

# Sustainable innovation practices and the degree of innovation of business models in Brazilian industrial companies

Sustainable  
innovation  
practices

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## Abstract

**Purpose** – This study has aimed to analyze the relationship between the adoption of sustainable innovation practices and the degree of innovation of business models in Brazilian industrial companies.

**Design/methodology/approach** – The study has been characterized as quantitative and comprised the conduction of a survey with Brazilian industrial companies.

**Findings** – Results have shown that companies with a high degree of innovation in their business models invest more strongly in strategic dimensions of sustainable innovation, which in general involve stakeholders and cross the organization's internal boundaries, requiring proactive attitudes from the company, probably because this type of investment gives them greater competitiveness in their market and also requires a radical modification of their business model.

**Practical implications** – This study seeks to present contributions to entrepreneurs and policy makers, in the face of the innovative and sustainable challenges imposed by society and the guidelines for sustainable development in order to reflect on positive impacts on local and global development.

**Social implications** – Comprehending the behavior of industrial companies in Brazil in relation to sustainable innovation and its impact on society contributes to understanding the benefits of adopting a strategic management of sustainable innovation, minimizing negative socio-environmental impacts.

**Originality/value** – By analyzing the themes of sustainable innovation and business model, the present study may contribute to adopting business behavior that strategically and systemically integrates the objectives of sustainable innovation.

**Keywords** Innovation, Sustainability, Business model, Brazil

**Paper type** Research paper

## 1. Introduction

Sustainability has repeatedly integrated the corporate agenda; thus, organizations have modified their business models to minimize the negative socio-environmental impacts of their activities. Coping with socio-environmental crises arouses an increasing awareness of society in the search for solutions to such problems, which includes the adoption of more sustainable lifestyles and the appreciation of sustainable organizations.



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In this scenario, a fundamental factor for this obstacle is implementing innovations that promote sustainability (Dyck and Silvestre, 2018). Sustainable innovation is understood as creating products, processes and organizational and marketing practices that improve sustainable performance in the social, environmental and economic spheres (Horbach *et al.*, 2012; Szekely and Strebel, 2013; Hall *et al.*, 2018). Therefore, such improvements are not restricted to technological changes and may even be related to changes in processes, practices, business models, thoughts and business systems.

According to Adams *et al.* (2016), sustainability-oriented innovation is associated with changing philosophy, values, products, processes or organizational practices to meet the specific purpose of creating and realizing social, environmental and economic value. In this sense, sustainability-oriented innovation considering these three aspects must be present in the business strategy and reflected in the organization's culture and not only represented through the adoption of isolated actions, such as the development of new environmentally correct products and processes. Moreover, such innovation requires changes in the business context and is linked to business models that strategically contemplate economic prosperity, social well-being and environmental preservation.

Based on the premise that business management is based on managerial decisions derived from corporate visions and strategies that shape the business model and organizational development, the continuous orientation of a company towards innovation and sustainability requires changes in its business model in order to manage social and environmental activities systematically (Schaltegger *et al.*, 2012). The business model is related to the mechanisms of creating, delivering and capturing value in an organization in order that its essence reflects the needs of customers and their ability to pay. This defines how the company delivers value and attracts customers, converting received payments into profits through the appropriate design and operation of the various elements of the value chain (Schaltegger *et al.*, 2016).

In this context, it is clear that sustainable innovation in organizations may cause reflexes in the business model, resulting from the insertion of intrinsic changes to adopt innovative practices oriented toward sustainability. These practices alter the mechanisms of creation, delivery and capturing a company's value. According to Adams *et al.* (2016), several studies have placed sustainability-oriented innovation as a challenge for their business models, following the example of Rohrbeck *et al.* (2013), reflecting the complexities of developing new value propositions and opportunities for creating and capturing the value that an orientation toward sustainability represents.

For Spiet and Schneider (2016), business model innovation is related to a transformative view of the business model to facilitate opportunities and commercialize new ideas and technologies. In this manner, business models serve as mediators by valuing new technologies and other types of innovation, where sustainable innovation motivates the business model and creates sustainable business cases (Lüdeke-Freund, 2020). According to Bocken *et al.* (2019), innovation in the sustainable business model is related to the creation of superior value for the client and the company, meeting social and environmental needs through the way business is conducted.

Geissdoerfer *et al.* (2018) consider innovation in the business model to be a key tool for implementing changes in organizations, providing greater social and environmental sustainability to the industrial system. According to Yang *et al.* (2017), this type of innovation is an emerging research area and an important approach to contribute to sustainability and the diffusion of sustainable businesses.

Agwu and Bessant (2021) highlight the need to transition into sustainable business models in the industrial sector, which is the object of this study, considering the negative impacts on the environment and society due to the significant growth of the sector caused by technological improvements that increased efficiency, reduced costs and allowed mass production, combined

with a growing world population. Thus, promoting sustainable innovation in the business model of industrial companies is essential for such a transition to occur.

Complementing this view, [Shakeel et al. \(2020\)](#) reported that the fourth industrial revolution placed considerable emphasis on sustainability in order that companies should focus on creating innovative solutions, maximizing value for stakeholders. The authors also emphasized that companies must go beyond the traditional business model and bring sustainability and innovation to their stakeholders.

