# Sustainable practices in the construction sector: an overview of copanies operating in Brazil and their contributions to achieving the UN SDGs

*Práticas sustentáveis no setor da construção: um panorama de empresas atuantes no Brasil e suas contribuições para alcance dos ODS da ONU*

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## Abstract

The civil construction sector is one of the main consumers of natural resources and presents the need to implement sustainable practices in its activities. We sought to present an overview of sustainability practices that have been developed by the civil construction sector in Brazil and their contributions to achieving the Sustainable Development Goals (SDGs) proposed by the UN. To this end, a review of the literature was carried out, considering the Brazilian sector, using the following steps: preparation; organization phase; reporting the analysis process and results. Twenty-four companies representing the sector were considered. According to the analysis of their reports, 19 sustainable practices are identified. It was possible to group these practices into four macro areas aligned with the sustainable development of organizations, such as environmental, economic, social, and extensive management practices. Finally, a synthesis of the practices that have been applied in the civil construction sector is presented. Sustainable practices were also aligned with the goals set out in the UN SDGs.

**Keywords:** Sustainability. Civil construction sector. Sustainable practices.

## Resumo

*O setor da construção civil é um dos principais consumidores de recursos naturais e apresenta a necessidade de implementação de práticas sustentáveis em suas atividades. Buscou-se apresentar o panorama das práticas de sustentabilidade que vem sendo desenvolvidas pelo setor da construção civil atuantes no Brasil e suas contribuições para o alcance dos Objetivos de Desenvolvimento Sustentáveis (ODSs) propostos pela ONU. Para tal, foi realizada uma revisão da literatura e em seguida um levantamento de empresas que se destacam no setor considerando o cenário brasileiro, utilizando as seguintes etapas: fase de preparação; fase de organização; e fase de relatar o processo de análise e resultados. Foram consideradas 24 empresas representativas do setor. Segundo a análise de seus relatórios, 19 práticas sustentáveis são desenvolvidas. Foi possível agrupar tais práticas em quatro macro áreas alinhadas ao desenvolvimento sustentável das organizações, como por exemplo, práticas ambientais, econômicas, sociais e práticas amplas de gestão. Por fim, apresenta-se uma síntese das práticas que vem sendo aplicadas no setor da construção civil. As práticas sustentáveis também foram alinhadas aos objetivos estabelecidos nos ODSs da ONU.*

***Palavras-chave**: Sustentabilidade. Setor de construção civil. Práticas sustentáveis.*

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# Introduction

Since the last century, sustainability has been the subject of important discussions, and the concern with the scarcity of natural resources for future generations has become an important debate (Abrahams, 2017). In 1987, the term "sustainable development" emerged, with the creation of the Brundtland Report, created by the World Commission on Environment and Development, which defined the term as follows: "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs." (Visser; Brundtland, 2013).

From this point onwards, several movements in favor of sustainable actions emerged, such as Agenda 21, which directly impacted the actions of society and companies, concerning environmental and social aspects (Oliveira *et al.*, 2014). In this sense, sustainability has become a new social conscience, thus encouraging environmental management as part of the competitive criteria in the business environment (Opoku; Ayarkwa; Agyekum, 2019; Silva *et al.*, 2017). In this scenario, civil construction gains important prominence, since it is one of the main sectors that generate negative sustainable impacts.

As the civil construction sector is characterized by meeting the needs of society's basic infrastructure, studies to encourage and develop sustainable practices are increasingly important Willar *et al.* (2021), as it is an important sector of the Brazilian economy, boosting the national economy. through the development of communities and the promotion of job creation. According to data from the Brazilian Institute of Geography and Statistics - IBGE, in 2021 the Gross Domestic Product (GDP) of the construction sector had a positive increase, with growth of 9.7%, in addition to promoting a significant portion of formal jobs in the country, accounting for 8.96% of new vacancies in the same year (BRAZIL, 2022).

On the other hand, there are the impacts caused by the sector's production chain. The activities developed in civil construction and the resources used are responsible for significant effects on the environment. From the extraction of raw materials used in construction to the demolition of these buildings, there is excessive use of important natural resources such as water and energy, in addition to a significant amount of waste that these operations generate. In 2020 alone, 47 million tons of construction and demolition waste was collected in Brazilian municipalities Abrelpe (2021), which demonstrates the volume and how much the sector needs the implementation of sustainable practices, with the reduction of the generation and reuse of this waste.

Thus, the importance of including sustainable practices in the sector's activities arises, which aims to resolve the social, economic, and environmental impacts. So-called green buildings have gained prominence in the market (GBC, 2019; Leoneti; Nirazawa; Oliveira, 2016). Such buildings are built based on responsive environmental planning, employing technologies capable of optimizing resources and reusing waste generated by construction. As a way of influencing these actions, these buildings have certifications created from the evaluation of sustainable guidelines throughout the production chain, in addition to standards from regulatory institutions, such as Law nº 12,305 of 2010 (Brazil, 2010), which deals with waste in civil construction. Brazil is one of the main markets in the construction industry worldwide, which means its activities have a significant impact on the environment and society. Additionally, the country boasts rich biodiversity and valuable natural resources that need to be preserved. Embracing sustainable practices in construction can contribute to reducing carbon emissions, responsible use of natural resources, waste reduction, and enhancing the quality of life for local communities. Moreover, favorable government policies towards sustainability and an increasing population awareness of the importance of environmental protection make analyzing this context crucial in driving the transition towards a more sustainable construction sector in Brazil.

