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Article

Effects of the COVID-19 pandemic on the sustainability-oriented business model of industrial companies

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Abstract

This study aimed to analyze the differences regarding changes in sustainability-oriented business models of Brazilian and Portuguese industrial companies due to the COVID-19 pandemic. This is a descriptive study with a quantitative approach. Data were collected from Brazilian and Portuguese industrial companies using a survey; univariate and bivariate statistics were used for data analysis. Our findings revealed that a higher proportion of Brazilian companies (44.3%) underwent a business model change compared to Portuguese companies (26.4%). The financial model and customer relationship elements underwent the most changes to the business model due to pandemic, and companies that changed their business models have sustainability embedded in their value proposition and their relationship with customers is sustainability-oriented.

Keywords: business model; COVID-19 pandemic; sustainability; industry.

Efectos de la pandemia COVID-19 en el modelo de negocio orientado a la sostenibilidad de las empresas industriales

Resumen

Este estudio tuvo como objetivo analizar las diferencias en cuanto a los cambios en los modelos de negocios orientados a la sostenibilidad de las empresas industriales brasileñas y portuguesas debido a la pandemia de COVID-19. Se trata de un estudio descriptivo con enfoque cuantitativo y recolección de datos realizado en empresas industriales brasileñas y portuguesas mediante encuesta. Para el análisis de los datos se utilizó estadística univariada y bivariada. Nuestros hallazgos revelaron que una mayor proporción de empresas brasileñas (44,3%) experimentaron un cambio de modelo de negocio en comparación con empresas portuguesas (26,4%). El modelo financiero y la relación con el cliente fueron los elementos que más cambios sufrieron en el modelo de negocio debido a la pandemia, y las empresas que cambiaron de modelo de negocio tienen la sostenibilidad incorporada en la propuesta de valor y están orientadas a la sostenibilidad en la relación con los clientes.

Palabras clave: modelo de negocio; pandemia de COVID-19; sostenibilidad; industria.

Reflexos da pandemia da Covid-19 no modelo de negócios orientado para a sustentabilidade de empresas industriais

Resumo

Este estudo tem como objetivo analisar as diferenças no que se referem às alterações nos modelos de negócios orientados para a sustentabilidade de empresas industriais brasileiras e portuguesas, em decorrência da pandemia da Covid-19. Em relação ao método adotado, trata-se de um estudo descritivo com abordagem quantitativa cujos dados foram coletados em empresas industriais brasileiras e portuguesas por meio de uma survey. Para análise dos dados, foi utilizada a estatística univariada e bivariada. Os resultados indicam uma proporção maior de empresas brasileiras (44,3%) que sofreram alteração em seu modelo de negócios em relação às empresas portuguesas (26,4%). O modelo financeiro e o relacionamento com clientes foram os elementos que mais sofreram alteração do modelo de negócios em virtude da Pandemia da Covid-19. As empresas que alteraram os seus modelos de negócios, possuem a sustentabilidade inserida na proposição de valor e uma orientação para a sustentabilidade no relacionamento com os clientes.

Palavras-chave: modelo de negócios; pandemia COVID-19; sustentabilidade; indústria.

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1. Introduction

The economic crisis brought on by the COVID-19 pandemic forced businesses, governments, the public, and society at large to be resilient. The significant effects on the global economy and the estimated impacts on all social spheres are greater than in previous recessions (Salamzadeh & Dana, 2021). Population and businesses worldwide have faced unprecedented challenges due to disruptions caused by the coronavirus outbreak and the resulting change of activities (Sousa Jabbour, Jabbour, Hingley, Vilalta-Perdomo, Ramsden, & Twigg, 2020).

Shutdowns in production processes, supply interruptions, heterogeneous demand drops, and similar occurrences worldwide have slowed down investments in environmental innovations (Hermundsdottir, Haneberg, & Aspelund, 2022); nonetheless, the COVID-19 pandemic has put sustainability in the spotlight in the business context despite the difficulties (Nicolletti, Alem, Blazek, Fillippi, & Bismarchi, 2021; Karmaker, Ahmed, Ahmed, Ali, Moktadir, & Kabir, et al., 2021; Alraja, Imran, Khashab, & Shah, et al., 2022). The slowdown in economic activity has significantly reduced air pollution and led to behavioral changes (Sarkis, Cohen, Dewick, & Schröder, 2020). Moreover, this new scenario may also drive deep and critical reflection on the assumptions, beliefs, and values that govern businesses and prompt major transformations in the production and distribution of goods (Nicolletti et al., 2021; Sarkis et al., 2020). Furthermore, it reinforced the lack of balance between the environmental, social, and economic dimensions of sustainability, which are considered fundamental to achieving corporate sustainability and have been part of their narrative for years (Nicolletti et al., 2021).

Supply chains have been severely affected by the crisis; however, those challenges have motivated companies to adopt technological innovations and improve supply chain collaborations (Javed, Basit, Hameed, Fodor, & Hossain, 2024). These authors add that advanced technologies and big data analysis can be applied to supply chains, contributing to recovery and making companies more resilient in crisis scenarios such as the pandemic.