In this sense, the present study aims to analyze the relationship between adopting sustainable innovation practices and the degree of innovation of business models in Brazilian industrial companies. In this way, when dealing with the relationship between sustainable innovation practices and the degree of modification in the business model, this study contributes to broaden the academic discussion about such themes and boost the adoption of business behavior that integrates the objectives of innovation and sustainability strategically and systemically. In addition, this study becomes even more relevant when addressing sustainable innovation practices in the context of the business model of Brazilian industrial companies, bearing in mind that it is increasingly necessary for the industrial sector to include innovation and sustainability in their business models.

To achieve this purpose, this study is structured into five sections in addition to this introductory one. The first and the second sections present the theoretical support that supports the development of the proposed research. Then, the third section deals with the methodological procedures adopted. Soon after, the analysis and discussion of the results are exposed. Finally, the final considerations are addressed.

## 2. Sustainable innovation in organizations

Sustainability-oriented innovation takes many forms, from developing new or improved products or services to creating new business processes and models that benefit the environment and society. Sustainable innovation is a process that helps companies to integrate sustainability into their operations and business strategies, including generating ideas, marketing technology, and product development processes, helping companies to better understand their ecosystem, and serve technological and market needs ([Lim and Sonko, 2019](#)). Hence, innovation through products, processes and business models oriented towards sustainability has placed organizations in a prominent position before stakeholders, contributing to greater competitiveness. [Hermundsdottir and Aspelund \(2021\)](#) showed that sustainable innovations contribute to the change in sustainability and generate competitive advantages for organizations.

[Seebode et al. \(2012\)](#) stated that sustainable innovation encourages companies to learn new approaches and leave behind old practices as it involves working with different components of knowledge such as new technologies, new markets and new environmental conditions and regulations. For [Jarmai \(2020\)](#), the literature identifies several potential factors to integrating sustainability criteria in companies' innovation strategies and practices based on innovation theory and environmental policy and classified them into the factors of supply, demand and regulatory structures.

In the view of [Adams et al. \(2016\)](#), sustainability-oriented innovation is related to changing organizational philosophy and values and its products, processes or practices to meet the specific purpose of creating and providing socio-environmental value as economic returns. Corroborating this, [Boons \(2009\)](#) states that sustainable innovations need to go beyond incremental levels since sustainable development requires the transformation of production and consumption systems.

Furthermore, [Adams et al. \(2016\)](#) believe that sustainability-oriented innovation appears initially as a response to regulatory stimuli with an incremental change at the business level, culminating in a radical change at the level of large-scale systems. In the authors' view, to

advance this level of change, a change in philosophy, values and behavior is necessary, and this is reflected in the company's innovation activity.

In this regard, [Dyck and Silvestre \(2018\)](#) propose two approaches for sustainable innovation considering the perspective adopted by the company. For the authors, the most common definition in the literature is Sustainable Innovation 1.0 (IS 1.0) and refers to sustainable innovations motivated by financial returns generated and aims to increase financial results by reducing organizations' negative socio-environmental externalities.

The second type, called Sustainable Innovation 2.0 (IS 2.0), refers to sustainable innovations motivated by socio-environmental returns generated in order to allow organizations to improve positive socio-environmental externalities, remaining financially viable, which does not mean that the financial dimension is not essential, but less important than the other two dimensions ([Dyck and Silvestre, 2018](#)).

In the authors' view, greater emphasis should be placed on sustainable development to promote positive externalities growth so that financial well-being is a dimension subservient to socio-environmental well-being. From the point of view of IS 2.0, the main objective is to promote socio-environmental development in order to increase current and future generations' capacity to meet their needs while maintaining organizations' financial viability ([Dyck and Silvestre, 2018](#)).

In this way, one can see the need for sustainable innovation to permeate the business environment and be valued by society in order for companies to invest in levels of radical innovation by building a new logic of value creation for sustainability.

[Bocken et al. \(2014\)](#) identified a wide range of examples of mechanisms and solutions that can contribute to the innovation of business models for sustainability from a review of the literature and business practices, proposing eight archetypes, grouped in the dimensions of technological, social and organizational innovations, that are: (1) maximize energy and material efficiency; (2) create value from waste; (3) replace with renewables and natural processes; (4) deliver functionality rather than ownership; (5) adopt a leadership role; (6) encourage sufficiency; (7) adapt the business to society/environment; and (8) develop a scale of solutions.

[Ritala et al. \(2018\)](#) updated the original archetypes and organized them into environmental, social and economic categories. In addition, the authors added the "inclusive value creation" archetype, which includes trends such as the growing number of peer-to-peer and sharing models, as well as the need to include segments not previously covered.

[Figure 1](#) presents the proposal by [Bocken et al. \(2014\)](#) and [Ritala et al. \(2018\)](#).

The archetypes proposed by [Bocken et al. \(2014\)](#) and [Ritala et al. \(2018\)](#) shall be used as a basis for analysis of sustainable innovation practices, considering that they include a wide range of actions that organizations can adopt for sustainability.

[Ludeke-Freund et al. \(2018\)](#) also propose a taxonomy of sustainable business models comprising 45 standards across 11 groups (pricing and revenue, financing, ecodesign, closing-the-loop, supply chain, giving, access provision, social mission, services and performance, cooperative and community platform) based on the environmental, social and economic dimensions, supporting, in this sense, innovation in the sustainability-oriented business model.