Given this, it is important to highlight that the construction sector still has an important role in achieving goals related to the Sustainable Development Goals proposed by the United Nations - UN. Khajuria *et al.*, (2022) point out that this organization defined the adoption of the 2030 development agenda entitled "Transforming our world: The 2030 Agenda for Sustainable Development". It outlines 17 development goals, sustainable development goals (SDGs), associated with 169 targets that are structured around five pillars (5Ps): people, planet, prosperity, peace, and partnership (UN, 2015).

Considering the context presented, it is possible to perceive a knowledge gap in the area considering the importance of a better explanation of the sustainable practices that the sector has been adopting. Kuasoski *et al.* (2020) report, for example, the difficulty of the red ceramic industry, one of the main pillars of civil construction, in adopting sustainable practices, as studies focus on energy and material consumption, in addition to the lack of processes that lead to a more ecological footprint. Ribeiro (2016), on the other hand, emphasizes that in the urban environment, it is still possible to perceive buildings and constructions that fully meet all the established principles of sustainable construction. In this sense, Alves, Borges and Nadae (2021) corroborate the principle of difficulty in implementing sustainability in civil construction due to planning and

clarification problems in the design phase, and difficulty in understanding the planning processes due to high initial data uncertainty and high-risk probability.

Therefore, it becomes relevant to analyze the integration of sustainable practices in the construction sector concerning the United Nations' proposed Sustainable Development Goals (SDGs), as this sector plays a crucial role in the pursuit of global sustainable development. The SDGs, which encompass ambitious targets such as eradicating poverty, ensuring access to clean energy, promoting gender equality, and protecting the environment, demand concrete and transformative actions across various sectors, including construction. In this context, it is worth highlighting that the adoption of sustainable practices in this sector directly contributes to the achievement of several SDGs, such as SDG 7 (clean and affordable energy), SDG 9 (innovation and resilient infrastructure), SDG 11 (sustainable cities and communities), and SDG 12 (responsible consumption and production). By embracing sustainable solutions in projects and operations, the construction industry can leverage global efforts to address socio-environmental challenges and secure a fairer and more prosperous future for present and future generations.

Given the context, the objective of this article is to present an overview of sustainability practices that have been developed by companies in the civil construction sector that operate in Brazil and their contributions to the achievement of the UN SDGs.

To this end, we followed the strategy of a literature review and content collection and analysis of sustainability reports from companies in the sector, relating sustainable practices to the objectives proposed by the UN. Details of the methodology are presented in methodological procedures.

# Background

In the 21st century, the concept of sustainability has been gaining more and more strength, especially in the context where organizations aim for a strategy of comfort for their customers and employees or responsibility for natural resources (Komolafe; Oyewole; Gbadegesin, 2020). Such companies assume, before their stakeholders, a commitment to the possibility of improving their business and achieving better indicators in economic, social and environmental aspects (Gilbert Silvius *et al.*, 2017; Kivilä; Martinsuo; Vuorinen, 2017; Lima *et al.*, 2021; Martens; Carvalho, 2017; Rosati; Faria, 2019; Thomas; Costa, 2017).

To implement sustainability in practice, organizations must have a strong knowledge of their production chains, to study their materials, methods, transport, and operations. With this, adopting the use of materials that harm the environment less, reduces the consumption of the finite and develops leaner processes with less environmental impact. It is worth mentioning that such actions also contribute to reducing costs guaranteeing greater comfort and meeting the new demands of current customers. Such customers prioritize companies and buildings that are socio-environmental, which use natural elements to facilitate day-to-day tasks, as well as the need for greater durability of buildings, thus reducing the need for maintenance (Aigbavboa; Ohiomah; Zwane, 2017; Alrashed; Asif; Burek, 2017; Alwan; Jones; Holgate, 2017; Chiang *et al.*, 2015; Liu *et al.*, 2018; Trindade *et al.*, 2020; Xu *et al.*, 2022).

For a better understanding of the topic, point out that given the volume of materials that the construction industry transports, whether in the extraction, construction, or maintenance phase, this chain corresponds to about 35% of the plant's $CO^2$ emissions and generates between 45 and 65% of the waste deposited in landfills and inappropriate places. In this way, the industry and its operational activities contribute approximately 30% of the gasses that provoke the greenhouse effect and cause climate change on the planet (Chen; Bidanda, 2019; Dos Santos; Godoy; Campos, 2019; Lima *et al.*, 2021; Marques; Gomes; Brandli, 2017; Zea Escamilla; Habert; Wohlmuth, 2016).

