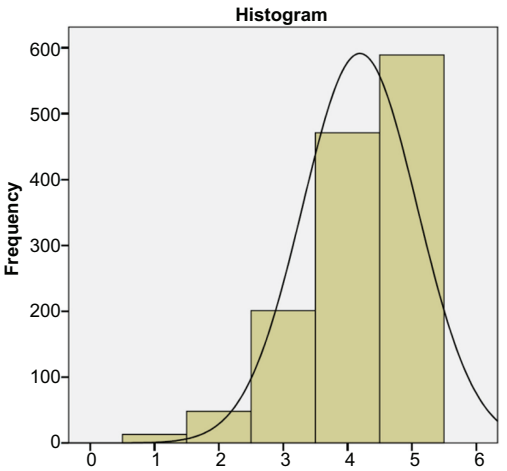

Figure 1.
Firms distributed by their responses to question #27

Also, Gray firms are concentrated in metal products, machinery and equipment, clothing, automotive and wood sectors. Green firms are distributed in different sectors and tend to have professional management and medium or medium-large size.

3.4 Innovation capabilities analysis

After scale validation and sample categorization, the innovation capabilities of the firms from both Groups Gray and Green were analyzed in three aspects: (1) the most prominent capabilities according to the means of the responses (i.e. actual arrangement); (2) the firms' arrangement of capabilities with the greatest impact on innovation, according to a model generated by linear regression.

The first analysis allowed us to verify which capabilities were evaluated with the highest score by the companies, considering the capabilities that receive the most attention, such as actual arrangement, by the firms. A descriptive analysis of the two groups was performed separately. The second analysis has identified, based on the model generated by linear regression, the successful arrangement of capabilities toward innovation and performance. Again, the analysis was generated for each group separately and performed by linear regression analysis with the objective to propose models that explain the impact of the capabilities in the innovation of the firms, proposing an innovation capabilities model for each group. The equation used in the model is:

$$\mathrm{IP} = K + \mathrm{DC}\,\beta 1 + \mathrm{OC}\,\beta 2 + \mathrm{MC}\beta 3 + \beta 4\,\mathrm{TC} + e$$

This model aims to explain the effects of capabilities on innovation by combining such capability measurements as processes and routines with an innovation performance outcome. Each capability (Development – DC, Operation – OC, Management – MC or Transaction – TC) has a standardized coefficient (respectively, $\beta 1$, $\beta 2$, $\beta 3$ and $\beta 4$), and the arrangement of capabilities will be determined by the combination of coefficients.

4. Results

The ANOVA test was performed. The results showed statistical differences between the two groups in the four capabilities surveyed, reinforcing the methodological choice and allowing the continuity of the comparative analyses between groups. ANOVA test scores are presented in Table 4.

We performed a descriptive analysis to identify the most prominent capabilities according to the firm's perception, the aforementioned "actual arrangement" of innovation capabilities. Table 5 shows the results referring to the averages attributed by the firms in Group Gray and Group Green. It is important to clarify that only valid responses are considered in the test of each capability. Thus, there are different Ns for each capability analyzed. The valid N of each

Table 2. Scores of groups after the *Z*-score test

	Response	*Z* score	Frequency	Percent	Valid percent	Cumulative percent
Valid	1	−3.57861	13	1	1	1
	2	−2.45727	48	3.6	3.6	4.6
	3	−1.33594	201	15.1	15.2	19.8
	4	−0.2146	471	35.4	35.6	55.4
	5	0.90674	589	44.3	44.6	100
Total 1			1322	99.3	100	
Missing			9	0,7		
Total			1331	100		