Thus, it should be noted that several studies have placed innovation-oriented toward sustainability as a challenge of the business model ([Rohrbeck et al., 2013](#); [Adams et al., 2016](#)), reflecting the intrinsic complexities of a sustainability orientation and the elements that make up the business model. Although several studies address the application of sustainable innovation in business environments, there are still gaps in terms of reflections on business models, which will be discussed in the next section.

| Innovation    | Archetypes                                   | Definition  |
|---------------|--|---|
| Environmental | Maximize energy and material efficiency      | Doing more with fewer resources, generating less waste, emissions, and pollution                |
|               | Close (cycles) resource loops                | Reuse materials and products, transform waste into raw materials for other products/processes   |
|               | Replace with renewable and natural processes | Use of non-finite materials and energy sources  |
| Social        | Deliver functionality, not ownership         | Provide services that meet users' needs without having to own physical products                 |
|               | Adopt leadership roles                       | Proactive engagement with stakeholders to ensure long-term health and well-being                |
|               | Encourage sufficiency                        | Solutions that actively seek to reduce end-user consumption                                     |
| Economic      | Redirect to society/environment              | Seek to create positive value for all stakeholders, in a particular society and the environment |
|               | Create inclusive value                       | Share resources, knowledge, ownership, and wealth creation, including value creation            |
|               | Develop sustainable solutions at scale       | Provide large-scale sustainable solutions to maximize benefits for society and the environment  |

**Source(s):** Developed based on by Bocken *et al.* (2014) and Ritala *et al.* (2018)

**Figure 1.**  
Archetypes of  
sustainable business  
models

### 3. Business models

The business model reflects the organizational structure and how the company communicates with its stakeholders and generates value to customers and society. Spieth and Schneider (2016) present three distinct business models: describing a company's main business logic, facilitating opportunities and marketing new ideas and technologies.

The business model concept refers to a representation of companies' ways of doing business; it demonstrates how companies create and deliver customer value to generate revenue and achieve a sustainable competitive position (Taran 2011; Taran *et al.*, 2015). This concept captures the factors necessary for a successful business by combining several elements such as (1) the value proposition, (2) the value creation configuration, which includes companies' relationship with suppliers and customers and (3) the revenue model, i.e. how costs and benefits are shared with economic agents (Boons and Lüdeke-Freund 2013).

Lüdeke-Freund *et al.* (2019) define as the dimensions of a business model the following elements: (1) the value proposal (products and services), (2) the delivery of value (target customers and value delivery processes), (3) the creation of value (partners and stakeholders and value creation processes) and (4) the capture of value (revenues and costs).

The creation of value is the core element of any business model, given that companies typically capture value by taking advantage of new business opportunities, new markets and new sources of revenue (Bocken *et al.*, 2014; Beltramello *et al.*, 2013; Teece 2010).

While value proposition is generally related to the supply of products and services to generate an economic return, in a sustainable business, the value proposition would result in measurable ecological and/or social value together with economic value (Bocken *et al.*, 2014; Boons and Lüdeke-Freund, 2013). Lastly, value capture relates to the way revenues are obtained from the provision of goods, services or information to users and customers (Bocken *et al.*, 2014; Teece, 2010).

Global competition has forced companies to rethink their business models more often since innovating exclusively in new products and serving local markets is not enough to sustain a competitive advantage and ensure companies' survival (Taran *et al.*, 2015). According to Pieroni *et al.* (2019), as sustainability and the circular economy gain greater attention from governments, industries and academia, business model innovation for sustainability and/or circularity is becoming critical to sustaining the competitive advantage of companies. In this way, more and more companies turn to social and environmental goals as part of the logic of doing business (Velter *et al.*, 2020).

In this regard, [Yang et al. \(2017\)](#) state that business model innovation does not necessarily uncover new products and/or services but rather uses new ways of creating and delivering existing products and/or services and new ways of capturing value from them. Based on the generic concept of the business model and its key components, it is necessary to understand that business-oriented sustainability, strategically speaking, may require adaptation or even radical change of companies' business models ([Schaltegger et al., 2012](#)). For the authors, the innovation of the business model aims to ensure business success and contribute to sustainable development.

Some authors have been placing sustainability-driven innovation as a challenge to business models ([Rohrbeck et al., 2013](#); [Adams et al., 2016](#)). [Boons and Leudeke-Freund \(2013\)](#) conclude in their study that searching for business models for sustainable innovation equals a quest that challenges the neoclassical economic vision. Complementing such a vision, [Evans et al. \(2017\)](#) emphasize that changes in business models are crucial to implementing sustainable innovations. However, there are still incipient studies dealing with the successful adoption of sustainable business models.

For [Schaltegger et al. \(2012\)](#), a sustainability-oriented business model must be actively managed to grow the customer base and create social value by integrating social, environmental and business activities. Sustainable business models incorporate a triple bottom line approach and broadly consider stakeholder interests, including the environment and society, being important elements in driving and implementing innovation for sustainability, contributing to more sustainable business and serving as a key factor for obtaining competitive advantage ([Bocken et al., 2014](#)). [Bocken and Geradts \(2020\)](#) also note that innovation in the sustainable business model is a crucial factor for multinational companies' competitive advantage and sustainability.

For [Bocken et al. \(2019\)](#), sustainable business model innovation has to do with creating superior value for both the customer and the company, meeting social and environmental needs through the way business is conducted. The authors introduced the idea of a business-model experimentation map in ecology that can stimulate innovation in these models more profoundly, enabling a systemic way of sustainable business model experimentation and creating a positive impact on organizational networks.