Companies needed to adapt their business models to maintain activities in the context of economic and health crises. The search for alternative strategic directions has required the digital transformation of business models (Priyono, Moin, & Putri, 2020; Seetharaman, 2020), sustainable supply chains (Sarkis et al., 2020; Sousa Jabbour et al., 2020; Karmaker et al., 2021), and even cost-cutting by discontinuing non-core operations (Chanyasak, Koseoglu, King, & Aladag, 2021). Furthermore, suppliers developed sustainability initiatives during the pandemic without support from global buyers, certification bodies, or the government, thus strengthening supply chain relationships (Pereira, Silva & Hendry, 2021).

In light of the ongoing crisis, Sustainable Development Goals (SDGs) act as safeguards and resilience boosters for countries, organizations, and communities to develop competencies against future crises (Corrales-Estrada, Gómez-Santos, Bernal-Torres, & Rodriguez-López, 2021). From this perspective, Karuppiah, Sankaranarayanan & Ali (2023) highlight that the sustainable business model is essential for the industrial sector to obtain a competitive advantage and remain in operation in a volatile, uncertain, complex, and ambiguous (VUCA) environment.

Literature points to the need to research organizations and sustainability in the COVID-19 pandemic context (Barreiro-Gen, Lozano, & Zafar, 2020). Few studies have been conducted about the adaptation of business models during the COVID-19 pandemic (Chanyasak et al., 2021). It is also worth noting that recovery from the crisis requires commitment to the SDGs by governments, businesses, and communities to build resilience to future economic, social, and climate shocks (Corrales-Estrada et al., 2021). Therefore, the sustainability-oriented business model allows verifying how companies redesigned alternative paths to survive the pandemic (Boons & Lüdeke-Freund, 2013; Kiron, Kruschwitz, & Reeves, 2013; Taran, Boer, & Lindgren, 2015; Lüdeke-Freund, Carroux, Joyce, Massa, & Breuer, 2018). Given this context, this study aimed to analyze the differences in changes to sustainability-oriented business models in Brazilian and Portuguese industrial companies as a result of the COVID-19 pandemic. Portugal stands out for its national innovative capacity with good circular economy and sustainability practices (DGAE, 2018). In Brazil, most organizations demonstrate little progress in terms of sustainability, while others demonstrate excellence in the adoption of practices for Sustainable Development (Martins, Rampasso, Siltori, Cazeri, Anholon, Quelhas, & Leal Filho, 2020).

Considering that industries of all sizes have been severely impacted by this phenomenon and are struggling to remain sustainable (Alraja et al., 2022), this study contributes to the business model and sustainability literature, especially in the context of adversity occasioned by the COVID-19 pandemic. It also provides useful managerial evidence for managers by demonstrating the changes made to business models in the countries under study.

The first section presents the introduction and the objective of the study, followed by the theoretical framework in the second section; the third section covers the methodological procedures, followed by the results and discussions in the fourth section, and, lastly, the final considerations.

2. Theoretical framework

The theoretical framework of this study addresses aspects related to the impact of the COVID-19 pandemic on businesses and their business model in order to provide the theoretical groundwork for further discussion of the results.

2.1 Impact of the COVID-19 pandemic on business models

The COVID-19 outbreak began in 2019 in China and, in March 2020, was declared a pandemic by the World Health Organization (WHO) (Giones, Brem, Pollack, Michaelis, Klyver, & Brinckmann, 2020). The pandemic shifted from a global health crisis to an economic and labor market crisis (Karmaker et al., 2021), which is a highly rare and pervasive business shock (Nader, El-Khalil, Nassar, & Hong, 2022).

The impact of the COVID-19 pandemic was felt in the short term with social distancing, lockdowns, and workplace relocation, although the economic, social, political, and cultural effects were also profound and long-lasting (He & Harris, 2020), with some industries and regions being more affected (Banks, Karjalanem, & Propper, 2020). The first economic impacts were triggered by the widespread shutdowns and reduction in consumption and investment brought about by the sharp drops in aggregate demand and supply (Seetharaman, 2020).

Nevertheless, some technology professionals consider the pandemic as a global disruption, which can be seen as an opportunity or as a challenge to transform business models or implement new technologies to support business processes (Gregurec, Tomičić Furjan, & Tomičić-Pupek, 2021). These changes have required the adoption of digital technology on a broader scale and under time pressure (Priyono, Moin, & Putri, 2020). Organizations have developed ways to securely deliver their products and services with minimal physical contact (Seetharaman, 2020).

Hassan, Hollander, Van Lent, Schwedeler, and Tahoun (2020) pointed out concerns and opportunities related to COVID-19 by identifying six issues: (1) supply chain disruption; (2) drop in demand; (3) employees; (4) reduced production capacity or store closures; (5) increased uncertainty; and (6) financial market/financing concerns.

