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SUSTAINABILITY AND INNOVATION IN THE PET INDUSTRY: AN ANALYSIS FROM THE PERSPECTIVE OF ECOLOGICAL MODERNIZATION THEORY

Sustentabilidade e inovação na Indústria Pet: Uma análise sob a perspectiva da Teoria da Modernização Ecológica

Sostenibilidad e innovación en el sector de mascotas: Un análisis desde la perspectiva de la Teoría de la Modernización Ecológica

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ABSTRACT

This study aims to analyze the sustainability and innovation of practices adopted by startups in the pet industry, from the perspective of the Ecological Modernization Theory (EMT). A multiple case study was conducted involving 25 Brazilian startups. Data collected from interviews with owners and managers of these organizations were evaluated through content analysis. The findings reveal that the practices of pet industry startups are partially aligned with the EMT. There is a significant presence of digitization and innovations in processes and products, as well as initiatives focused on recycling, waste reduction, and conscious consumption. The absence of public policies and strict regulatory standards are the main identified barriers that hinder the adoption of a sustainable strategic vision. The study bridges the EMT with organizational reality, uncovers opportunities for collaboration in open innovation, and presents practical actions for advancing sustainability in organizations.
Keywords: pet industry, sustainable business, organizational diagnosis, innovative business, startups.

RESUMO

Este estudo tem por objetivo analisar a sustentabilidade e a inovação das práticas adotadas por startups da indústria pet, sob a perspectiva da Teoria da Modernização Ecológica (TME). Um estudo de caso múltiplo foi realizado com 25 startups brasileiras. Dados coletados a partir de entrevistas com proprietários e gestores dessas organizações foram avaliados por meio de análise de conteúdo. Os achados revelam que as práticas das startups da indústria pet estão parcialmente alinhadas à TME. Há uma presença marcante da digitalização e de inovações em processos e produtos, além de iniciativas voltadas a reciclagem, redução de resíduos e consumo consciente. A ausência de políticas públicas e normas regulamentadoras rígidas são as principais barreiras identificadas, que dificultam a adoção de uma visão estratégica sustentável. O estudo aproxima a TME da realidade organizacional, revela oportunidades de colaboração para inovação aberta, e apresenta ações práticas para a avanço da sustentabilidade nas organizações.
Palavras-chave: *indústria pet, negócios sustentáveis, diagnóstico organizacional, negócios inovadores, startups.*

RESUMEN

El objetivo de este estudio es analizar la sostenibilidad y la innovación de las prácticas adoptadas por las startups del sector de animales de compañía desde la perspectiva de la Teoría de la Modernización Ecológica (TME). Se realizó un estudio de casos múltiples con 25 startups brasileñas. Los datos recogidos en las entrevistas con los propietarios y directivos de estas organizaciones se evaluaron mediante análisis de contenido. Los resultados revelan que las prácticas de las startups del sector de mascotas están parcialmente alineadas con la TME. Hay una marcada presencia de digitalización e innovaciones en procesos y productos, así como iniciativas dirigidas al reciclaje, la reducción de residuos y el consumo consciente. La falta de políticas públicas y de normas regulatorias estrictas son las principales barreras identificadas, que dificultan la adopción de una visión estratégica sostenible. El estudio acerca la TME a la realidad organizativa, revela oportunidades de colaboración para la innovación abierta y presenta acciones prácticas para avanzar en la sostenibilidad de las organizaciones.
Palabras clave: *industria de mascotas, negocio sostenible, diagnóstico organizacional, negocios innovadores, startups.*

INTRODUCTION

The demand from stakeholders for ecological products and services necessitates a shift in organizational attitudes (Yin et al., 2023). Within the pet industry sector, the provision of healthy and sustainable products, procedural modernization, and enhanced customer communication represent some of the changes advocated by a sector aligning itself with innovation and sustainability standards (Kuzma, 2022).

The revenue of the Brazilian pet industry, characterized by veterinary medicines, pet food, and hygiene and healthcare products, surged from R$ 3.3 billion in 2006 to R$ 41.96 billion in 2022 (ABINPET, 2023a; 2023b). Market development is grounded in the benefits of human-animal interaction for the well-being of both, coupled with shifts in the profiles of Brazilian families. The more solitary lifestyle in large cities or the choice to remain childless translates into pet owners willing to invest more in healthcare, nutrition, and specialized care facilities for their animals (ABINPET, 2023a).

The market's growth trend encourages segment diversification and presents an opportunity for innovative businesses (Kuzma, 2022). The expansion of a sector, while creating jobs and providing goods and services, results in societal and environmental impacts, primarily due to the consumption of substantial natural resources and waste generation (Silva et al., 2020). To mitigate such impacts, companies seek to adopt sustainability practices, aiming to enhance competitiveness in the market (Centobelli et al., 2017).

Organizational changes are propelled by sustainability (Seebode et al., 2012). The pursuit of a more sustainable business is not a static process (Oliveira et al., 2019) and involves the adoption of innovations in products, processes, services, marketing, and at the level of the business model (Seebode et al., 2012). Innovations arise when ideas are transformed into technologies, products, or processes capable of capturing value and improving an organization's performance (Tidd & Bessant, 2015).

Innovation and sustainability are concepts that can be jointly addressed through the Ecological Modernization Theory (EMT). EMT's premise lies in overcoming environmental problems through technological innovation, pollution prevention actions, and public policies focused on simultaneous environmental and economic solutions (Spaargaren & Van Vliet, 2000). EMT can also play a relevant role in understanding sustainable development goals (Ahmed & Cokinos, 2017).

Innovative and sustainable businesses are already identified in organizational realities of startups across various sectors (Sehnem et al., 2022; Sehnem et al., 2023). Besides being acknowledged as innovative, startups are companies born with sustainability in their DNA, capable of generating results aligned with global needs (Sehnem et al., 2021). Considering the lack of clarity on how startups grow and introduce their sustainable innovations to the market, necessitating more empirical research on the subject (Horne & Fichter, 2022), this study aims to analyze the sustainability and innovation practices adopted by pet industry startups from the perspective of EMT.

The study contributes to expanding the understanding of EMT in the organizational context of an emerging country, deemed relevant by Julkovski et al. (2021). Bridging theoretical discussions with organizational practices is crucial, and while sustainability is widely discussed, there is still a lack of exploration in terms of actual practices adopted in companies' everyday operations (Nawaz & Koç, 2019).