According to [Shakeel et al. \(2020\)](#), the innovation of the sustainable business model covers the logic of creating value in the business model and incorporates sustainable value and value innovation as a way to face the challenges of sustainability. Moreover, it is also possible to understand that the innovation of the sustainable business model arises from the interest of organizations in incorporating social aspects into the innovation of the business model ([Bocken and Geradts, 2020](#)).

The sustainable business model is a model that analyzes not only how organizations produce and deliver goods and services but also how they contribute to improving society from an environmental and social perspective ([Ulvenblad et al., 2018](#)). Thus, sustainable business models have a broad scope in their ambition to generate positive social impacts or eliminate negative ones ([Velter et al., 2020](#)).

[Boons et al. \(2013\)](#) argue that any significant change in the dominant economic logic involves the application of new business models by social actors seeking to promote ideas, develop different types of innovations and implement new sustainability practices. In addition, the authors assert that from this perspective, each dimension of the business model needs to be changed: value propositions need to reflect citizens' real needs and revenue distribution needs to be defined in categories that are not purely economic, which requires some fundamental shift in the way companies connect with each other and with society.

When analyzing the challenges faced by organizations related to sustainability, from the scarcity of resources to customers' demands for greener products, it was found that most of the companies analyzed modified their business model due to opportunities identified

through sustainability. Additionally, the creation of economic value resulting from sustainability activities and decisions are those that modify their business models, have the support of senior management, the collaboration of customers and external stakeholders (Kiron *et al.*, 2013a, b).

According to Silvestre and Tirca (2019), the paths for ecological approaches require changes in the mentality of top management and staff in organizations. In addition, the extent to which sustainability principles will be incorporated into business models and generate significant results from a triple bottom line perspective will depend on the ambition levels of decision makers (Pieroni *et al.*, 2019). In this perspective, business models require the intentional design to provide sustainability impacts (Bocken *et al.*, 2019).

Complementing this vision, Geradts and Bocken (2018) identified five essential elements that can help business people to promote innovation focused on sustainability: (1) provide a clear direction and promote employee understanding and engagement with global objectives; (2) provide an adequate budget and other resources (space, time and training) in order that employees are able to carry out projects related to sustainability-oriented innovation; (3) promote collaborative relationships within the company and with external groups in order to fill the knowledge and resource gaps; (4) motivate employees involved in innovation projects by showing that personal rewards exceed costs; and (5) adopt assessment systems that establish the creation of social and environmental value as a priority.

In this perspective, organizations are challenged to remodel their business models starting at the moment they insert sustainability-oriented innovation into their management.

Complementing this view, Boons and Lüdeke-Freund (2013) emphasize that while innovation takes on the potential for sustainability, the business model is the market mechanism that drives or hinders the deployment of this potential. Lüdeke-Freund (2020) reported that the most critical function of the business model for creating ecological, social and economic value is its ability to mediate innovations such as new processes, products or services and valuable outcomes that include solving ecological and social problems.

Thus, the elements of the business model must reflect the organization's investments in sustainable innovation in order to create and deliver value to the customer, generating revenue and achieving a sustainable competitive position, in order to corroborate Dyck and Silvestre (2018) that sustainable innovations should focus on enhancing positive socio-environmental externalities in financially viable ways.

In this sense, the degree of modification of the business models should enable companies to invest in significant levels of sustainable innovation, thus building a new logic of value creation in the business environment that sees sustainability-oriented innovation as a driver of sustainability and generator of sustainable competitive advantages.

The business models include essential aspects of companies, such as value proposition, supply chain, customer relationships and the financial model and, thus, the adoption of sustainable innovation practices can be associated with the modification of these elements at different levels.

For Taran *et al.* (2015), companies with a radical degree of modification of business models focus on the offer of differentiated products and/or services, target new markets, seek new channels of relationship with customers, have a value chain with external focus, have core competencies based on searching new resources and a dynamic partner network, seeking new processes to generate revenue and reduce bursting costs in existing processes.

Nonetheless, companies with an incremental degree of modification of business models focus on expanding the offer of the same products and/or services, target the current market, seek continuous improvements in relationship channels with current customers, have a chain with core focus, have core competencies based on existing technologies and fixed partner network, and seek to cut incremental costs in existing processes (Taran *et al.*, 2015).

The following is the method for developing the study.

#### 4. Study method

The research is characterized as descriptive, of a quantitative nature and delineated through a survey with Brazilian industrial companies. Descriptive research aims to describe the characteristics of certain populations or phenomena (Gil, 2008) and is used to estimate the proportion of these characteristics or behaviors to verify the relationship among variables (Mattar, 1997). Quantitative research, for Malhotra (2006), seeks to quantify data and generally applies some form of statistical analysis. The survey, in turn, is a method for collecting primary data from individuals who report their attitudes and behaviors through questionnaires or interviews (Adams and Lawrence, 2019).

The conceptual research model is defined from the identification of interdependence relationships between the degree of innovation in the business model and the sustainable innovation practices as illustrated in Figure 2:

According to the study objectives, the variables analyzed were grouped in two fundamental dimensions: sustainable innovation and business models.

Sustainable innovation was analyzed based on the studies by Bocken *et al.* (2014) and Ritala *et al.* (2018) and listed the following dimensions according to the specificities of the companies studied: adaptation of businesses to society; development of sustainable solutions; maximizing energy and water efficiency and reducing emissions; creation of value from waste; substitution by renewables and natural processes; delivery of functionality rather than ownership; adopting a leadership role. Regarding the business models, they were based on studies by Boons and Lüdeke-Freund (2013), Kiron *et al.* (2013a) and Taran *et al.* (2015), seeking to identify the business model degree of innovation from investments in sustainability. Respondents assessed the impacts of investments in sustainability on the degree of innovation in the company's business models, assigning scores from 1 to 10, with 1 being characterized as low (incremental) and 10 as high (radical).