The environmental impacts arising from civil construction begin in the materials production phase and the red ceramic industry is one of the links that make up the production chain, with bricks and blocks used for the base and wall coverings, tiles, and ceramic tubes. Point out that the main raw material for the production of red ceramic is clay extracted in the open from the manufacturer's deposits and most of the time there is no sustainable management plan for the best practice of extraction, or post-extraction (Figueredo; Sevegnani; Aumond, 2007; Grigoletti; Sattler, 2003; Kuasoski *et al.*, 2020). Grigoletti (2001), Lima *et al.* (2021) emphasize that it is necessary to cover the area with soil and add compost to enhance the physical, chemical, and biological reconstitution process. Another step is through the reconstruction of vegetation with similar types of plants and trees that grew in the area before extraction.

To better demonstrate the effectiveness of civil construction from an environmental point of view, Khajuria *et al.* (2022) state that the use of Life Cycle Analysis - LCA as a tool to minimize environmental impacts depends on the availability of reliable data that represent the impact of companies that are offering competing solutions

for the project. This tool can help the sector in the search for more sustainable management and monitoring of indicators.

Continuing the analysis of the civil construction chain, one of the areas that also impacts the environment greatly is the logistics stage, given the volume and frequency of transport of materials and people, with fuels derived from finite inputs, such as petroleum. In this sense, Chiang *et al.* (2015) and Martins *et al.* (2019) demonstrate the importance of adopting strategies of sustainable practices in logistics systems and implementing practices in the process of transport and storage. The authors identified the importance of external collaboration between links in the chain, as well as the adoption of management practices focused on the tripod of sustainability, being one of the positive factors that have contributed to improvements in the sector.

A systematic review was carried out by Lima *et al*. (2021) on sustainability in civil construction, using 433 articles for analysis, through the meta-analysis methodology that consequently evaluated the articles in the area of sustainability in civil construction, using a set of keywords in the last 18 years.

Lima *et al.* (2021), through the VOSviewer Software, presented an overview of the main keywords that appear in research related to the topic of sustainability. The most discussed topics are construction, energy, materials, life cycle, projects, sustainability, and performance. The area that encompasses materials is widely studied, as it justifies the search for new materials that harm the environment less and generate less environmental impacts, as well as the possibility of reducing and reusing them. Other points were the studies of environmental assessment methodologies, which survey the physical and chemical properties, volume, size, and useful life of the components of the sector. Such a systematic review helps to understand how sustainability is related to civil construction and what the main issues related to the theme are, as well as the amount of research that has evidenced the practices in recent years.

Another important area under study is the certifications explored in the articles, where Leadership in Energy and Environmental Design - LEED was the most used, as this classification system focuses more on the production of green and sustainable buildings (Lima *et al.*, 2021).

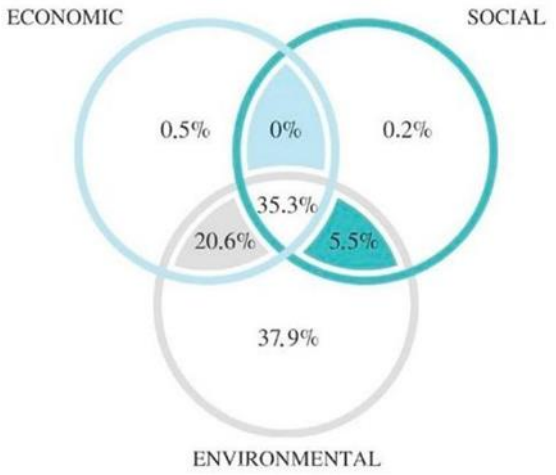
To have a broad understanding of the concepts of sustainability, Elkington (2012) created a common concept in sustainability management that, in Brazil, is known as the sustainability tripod. The concept advocates that sustainability needs to work as a tripod, composed of social, economic, and environmental actions.

Still in line with the pillars of sustainability, Figure 1 points to a large discrepancy in the studies, where 37.9% address only studies related to environmental practices, 35.3% address the tripod of the pillars, while the economic and social factors in isolation compose a small portion of the studies. One of the hypotheses raised by Lima e*t al.* (2021), highlights that organizations dedicate more time and projects to the social pillar, mainly due to environmental laws, which are increasingly severe while society demands an explanation of such practices and commitment to the environment. In contrast to the concepts of the three pillars being integrated, emphasize that the countries and companies that operate the pillars of sustainability, prioritize the economy and sustainable development, neglecting the environmental pillar, as they are compelled to act in ways degrading to the environment due to the divergence between individual rewards and collective goals of sustainability (Dhahri; Omri, 2018; Piccarozzi *et al.*, 2022; Taghvaee *et al.*, 2022).

Considering the context of sustainability in the construction sector, it is important to analyze the sector's contributions to the achievement of the SDGs proposed by the UN. Highlight that civil construction plays an important role in improving the 2030 Agenda scenario, given its impact on the environment (Figure 2) (Schmidt-Traub *et al.*, 2017).