The study may have practical implications and provide valuable information for stakeholders—such as investors, governments, and sector organizations—interested in promoting sustainability in the pet industry. It can assist in formulating policies, investment strategies, and incentives to drive the adoption of more sustainable and innovative practices in the sector, which, according to Kuzma and Sehnem (2023), shows potential for "conscious growth," contributing to the achievement of SDG 12 - Responsible Consumption and Production.

In addition to this introduction, this article comprises four other sections. The second section presents the theoretical framework of the research, gathering concepts and discussions on sustainability, innovation, and EMT. Section 3 outlines the methods used for the research development, while Section 4 presents the obtained results, discussed based on the objective of this work. Finally, the fifth section presents the researchers' reflections on the study, with recommendations for future research.

THEORETICAL BACKGROUND

Sustainability and innovation

Sustainability is a frequently addressed theme in various fields of knowledge (Ruggerio, 2021). Considered a joint construction where meanings are deeply rooted in the incorporation of the theme at organizational and institutional levels (Zanoni & Oliveira, 2023), sustainability is centered on the relationship between society and nature (Ruggerio, 2021).

The literature does not provide a clear, consistent definition of sustainability (Vos, 2007). Elkington (1994) proposed a model based on the perspective of balance among the environmental, economic, and social pillars, the Triple Bottom Line, commonly adopted in studies. The various definitions of sustainability, according to Voss (2007), share fundamental elements that highlight the connection between the three aforementioned pillars. Sustainability looks at the relationship between the environment, economy, and society in a systemic perspective, with mutual support or reinforcement (Vos, 2007).

The negative impacts generated by business activities underscore the urgency of adopting sustainable practices at the organizational level (Lopez-Torres et al., 2022). Despite facing challenges in adopting sustainable practices, sustainability is seen as an opportunity to enhance competitiveness in the market (Centobelli et al., 2017).

In addition to the adoption of sustainable strategies (Lopez-Torres et al., 2022), organizational competitiveness is strengthened by innovation, understood as a source of value generation

against competitors (Albuquerque et al., 2020). Innovation occurs when an idea is transformed into technology, enabling value capture (Tidd & Bessant, 2015).

Innovation, therefore, means incorporating a new or improved product or process capable of bringing significant changes to the organization's context (Organization for Economic Co-operation and Development, 2018). When this change is gradual and creates small impacts, innovation is termed incremental; when high-impact changes are observed, creating transformative and entirely new solutions, it is called radical innovation (Tidd & Bessant, 2015).

Cillo et al. (2019) also highlight the existence of sustainable innovations—innovations that seek to reconcile economic, environmental, and social objectives. Organizations adopting a sustainability orientation tend to focus their work and results not only on complying with regulatory standards, and innovation is a tool capable of fostering this context (Vos, 2007).

Sustainability-oriented innovation systems are a response to social pressures to minimize impacts generated by increased production and resource extraction, capable of positively impacting an organization's sustainable performance (Kuzma et al., 2020). Associated with cost reduction, optimization of water and energy consumption, and the provision of food, products, and services for a healthy life, innovations also contribute to organizations managing large volumes of data, as well as increasing their productivity and efficiency (Sehnem et al., 2022).

Studies such as those by Sehnem et al. (2022) and Sehnem et al. (2023) emphasize that innovative and sustainable businesses are possible, identifying disruptive innovations in Brazilian startups that support resource circularity and increase the value of the product or service provided to the customer. To expand the discussion on sustainable and innovative businesses, the next subsection addresses the Ecological Modernization Theory (EMT), aligned with these two constructs.

Ecological Modernization Theory

The proposition of the Ecological Modernization Theory (EMT) commences with the works of the sociologist Joseph Huber, aiming to highlight that the problems or structural flaws of the system in industrial societies pertain to the colonization of the "socio-sphere," "eco-sphere," and "techno-sphere" (Huber, 1986). EMT possesses a provocative and challenging character concerning the adaptability of institutions, asserting that eco-efficiency can be easily achieved within a framework of applying modern experimental science and technological capabilities of industrial capitalism (Buttel, 2000).

The theory seeks to overcome environmental problems through technological innovation, integrated environmental and economic solutions, prevention, and public participation in decision-making (Sehnem et al., 2021). EMT, therefore, involves the process of resolving environmental crises through resource efficiency and the adoption of less impactful industrial processes, without sacrificing economic growth (Bugden, 2022). There is a strong alignment of the Sustainable

Development Goals (SDGs) with the EMT approach, as both are based on this theory to integrate environmental and development goals simultaneously (Weber & Weber, 2020).

In the context of EMT, technologies and industrial operations are directly or indirectly influenced and even controlled by public policies, legislation, public opinion, as well as scientific knowledge. This configuration suggests a relationship of interdependence and involvement of various actors (Lazzarotti et al., 2019), reinforcing the importance of economic and market dynamics of innovative entrepreneurs and economic agents as social catalysts for ecological restructuring (Sehnem et al., 2021).

For EMT, the transformation of environmental policies is fundamental to being more preventive than reactive, as well as participative and decentralized, creating conducive contexts for environmentally friendly behaviours by producers and consumers (Buttel, 2000). The theory proposes that regulation can help solve environmental challenges while simultaneously making the industry more competitive by encouraging the development and application of innovative technologies and productive techniques (Murphy & Gouldson, 2000). Bugden (2022), however, emphasizes that environmental technologies are not always capable of significantly mitigating the negative effects of economic activities, and caution should be exercised when exclusively emphasizing technological solutions to ecological problems.

In addition to technological aspects, companies need to make a series of choices related to organizational changes and new forms of management, offering the potential for changes in environmental performance (Murphy & Gouldson, 2000). The premises of EMT can be adopted both within the organization and in the supply chain (Zhu et al., 2012).

This theory seeks alternatives for a greener economy by stimulating the formation of networks and ecosystems capable of generating results for different stakeholders (Sehnem et al., 2021). However, this may involve various stakeholders and conflicting interests, becoming a complex process for some countries (Ahmeda & Cokinos, 2017).