Characteristics	Type	Gray		Green		Sample (Total)	
		n	%	*n*	%	*n*	%
Sector	Metal products	100	11.54%	68	13,64%	168	12.71%
	Machinery and equipment	95	10.87%	64	12,96%	159	12.03%
	Footwear and leather	69	10.87%	64	9.41%	133	10.06%
	Food	62	9.85%	58	8.46%	120	9.8%
	Furniture	56	9.00%	53	7.64%	109	8.25%
	Plastic and rubber	55	8.66%	51	7.50%	106	8.02%
	Clothing	59	3.57%	32	5.05%	91	6.88%
	Automotive	37	3.57%	21	4.23%	58	4.39%
	Wood	31	4.75%	21	3.00%	52	3.93%
	Non-Metal products	22	4.24%	28	3.14%	50	3.78%
	Chemicals	23	2.72%	25	2.73%	48	3.63%
	Diverse	20	2.55%	16	2.32%	36	2.72%
	Electric	17	2.72%	15	2.05%	32	2.42%
	Pulp and paper	15	1.70%	16	2.59%	31	2.34%
	Metallurgy	19	1.53%	10	1.91%	29	2.19%
	Engraving	14	1.70%	9	1.09%	23	1.74%
	Electronics	8	0.85%	10	1.36%	18	1.36%
	Textiles	10	0.85%	5	0.95%	15	1.13%
	Machinery maintenance	7	1.19%	5	0.41%	12	0.91%
	Beverage	3	1.02%	7	0.14%	10	0.76%
	Tobacco	1	0.17%	6	0.68%	7	0.53%
	Transportation equipment	5	0.34%	1	0.55%	6	0.45%
	Petroleum refining	1	0.17%	1	0.14%	2	0.15%
	Pharmaceuticals	0	0.17%	1	0.00%	1	0.08%
	Missing	4	5.43%	2	8.05%	6	0.45%
Total		733	100%	589	100%	1322	100%
Revenue	Micro-sized (less than or equal to $0,6 million)	417	56,89%	297	50,42%	714	54.01%
	Small-sized (+$0,6 and less than $4 millions)	238	32.47%	195	33.11%	433	32.75%
	Medium-sized (+$4 $ and less than $22,5 millions)	48	6.55%	59	10.02%	107	8.09%
	Medium-Large-sized (+$22,5 and less than $75 millions)	11	1.50%	19	3,0.3%	30	2.27%
	Large-sized (more than $75 millions)	6	0.82%	6	1.02%	12	0.91%
	Missing	13	1.77%	13	2.21%	26	1.97%
	Total	733	100,00%	589	100,00%	1322	100,00%
Management Model	Custom centered on the figure of the owner(s)	301	41.06%	179	30.39%	480	36.31%
	Organization with family executive positions	206	28.10%	171	29.03%	377	28.52%
	Professional family organization	155	21.15%	149	25.30%	304	23.00%
	Professional organization	61	8.32%	82	13.92%	143	10.82%
	Corporate governance	7	0.95%	7	1.19%	14	1.06%
	Missing	3	0.41%	1	0.17%	4	0.30%
	Total	733	100%	589	100%	1322	100%

Note(s): *Revenue criteria according to BNDES (2019), converted to the dollar (1 dollar = 4 Brazilian reais)

Table 3. Sample characterization

group refers to the number of respondents who completed the questionnaire in its entirety (Valid N Group Green = 496; Valid N Group Gray = 609).

Capabilities		∑ squares	df	Mean square	*F*	Sig
Development	Between Groups	14.962	1	14.962	25.335	0.000
	Within Groups	651.401	1103	0.591		
	Total	666.364	1104			
Operation	Between Groups	15,5	1	15.5	54.156	0.000
	Within Groups	315.701	1103	0.286		
	Total	331.202	1104			
Management	Between Groups	84.428	1	84.428	305.536	0.000
	Within Groups	304.791	1103	0.276		
	Total	389.22	1104			
Transaction	Between Groups	17.417	1	17.417	35.316	0.000
	Within Groups	543.969	1103	0.493		
	Total	561.385	1104			

Table 4.
ANOVA test scores

		Capabilities			
		Development	Operation	Management	Transaction
Group Gray	*N*	692	695	695	713
	Min	1	2.22	1.14	1
	Max	5	5	4.86	5
	Mean	3.429	3.8074	3.5307	3.3333
	Std. Dev	0.76683	0.54033	0.56302	0.71145
	Sig	0.000	0.000	0.000	0.000
Group Green	*N*	565	558	568	562
	Min	1	1	2.14	1.17
	Max	5	5	5	5
	Mean	3.6759	4.0396	4.0983	3,5967
	Std. Dev	0.77929	0.54754	0.47679	0.68761
	Sig	0.000	0.007	0.000	0.000

Table 5.
Most important capabilities according to the firms

The analysis reflects what the firms perceive as more relevant to achieve better performance. Analyzing the means attributed by the companies to their innovation capabilities, it is verified that Group Gray attributes greater importance to the Operation capability, followed by Management, Development and Transaction capabilities. The companies of Group Green evaluate as most relevant the Management capability, followed by Operation, Development and Transaction capabilities. However, it is noteworthy that Group Green has higher means in all capabilities than those of Group Gray.