For a better understanding of the advances in achieving the goals proposed by the UN, show the progress with indicators and dashboards in several countries in Figure 3. The authors point out that there is still a lack of standardization of indicators and greater homogeneity for monitoring them (Schmidt-Traub *et al.*, 2017). Point to positive results, especially for SDGs 1, 3, 7, 8, and 9: Poverty alleviation and empowerment of the economy, linked to innovation and modern infrastructure, therefore, becomes the basis for the other SDGs to be achieved. However, SDGs 11, 13, 14, 16, and 17 in particular still do not show great employability, and often do not prioritize other goals for the future (Kroll; Warchold; Pradhan, 2019; Liu *et al.*, 2021; Sachs *et al.*, 2019; Teresa; Barbosa, 2021). This emphasizes the need to foster innovations and policies that can make our cities more sustainable communities, as well as strengthen sectors and spur them on to more efficient climate action.

Figure 1 – **Keywords used in the articles**




**Source**: Lima *et al*. (2021).

Figure 2 – **Sustainable Development Goals**


**Source**: United Nations Organization (2022).

It is possible to identify that much remains to be done to reach the SDGs in general and in Brazil, of the 17 goals, only two have more advanced indicators, goal 7 (Clean and accessible energy) and 17 (Partnerships and a half of implementation). According to the objective of this research, by relating civil construction and the SDGs, it is possible to perceive the importance of achieving the goals, especially the goals that are part of SDGs 9 (Industry, Innovation, and Infrastructure) and 11 (Sustainable Cities and Communities) by 2030.

Studies were found in the literature review on the identification of protective barriers, reducing the effects of the consequences of waste generation and preventive barriers, to reduce threats that can cause an event such as material wastage (Trindade *et al*., 2020; Bourdot *et al*., 2016; Del Rey *et al*., 2016; Barritt, 2016). Thus, we propose the use of the bow tie tool to fill this gap in the literature, identifying the main obstacles to the implementation of green construction practices and thus addressing the possible consequences for the organization, in addition to protecting and preventing barriers. Also according to what was shown in the introduction, there is a gap in the literature on how to implement practices in the construction sector. This study is of great relevance to explain which ones are being implemented and how they relate to the SDGs proposed by the UN. It allows the reader to visualize which practices tend to be reached and others that are even further away in terms of sustainable implementation.

After a study carried out in Japan of more than 30 works, Liu *et al.* (2021) point out that the reasons for the difficulty in the road design included natural preconditions, insufficient data, specifications, constructability and maintainability, and interface coordination. A list of 11 potential obstacles to implementing the environmental management system (EMS) in construction include the high cost of implementation, lack of technology and materials, and lack of government pressure. Holton, Glass and Price (2010) investigated the UK prefab concrete companies and found barriers to managing sustainability, including the commitment of senior management or local ownership, knowledge and experience, and communication.

Lam *et al*. (2009) found 15 potential barriers to the integration of green specifications in construction. They were grouped into five categories, including cost, time, technical issues, contractual considerations, and management issues. Management issues were related to the owner's compromises, inadequate experience, and available resources. Among these barriers, engineering consultants were particularly concerned about the additional costs of, and limited knowledge about green technology and materials.

## Methodological procedures

For the development of this study, the following steps were carried out:

(a) review of the literature on engineering companies and sustainability in construction;

(b) collection of sustainability reports published by companies in the civil construction sector operating in Brazil;

(c) content analysis of the reports collected according to the guidelines proposed by Elo and Kyngäs (2008); and

(d) discussion of the results according to the theoretical framework addressed for the elaboration of the conclusions.

The literature review was carried out on the following scientific bases: ScienceDirect, Springer, Scopus, Web of Science, Emerald Insight, and Wiley, the following terms were used as search elements: “sustainability”, “civil construction”, “sustainable practices” and for greater breadth and scanning of the literature, the search was also made by combining the terms: “sustainability in civil construction” and “sustainable practices in civil construction”. After analyzing the main works related to the scope of this research, a synthesis of the main concepts was carried out for a better understanding of the theme as found in Background.

During the preparation phase Elo and Kyngäs (2008) state that the unit of analysis is defined by a word or theme. The object of analysis of this study is based on: "Sustainable practices developed by Brazilian builders". As a sample size, Pearce (1989) argues that it should represent the group. In this article, 24 companies representing the Brazilian economy that published sustainability reports between 2015 and 2018 were selected. From May to July 2022, the reports were downloaded by the authors from the companies' websites, therefore a secondary data collection, and, in the elaboration phase, the authors of this study analyzed sustainability reports to become familiar with the theme. Polit and Beck (2004) cited by Elo and Kyngäs (2008), recommend this familiarity and emphasize that no detailed analysis should be done unless researchers are familiar with the information.

Through the official website of B3: The Brazilian Stock Exchange, it was possible to collect 21 sustainability reports for this survey of companies in the civil construction sector. Another 3 companies were also added to the survey because they have information on sustainability on their official websites. All information used on the sustainable practices of these companies was disclosed in their sustainability reports. Some of the companies initially analyzed expressly stated in their reference forms that they do not produce sustainability reports or even that they have not yet adopted sustainable policies in the company.

It is worth mentioning that these 24 companies represent a great part of the civil construction sector (considering large companies), as they are the largest contractors in Brazil, in terms of the number of civil construction projects, revenue, and company time. These projects are related to housing and infrastructure such as roads, ports, and power plants.

The reports were analyzed using the guidelines suggested by Elo and Kyngäs (2008) to perform content analysis. According to these authors, content analysis can be carried out in three stages:

(a) preparation phase;

(b) organization phase; and

(c) reporting of the review process and results.