EMT is a theory used in studies that address varied contexts. Bugden (2022) discusses the central hypothesis of EMT, relating technological innovation and environmental impacts, through the analysis of patents; Ahmed and Cokinos (2017) use it to explain the implementation of climate policies for reducing greenhouse gas emissions in Bangladesh; Lazzarotti et al. (2019) adopt EMT as a basis for analyzing the social phenomenon of collecting animal carcasses in a region of Brazil; Sehnem et al. (2021) relate the constructs of circular economy and EMT in the context of Brazilian breweries, and Pal et al. (2023) use the assumptions of the theory to identify factors affecting the climate and respective preventive measures in the transportation sector.

Analyses employing EMT to understand aspects related to the pet sector have not been mapped. This theory is adopted to analyze and discuss whether innovative and sustainable practices are indeed capable of mitigating impacts and promoting development towards the conscious growth of the pet industry, as mentioned by Kuzma and Sehnem (2023).

METHODOLOGY

This study constitutes a qualitative research of a descriptive nature. The case study method was applied, supported by Yin's (2015) foundations, recommending its use to comprehend, among other situations, organizational and administrative processes, justifying its selection.

Concerning data collection, a database of Brazilian startups in the pet sector, compiled for Kuzma's (2022) study, was utilised. It was constructed using Google Maps, employing search terms such as "city name" + state + "pet shop," "agribusiness," or "veterinary." The search covered all Brazilian cities, resulting in a database with company names, email contacts, phone numbers, and websites. The sample selection was convenience-based, non-probabilistic, through invitation and acceptance of participants, resulting in the participation of 25 startups in the pet sector.

Data collection involved the application of semi-structured interviews with owners and managers of pet sector startups, as detailed in Table 1. The unit of analysis is startups, small enterprises typically composed of few individuals occupying multiple roles. ABStartup's (2023) study indicates that startups commonly consist of 2 to 3 people. Therefore, a key informant surveyed often represents 50% of the structural framework of the enterprise, indicating significant representativeness for a qualitative study.

The interviews followed a semi-structured script comprising 18 open-ended questions, covering topics such as the history and characteristics of startups, adopted innovation practices, adopted sustainability practices, and critical aspects and challenges for the success of the startup business model. A research protocol was adhered to, as asserted by Yin (2015). Regarding the validity and reliability criteria of qualitative research, the premises elucidated by Kaufmann and Denk (2011) were adopted. To ensure credibility, i.e., elucidating results that are acceptable representations of the data, the research protocol and defined questions identified in the literature were utilised, aligning with the research's analytical dimensions. Additionally, two researchers collected and, along with two other researchers, analysed the data. A three-page summary of initial interpretations was provided to the interviewees to solicit feedback and validate the results.

To ensure transferability, i.e., the extent to which the conclusions of a study in one context apply to other contexts, a theoretical sampling was developed based on startups in the pet sector offering food products and in the services and trade segment. The sample included startups of different sizes and located in different geographical contexts.

Regarding reliability (the extent is exclusive to time and place), stability, or the consistency of explanations, interviewees reported experiences related to the studied phenomenon (sustainability and innovation in the pet sector), as well as historical data from other historical events. Multiple data sources were used for each startup researched, triangulation of data was conducted, and secondary documents were consulted, including flyers, technical reports, and online communications.

Finally, concerning confirmability (the extent to which interpretations are the results of participants and the phenomenon, as opposed to the researcher's biases), all interviews and

documents were analysed by four co-researchers. The summary of preliminary conclusions was analysed by other team members acting as controllers.

Researchers maintained contact with participants via email and phone, and interviews were scheduled and conducted online, using Google Meet and Teams, between March and April 2023, following participant acceptance. The decision to interview only one person per startup is associated with the size of the enterprise, similar to the guidelines in Sehnem et al.'s (2023) study, as most of them have a small scale and lean teams of up to four people. However, the contacted participants, recommended by Voss et al. (2002), are characterised as key informants, capable of providing the information and knowledge desired by this study.

In total, the research included 25 startups in the pet sector, represented by owners and managers. Interviews were recorded with participants' permission, totaling approximately 15 hours of recording. The recordings were transcribed using the Transkiptor and Word Online software, and reviewed for transcription adequacy to the interviewee's speech. The research yielded 295 pages of transcription, divided into 25 documents.

Table 1. Characterization of the Research Sample

Code	Education	Company Size	City	Position	Time in the Company	Interview Duration
E1	Postgraduate	Microenterprise	Curitiba - PR	Owner Partner	2 years	59 min
E2	Postgraduate	Microenterprise	São Paulo - SP	Owner	7 years	27 min
E3	Completed Higher Education	Small Business	Brasília - DF	Owner	3 years	39 min
E4	Incomplete Higher Education	Small Business	Curitiba - PR	Owner	7 years	42 min
E5	Postgraduate	Small Business	Belo Horizonte - MG	CEO	5 years	20 min
E6	Completed Higher Education	Medium-sized Business	Campinas - SP	Owner	4 years and 9 months	57 min
E7	Completed Higher Education	Medium-sized Business	São Paulo - SP	Administrator	3 years and 10 months	28 min
E8	Completed Higher Education	Medium-sized Business	São Paulo - SP	Administrator	4 years	19 min
E9	Completed Higher Education	Small Business	Natal - RN	CEO	9 years	28 min
E10	Master's Degree	Small Business	Porto Alegre - RS	Founder	2 years	28 min

Continue

Table 1. Characterization of the Research Sample

Concludes

Code	Education	Company Size	City	Position	Time in the Company	Interview Duration
E11	Completed Higher Education	Medium-sized Business	Curitiba - PR	Director	7 years	32 min
E12	Completed Higher Education	Small Business	São Paulo - SP	Owner Partner	6 years	29 min
E13	Completed Higher Education	Medium-sized Business	São Paulo - SP	Founder	10 years	38 min
E14	Master's Degree	Small Business	São Paulo - SP	Owner	1 years	34 min
E15	Completed Higher Education	Small Business	Fortaleza - CE	Owner	4 years	1h e 17 min
E16	Doctorate	Microenterprise	São José dos Campos - SP	Owner Administrator	5 years	35 min
E17	Doctorate	Microenterprise	Curitiba - PR	Owner Administrator	4 years and 6 months	36 min
E18	Postgraduate	Microenterprise	Birigui - SP	Owner Partner	5 years	44 min
E19	Completed Higher Education	Small Business	Curitiba - PR	Owner Partner	6 years	39 min
E20	Completed Higher Education	Medium-sized Business	Londrina - PR	Administrator	2 years	28 min
E21	Completed Higher Education	Medium-sized Business	São Paulo - SP	Owner Partner	4 years	28 min
E22	Postgraduate	Small Business	São Paulo - SP	Owner Partner	9 months	35 min
E23	Postgraduate	Small Business	Salvador - BA	Owner	5 years	37 min
E24	Completed Higher Education	Small Business	Florianópolis - SC	Owner Partner	2 years	36 min
E25	Completed Higher Education	Small Business	São Paulo - SP	Commercial Representative	7 months	21 min

The data underwent content analysis, following Bardin's (2016) premises. Researchers engaged in a floating reading of the interview transcriptions (pre-analysis stage). Subsequently, the quotations were coded, considering categories identified a posteriori during material exploration. The coding was assisted by Atlas.ti 23 software, resulting in a total of 548 quotations.