Brazilian companies from the industrial sector that showed signs of investments in innovation constituted the research universe. This choice is justified by the fact that Brazil consists of an emerging economy that requires investments in innovation and sustainability, as shown by PINTEC [Innovation Research], which is a survey carried out by the Brazilian

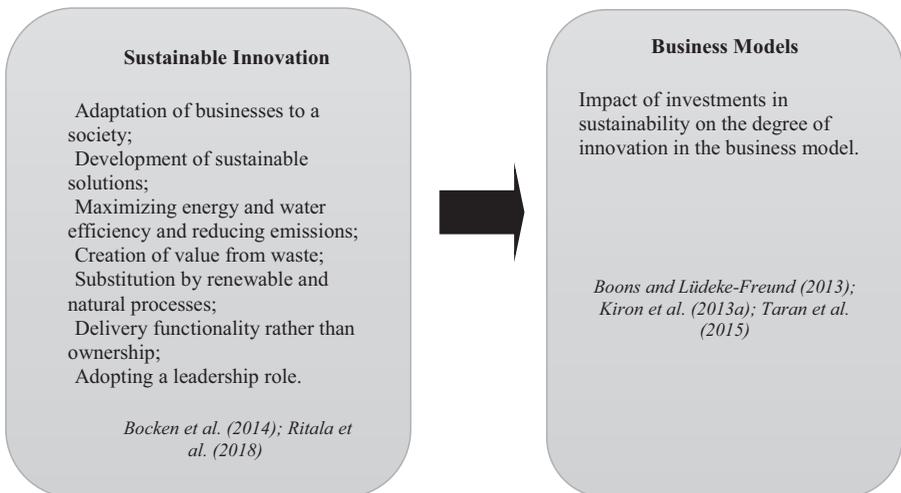


Figure 2.  
Conceptual model

Source(s): Developed from Bocken *et al.* (2014), Ritala *et al.* (2018), Boons and Lüdeke-Freund (2013), Kiron *et al.* (2013a), Taran *et al.* (2015)

Institute of Geography and Statistics (IBGE, 2020). This survey showed a drop in the general innovation rate of Brazilian companies between 2014 and 2017 and reduced investments in innovation by these companies and government incentives to develop innovations.

The study target population is 256 companies linked to the Brazilian National Association of Research and Development of Innovative Companies (ANPEI, in the Brazilian Portuguese abbreviation) and participants in MERCOPAR – Latin America’s subcontracting and industrial innovation fair. All companies that were the object of the study were contacted, and the sample was constituted by those that actually received, answered and returned the completed questionnaires. We have obtained a return of 51 questionnaires, representing 19.92% of the population surveyed. Although the return index is not considered high, the results obtained allow the specific analysis of the characteristics and behaviors of the companies studied. Evidence found cannot be extrapolated to the universe of research considered.

The questionnaire consisted of closed questions and used an interval scale in which respondents indicated the ranking grade that best translated their agreement with sustainable innovation practices adopted by the company in a range between 1 (lower degree of agreement) and 5 (maximum degree of agreement) and in relation to the degree of innovation in companies’ business models in the range between 1 (incremental) and 10 (radical). Questionnaires were sent to companies through the (online survey development cloud-based software as a service company) SurveyMonkey system along with a letter of invitation clarifying the study objectives. Telephone and social network website contacts were also carried out with companies to clarify the research purpose and importance.

Data collected were tabulated with the help of the Microsoft Excel and Statistical Package for Social Sciences (SPSS) and analyzed using univariate analysis techniques, through the descriptive analysis of categories and variables that comprised such categories multivariate, from the analysis of multiple correspondences. The procedure used to perform the correspondence analysis was Homals (Homogeneity Analysis), a technique applied when one intends to study the relation between two or more nominal or ordinal variables (Pestana and Gageiro, 2008). The application of this technique makes it possible to view the results through a perceptual map, allowing the correspondence between variables to be identified. Thus, it is intended to satisfy the interest in proving the relationship between the degree of innovation in business models and sustainable innovation practices in an illustrative and reliable manner. Based on the explanation of the methodological procedures used, we will analyze and discuss the results below.

## 5. Analysis and discussion of results

The results of the study are analyzed below. First, data on the characterization of the sample are presented. Next, we present the descriptive statistics of the categories and variables that make up sustainable innovation practices and the degree of innovation in the business models. Finally, a multiple correspondence analysis (homals) is carried out to verify the relationship between the degree of innovation in the companies’ business model and the sustainable innovation practices.

### 5.1 Sample characterization

Table 1 presents the data for the sample studied.