The second analysis, the "ideal arrangement", aimed to identify the best capabilities arrangements for performance based on the model generated by linear regression. The results of both groups provided a model with an adjusted R^2 and significance that confirmed its validity, and the R scores found are considered acceptable for research in the Social Sciences (Malhotra and Birks, 2007). Table 6 presents the model generated for Group Gray, and Table 7, the model for Group Green.

The main difference in the "ideal arrangement" between the two groups is visible when comparing Tables 6 and 7. For the Gray companies, the data suggest that Development capability has a greater impact on innovation and performance, followed by Management and Transaction, and, with the least impact, Operation capability. For the Green companies, the capabilities with the greatest impact on innovation and performance are, respectively, Transaction and Management, followed by Development and Operation.

5. Discussion and concluding remarks

The research sought to identify and compare the arrangements of innovation capabilities and their correlation with socio-environmental responsibility of two groups: companies with less socio-environmental concern (Group Gray) and companies with greater socio-environmental concern (Group Green). Comparing each group separately, the data suggest that there is a difference between the capabilities that effectively receive the attention of the companies, i.e. "actual arrangement", and the capabilities that should be valued and developed, i.e. "ideal arrangement". This situation is found in the two groups studied. Figure 2 summarizes both the real and the ideal arrangements of capabilities for the two groups. Specifically, only one capability in each group is in the ideal position within the actual arrangement: Management capability in Gray companies and Transaction capability in Green companies. This demonstrates that the efforts committed by each group for these specific capabilities are right and need to continue. However, modifications are necessary for the other three capabilities.

Gray companies in their "actual arrangement" seem to pay more attention to Operation and, then, Management capability. These are followed by Development and Transaction capabilities. Operation is, precisely, the capability with the least impact on innovation, according to the proposed "ideal arrangement" (see Table 7). This result suggests that focus on operations can lessen the interest or willingness to implement sustainability actions on the strategic agenda. One possible explanation is the need for controlling costs in firms that are focusing their business strategy on Operation capability (Zawislak *et al.*, 2012), which can lead to a lack of prioritization of sustainability concerns.

In contrast, Development capability must be prioritized to improve the innovative performance of Gray companies, as indicated by the "ideal arrangement". While Gray companies nowadays focus on cost minimization and process improvement (Operation capability), they should be focusing on Research and Development (R&D) to develop new, sustainable technologies and standards (Development capability). This group should be investing higher costs to generate new and sustainable products and processes and not only

Table 6. Model by regression Analysis-Group Gray

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. Error	Beta	*T*	Sig
(Constant)	0.024	0.037	–	0.649	0.517
Development	0.311	0.035	0.311	8.851	0.000
Operation	0.157	0.035	0.156	4.433	0.000
Management	0.265	0.036	0.260	7.424	0.000
Transaction	0.251	0.035	0.251	7.147	0.000

Note(s): $R^2 = 0.234$ and sig = 0.000

Table 7. Model by regression Analysis-Group Green

Model	Unstandardized coefficients		Standardized coefficients		
	B	Std. Error	Beta	*T*	Sig
(Constant)	−0.038	0.040	–	−0.963	0.336
Development	0.211	0.037	0.217	5.638	0.000
Operation	0.102	0.037	0.105	2.732	0.007
Management	0.338	0.041	0.317	8.266	0.000
Transaction	0.310	0.037	0.320	8.332	0.000