For data presentation, Sunkey charts and tables were developed with the support of Atlas.ti 23. The information obtained from interviews was supplemented with secondary data collected from startup websites and social media platforms Facebook and Instagram, aiding the triangulation of data from various interviewees and different sources. Finally, an analysis of the results from the perspective of the TME was conducted.

PRESENTATION AND ANALYSIS OF RESULTS

This section presents the research results, commencing with a brief quantitative analysis of the interviewee data, followed by a preliminary analysis of the categories identified a posteriori in the conducted interviews. The analyzed sample consists of startups managed by qualified professionals, with a minimum educational attainment of incomplete higher education (4% of the total). Among the interviewees, 56% have completed higher education, 24% have postgraduate degrees, and 16% hold a master's or doctoral degree. On average, individuals in the sample have been working in startups for just over 4 years.

The researched startups are concentrated in the Southeast and South regions, housing 52% and 32% of the companies, respectively. Regarding the company's size, as indicated by the interviewees, the majority are characterized as small enterprises (52%). A portion of 20% comprises micro-enterprises, and 18% are medium-sized enterprises. In summary, the sample is predominantly composed of small startups located in the central-southern region of Brazil, whose administrators and founders have high educational backgrounds.

Concerning categorization, due to the number of observed categories and participating companies, it was decided to export the quotations to an Excel spreadsheet and construct Table 2 to enhance result visualization. Based on the occurrence of categories in each researched startup, the sustainable practices aligned with categorized TME and their respective adopting companies are presented below.

Table 2. Identified Sustainable Practices and TME

Identified Practices	Adopting Startups
Waste reduction	E18, E19, E20
Conscious consumption	E1, E2, E3, E6, E8, E11, E14, E17, E18, E19, E20, E21, E24
Pollution prevention	E3, E6, E12, E16, E17, E20, E24
Sustainable products	E1, E6, E8, E10, E11, E12, E19, E24

Continue

Table 2. Identified Sustainable Practices and TME Concludes

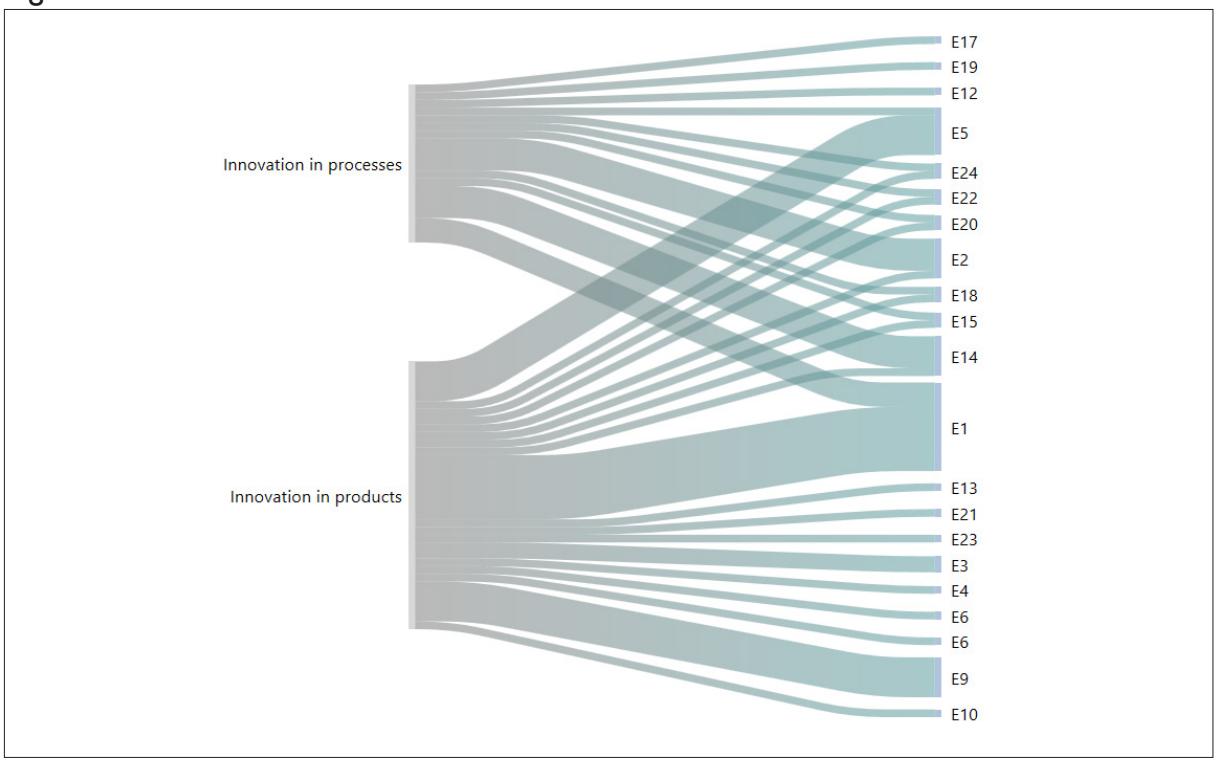
Identified Practices	Adopting Startups
Clean energy	E11, E16
Material recycling	E2, E3, E4, E5, E11, E12, E13, E14, E19, E20
Waste as a resource	E12, E15, E19, E20
Reuse	E2, E3, E8, E11, E12, E14, E18
Innovation in processes	E1, E2, E5, E12, E14, E15, E17, E18, E19, E20, E22, E24
Innovation in products	E1, E2, E3, E4, E5, E6, E7, E9, E10, E13, E14, E15, E18, E20, E21, E22, E23, E24
Digitalization	E1, E2, E3, E4, E5, E6, E8, E10, E11, E12, E13, E14, E15, E16, E18, E19, E20, E21, E22, E23, E24, E25
Online sales platform	E1, E3, E4, E5, E14, E16, E18, E19, E20, E22, E23, E25
Partnerships for innovation	E1, E4, E5, E6, E9, E10, E11, E13, E14, E15, E16, E17, E18, E19, E22, E23, E24
Cooperation for sustainability	E3, E6, E10, E11, E15, E17, E19, E20, E21, E22
Engagement with stakeholders	E3, E14, E16, E17, E18, E20, E21
Transparency	E1, E2, E3, E5, E6, E10, E14, E16, E17, E18, E20, E21, E22, E23