The pandemic has led companies to redesign their business models, learn from other organizations, and focus on environmental, industry, economic, technological, and social factors that influence how business is done (Gregurec et al., 2021). When it comes to sustainability, these areas must assume a greater purpose for action, inside and outside companies, in the context of instability and uncertainty accentuated by the COVID-19 pandemic (Nicolletti et al., 2021).

This concerning scenario triggered by the pandemic and the need for adaptation and resilience presented innovation opportunities for organizations that had to redesign their existing products, design alternative digital products and services, rethink their product and service delivery channels and mechanisms, and seek strategic positions and partners in the new ecosystem (Seetharaman, 2020). Therefore, a business model redesign has become an opportunity to maintain market survival.

The business model describes value proposition, creation, value delivery, and value capture (Richardson, 2005; Zott, Amit, & Massa, 2011). The Business Model Canvas tool, proposed by Osterwalder and Pigneur (2010), has been used to structure business models and is based on nine blocks: value proposition, customer segments, customer relationships, channels, key partners, key activities, key resources, cost structure, and revenue streams. Thus, the concept refers to the internal processes that create and capture value, which are susceptible to external and environmental changes (DiBella, 2020).

Boons and Lüdeke-Freund (2013) proposed a generic concept of the business model with the following elements: (1) value proposition (the value is embedded in the product/service offered); (2) supply chain (how relationships with suppliers are structured and managed); (3) customer interface (how downstream relationships with customers are structured and managed); and (4) financial model (costs and benefits of the previous elements and their distribution among the business model stakeholders). Taran, Boer, and Lindgren (2015) reported that innovation based solely on new products and targeting local markets is no longer enough to sustain competitiveness and survival. Hence, sustainability is being incorporated as an integral part of the company's value proposition and value creation logic (Abdelkafi & Tauscher, 2016).

From this perspective, the literature moves towards adopting sustainability-oriented business models (Boons & Lüdeke-Freund, 2013; Lüdeke-Freund et al., 2018); business model innovation enables profits from sustainability investments (Kiron et al., 2013). Along these lines, some studies have analyzed sustainability-oriented business model archetypes and proposed a tool to explore sustainability-oriented business model innovation (Bocken, Short, Rana, & Evans, 2014; Ritala, Huotari, Bocken, Albareda, & Puumalainen, 2018; Joyce & Paquin, 2016).

Kiron et al. (2013) developed a framework to analyze organizations' business models concerning sustainability, and the authors found that 50% of respondents who changed three to four elements of their business model reported profits by integrating sustainability. Business model innovation is an important factor in responding to crises in order for the firm to become more resilient (Breier, Kallmuenzer, Clauss, Gast, Kraus, & Tiberius, 2021; Schaltegger, 2020). Companies have encountered changes requiring managers to rethink what value they are offering to customers; additionally, adapting to the environment requires reevaluating business models (Chanyasak et al., 2021).

Mattera, Gonzalez, Ruiz-Morales, & Gava (2021) reported that effective communication strategies contributed to Spanish energy companies outperforming the stock market during the COVID-19 pandemic and demonstrating their commitment to sustainability. Companies with good relationships with customers, employees, and the community outperform their competitors in a crisis scenario, inspiring trust and cultivating loyalty (Tampakoudis, Noulas, Kiosses, & Drogalas, 2021).

Unbridled consumerism has also been impacted and brought about changes for companies and customers. The economic crisis occasioned by the pandemic triggered

changes in consumption habits, and at the awareness level, it changed in two significant directions: general awareness and more efficient ways of managing resources (Orîndaru, Popescu, Căescu, Botezatu, Florescu, & Runceanu-Albu, 2021). In the textile sector, Vătămănescu, Dabija, Gazzola, Cegarro-Navarro, and Buzzi (2021) observed that stakeholders have increasing expectations for sustainable practices and a growing trend for sustainability attributes even after the COVID-19 outbreak. Thus, companies have the chance to reconfigure their entire business model and communicate their actions responsibly and authentically (Vătămănescu et al., 2021).

Resilience means reducing negative sustainability impacts by fundamentally innovating the value proposition and value creation from a sustainability perspective. Changes in the business model and business are essential in this process (Schaltegger, 2020). The focus of small and medium-sized enterprises' (SMEs) transformational initiatives during COVID-19 has shifted from technology to social, customer, and organizational changes (Gregurec et al., 2021).

In the supply chain, strategies and practices needed to be rethought for the pandemic (Karmaker et al., 2021), alternative suppliers, collaboration among partners, agility, and sustainable procurement strategies contribute to a sustainable and resilient supply chain (Sousa Jabbour et al., 2020). A sustainable supply chain improves reputation and brand image and is an important approach to supporting industries' transformation to their sustainable futures (Karmaker et al., 2021; Schaltegger, 2020). Companies with a higher commitment to environmental innovations were more prone to the impact of the COVID-19 pandemic as they relied on less diversified and more volatile supply chains (Hermundsdottir, Haneberg, & Aspelund, 2022).