Note(s): $R^2 = 0.256$ and sig = 0.000

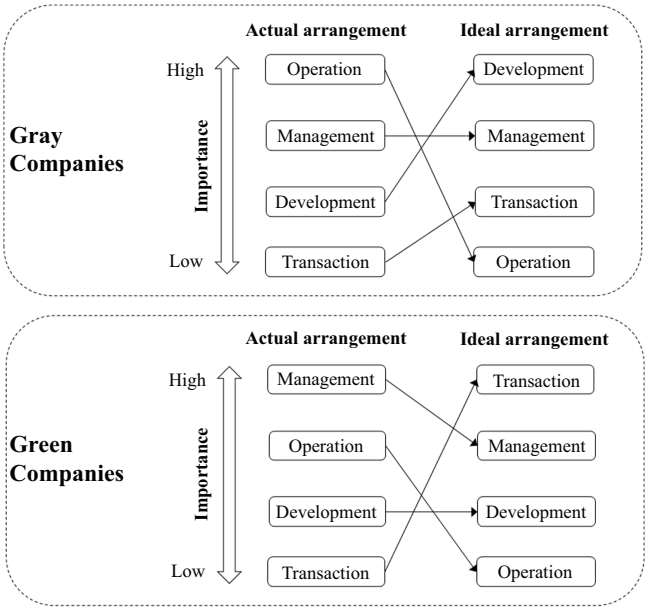

Figure 2.
Comparison of capabilities arrangements

minimizing costs. These investments tend to be high in the initial stage of any innovation. However, without them, incumbents facing the sustainability era and its unavoidable challenges will find it difficult to outperform their competitors in the short and long term. Hence, Gray companies need to be technology-driven regarding sustainability.

The results of Green companies suggest that they currently pay more attention to Management capability, followed by Operation. This may explain why these companies already have value-added products that are well accepted in the market. In addition, as companies of this group are larger in size compared to the Gray companies, the amount of production and sales tend to be high, requiring greater efforts and novelties on Management capability to maintain harmony and orchestration among the other capabilities and their functions. Also, Group Green has higher means in all capabilities than those of Group Gray. This suggests that Green companies are more innovative than Gray companies in the four types of innovation: product, process, management and commercial (marketing), which justifies the fact that Green companies have a greater strategic concern with sustainability-based innovation.

The proposed model indicates that the most relevant innovation capability for this group is Transaction. This can indicate that these companies have already invested in R&D and, at this point, they need to invest in other forms of innovation to maintain or increase the level of sales, which occurs through the Transaction capability. This capability, for instance, allows new features to be introduced in the logistics and sales standards. One may not forget that transaction capability, by connecting the firm with the market, ends up by dealing with consumer behavior, marketing trends and institutional change. Transaction capability is thus connected to the generation of value co-creation platforms, which can leverage the reception of sustainable ideas from consumers, and the introduction of novelties in marketing, inducing the disclosure of sustainability actions developed. All this can improve the company's awareness of expectations, its brand and, consequently, the revenue and the sustainable development of the society. In this arrangement, Transaction is followed by

Management and Development capabilities, respectively, leaving Operation in the last place. Thus, to cope with Transaction, Management and Development capabilities seem to be more influential for sustainability ventures.

Aligned with Engert *et al.* (2016), integrating sustainable actions into corporate strategies requires a decision-making process in a complex environment in which social, natural, cultural and economic factors should be considered. It demands management competencies, the development of organizational learning structures and process changes (Engert *et al.*, 2016). However, our study showed that these Green companies must value and develop Transaction capability to improve their innovation performance, which is new in the field. Perhaps, the challenges to implementing sustainable strategies described for literature, about value chain, supply chain management and relations with stakeholders (Kumar *et al.*, 2019; Lüdeke-Freund *et al.*, 2019), demand arrangements and capabilities targeted to transactions abilities, related by outsourcing, bargaining, logistics and delivering costs (Zawislak *et al.*, 2012).

Comparing the "actual arrangement" of capabilities of the two studied groups, both are similar, trading off Operation and Management at the top and both having Development-Transaction rank at the bottom. Both groups currently give less attention to Transaction capability. This may be explained by the fact that Brazilian companies are more reactive, classic suppliers of chains, providers of industrial services (Reichert *et al.*, 2016). In a way, this ends up in weaker transactional capabilities.

Concerning the "ideal arrangement", the differences between groups are accurate. For Gray companies, Development tops their capabilities arrangement, while for Green companies, Transaction capability is the most prominent for innovation and performance. As proposed by literature, Development capability is supposedly the one that presents the greatest innovative impact. One interpretation may be, exactly, in the fact that Green companies are yet more concerned with marketing and management than with development issues. Gray companies are still focused on traditional innovation patterns, such as product development.