Table 2 illustrates that the identified practices align with ecological modernization. For instance, the fight against waste aims to reduce excessive consumption and focuses on the efficient use of natural resources, aligning with environmental efficiency (Saraceni, 2014) and eco-efficiency (York & Rosa, 2003). The promotion of conscious consumption (Carolan, 2004) involves awareness of the environmental impacts of consumption and the pursuit of more sustainable practices (Buttel, 2000). Pollution prevention (Ewing, 2017) avoids or minimizes the emission of pollutants and environmental degradation (Bugden, 2022). The adoption of sustainable products is in harmony with TME, as it involves the production and supply of products that have a lower environmental impact (Spaargaren, 2000).

The use of clean, renewable energy seeks to reduce dependence on polluting energy sources and contribute to the transition to a more sustainable energy system (Mol, 2002). Material recycling saves natural resources and reduces pressure on the ecosystem. Treating waste as a resource maximizes the value and utility of these wastes, avoiding improper disposal (Sehnem et al., 2021). The pet sector also promotes the use of products and materials for a longer duration, reducing the need for new extractions or production.

Innovation is a strategic element of ecological modernization theory (Lazzarotti et al., 2019). Among startups, innovative practices prevail that reinforce the characteristic of this type of company in seeking innovative solutions to societal dilemmas and reducing the environmental impact of their activities (Figure 1).

Figure 1. Identified Codes on Product Innovation and Process Innovation



Process and product innovations predominate among companies, in most cases, implemented from the inception of startup activities. For example, E1 innovates by offering a collar with natural repellent; E5 has its entrepreneurial journey linked to the launch of a collar with a QR Code identification, enabling the location of lost animals, and E9 brought to the market an innovative device to assist visually impaired animals in perceiving obstacles. Innovation in products, especially in making them more sustainable, aligns with TME as it seeks to promote more environmentally conscious practices (Carolan, 2004).

Process innovations are more evident in startups operating in the natural pet food segment. The composition of customised rations is relatively similar, according to the interviewee reports, and companies seek to innovate by introducing different cooking processes (E12), preparation techniques for better nutrient preservation (E15), and vacuum packaging (E19), for example.

In some cases, innovation is confirmed by the adoption of 3D printing technologies (E25), nanocapsules and nanotechnology (E24), and biotechnology (E16). In common, the innovations adopted by startups aim at animal well-being and have the purpose of improving the quality of life for animals and, consequently, their guardians. This perception is obtained through the analysis of some descriptions on websites and social media, such as:

> We research and select natural, high-quality products for your pet, prioritizing the health and well-being of our four-legged children (E1).

> Technology for animal well-being. A startup whose mission is to find and implement effective solutions to end abandonment and suffering (E5).

> We are born to combine animal nutrition with environmental preservation. Your pet deserves it. Our planet thanks you! (E6).
>
> [name of the company] is an innovative and modern company that cares about both the pet and its owner. It is built on four fundamental pillars to achieve success: quality, innovation, design, and sustainability (E9).

The technological advancement in the researched startups becomes evident through the adoption of digitalization practices, considered one of the major global trends. The integration of digital technologies in the organization or operational environment is transforming society and businesses (Parviainen et al., 2022). Evidence of digitalization was mentioned by 88% of the respondents, with practices such as remote work, customer service, online procurement of inputs, and digital marketing identified. Regarding the digital presence of startups on websites and social media, 100% embraced this format. Digital technologies can be considered aligned with TME as long as these technologies are used to promote energy efficiency, resource reduction, and sustainability improvement (Carolan, 2004).

It is observed that the Covid-19 pandemic accelerated digitalization. E20 comments that "digital transformation is part of our foundation and gained greater strength with the pandemic and post-pandemic," and businesses like E1 were created during the pandemic and were already configured entirely digitally.

The adoption of online sales platforms, an integral part of digitalization, was identified in twelve startups (48% of the sample). These platforms are responsible for promoting efficiency, the need for reducing physical travel, offering more sustainable options to consumers, and reducing the ecological footprint of transportation and product movement (Sehnem et al., 2022). E-commerce has become popular, allowing users to shop from the comfort of their homes. The results demonstrate that some startups used an online sales platform from the inception of the business, while others adopted this format to expand their market, as exemplified by E4:

> We are already entering Mercado Livre [marketplace] because of the snacks because snacks have a high turnover, you know? Snacks are in high demand.

It is also observed, in the statements of E2 and E17, that digitalization, directly or indirectly, resulted in the internalization of sustainable practices in some startups:

> We all work remotely. I don't have fuel expenses, I don't have paper being consumed, so from a sustainability standpoint, I think the company is quite sustainable (E2).
>
> […] We completely removed paper from our workstations; we work with tablets and computers, and the vet on the other side on his computer, because he puts all the requests in the cloud, so we no longer have paper here (E17).

The fact that the majority of startups adopt digitalization in various processes may justify the relatively low frequency of mentions of practices related to waste management. Some interviewees mention that, due to the digital nature of their activities, there is no waste generation, and consequently, there is no need to implement associated practices. This view is reinforced

by the perceptions mentioned earlier, where the reduction in paper usage is related to the adoption of digital activities.

On the other hand, especially among startups whose main activity is the production of natural pet food, there is an issue related to plastic packaging. As the disposal of plastic packaging ends up being the responsibility of the consumer, companies have sought to offset this impact, as exemplified by E3 and E19, as well as replacing plastic with materials such as cardboard and biodegradable packaging through innovation, as is the case with E6. These changes require innovation partnerships, involving collaboration with different actors to develop more sustainable solutions and promote the transfer of knowledge and technologies, aspects that are closely aligned with TME (Munck & Souza, 2010).