Furthermore, improved data management, blockchain, the Internet of Things, and radio frequency identification sensor technologies enhance traceability and transparency in supply chains, saving time, energy, and resources (Sarkis et al., 2020). The changes required in the pandemic scenario have driven the fourth industrial revolution, in the case of the textile industry, using digital technologies to meet the demands of customers (Jin & Shin, 2021).

Le and Ferasso (2022) conducted a study in Vietnam's pharmaceutical industry and found that green investments improve sustainable business performance by increasing competitive advantage in terms of products (differentiation), environmental and productivity efficiency, and reputation, leading to improved revenue, market share, profitability, and customer base. This increases new products entering the market, which save on environmental disposal costs. From a digital transformation perspective, investing in green innovation seeks to improve the production process and quality (Alraja et al., 2022).

Alraja et al. (2022) suggested that investing in Research and Development (R&D) to produce high-quality products or use new technologies in the production process in SMEs can contribute to the use of greener materials and cleaner or renewable technologies to save more.

In Norway's manufacturing industry, Hermundsdottir, Haneberg, and Aspelund (2022) demonstrated that environmental innovations are less prioritized during the COVID-19 pandemic, with a negative impact on the 'greenest' companies prior to the pandemic, whereas companies severely hit by the crisis actively responded to a wide range of green strategies. Along these lines, Barreiro-Gen, Lozano, and Zafar (2020) analyzed organizations worldwide in the context of a pandemic and observed that the priority for companies is social issues, followed by survival (economic dimension), and finally, with a negative impact, environmental issues.

Therefore, from the literature presented, one can observe that the pandemic brought forth changes in business models, digitalization, in a way, presented some benefits for sustainability, and the social dimension gained emphasis in a moment of uncertainty that demanded resilience from organizations to maintain their operations. The next section describes the research method.

3. Method

This study employed a quantitative approach and descriptive nature and was conducted using a survey. For Marconi and Lakatos (2021, p. 89), quantitative descriptive research consists of investigations "whose main purpose is to delineate or analyze the characteristics of facts or phenomena, the evaluation of programs, or the isolation of main or key variables." Therefore, this study sought to contribute to inferences regarding the differences in sustainability-oriented business models from Brazilian and Portuguese industrial companies due to the COVID-19 pandemic. The research instrument was validated by experts (research professors) in innovation and sustainability. The conceptual model is defined from the variables of the sustainability-oriented business model, nationality, and changes resulting from the pandemic (Figure 1).

The analyzed variables were grouped into the sustainability-oriented business model dimension and were based on Boons and Lüdeke-Freund (2013), Kiron et al. (2013), and Taran, Boer, and Lindgren (2015). As shown in Figure 1, the variables refer to company value proposition, supply chain, customer relationship, financial model, degree of business model innovation, and business model and COVID-19 pandemic. The characteristics of each variable are listed in Table 1.

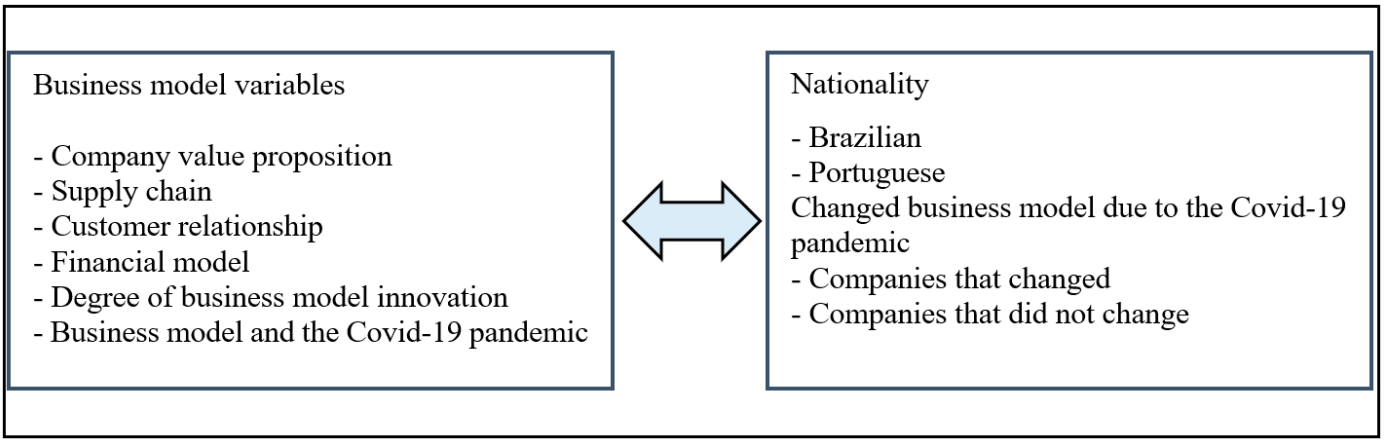

Figure 1. Conceptual Model
Source: Prepared by the authors based on Boons and Lüdeke-Freund (2013), Kiron et al. (2013), and Taran, Boer, and Lindgren (2015).