Data that characterize the companies surveyed indicate that, in relation to respondents’ profiles, interviewees’ average working times in the company and the sector are approximately nine and ten years, respectively. These data show high experience of professionals interviewed, despite the data high variability.

|   | Mean   | SD  | Coefficient of variation  | Minimum time   | Maximum time                                 |
|---|--|---|---|--|--|
| Time in the company                             | 8.99 years   | 8.06 years  | 89.66%  | 1 month  | 34 years                                     |
| Time in the sector                              | 10.47 years  | 8.22 years  | 78.51%  | 1 month  | 34 years                                     |
| Time of foundation                              | 28.08 years  | 27.37 years   | 97.47%  | 1.30 years   | 116 years                                    |
| Branch of activity                              | Machinery and equipment<br>21.6%                                       | Technology<br>21.6%   | Chemistry<br>9.8%   | Other<br>47%   |  |
| Net operating revenue                           | Up to BRL 2.4 million (micro-enterprise)<br>33.3%                      | Above BRL 2.4 million to BRL 16 million (small businesses)<br>21.6% | Above BRL 16 million to BRL 90 million (average-sized companies)<br>25.5% | Above BRL 90 million to BRL 300 million (medium-large companies)<br>2% | Above 300 million (large companies)<br>15.7% |
| Number of employees                             | Up to 19 employees (micro-enterprises)<br>27.5%                        | From 20 to 99 employees (small businesses)<br>33.3%                 | From 100 to 499 employees (average-sized companies)<br>21.6%              | Above 499 employees (large companies)<br>17.6%                         |  |
| Introduction to the innovation market           | Product and process innovation<br>58.8%                                | Innovation in product<br>17.6%                                      | Innovation in process<br>13.7%  | Not applicable<br>9.8%   |  |
| Main responsibility for the innovation activity | The company is solely responsible for the innovation activity<br>36.8% | The company innovates in cooperation with other companies<br>19.7%  | The company innovates in cooperation with institutes<br>21.1%             | The company innovates in cooperation with universities<br>22.4%        |  |

**Table 1.**  
Sample characteristics

Considerable variability in companies' time of existence suggests the existence of traditional and conservative perceptions from the oldest ones, considering that 25% of the companies are more than 35 years old, as well as from organizations' more modern and entrepreneurial conceptions since 25% of companies are less than eight years old.

Also, companies analyzed belong, in the majority, to the sectors of machinery and equipment, technological and chemical ones. For these sectors, investments in innovation and/or sustainability have fundamental importance due to their productive nature. In addition, it is observed that the sample consists, for the most part, of less extractive sectors that, in general, have more significant innovation activity.

In terms of size, the companies studied can be classified as micro-, small- and medium-sized enterprises (SMEs). These data are justified because, in Brazil, micro and small companies are predominant. Therefore, understanding business behavior regarding innovation and sustainability in the sample studied can contribute to the diffusion of practices that provide greater business competitiveness.

When analyzing characteristics related to innovation, data reveal that the organizations have introduced innovations in products and processes in the last five years, evidencing that product innovation is linked to processes, which can contribute to greater business competitiveness. Despite a significant number of companies being responsible for innovation activities, it is perceived that the search for external sources for innovation introduction

predominates, such as cooperation with other companies, institutes and universities. Data corroborates findings from Brazilian government research PINTEC (IBGE, 2013) by pointing out that, in Brazilian industrial companies, investments in external sources of innovation are higher than those spent on internal Research and Development (R&D) activities.

From the characterization of the sample, the mean, SD and coefficient of variation of the categories and variables studied are analyzed later.

### 5.2 Descriptive analysis of categories and variables

Table 2 shows the mean, SD and coefficient of variation of the seven categories and the variables that make up each category in relation to sustainable innovation practices, and the variable that reflects the degree of innovation of the companies' business models. Variables were measured using a five-point Likert scale for those related to sustainable innovation practices and a ten-point scale related to the degree of innovation of the business models.

Results have shown that companies seek to develop products and/or services aiming at the least use of resources to reduce waste, emissions and pollution. These results corroborate ideas by Porter and Van Der Linde (1995) that product offsets occur when products, in addition to improving their environmental performance, offer other advantages such as

| Categories and variables   | Mean  | SD     | CV (%) |
|--|-------|--------|--------|
| 1. Adapting business to society/environment  | 3.678 | 1.1248 | 30.58  |
| 1.1 Integration with local communities and other stakeholders to generate socio-environmental benefits   | 3.778 | 1.0420 | 27.58  |
| 1.2 Mechanisms of interaction with its stakeholders  | 3.578 | 1.2521 | 34.99  |
| 2. Development of sustainable solutions and encouragement to sufficiency   | 4.113 | 0.7808 | 18.99  |
| 2.1 Sustainable solutions that bring benefits to society and the environment   | 4.021 | 0.8870 | 22.06  |
| 2.2 Products and/or services aiming at the least use of resources to reduce waste, emissions and pollution   | 4.204 | 0.8411 | 20.01  |
| 3. Maximizing energy and water efficiency and reducing emissions   | 4.027 | 1.0295 | 25.56  |
| 3.1 Practices to improve energy efficiency   | 4.130 | 1.0024 | 24.27  |
| 3.2 Practices to improve water efficiency  | 4.023 | 1.1231 | 27.92  |
| 3.3 Practices to reduce emissions from the supply chain  | 3.929 | 0.9726 | 24.75  |
| 4. Creating value from waste   | 3.990 | 1.0026 | 25.13  |
| 4.1 Practices aimed at eliminating the concept of "waste" from transforming wasted inputs into a useful and valuable contribution to another production  | 4.021 | 0.9998 | 24.86  |
| 4.2 Reduced economic and environmental costs through reuse of material and transformation of waste into value  | 3.958 | 1.0907 | 27.56  |
| 5. Replacement by renewable and natural processes  | 3.875 | 0.9658 | 24.92  |
| 5.1 Innovation in products and production processes by using renewable resources and energy and designing new sustainable solutions  | 3.875 | 0.9658 | 24.92  |
| 6. Delivering functionality rather than ownership  | 3.390 | 1.0846 | 31.99  |
| 6.1 A product-service system (PSS) that seeks to create alternatives for substitution of products for services starting from the idea that consumers do not buy the product itself but rather the usefulness offered | 3.351 | 1.4185 | 42.33  |
| 6.2 Actions that seek creation and projection of new sustainable needs that can change the population's current lifestyles   | 3.429 | 1.0852 | 31.65  |
| 7. Adoption of a leadership role   | 3.892 | 0.9634 | 24.76  |
| 7.1 Sustainable practices to ensure stakeholders' well-being (employees, customers, suppliers, shareholders)   | 3.957 | 0.9546 | 24.12  |
| 7.2 Production systems and suppliers selected to provide environmental and social benefits   | 3.826 | 1.0393 | 27.16  |
| 8. Degree of innovation of the company's business models   | 5.900 | 2.4516 | 41.55  |