According to Martins *et al.* (2019), inductive analysis is recommended when there are no previous studies on the phenomenon, or if knowledge is fragmented. As mentioned earlier, the study of sustainable practices applied to civil construction activities undertaken by Brazilian companies is original, and current studies are focused on specific points. Thus, we understand that the inductive analysis proposed by Elo and Kyngäs (2008) is more suitable for the analysis performed. For dynamic analysis, Elo and Kyngäs (2008) recommend taking the following steps: open coding, categorization, and extraction. First, is the open coding step, where all material is analyzed and categories are freely created. (Burnard, 1991) states that the creation of categories increases the understanding of the material studied. In this study, during the coding phase, all sustainability reports were read and categories related to the mentioned information were created. Examples of these categories are: "Environmental Practices", and as a practice of this group, "Water treatment", among others.

Following the recommendations of Burnard (1991) and McCain (1988), the next step was to group the sections into "high-level topics", known as "core areas". This was done because many of the categories produced presented similar information, or were similar in terms of themes. For example, processes related to choosing a model, using a car, and writing are close in terms of themes and, therefore, have been grouped. Dey *et al.* (1993), point out that grouping categories into "high-level topics" requires comparisons between the data collected, and this was done in this study. As a result of the integration process, it was possible to find four major areas; that is:

(a) Environmental Practices;

(b) Social Practices;

(c) Economic Practices; and

(d) Extensive practices.

The third step of inductive analysis is "abstraction". According to Elo and Kyngäs (2008), in the taking phase, the researcher tries to make a general design. In this study, in this section, the objective is to establish an overview of the use of sustainable practices developed by Brazilian companies in the civil construction sector. When authors show a link between data and results, the credibility of the study increases; in addition, authors should explain the results in detail, with tables and appendices being useful to increase credibility. After this step, sustainable civil construction practices were related to the goals established in the UN SDGs, where the practices were correlated with each of the 17 SDGs.

According to Global Reporting Initiative (GRI, 2021), sustainability reports allow the demonstration of economic, social, and environmental data and practices by the company itself. Corporate sustainability reports have been used over the years by several researchers around the world, as they consolidate a large amount of relevant information on sustainability to be discussed and analyzed. Such reports are increasingly important as they organize and standardize relevant information on sustainability from a large corporation. This information is very important for the study of sustainability since such corporations have a direct influence on their stakeholders and the entire environment in which they operate. This includes employees, customers, suppliers, government, and local people, as well as all materials used and discarded at construction and preparation sites. Therefore, it is clear why the definition of the collection of the main information is through the sustainability reports.

# Results and discussions

In this section, the main results of this research will be presented, as well as discussions.

## Results

Analyzing each company considered in this study, the occurrence of sustainable practices was observed in the number of companies in the sample, in addition to investigating the greater variety of practices that these institutions seek to develop. Thus, a total of 19 different practices were found. Such sustainable activities, developed by organizations, were categorized into 4 macro areas: environmental, social, and economic, these three together form the so-called sustainability tripod, with the fourth macro area, extensive practices, covering non-profit activities. By dividing these practices into 4 macro areas, it is possible to notice that some of them are repeated, as they have impacts on both categories, as shown in Table 1.

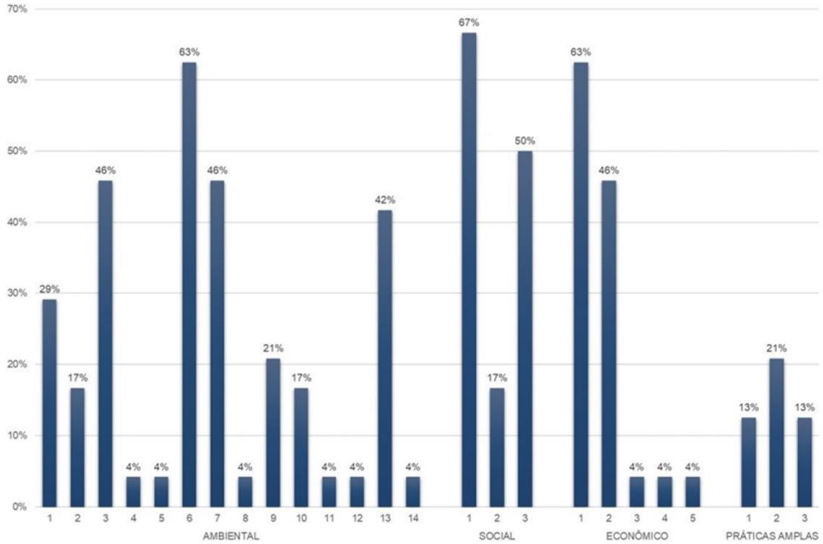
According to Figure 3, it is possible to identify that the macro area that includes the greatest number of sustainable practices is the environmental one, with 14 sustainable practices, which represents 73.68% of the practices raised in this study. In the third macro area, only 4 practices were found, and are shared with the

environmental macro area, that is, they are part of the practices of the environmental aspect, as they have resulted in both areas. Therefore, the actions of the category economy represent 21.05%. Next is the fourth macro area, with 15.78% of the practices found and the social aspect, and the second macro area, with only 10.52% of practices focused on social responsibility.