Table 1. Characteristics of the variables referring to the business model

Sustainability-oriented business model	
Variables	**Indicators**
Company value proposition	- Company value proposition related to economic, social, and environmental criteria.
Supply chain	- Suppliers are actively involved in sustainable supply chain management aiming at developing new products and/or processes that integrate sustainability.
Customer relationship	- Mechanisms that seek to motivate customers to take responsibility for their consumption. - Customer relationships based on sustainability challenges.
Financial model	- Financial model that reflects an appropriate distribution of economic costs and benefits among the company's stakeholders. - Financial model responsible for the ecological and social impacts of the company.
Degree of business model innovation	- Changing the business model from sustainability activities and decisions. - Impact of sustainability investments on the degree of business model innovation.
Business model and the COVID-19 pandemic	- Business model changes as a result of the COVID-19 pandemic.

Source: Boons and Lüdeke-Freund (2013), Kiron et al. (2013), and Taran, Boer, and Lindgren (2015).

Companies' nationality was considered for classification purposes, and a group of Brazilian companies and another group of Portuguese companies were obtained. A second classification was performed based on the change in the business model due to the COVID-19 pandemic, thus obtaining two groups: companies that changed their business model and companies that did not. The research sample consisted of 70 Brazilian companies (from the database of a company specialized in corporate data) and 53 Portuguese companies (obtained from the Iberian Balance Sheet Analysis System [SABI] database).

Data were collected using a structured questionnaire prepared from the conceptual model; it was composed of closed questions and an interval scale, in which the respondents scored the degree (score) that best translated their agreement concerning the business model variables in the interval between 1 (the lowest degree of agreement) and 5 (the highest degree of agreement). Questionnaires were sent via an online platform to the companies with an invitation letter explaining the study's objectives; other forms of contact (e.g., telephone and social media) were also used to clarify the purpose and importance of the research.

Data were collected from July 2020 to January 2022. Data were tabulated and analyzed using Microsoft Excel and the Statistical Package for the Social Sciences (SPSS) software through univariate and bivariate analysis. Given that the assumption of data normality was not met after performing the non-parametric Kolmogorov-Smirnov (KS) test, we adopted non-parametric statistics.

Lastly, in order to verify whether there is a mean difference when considering the nationality and the change in the business model due to the COVID-19 pandemic, we used the non-parametric Mann-Whitney test, which is considered an alternative to the t-test for two independent samples. This test is preferable to the t-test when there is a violation of normality because it enables the verification of behavior between two groups of cases (Pestana & Gageiro, 2008). The following section presents the analysis and discussion of the results.

4. Results and discussions

This section presents the main results obtained in this study, as well as the relationship of these findings with what is already found in the literature. The sample's characteristics, respondents' time of employment in the company and the industry, and companies according to their time of founding, the number of employees, gross operating revenue in 2020, and the industry of operation are listed in Table 2.

According to the data in Table 2, the mean employment time that interviewees have worked for the company is between 14 years (Brazil) and 13 years (Portugal), in the sector, it is between 15 years (Brazil) and 17 years (Portugal) approximately. These data show high work experience of the professionals interviewed, despite the variability of the data.

The mean founding time of the Brazilian companies analyzed is 51 years, the oldest organization being 355 years old and the youngest 3 years old. Among the Portuguese companies, the oldest organization is 85 years old and the youngest is 2 years old. The considerable variability in relation to the time of existence of the companies suggests the existence of traditional and conservative perceptions on the part of the older ones and more modern and entrepreneurial conceptions of the newer organizations.

As for the number of employees, most of the surveyed Brazilian companies have between 100 and 499 employees (37.14%; medium-sized companies) and above 499 employees (35.71%; large companies). In the Portuguese companies, most of them have between 20 and 99 employees (60.38%) and are considered small companies.

Table 2. Sample characteristics

	Mean		Standard deviation		Coefficient of variation		Minimum time		Maximum time	
	Brazil	**Portugal**	**Brazil**	**Portugal**	**Brazil**	**Portugal**	**Brazil**	**Portugal**	**Brazil**	**Portugal**
Time in the company	13.55 years	13.20 years	11.28 years	12.32 years	83.2%	93.3%	26 days	1 year	47 years	70 years
Time in the sector	15.27 years	16.76 years	11.97 years	13.73 years	78.40%	81.92%	26 days	1 year	47 years	76 years
Founding time	51.44 years	31.79 years	45.31 years	18.84 years	88.08%	59.26%	3 years	2 years	355 years	85 years
Number of employees	≤19 employees (microenterprise)		20–99 employees (small enterprise)		100–499 employees (medium enterprise)		>499 employees (large enterprise)			
	11.43%	16.98%	15.71%	60.38%	37.14%	16.98%	35.71%	5.66%		
Gross operational revenue in 2020 (BR)	≤2.4 million BRL		>2.4 million up to 16 million BRL		>16 million up to 90 million BRL		>90 million up to 300 million BRL		>300 million BRL	Not informed
	7.14%		12.86%		38.57%		17.14%		22.86%	1.43%
Gross operating revenue in 2020 (PT)	≤2.0 million EUR		>2.0 million up to 10 million EUR		>10.0 million up to 50 million EUR		≥50 million EUR		Not informed	
	32.08%		41.51%		16.98%		7.55%		1.89%	