> Our delivery box is made of recyclable cardboard [...]. Additionally, our meal packaging [...] is made of a different plastic that can withstand high temperatures, and we offset all of them environmentally (E3).

> We have a partnership with 'Eu Reciclo' [...]. They provide compensation, so every month, if I'm not mistaken, we report what we produced, the number of packages, for example, and we pay compensation to them. They take this compensation and distribute it to waste pickers, cooperatives for plastic and paper collection on the streets, that is, most of these [business sustainability impacts] are indirect (E19).

> We always aim to use organic or plastics that dissolve more quickly, eliminating them from the environment (E1).

> It's a packaging case, it's wonderful [...]. It was awarded, to give you an idea, not only for sustainability but also for functionality by the Brazilian Packaging Association (E6).

The shift of organizations towards sustainable and environmentally friendly packaging reinforces the evidence found in interviews related to conscious consumption and pollution prevention. Waste reduction, maximum use of inputs, water reuse, and the extension of machine lifespan are some of the reported practices, as observed in the following transcribed statements.

> [...] actually seeks to buy products with more capacity, so that they become obsolete for a long time. So, as you have a good machine, which will give you longer lifespans, it makes more sense to have a more aggregated investment at the beginning so that you have a longer lifespan for this product (E2).

> For example, carrots, we used to peel them. Our technical manager [responsável técnica] said: 'guys, you don't need to peel the carrots, you need to clean them well' and then you don't need to go through the wear and tear of peeling the carrot itself (E3).

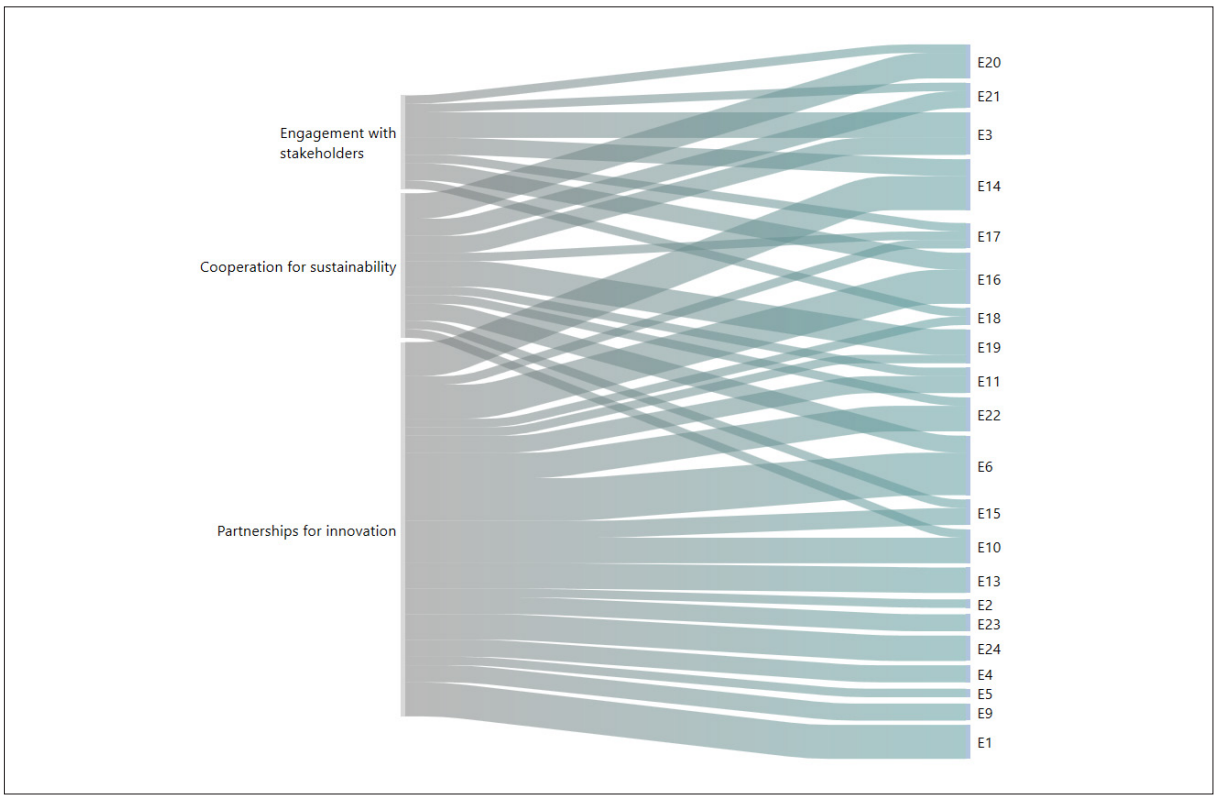
> And also avoid always changing this water, right? We try to use some products that clean the water so that we don't keep changing the water (E8).

> And the issue of usage that we talked about, like, shampoo, material, it's all in the machine, everything. Like, there's the right amount for each type of animal by size. So, in short, the quantity is controlled for the number of baths I have scheduled for that day (E14).

Regarding the adoption of clean energy, only two startups explicitly mentioned the use of renewable energy, such as solar power. This situation is related to the fact that companies operate in a home office regime and do not have a physical headquarters (E2), and they use third-party spaces such as incubators and shopping malls (E16, E17). The high investments and lack of incentives for adopting clean energy are cited by E18 as a barrier, but there is mention of projects and/or intentions to install solar panels by E3, E18, E19, and E25.

The coding of interviews also revealed the occurrence of partnerships for innovation and cooperation between parties for sustainability. These practices, in turn, are directly or indirectly related to stakeholder management. Figure 2 illustrates the codifications identified for these three aspects.