Table 1 - **Identified sustainable practices**

| | |
|---|---|
| **Macro Area 1: Environmental Practices** | |
| **1** | Water treatment |
| **2** | Rainwater harvesting |
| **3** | Optimization of water use |
| **4** | Use of raw materials with a lower rate of aggression |
| **5** | Restoration of deposits that provide raw material |
| **6** | Reuse or reduction of Waste |
| **7** | Waste for recycling |
| **8** | Less use of paper |
| **9** | Methods that reduce the emission of gasses |
| **10** | Reforestation |
| **11** | Planting seedlings in construction |
| **12** | Power generation by heat generation |
| **13** | Use of solar energy |
| **14** | decontamination |
| **Macro Area 2: Social Practices** | |
| **1** | Social responsibility |
| **2** | Community projects |
| **3** | Waste for recycling |
| **Macro Area 3: Economic Practices** | |
| **1** | Reuse or reduction of Waste |
| **2** | Waste for recycling |
| **3** | Less use of paper |
| **4** | Power generation by heat generation |
| **5** | Restoration of deposits that provide raw material |
| **Macro Area 4: Extensive Practices** | |
| **1** | Education for Sustainability |
| **2** | Sustainable Certification / Sustainable Materials or Awards |
| **3** | The event focused on sustainability |

Figure 3 - **Percentage of analyzed companies that develop each identified sustainable practice - frequency chart**



In the macro-environmental area, the greatest variety of sustainable practices was identified. This can be explained considering that this sector has a high level of environmental impacts throughout its production chain, and thus, it is clear that the attention of customers and stakeholders in the sector attracts greater demands from organizations so that they develop activities (Silva *et al.*, 2017). It is important to remember that there are some legal requirements in this area so that they maintain the lowest possible impact throughout their chain.

In the environmental category, three areas stood out in which companies act strongly in different ways. The first was the sustainable use of drinking water, where activities such as water treatment, which is carried out by 29% of the companies analyzed, reuse of rainwater (17%), and control of the amount of water, thus imposing goals for optimizing this use (46%).

The second important point analyzed was waste management, an aggravating factor in civil construction, where it was noticed that 46% of companies carry out the entire recycling process and 63% of them reuse or seek to reduce this waste.

Another highlight was sustainable energy, where 42% of companies use solar energy and 4% use energy that comes from other sources of heat. Solar energy is gaining strong prominence in the Brazilian scenario, mainly due to economic incentives to stimulate growth in solar energy (Santos; Lélis; Junqueira, 2022).

Still, on the environmental aspect, practices are developed that aim to reduce other important impacts in this sector, such as methods to reduce the emission of gasses, responsible for exacerbating the greenhouse effect. In this sample, 23% of the companies are concerned with monitoring these gas emission indicators and seek to improve the company's productive performance, gradually reducing these impacts. Another highlight is the deforestation in the areas where the company operates, where 17% of the companies carry out reforestation. In addition, companies carry out other practices in their operations, such as reduced use of paper (4%), planting of seedlings on the work site (4%), and use of raw materials with a lower rate of aggression (4%), restoration of deposits that provide raw material (4%) and decontamination (4%). In the social macro area, companies that have some activities focused on social responsibility represent 67% of the organizations studied.

These sustainable and social policy actions by the companies not only generate greater visibility for the brand but also, according to Silva *et al.* (2019) generate greater acceptance of their products and services, as well as greater investor interest in socially responsible companies, which makes them even more competitive.

In the third macro area, the economic one, it was possible to identify only practices that are already practiced in the environmental aspect and also influence results in the economic aspect, which are: reuse or reduction of waste (67%), waste for recycling (46%), less use of paper (4%), use of raw materials with a lower rate of aggression (4%) and restoration of deposits that supply raw materials (4%).

In the last macro area, important practices for raising awareness about sustainability were observed, such as events, present in 13% of the companies, to generate greater engagement of internal and external customers regarding the sustainability theme. There are also projects for education about sustainability in 13% of these organizations. Silva *et al.* (2019) highlight the importance that companies have when instructing their employees in sustainable education, and for the author, this practice generates more citizens aware of sustainable aspects. Also point out that, in addition to training and developing employees, companies need to establish environmental education, including it in their mission, vision, and values, that is, they also need to transform their organizational culture (Silva; Castro; Américo-Pinheiro, 2019).

## Associated discussions

Jannuzzi *et al.* (2020), state that water is an extremely important natural resource and that its scarcity has a global impact. However the management of water resources, according to the author, is not always perceived as having such relevance. These actions contribute to the achievement of the goals of SDGs 6, 12, and 14. For example, goal 6.3: By 2030, to improve water quality, reduce pollution, eliminate dumping, and minimize the release of chemicals and hazardous materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally.

Marques *et al*. (2020) state that the sustainable practice of waste recycling is growing in Brazil. However, Santos and Marchesini (2018) point out that waste recycling, despite having several advantages, still has some limitations, which for the authors, go beyond low technology and few fiscal requirements, being a reluctance on the part of Brazilian culture. This practice is directly related to SDG 12, and its target 12.5 which aims to establish by 2030, to substantially reduce waste generation through prevention, reduction, recycling, and reuse.