Area of operation	**Brazil**	**Portugal**	**Area of operation**	**Brazil**	**Portugal**
Machinery and equipment	1.4%	3.8%	Chemical	5.7%	0.0%
Agribusiness	8.6%	0.0%	Pharmaceutical	4.3%	1.9%
Food	8.6%	18.9%	Rubber	0.0%	1.9%
Beverages	0.0%	5.7%	Plastic	10.0%	7.5%
Energy generation	5.7%	0.0%	Steel	12.9%	15.1%
Textile	1.4%	7.5%	Electrical and electronic Materials	8.6%	1.9%
Clothing	1.4%	11.3%	Automotive	10.0%	3.8%
Footwear	1.4%	0.0%	Furniture	4.3%	0.0%
Mining	1.4%	0.0%	Construction material	5.7%	5.7%
Cork	1.4%	3.8%	Cultural and creative	4.3%	11.3%
Pulp and paper	2.9%	0.0%			

Source: Research data (2022).

As far as operational revenue is concerned, most Brazilian companies have revenue between 16 million and 90 million BRL. Most of the Portuguese companies have revenues between 2.0 million and 10 million EUR, which highlights the fact that there are differences in the number of employees and operating revenues between Brazilian and Portuguese companies.

Finally, the analyzed Brazilian companies belong mostly to the steel, plastic, and automotive sectors; most of the Portuguese companies belong to the food, steel, clothing, and cultural and creative sectors. It is worth noting that the industrial sectors faced the COVID-19 crisis and post-crisis differently, depending on the company's resource availability and consumer demands. In this context, the effects of events such as pandemic and climate change require companies to develop capabilities such as innovation for sustainability (Esen, Saygili, & Ates, 2023). Table 3 presents the responses collected from the companies regarding the change in business models due to the COVID-19 pandemic.

The data in Table 3 shows a higher proportion of Brazilian companies (44.3%) that have undergone changes in their business model compared to the Portuguese companies (26.4%). Table 4 lists the business model elements of the companies investigated that have undergone the most changes due to the COVID-19 pandemic.

Table 3. Change in the company's business model due to the pandemic

	Brazilian companies	(%)	Portuguese companies	(%)
Yes	31	44.3	14	26.4
No	30	42.9	29	54.7
Did not answer	9	12.9	10	18.9
Total	70	100.0	53	100.0

Source: Survey results (2022).

As shown in Table 4, the elements that underwent the most changes to the business model due to the COVID-19 pandemic were the financial model (51.3% in Brazilian companies and 54.9% in Portuguese companies) and customer relationship (23.1% in the Brazilian companies and 19.6% in Portuguese companies). Regarding changes in the financial model, Seetharaman (2020) reported that the first economic impacts were triggered by the generalized shutdowns and reduced consumption and investment caused by sudden drops in demand and aggregate supply. Furthermore, the COVID-19 pandemic stimulated the social dimension of sustainability through social actions and projects evidencing the responsibility of companies to stakeholders, corroborating Barreiro-Gen, Lozano, and Zafar (2020). These initiatives brought reflections to the financial model of companies, as the revenue shock led sustainability activities to become more costly in the crisis scenario (Tampakoudis et al., 2021).

Table 4. Change in the elements of the business model due to the pandemic

	Brazil	(%)	Portugal	(%)	Total	(%)
Value proposition	6	15.4	3	25.0	9	17.6
Supply chain	4	10.3	0	0.0	4	7.8
Customer relationship	9	23.1	1	8.3	10	19.6
Financial model	20	51.3	8	66.7	28	54.9
Total	39	100.0	12	100.0	51	100.0

Source: Survey results (2022).

In terms of the customer relationship, the adaptations imposed by the pandemic required companies to rethink what constitutes value to their customers (Chanyasak et al., 2021). For instance, digital technologies were driven by the pandemic scenario to facilitate customer relationships (Seetharaman, 2020; Jin & Shin, 2021).

The element related to the supply chain was classified as the least impacted in both countries (10.3 and 0% in Brazilian and Portuguese companies, respectively). Although this element was cited as the one that the pandemic least impacted, Karmaker et al. (2021) stated the fact that some strategies and practices related to the supply chain had to be rethought, including the use of alternative suppliers, the collaboration between partners, and agility and sustainable procurement strategies, which contribute to a sustainable and resilient supply chain (Sousa Jabbour et al., 2020). Table 5 presents the variables corresponding to the business model according to the nationality of the surveyed industrial companies.