**Table 2.**  
Descriptive analysis  
of categories and  
variables

better technical performance, better quality, more safety, lower costs, better resale price or greater possibility of reuse.

In general, all dimensions related to sustainable innovation practices have moderate to high-intensity averages, showing that the companies analyzed invest in such practices. The development dimension of sustainable solutions and encouragement to sufficiency has the highest average, mainly motivated by the variable products and/or services that aim at the lower use of resources in order to reduce waste, emissions and pollution, confirming the view by Kobayashi *et al.* (2011) that, for manufacturing companies, environmental issues in R&D are of fundamental importance in order to seek new elements of technology and invest in eco-innovation. It is also important to highlight the maximization dimension of energy and water efficiency and emissions reduction, justified by the fact that industrial companies seek practices that alleviate environmental impact generated by their activity with the reduction of costs in energy and water consumption in order to position them more competitively in the market.

Nevertheless, the dimension of delivery of functionality rather than ownership presented the lowest average, and it is possible to show that substitution of products for services is still difficult for industrial companies to provide products to intermediaries or final consumers. Moreover, respondents have evaluated the degree of innovation of companies' business models, assigning a score from 1 to 10, with 1 being characterized as low (incremental) and 10 as high (radical). From the data, it has been verified that the average is higher than 5, which allows affirming that impact varies from medium to high. These results confirm the findings by Boons *et al.* (2013) that argue that any significant change in the dominant economic logic involves the application of new business models by social actors seeking to promote ideas, develop different types of innovations and implement new sustainability practices. Moreover, they also support studies by Kiron *et al.* (2013a), which indicate that most of the companies analyzed have modified their business models due to opportunities identified through sustainability.

It should be emphasized that all variables presented coefficients of variation that represent low or moderate variability in responses (less than 50%). Finally, the relationship between the degree of innovation in the business models and the sustainable innovation practices through correspondence analysis is verified.

### 5.3 Correspondence analysis of categories

In order to verify the relationship between sustainable innovation practices and the degree of innovation in the business models, a multiple correspondence analysis (homals) was carried out. The initial model of analysis was formed by the categories associated with the variables of sustainable innovation practices and the variable representing the degree of innovation in the company's business models. These new variables were then divided into indicators according to Table 3.

From the application of the multivariate analysis technique (homals), it has been observed that dimension 1 has eigenvalues of 0.4483 and dimension 2 presents the value of 0.1969. The values allow identifying the clear disaggregation of the different categories, discriminating

| Variables   | Indicators             |
|---|------------------------|
| Sustainable innovation practices                      | Low<br>High            |
| Degree of innovation in the company's business models | Low<br>Average<br>High |

**Table 3.**  
Variables and indicators of correspondence analysis

each variable and forming differentiated groups of variable categories. Table 4 shows the measures of discrimination of variables according to dimensions.

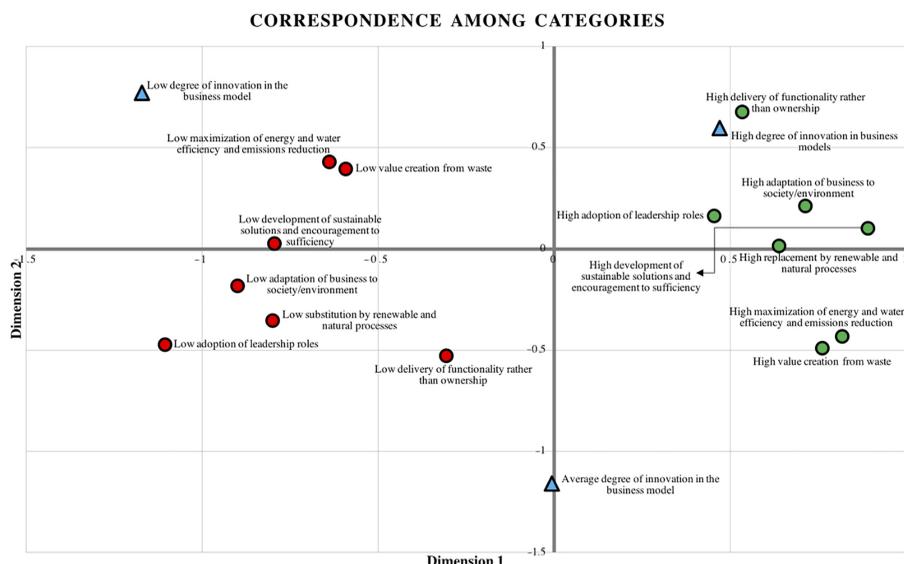
In Figure 3, the correspondence relations among the categories of variables and indicators analyzed are presented.