Figure 2. Identified Codes on Cooperation, Partnerships, and Stakeholder Engagement



Through the interviews, the structuring of open innovation environments was observed, with startups forming partnerships with other companies, universities, suppliers, and even their employees, aiming at developing solutions or improving processes, and participating in business acceleration programs. Additionally, startups also engage with some stakeholders, such as employees and partner companies, with the goal of developing and enhancing sustainable practices:

> The Klabin [company partner of the startup] says: 'we have never put braille on corrugated cardboard, and then, through our research, we have never seen this anywhere in the world, but we will accept the challenge.' It was a nine-month project, where Klabin is the first

> company in the world to put braille on corrugated cardboard, and we already have an international patent for this braille, for this technology (E6).
>
> We have a department focused on project management, projects for the awarding of good ideas from employees quarterly. There is an incentive for changes and improvements in all areas (E11).
>
> Our technology implementation today is more within the Federal University, where they are developing our natural food formulations. I decided to do it there because the university has the best laboratories and the most modern technologies to justify that, in addition to being innovative, I also implement technology in my business, right? (E15).
>
> The clothes and collars are made from pet products collected through reverse logistics. The company runs campaigns with discounts on new products when customers present used products in their purchases (E21).

Another strategic element observed is transparency, especially in disclosing environmental information and business practices. These behaviors promote accountability and accountability of companies regarding their environmental performance. Regarding transparency, frequent mentions of the General Data Protection Law (LGPD) were observed, regulating the treatment of personal data. Part of the startups offers applications and remote services that require the provision of basic information, and therefore, there is concern about compliance with current legislation.

Concerning public policies, another strategic element of the TME, respondents mentioned only issues of strict laws and rigorous inspections by bodies such as the Ministry of Agriculture, Livestock and Supply. The comments were made by respondents linked to startups whose main activity is the production of natural pet foods, and it can be understood that, in the Brazilian context, regulatory standards may hinder the sector's expansion and investment in innovations, as demonstrated by the following reports:

> [...] we are subordinate to the Ministry of Agriculture, you know. And the surveillance is very strict, starting with the location, right? Because I would say that the production, our operating model is stricter than a human restaurant, you know? (E4).
>
> The Ministry of Agriculture is more demanding than health surveillance. For example, there will be more requirements making food for an animal than making a restaurant where you go to have lunch (E18).
>
> There is a certain bureaucracy for growth, right here in the country, you know? I think this is something that, especially for a company like ours, impacts a lot, right? [...] So, now we have this idea, we are changing, right, our location, and we have been waiting for viability for 3 months (E24).

The perceptions of the respondents denote engagement with sustainability issues, directly or indirectly addressed through product or process innovation, resulting in positive environmental,

economic, and social impacts. Entrepreneurs with a vision and purpose focused on sustainability can be driving forces in the evolution of this journey, as can be observed in the statements below:

> I have to do something, thinking about the legacy. Obviously, it needs to make money, it needs to stand on its own, that's the business, but I have to do something more. So, when we create a company with a focus on sustainability, a focus on inclusion, a focus on helping the customer's journey, I am looking at the customer, I am not looking at my cash register, I look at the customer, and we have a virtuous cycle" (E6).
>
> The interest comes from top management, passing the mission to the R&D and marketing sector to develop more sustainable products (E11).
>
> We are aware that we need to leave a better world for future generations (E20).

DISCUSSION OF RESULTS

The research evidence demonstrates that innovation is one of the cornerstones of the businesses investigated in startups. Whether through product or process innovation, at an early or advanced level, all startups offer some form of innovation, primarily focused on animal well-being and natural pet food. These startups are committed to introducing innovations from the beginning of their operations. They establish strategic partnerships with other companies, universities, suppliers, and collaborators to develop innovative solutions and enhance processes. These partnerships promote cooperation and knowledge-sharing to address environmental challenges, indicating the existence of a systemic vision seeking balance in the relationship between society and nature, as advocated by sustainability (Ruggerio, 2021).

Innovations associated with cost reduction and the reduction of plastic waste generation, with substitution by recycled or recyclable materials, have been identified, which can be considered sustainable innovations (Cillo et al., 2019). Practical solutions for sustainability among pet sector startups that promote differentiation and serve as value sources for the companies are observed (Albuquerque et al., 2020). Disruptive innovations and sustainable practices applied in Brazilian startups had already been identified by Sehnem et al. (2022), reinforcing the potential of such companies to positively impact the economy, environment, and society. Thus, there is alignment between the researched startups and the core tenet of TME, stating that technological innovation in the organization contributes to improving environmental and economic dimensions (Zhu et al., 2012).

As for public policies, the research indicates that the public sector does not encourage decision-making and the provision of environmental solutions, as advocated by TME (Spaargaren & Van Vliet, 2000). Legislation is mentioned by respondents only in the context of health inspection, highlighting the rigor of Brazilian laws and excessive bureaucracy, which may hinder the sector's expansion and investment in innovations. This result aligns with the findings of Sehnem et al. (2021), who analyzed the brewery sector and obtained similar perceptions regarding strict legislation,

which can impact both the final product quality and the company's continued presence in the sector due to compliance with legal requirements.

Pollution prevention policies and the promotion of technological innovation are two dimensions of TME seen as drivers of sustainable supply chains (Zhu et al., 2012). It can be observed that, in the context of the pet sector analyzed in this research, technological innovation is widely disseminated, while public policies lack attention. There are mentions of a lack of government incentives for solar energy adoption, for example, indicating that legislation intrinsic to the pet sector is more focused on monitoring and regulating activities than preventing pollution. This is an important point of concern, as environmental technologies are not always capable of mitigating environmental impacts by themselves (Bugden, 2022).

The research indicates that startups establish partnerships for innovation and also cooperate with partners aiming at sustainability, either for the business as a whole or for sustainable practices, such as plastic recycling. The involvement of startups with various actors (universities, business partners, animal welfare NGOs, and customers) is a positive factor for the development of businesses guided by TME. In this regard, Lazzarotti et al. (2019) emphasize the need for interaction between actors to overcome barriers to innovation.

Our findings also demonstrate that startups value a close and humanized relationship with customers, encouraging employee participation in proposing innovative solutions. These observed premises contribute to the advancement of sustainable practices, as the development of customer environmental awareness and the role of employees as disseminators of new technologies and products are crucial factors for sustainability (Lazzarotti et al., 2019). Additionally, they are important for the sector's growth, as their consumers prioritize product quality and reject the use of harmful materials (Kuzma & Sehnem, 2023). Sustainable and innovative practices identified among the researched startups confirm the potential for conscious growth in the pet sector mentioned by Kuzma and Sehnem (2023), aligned with the Sustainable Development Goals (Weber & Weber, 2020). However, the lack of economic incentives from the government for promoting sustainability, especially for small and medium-sized enterprises, is a barrier to be overcome (Ormazabal et al., 2016; Ormazabal et al., 2018).