The "ideal arrangement" is also dichotomous. Green companies with the predominance of Transaction and Management capabilities are in accordance with the list of initiatives that companies focused on Sustainability do (see Kiron *et al.*, 2012), especially when arranging actions in relation to the market (transactions) and internally (management). Gray companies are closer to the expected standard of the Brazilian manufacturing industry, reinforcing, in a very similar way, respectively Development, Management and Transaction capabilities, in the expanse of Operation capability, a sort of "ordinary capability" (see Alves *et al.*, 2017). For Green firms, the ideal capability is Transaction, and for Gray firms, it is Development.

There is also an interesting discussion about the concentration of answers at higher scores of the scale in the question that measures the firms' socio-environmental actions, which caused us to apply *Z*-score test. According to Kiron *et al.* (2012), there is a growing number of companies that have placed sustainability in their management agenda. Considering the socio-economic context, sustainability is no longer a choice for companies, and the discussion is now on how to do so and no longer on whether they should embrace sustainability or not. This concentration can be analyzed by considering social standards, which reflect the behavior of most people and refer to the rules and beliefs that accept or disapprove of social conduct (Cialdini *et al.*, 1990). Thus, social standards affect people's preferences and behaviors and, thus, firms' trajectories. Managers may have been influenced by social standards in their higher demonstration of socio-environmental interest and concern.

However, as pointed by Sheth *et al.* (2011), recognizing the importance of sustainability does not necessarily lead to effective actions by the firms. To achieve sustainability, business practices must encompass and balance environmental, social and economic dimensions. Firms' environmental actions are mostly pushed by compliance, regulation or legal

enforcement. In this context, social and economic dimensions seem to be materialized in programs and projects not necessarily integrated with business practice (Sheth *et al.*, 2011). To get more effective results, it is necessary not only to mitigate actions but to implant a new business logic, including new products, operations, supply chain management (most widely, value chain management) and marketing actions, which drive consumption (White *et al.*, 2019). All this emerges from innovation, which takes shape from the innovation capabilities of the companies.

5.1 Conclusion

Given the relevance of innovation capabilities for sustainability and the lack of such relation understanding in prior studies, this research highlights a new perspective on innovation and sustainability literature. This study aimed to compare the arrangement of innovation capabilities between companies that are more and less prone (Green companies and Gray companies, respectively) to socio-environmental concerns, highlighting their differences and specificities. From the results, we concluded that there is a difference in the arrangement of capabilities of the two groups studied, just as there is a difference in the model of innovation capabilities that influence their innovative performance. Also, it was found that the "ideal arrangement" of capabilities does not correspond to the "actual arrangement" for their innovation performance. Therefore, for both Green and Gray companies to achieve greater innovation performance to drive the adoption of socio-environmental responsibility, they need to migrate from the actual arrangement to the ideal.

More precisely, Brazilian companies looking to be innovative from sustainability lenses need to pay attention to their innovation capabilities model (arrangement of capabilities). On this, Gray companies that currently focus on Operation capability as highly important for innovation performance must replace this with Development capability as shown in the ideal model. By achieving this, companies will overcome their limitations in social, environmental and economic dimensions, being able to expand the development of sustainable innovations. It also allows new sustainable processes, products and technologies to be developed (such as technologies that reduce the use of natural resources or reuse leftover raw materials), in addition to providing better profitability returns. By moving from the "actual arrangement" to the "ideal arrangement" of innovation capabilities, Gray companies can even become Green companies, i.e. companies whose sustainability practices are highly valued and considered in their strategic agendas.

Regarding Green companies, they currently focus on Management capability as highly important for their innovation performance but must replace this with Transaction capability as shown in the ideal model. As already discussed, this change will induce sustainable innovations in market relations, whether business-to-consumer or business-to-business, with a focus on social and sustainable marketing actions. Thus, sustainable innovations can be directed, for example, to distribution and consumption channels, with new technologies such as smartphone applications that can help the consumer facilitate the return of used products to be recycled. As much as Green companies are examples of innovative business models, if they do not migrate from the "actual arrangement" to the "ideal arrangement" of innovation capabilities, their sustainable, innovative potential may not be fully realized. This can induce a setback, making it possible for these companies to become Gray, i.e. companies whose sustainability practices are less valued and not considered in their strategic agendas.