From the data obtained in Table 5, regarding the country, Brazilian companies have the highest mean in relation to (1) the company's value proposition being related to economic, social, and environmental criteria; (2) having a financial model responsible for the company's ecological and social impacts; and (3) having suppliers actively involved in the sustainable management of the supply chain aiming at developing new products and/or processes that integrate sustainability.

The lowest means refers to (1) having mechanisms to motivate customers to take responsibility for their consumption and (2) presenting a high degree of modification in their business model based on sustainability activities and decisions. Portuguese companies have the highest mean regarding (1) the company's value proposition being related to economic, social, and environmental criteria and (2) having relationships with clients based on sustainability challenges. The lowest scores are related to (1) having a high degree of modification in their business model from sustainability activities and decisions and (2) having a financial model responsible for the company's ecological and social impacts.

By comparing the business model elements according to nationality, the Mann-Whitney test proved to be significant

Table 5. Descriptive analysis of the companies' business model by country

Variables - business model n		BR company		PT company		Mann-Whitney test
		n	Mean	n	Mean	
x1	**The company has [value proposition related to economic, social, and environmental criteria]**	**67**	**4.22**	**53**	**3.85**	**0.021****
x2	The company has [suppliers actively involved in sustainable supply chain management aimed at developing new products and/or processes that integrate sustainability]	66	3.61	53	3.68	0.960
x3	The company has [mechanisms that seek to motivate customers to take responsibility for their consumption]	62	3.39	52	3.62	0.293
x4	The company has [relationships with customers based on sustainability challenges]	64	3.52	53	3.75	0.333
x5	The company has [a financial model that reflects an appropriate distribution of economic costs and profit among the company's stakeholders]	66	3.58	53	3.62	0.833
x6	The company has [a financial model responsible for the company's ecological and social impacts]	67	3.61	52	3.56	0.584
x7	The company has [a high degree of change in its business model from sustainability activities and decisions]	65	3.51	51	3.39	0.425
x8	Please evaluate, in general, the impact of investments in sustainability on the degree of innovation of the company's business model by assigning scores from 1 to 10, in which 1 is low (incremental) and 10 is high (radical):	63	6.49	49	6.22	0.282

Notes. [1]Means refer to the level of agreement of the companies on applying such practices on a scale ranging from 1 to 5, in which 5 is the highest level of agreement. [2]Means for each dimension were calculated from the arithmetic mean of its variables. Level of significance between means: *** $p < 0.01$; ** $p < 0.05$.

Source: Survey results (2022).

for one of the eight variables analyzed. Thus, from the test results, one can conclude that there is a difference in the company's value proposition related to economic, social, and environmental criteria according to nationality, so Brazilian companies have a higher mean when it comes to this aspect. Although the two groups refer to companies from countries at different stages of development, it should be noted that regarding the number of employees, most of the surveyed Brazilian companies are classified as medium and large companies; this contrasts with the Portuguese companies, most of which are classified as small companies. Table 6 lists the variables corresponding to the business model according to the criterion corresponding to whether or not there was a change in the business model due to COVID-19.

Data presented in Table 6 indicates that companies that changed their business model due to COVID-19 have the highest means in relation to (1) the company's value proposition being related to economic, social, and environmental criteria; (2) having customer relationships based on sustainability challenges; and (3) having mechanisms that seek to motivate customers to assume their responsibilities for consumption. The lowest means refer to (1) having suppliers actively involved in sustainable supply chain management to develop new products and/or processes that integrate sustainability and (2) having a financial model responsible for the company's ecological and social impacts.

As for the highest means regarding the companies that changed their business model due to COVID-19, sustainability inserted in the companies' value proposition and orientation for sustainability in the relationship with customers were fundamental aspects for such modifications to occur.

The relationship with customers based on sustainability may be associated with the change in consumption habits arising from the financial crisis, requiring companies to adapt, thereby corroborating Orîndaru et al. (2021). Hence, reducing consumption has a positive effect on the reduction of waste.

Nevertheless, the lower supply chain means may be related to the fact that in the pandemic scenario, companies with a higher commitment to sustainability relied on less diversified and more volatile supply chains (Hermundsdottir, Haneberg, & Aspelund, 2022). Furthermore, the pandemic boosted the use of data (e.g., big data), so low investment in data analytics may hinder sustainable supply chains (Sarkis, 2020).

Companies that did not change their business model due to COVID-19, however, have the highest means regarding (1) the company's value proposition being related to economic, social, and environmental criteria and (2) having a financial model that is responsible for the company's ecological and social impacts. The lowest scores are related to (1) having mechanisms that seek to motivate customers to take responsibility for their consumption and (2) having a high degree of modification in their business model from sustainability activities and decisions.