Data presented allow us to make some considerations about the relationship between the degree of innovation in the companies' business models and sustainable innovation practices:

- (1) The high degree of innovation in business models is associated with high delivery of functionality rather than ownership, high adoption of leadership roles, high adaptation of business to society/environment, high replacement by renewable and natural processes and high development of sustainable solutions and encouragement to sufficiency.
- (2) The average degree of innovation in the business models is associated with low delivery of functionality rather than ownership, low substitution by renewables and natural processes, low adaptation of business to society/environment and low adoption of leadership roles.

| Categories  | Scores      |             |
|---|-------------|-------------|
|   | Dimension 1 | Dimension 2 |
| Adapting business to society/environment                              | 0.583       | 0.036       |
| Development of sustainable solutions and encouragement to sufficiency | 0.678       | 0.005       |
| Maximizing energy and water efficiency and reducing emissions         | 0.476       | 0.167       |
| Creating value from waste   | 0.420       | 0.179       |
| Replacement by renewable and natural processes                        | 0.379       | 0.032       |
| Delivering functionality rather than ownership                        | 0.151       | 0.301       |
| Adoption of a leadership role   | 0.493       | 0.083       |
| Degree of innovation of the company's business models                 | 0.406       | 0.772       |

**Table 4.**  
Measures of discrimination of correspondence analysis



**Figure 3.**  
Analysis of correspondence among categories

- (3) The low degree of innovation in the business models is associated with low maximization of energy and water efficiency and emissions reduction, low-value creation from waste and low development of sustainable solutions, and encouragement to sufficiency.

These considerations lead to the understanding that companies with a high degree of innovation in their business models invest more strongly in strategic dimensions of sustainable innovation, which in general involve stakeholders and cross the organization's internal boundaries, requiring proactive attitudes from the company, probably because this type of investment gives them greater competitiveness in their market and also requires a radical modification of their business models. This result is in line with the view from [Bocken et al. \(2014\)](#) that sustainable business models incorporate a triple bottom line approach and broadly consider stakeholder interests, including the environment and society, being important elements in driving and implementing innovation for sustainability, contributing to more sustainable business and serving as a critical factor for obtaining competitive advantage.

Thus, it has been observed that a high degree of innovation of the business models requires that companies integrate environmental or social objectives of sustainability in the business central logic ([Schaltegger et al., 2012](#)). Regarding companies that have a medium degree of innovation in the business models, there is a behavior toward low investment in sustainable innovation dimensions that require a proactive strategic position from companies, demonstrating that even low investments in such practices require a moderate level of modification of the business model.

Companies with a low degree of innovation in the business model, in turn, present low adoption of sustainable innovation practices related mainly to internal aspects of the organizational environment, showing that sustainable innovation practices related to internal processes require an incremental modification in the business model.

Results reinforce the view from [Taran et al. \(2015\)](#), in which global competition has forced companies to rethink their business models more often, since innovating exclusively in new products and serving local markets is not enough to sustain competitively and ensure companies' survival.

Moreover, the findings confirm propositions from [Boons and Lüdeke-Freund \(2013\)](#) and [Lüdeke-Freund \(2020\)](#) that the business models are the market strategy that drives or hinders the unfolding of potential for sustainable innovation. In this regard, the degree of modification of the business models must foster the adoption of radical levels of sustainable innovation as well as the construction of a new logic of value creation in the business environment that does not consider only economic returns from sustainable innovations but focus on new ways of generating value from socio-environmental investments.

## 6. Final thoughts

According to our findings, the analyzed companies seek to develop products and/or services to minimize the use of resources and reduce waste, emissions and pollution. In general, the averages of the dimensions related to sustainable innovation practices reveal that the analyzed companies invest in these practices, mainly to reduce the environmental impact generated by their activities and increase their competitiveness in the market. Nevertheless, it has been evidenced that the substitution of products for services is still difficult for industrial companies to provide products to intermediaries or to final consumers.

Furthermore, the medium and high degree of innovation in the business models of the analyzed companies confirmed that any significant change in the dominant economic logic involves applying new business models by social actors seeking to promote ideas, develop different types of innovations and implement new practices for sustainability and target opportunities related to sustainability by promoting the modification of the business models

in most companies. In the analysis of the relationship between sustainable innovation practices and the degree of innovation of the business models, it can be observed that companies with a high degree of innovation invest more strongly in strategic dimensions of sustainable innovation, which require a proactive attitude from companies.

Regarding companies with a medium degree of innovation in the business model, there is a behavior toward low investment in strategic dimensions of sustainable innovation that require a proactive position from organizations, demonstrating that even low investments in such practices require a moderate level of modification of the business models. This study seeks to contribute to entrepreneurs and policymakers in the face of the innovative and sustainable challenges imposed by society and the guidelines for sustainable development to reflect on positive impacts on local and global development.

From the study results, it is recommended for managers and decision-makers of industrial companies to insert innovation and sustainability in their business models strategically and proactively. This study presents as a limitation the impossibility of generalizing from the results presented and discussed. As a suggestion for future studies, the use of other business sectors and other statistical techniques to evaluate the relationship between the degree of innovation of the business models and companies' sustainable innovation practices is recommended.

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