5.2 Theoretical implications

The study advances knowledge on the innovation literature, specifically on innovation capabilities' perspective. Nowadays, innovation capabilities can be seen as a theoretical approach (Wang and Hu, 2020) capable of improving the understanding of different

phenomena and facts of companies' innovation during daily life. Such an approach can help with the conduction of scientific research that predicts the innovation behaviors of companies. This study collaborates with the theory advance, especially in terms of firms' internal factors and the capabilities arrangements in the context of sustainability. Thus, the theoretical contribution expands also to sustainability literature, more precisely, to the intertwining between innovation and sustainability fields. The innovation capabilities approach can be an effective base to understand companies' sustainable innovation behavior and how these behaviors can be improved or adapted to new market dynamics to leverage the four types of innovation: product, process, management and commercial (marketing).

5.3 Practical implications

The results contribute practically by providing insights for researchers and managers to understand the differences between companies with different levels of socio-environmental concerns. By identifying the "ideal capabilities" arrangement, this research provides important information that can guide practitioners and managers in planning internal strategies for investments, prioritizing management efforts and rearranging capabilities to achieve sustainability at the firm level.

The research findings indicate that the innovative behavior of Green companies should focus on Transaction capability. This innovation capability can contribute to the formation of sustainable value chains, which can help in adopting sustainable strategies (e.g. Circular Economy) from a systemic perspective, including multiple agents and closed-loop supply chains. Transaction capability can also facilitate the formation of inter-organizational sustainability networks, e.g. among firms, non-profit and public organizations and institutions, supporting the development of open innovations for sustainability and the formation of platforms for second-hand products. Regarding Gray companies, their innovation behaviors should be concentrated on Development capability. This capability can allow the creation of new machinery and equipment to improve practices of the Circular Economy, such as cleaner production and digital technologies; and the development of clean-tech and renewable new materials, waste handling and processing and the repairing and refurbishment of used products by reusing and recycling. Such actions can have a positive impact on improving the level of eco-efficiency of manufacturing companies. Thus, each group of companies can better understand which innovation behavior they should adopt and which capabilities must be prioritized in those behaviors to generate sustainable innovations.

Additionally, beyond Brazil, companies from other developing countries with similar characteristics and contexts (social, environmental, economic and political) may allocate the research findings to improve sustainable development. Also, public initiatives, such as the creation of public policies and incentives for companies to analyze their innovation capabilities and shape and arrange them to achieve better results for sustainability, can be carried out.

5.4 Limitations and future research

The present research has some limitations. First, the models proposed for the study of groups Gray and Green, resulting from linear regression, explain only 23.4% and 26.5% of the cases, respectively. Although it is an acceptable R^2 factor in terms of Social Sciences research, it may be related to the limitations of the proposed model. As suggested by Alves *et al.* (2017), the unexplained portion may be because of external variables, such as homogenous standards, regulations and even technological basis. Another limitation is that the data analyzed are derived from a previous research database. The group segmentation for the current research was performed based on a question that was not formulated originally for this goal.

For future studies, the formulation of the question could observe the classification proposed by Kiron *et al.* (2012). Since this research was carried out on Brazilian companies, it is recommendable to replicate this study in other countries, with other sectoral industry groups, and also a longitudinal follow-up of the firms. A longitudinal investigation can follow the limitations that companies could face in the migration from the "actual arrangement" to the "ideal arrangement" of innovation capabilities, allowing in identifying solutions and facilitating the migration. Further studies can also analyze the pace of change that companies need to adopt in their capabilities' arrangement and when to change it; as the market is dynamic, innovation capabilities need to be improved over time and thus meaning new arrangements will become necessary. Future investigations can analyze the business models of manufacturing companies from the perspective of innovation capabilities, indicating how companies can innovate in their business models for the effectiveness of sustainability. Lastly, future research regarding innovation capabilities for sustainability can be applied to the service industry, which has distinct specificities from the manufacturing industry.

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