By comparing the business model elements between the two categories, the Mann-Whitney test proved to be significant for two of the six variables analyzed. Thus, from the results of the test, it is possible to conclude that there is a difference between the companies in relation

Table 6. Descriptive analysis of the companies' business model according to changes in the business model.

Variables - business model n		Changed the business model		Did not change the business model		Mann-Whitney test
		n	Mean	n	Mean	
x1	The company has [value proposition is related to economic, social, and environmental criteria]	44	4.41	58	3.93	0.003***
x2	The company has [suppliers actively involved in sustainable supply chain management aimed at developing new products and/or processes that integrate sustainability]	44	3.66	57	3.58	0.707
x3	The company has [mechanisms that seek to motivate customers to take responsibility for their consumption]	45	3.82	51	3.29	0.023**
x4	The company has [relationships with customers based on sustainability challenges]	44	3.84	55	3.55	0.275
x5	The company has [a financial model that reflects an appropriate distribution of economic costs and benefits among the company's stakeholders]	44	3.77	57	3.61	0.396
x6	The company has [a financial model responsible for the company's ecological and social impacts]	43	3.74	58	3.64	0.513

Note. [1]Means refer to the level of agreement of the companies on applying such practices on a scale ranging from 1 to 5, in which 5 is the highest level of agreement. [2]Means for each dimension were calculated from the arithmetic mean of its variables. Level of significance between means: *** $p < 0.01$; ** $p < 0.05$.

Source: Survey results (2022).

to the company's value proposition being related to economic, social, and environmental criteria and in the mechanisms that seek to motivate customers to assume their responsibilities for consumption.

Regarding the value proposition, results confirm what was exposed by Chanyasak et al. (2021) that managers needed to rethink what constitutes the value they are offering to customers. Reconfiguring the business model is one way to communicate and integrate stakeholders into the organization's actions. Therefore, it can be inferred that the elements mentioned above demonstrate a responsible and authentic way for the organization to communicate its sustainable actions (Vătămănescu et al., 2021). Regarding the value proposition, resilience was required to reduce environmental damage and integrate sustainability dimensions into the value proposition (Schaltegger, 2020).

In the context of the pandemic, companies had a different look at customers (Gregurec et al., 2021). Thus, there is a trend of change in consumption. Even after the pandemic, it is increasing for sustainability attributes (Vătămănescu et al., 2021), thereby presenting an opportunity for the insertion of mechanisms to motivate and empower customers to assume their consumption responsibilities. The next section presents the final considerations and implications of this study.

5. Concluding remarks

We sought to analyze the differences in the sustainability-oriented business models of Brazilian and Portuguese industrial companies due to the COVID-19 pandemic. The health and economic crisis scenario demanded resilience from companies. Our findings indicated that more Brazilian companies (44.3%) had changed their business model than Portuguese companies (26.4%). Regarding the business model, the elements that underwent the most changes due to the COVID-19 pandemic were the financial model (51.3% in Brazilian companies and 54.9% in Portuguese companies) and customer relationship (23.1% in Brazilian companies and 19.6% in Portuguese companies). These changes may be related to reducing consumption and investment and increased social actions that affected the financial model (Seetharaman, 2020; Tampakoudis et al., 2021). Regarding customer relationships, the imposed changes required companies to adopt digital technologies (Seetharaman, 2020; Jin & Shin, 2021), which was driven by social distancing and still enduring.

Moreover, we found that there is a difference in the company's value proposition related to economic, social, and environmental criteria according to nationality, revealing that Brazilian companies have a higher mean in relation to this aspect. Regarding the changes in the business model as a result of the COVID-19 pandemic, the companies with higher means have sustainability as a key factor in the value proposition and customer relationships.

From a theoretical point of view, this study advances the literature by analyzing the sustainability-oriented business model in crisis context (health and economic) triggered by the COVID-19 pandemic. Moreover, it enabled a comparison between a developing country (Brazil) and a developed economy (Portugal). As for managerial implications, the results may be interesting for companies that have sustainability as part of their business strategy.

Furthermore, they promote the adoption of sustainable practices that contribute to the Sustainable Development Goals of the 2030 Agenda. Companies can learn from each other, in both contexts, by adopting practices that minimize negative socio-environmental impacts. In terms

of regulation and government support, results can be useful for expanding public policies to drive transitions to sustainability.

Despite our promising findings, this study has several limitations; results cannot be generalized in the industrial sector, given the limited number of participating companies.

Future research is suggested to allow further and complementary analysis of the matter. We recommend that studies be carried out in specific industrial sectors that have had their business models impacted, as well as analysis according to the size of the companies. Future studies can analyze the reflexes of the pandemic in the transition to sustainable consumption as well as the transformations that occurred in the entire production chain regarding adopting sustainability. Furthermore, additional research on this theme can analyze the relationship between social actions (social dimension of sustainability) and the sustainability-oriented business model; qualitative research or mixed methods (quantitative and qualitative) can also shed more light on this matter.

Conflict of interest

The authors declare no conflict of interest.

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