The researched businesses operate with purpose and a sustainable vision, as entrepreneurs demonstrate a commitment to sustainability and a purpose focused on creating a positive environmental, economic, and social impact, as noted by Sehnem et al. (2022), who observed sustainability ingrained in the DNA of startups. These entrepreneurs aim to leave a legacy and develop more sustainable products and processes, considering both the customer and future generations. These commitments highlight the relationship between innovation and sustainability in the pet sector, where companies are seeking creative solutions, strategic partnerships, and stakeholder engagement to address environmental challenges and promote sustainable actions.

Stakeholders were also deemed fundamental for activating circular economy cycles supported by innovative Industry 4.0 technologies in Brazilian startups, as per the study by Sehnem et al. (2023). Our findings reinforce the role of interaction with stakeholders in structuring innovative and sustainable businesses aligned with TME, generating practical implications for

the strategic stakeholders in the pet sector—partner companies, universities, research institutions, employees, suppliers, and consumers.

The key practical proposals for these stakeholders are:

a. Partnership companies: Through cooperation with startups, these companies have the opportunity to develop new technologies, products, and processes that meet the demands of the pet market and promote innovation and sustainability. Partnering with startups can also bring benefits in terms of reputation and differentiation in the market.

b. Universities and research institutions: Startups in the pet sector can benefit from establishing strategic partnerships with universities to drive research and the development of more sustainable products, gaining access to modern laboratories, specialized knowledge, and research resources.

c. Suppliers: Suppliers have the opportunity to engage in sustainable practices through cooperation with companies in the pet sector. This may involve adopting reverse logistics practices, supplying sustainable materials, or developing more efficient and environmentally friendly processes. The search for suppliers aligned with sustainable practices can be a crucial strategy for pet sector companies, enabling them to offer more sustainable products and services throughout the value chain, extending the principles of TME beyond organizational boundaries (Zhu et al., 2012).

d. Employees: Promoting awareness and engagement of employees in sustainable practices can strengthen organizational culture and stimulate innovation. Employees can also contribute valuable ideas and insights to improve the sustainability of operations and products.

e. Consumers: Consumers can engage with pet sector companies adopting sustainable and responsible practices, influencing their purchasing decisions by demonstrating a preference for brands that share their environmental values, as observed by Kuzma and Sehnem (2023). This relationship also implies consumers' access to more sustainable pet products and services, such as natural foods, products made from recycled or biodegradable materials, and reverse logistics practices.

In summary, the suggestions include collaboration opportunities for innovation, access to research resources, engagement in sustainable practices, reverse logistics actions, employee-driven innovation, and offering more sustainable products and services to conscious consumers. Startups and companies in the pet industry can use these proposals to align their innovation and sustainability strategies with the interests of their stakeholders. Based on the research perceptions, we outline four central propositions for empirical validation in future studies seeking to deepen the understanding of the role of entrepreneurs, interaction with stakeholders, and open innovation for the ecological modernization of industrial sectors, confirming the findings of this study. They are:

a. The education and individual values of startup founders influence the creation and development of innovative and sustainable businesses.
b. Open innovation facilitates the development and adoption of technology-oriented sustainability solutions in startups.
c. Interaction with stakeholders is a key factor in the development of innovative products and solutions in startups.
d. Interaction with stakeholders strengthens the consolidation of businesses aligned with sustainability principles.

CONCLUSION

The study was undertaken with the aim of analyzing the alignment of sustainable and innovative practices in the pet industry with the Theory of Ecological Modernization (TME). We conclude that the practices of startups in the pet sector are partially aligned with the TME. Evidence of advanced adoption of innovative practices, some of them disruptive, such as 3D printing, was observed, along with a significant presence of technology and digitization in the analyzed businesses. Various positive initiatives were identified, related to both animal well-being and concerns about environmental issues, waste, and the rational use of resources. On the other hand, in terms of public policies, there were no indications of their existence, indicating an opportunity gap for advancement.

The research results provide a practical organizational diagnosis of Brazilian startups in the pet sector, revealing the organizations' commitment to innovation and the prospect of adopting sustainability-oriented practices. It is observed that sustainability is intrinsic to the purpose of the CEOs of some startups – at this point, the high education level of the interviewed founders stands out, and the business is guided from the beginning with this perspective. In other cases, it can be seen that technology and innovation in products and processes have reflected environmental and cost reduction practices.

The research also contributes to advancing the connection between the TME and organizational reality. The evidence suggests that it is possible to use the premises of the TME to minimize the impacts of business activities and maximize positive impacts. Startups are born with an innovative and disruptive perspective ingrained, being an important group that can serve as inspiration for the enhancement of identified best practices. Finally, they offer insights into how companies in this sector are addressing environmental challenges, seeking sustainable solutions, and promoting ecological modernization in their operations. This theoretical contribution is relevant as it helps promote knowledge about how companies can incorporate sustainable practices in specific sectors, such as the pet industry, and how these practices can contribute more broadly to ecological modernization. The study highlights the importance of innovation, stakeholder engagement, and transparency as key elements to drive sustainability in this sector.

The practical implications of the study are associated with the realization of the importance and need for fostering open innovation, stakeholder engagement, transparency, and responsibility, addressing regulatory challenges, the need for a long-term strategic vision, and investment in research and development of sustainable products, adoption of circular economy practices, and development of business strategies aligned with sustainability and conscious consumption.

The study's limitation is associated with the subjectivity and bias of the respondents and the sample size. Despite researchers collecting additional data on websites and social networks, only one professional was interviewed in each startup. As opportunities for future studies, in addition to the theoretical propositions presented in the results section, it is recommended to conduct more in-depth interviews with better segmentation of the pet industry, for example, focusing only on the food industry or the services and commerce segment. It is also recommended to replicate the study in developed countries and established companies to compare and discuss the practices adopted with the findings of this study, as well as with a set of startups from other economic sectors.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHORS CONTRIBUTION

Tais Provensi: Data curation; Formal analysis; Validation; Writing – original draft; Writing – review and editing.

Maiara Lais Marcon: Data curation; Formal analysis; Validation; Writing – original draft; Writing – review and editing.

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