However Pereira, Santos, and Manenti (2020) consider that the expansion of this sustainable energy still has obstacles, which for him are not in its efficiency, but the total cost of installing solar panels. Relating to the goals established by the UN, this practice is aligned with SDG 7 - Clean and accessible energy, where it is found: 7.2: By 2030, to substantially increase the share of renewable energy in the global energy matrix.

Corresponding with the UN SDGs, there is 15 - Terrestrial life: 15.2 By 2020, to promote the implementation of sustainable management of all types of forests, stop deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally. This high number is due, according to Lima *et al.* (2021), to a greater demand from society with companies, regarding their responsibility to the community. In this category, it was also possible to identify that 17% of the companies carry out continuous projects with the community where they operate, through workshops, and donations, among other actions that directly affect a portion of the local population.

For the community, Pinto e*t al.* (2020), claim that social technologies contribute to the development of communities. According to SDG - 10 Reduction of inequalities, is established in goal: 10.2 by 2030, to empower and promote the social, economic, and political inclusion of all, regardless of age, gender, disability, race, ethnicity, origin, religion, economic, or other status.

According to GBC (2019), in organizations that have a social and environmental alignment, practitioners of actions such as those observed in companies, also gain, as a consequence, a financial return, increasing earnings and also improving their business. This practice is related to SDG – 12 Responsible consumption and production established in SDG 12 topic c: to rationalize inefficient subsidies to fossil fuels, which encourage overconsumption, eliminating market distortions, according to national circumstances, and 12.7 Promote practices of sustainable public procurement, in line with national policies and priorities. 8.2 Achieve higher levels of productivity in economies through diversification, technological modernization, and innovation, including through a focus on high-value-added sectors and labor-intensive sectors.

This concept can be evidenced in SDG 4 - Quality Education, which presents 4.7. By 2030, to ensure that all students acquire the knowledge and skills necessary to promote sustainable development, including, among others, through education for sustainable development and styles of sustainable lifestyles, human rights, gender equality, promoting a culture of peace and non-violence, global citizenship and valuing cultural diversity and the contribution of culture to sustainable development.

Another important point is the certification of these companies, an aspect of paramount importance in the present study, as they aim to encourage sustainable development, in addition to collaborating with the valorization of certified buildings in the market (GBC, 2019). In contrast to this importance, only 21% of the companies studied have some certification regarding sustainability, awards, or their products with sustainability seals, which represents 2 companies out of the 24 analyzed. Such data suggests the lack of interest of these companies in the search for these certifications.

Certifications according to Kita (2018) are important allies when it comes to sustainability, because of the 169 goals proposed by the document “Transforming Our World: the 2030 Agenda for Sustainable Development”, 16 of them are covered by environmental certifications. According to the certifications, SDG 9 - Industry, innovation, and infrastructure, establishes that: 9.4 By 2030, to modernize infrastructure and rehabilitate industries to make them sustainable, with increased efficiency in the use of resources and greater adoption of technologies and industrial processes clean and environmentally friendly; with all countries acting by following their respective capabilities. Table 2 presents the summary of the relationships between the identified sustainable practices, the goals, and the corresponding SDGs.

Table 2 - **Overview of the relationship between practices, target and SDGs**

| Macro areas | Sustainable Practices in the civil construction sector in Brazil | Related target | SDG's UN |
|---|---|---|---|
| Environmental | Water treatment | 6.3: By 2030, to improve water quality by reducing pollution, eliminating dumping and minimizing the release of hazardous chemicals and materials, halving the proportion of untreated wastewater, and substantially increasing recycling and safe reuse globally.<br>12.4: By 2030, achieve environmentally sound management of chemicals and all waste, throughout their entire life cycle, following agreed international frameworks, and significantly reduce their release into the water. | 6 - Clean water and sanitation<br>12 - Responsible consumption and production |
| Environmental | Rainwater harvesting | | |
| Environmental | Optimization of water use | | |
| Environmental | Use of raw materials with a lower rate of aggression | 8.2 Achieve higher levels of productivity in economies through diversification, technological modernization, and innovation, including through a focus on high-value-added sectors and labor-intensive sectors.<br>9.4 By 2030, modernize infrastructure and rehabilitate industries to make them sustainable.<br>12.5 establishes that by 2030, to substantially reduce the generation of waste through prevention, reduction, recycling and reuse.<br>12.c: Rationalize inefficient subsidies to fossil fuels, which encourage overconsumption, eliminating market distortions, according to national circumstances.<br>12.7 Promote sustainable public procurement practices, in line with national policies and priorities. | 8 - Decent work and economic growth<br>9 - Industry, innovation and infrastructure<br>12 - Responsible consumption and production |
| Environmental | Restoration of deposits that provide raw material | | |
| Environmental | Reuse or reduction of Waste | | |
| Environmental, social and economic | Waste for recycling | | |
| Environmental, and economic | Less use of paper | | |
| Environmental | Methods that reduce the emission of gasses | 9.4 By 2030, to modernize infrastructure and rehabilitate industries to make them sustainable.<br>15.2 By 2020, to promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally. | 9 - Industry, innovation and infrastructure.<br>15 - Terrestrial life |
| Environmental | Reforestation | | |
| Environmental | Planting seedlings on construction sites | | |
| Environmental, and economic | Power generation by heat generation | 7.2: By 2030, to substantially increase the share of renewable energy in the global energy matrix. | 7 - Clean and accessible energy, where you can find it. |
| Environmental | Use of solar energy | | |
| Environmental | Decontamination | 15.2 By 2020, to promote the implementation of sustainable management of all types of forests, halt deforestation, restore degraded forests, and substantially increase afforestation and reforestation globally. | 15 - Terrestrial life |
| Social | Social responsibility | 4.7 By 2030, to ensure that all students acquire the knowledge and skills necessary to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and the contribution of culture to sustainable development. | 4 - Quality education |
| Social | Community projects | | |
| Extensive practices | Education for Sustainability | | |
| Extensive practices | The event focused on sustainability | | |
| Extensive practices | Sustainable Certification/ Sustainable Materials or Awards | 9.4 By 2030, to modernize infrastructure and rehabilitate industries to make them sustainable. | 9 - Industry, innovation and infrastructure. |

It is possible to notice that the Brazilian civil construction sector still has a lot to improve, because according to Figure 3, some practices still need to be implemented by civil construction companies, such as practices of using raw materials with a lower rate of aggression and restoration of deposits that provide the raw material that reached only 4% of the total number of companies analyzed and, consequently, are still unable to enhance their contributions to the launch of a more sustainable future, considering the achievement of the goals belonging to the SDGs proposed by the UN. Although the practices still have a relationship with the SDGs, other SDGs were not mentioned or visualized in the practices of the current scenario of Brazilian civil construction, such as the SDGs: 1, 3, 5, 10, 11, 13, 16, and 17. Also as already mentioned in Figure 3, Brazil still needs to improve its performance in terms of achieving the SDGs and most of them have a red indicator that warns that major challenges must be overcome to reach the goal.

# Conclusions

From the results presented here, it was possible to achieve the desired objectives for this research, that is, through the practices identified in the sustainability reports of each of the 24 organizations chosen for the sample presented here, an overview of sustainable practices was presented, that have been developed in the Brazilian civil construction market and that are directly related to the achievement of the SDGs proposed by the UN. It is important to highlight that, as the literature presented here points out, this sector has a considerable impact on the sustainability of its activities. Therefore, regulatory bodies must encourage sustainable practices so that finite resources are sufficient for the present generation and are maintained for future generations.

It is possible to perceive through the analysis of Figure 3, that a large number of companies in the sample of this study have practices present in the environmental and social aspect, with the highest occurrence in social responsibility practices, with 67%, followed by a reduction and reuse waste, with 63% of the active companies. Much is due to how they are perceived by consumers and thanks to the legal incentive to comply with these actions. However, it is also possible to identify that few companies have dedicated themselves to carrying out differentiated practices, such as certifications, which are so important in the sustainable construction market.

As the main point, this research presents the sustainable practices that have been adopted by construction companies and their relationship with the goals established by the UN 2030 Agenda. It is possible to observe initiatives in goals 4 – Quality education; 6 – Potable water and sanitation; 7 – Clean and affordable energy; 9 – Industry, innovation, and infrastructure; 10 – Reduction of inequality; 11 – Sustainable cities and communities, as well as the other goals that are represented with their target.

As seen in the results, there is already an initial movement on the part of companies to achieve sustainability goals, but globally, there is still a lack of direction and homogeneity in their application, mainly in maintaining the balance between the three pillars of sustainability. Through the analysis presented in this study, it was possible to see how the main concepts are being worked and disseminated in academia, as well as to explain sustainable practices in the civil construction sector, providing relevant information about companies, with emphasis on their investments, solutions and the sustainability tripod. It also demonstrates in practice how this implementation is happening, opening doors for new research in this sector, and promoting the benchmarking of sustainable development opportunities for this market. It is still very common to see buildings that do not follow sustainability standards, not taking advantage of natural light and ventilation, no water treatment or rainwater reuse, without analyzing the life cycle of materials and more lasting processes, and avoiding timely maintenance. Such changes will have direct impacts on the economic and commercial aspects of works that already adopt such sustainable concepts and put into practice the theory of the sustainability tripod.

It is important to highlight the incentive for the adoption of practices that involve social and economic aspects because as can be seen in the data collected, there is still a great lack of practices regarding these pillars of sustainability. Government incentives and greater publicity of such practices can contribute to their growth. As a research limitation, the exploratory character is highlighted, not being possible to generalize the results achieved to other contexts and regions in which the sample of analyzed companies do not carry out activities.

As a proposal for future studies, there would be great relevance for continuity on this subject, and related research, identifying the maturity of understanding and development of actions by Brazilian civil construction companies regarding their contributions to the achievement of sustainable development. Also of interest is how frameworks can be designed to enhance the insertion of sustainable guidelines in civil construction companies operating in Brazil.

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