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PRODUÇÃO DE PLACAS DE BAMBU RECICLADO BIODEGRADÁVEL: INVENTÁRIO DO CICLO DE VIDA (ICV)

PRODUCTION OF BIODEGRADABLE RECYCLED BAMBOO BOARDS: LIFE CYCLE INVENTORY (LCI)

PRODUCCIÓN DE TABLEROS DE BAMBÚ RECICLADO BIODEGRADABLE: INVENTARIO DEL CICLO DE VIDA (ICV)

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Resumo: O objetivo do presente estudo foi realizar um inventário de ciclo de vida qualitativo e avaliar os impactos do processo de produção de placas de bambu recicladas e biodegradáveis. Para tanto, estabeleceram-se os itens que compõem o escopo do processo produtivo, elaborou-se o fluxograma e definiram-se os aspectos de entrada e saída relacionados a cada etapa do processo; com base nisso, levantaram-se e avaliaram-se os impactos segundo os critérios de abrangência, severidade e frequência. A partir dos níveis de impacto obtidos, foi possível

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correlacionar o processo e seus efeitos aos Objetivos de Desenvolvimento Sustentável (ODS), proporcionando uma compreensão sistêmica. Os resultados indicaram que, na elaboração do inventário, houve predominância de aspectos geradores de impactos avaliados posteriormente como moderados, enquanto impactos desprezíveis foram minoria e não foram identificados impactos críticos. Ao correlacionar os impactos com os ODS, observou-se que os aspectos relacionados ao controle e monitoramento das etapas produtivas favorecem o pleno atendimento aos ODS ligados à inovação na indústria (ODS 9), viabilizando o uso em mobiliário urbano sustentável (ODS 11) e fundamentando-se na produção e no consumo conscientes (ODS 12). Tais perspectivas fornecem indicadores que possibilitam, futuramente, a racionalização de processos cujos impactos foram majoritariamente avaliados como desprezíveis.

Palavras-chave: Compósito biodegradável; Polímero; Bambu; Inventário de Ciclo de Vida.

Abstract: The aim of this study was to carry out a qualitative life cycle inventory and evaluate the impacts of the production process of recycled and biodegradable bamboo boards. To this end, the items that make up the scope of the production process were established, the construction of the flowchart was carried out, the input and output aspects related to each stage of the production process were established and based on them, the impacts were surveyed, where they were evaluated following the criteria of comprehensiveness, severity and frequency. From the levels of impacts obtained, it was possible to correlate the process and its impacts with the Sustainable Development Goals (SDGs) for a systematic understanding. The results indicated that, in the construction of the inventory, the aspects led to the predominance of impacts that were later evaluated as moderate, while negligible impacts were a minority and critical impacts were not found. Correlating the impacts with the SDGs, it was possible to note that the aspects related to the control and monitoring of the stages of the production processes, allow the fullness of the SDGs linked to innovation in the industry (SDG 9), allowing the use in sustainable urban furniture (SDG 11) and based on conscious production and consumption (SDG 12). These perspectives give indices that make it possible, in the future, to rationalize processes with impacts evaluated as negligible in their predominance.

Keywords: Biodegradable composite; Polymer; Bamboo; Lifecycle Inventory.

Resumen: El objetivo de este estudio fue realizar un inventario cualitativo del ciclo de vida y evaluar los impactos del proceso de producción de tablas de bambú recicladas y biodegradables. Para ello, se establecieron los ítems que componen el alcance del proceso de producción, se realizó la construcción del diagrama de flujo, se establecieron los aspectos de entrada y salida relacionados con cada etapa del proceso de producción y se basaron en ellos, se encuestaron los impactos, donde se evaluaron siguiendo los criterios de comprensividad, severidad y frecuencia. A partir de los niveles de impactos obtenidos, fue posible correlacionar el proceso y sus impactos con los Objetivos de Desarrollo Sostenible (ODS) para una comprensión sistemática. Los resultados indicaron que, en la construcción del inventario, los aspectos llevaron al predominio de impactos que luego fueron evaluados como moderados, mientras que los impactos insignificantes fueron minoría y no se encontraron impactos críticos. Correlacionando los impactos con los ODS, fue posible notar que los aspectos relacionados con el control y seguimiento de las etapas de los procesos productivos, permiten la plenitud de los ODS vinculados a la innovación en la industria (ODS 9), permitiendo el uso en mobiliario urbano sostenible (ODS 11) y basado en producción y consumo conscientes (ODS 12). Estas perspectivas dan índices que hacen posible, en el futuro, racionalizar procesos con impactos evaluados como insignificantes en su predominio.

Palabras clave: Compuesto biodegradable; Polímero; Bambú; Inventario del ciclo de vida.

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Contribuição dos autores segundo a Taxonomia CRediT

Sigla dos autores: Autor 1: Tiago Henrique da Costa Viana, THCV Autor 2: Iara Janaína Fernandes, IJF Autor 3: Carlos Alberto Mendes Moares. CAMM THCV: conceptualization, investigation, methodology, formal analysis, and writing – original draft. CAMM: project administration, formal analysis, resources, Writing – review amp; editing, conceptualizationand supervision and data curation. IJF: Investigation, methodology, visualization, and writing – review amp; editing.

Conflito de interesses

Declaração de conflitos de interesse.

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clo de vida y evaluar los impactos del proceso de producción de tableros de bambú reciclados y biodegradables. Para ello, se estableció el alcance del proceso de producción, se elaboró un diagrama de flujo y se definieron los aspectos de entrada y salida asociados a cada etapa; a partir de esto, se identificaron y evaluaron los impactos según criterios de alcance, gravedad y frecuencia. Los niveles de impacto resultantes permitieron establecer una correlación entre el proceso y los Objetivos de Desarrollo Sostenible (ODS), proporcionando una comprensión sistémica. Los resultados indicaron que el inventario estuvo dominado por aspectos que generaban impactos calificados posteriormente como moderados, mientras que los impactos insignificantes fueron minoritarios y no se identificaron impactos críticos. Al correlacionar los impactos con los ODS, se observó que los aspectos relacionados con el control y seguimiento de las etapas de producción favorecen la plena consecución de los ODS vinculados a la innovación industrial (ODS 9), permiten su uso en mobiliario urbano sostenible (ODS 11) y se fundamentan en la producción y el consumo responsables (ODS 12). Estas perspectivas aportan indicadores que facilitarán la futura optimización de aquellos procesos cuyos impactos se calificaron predominantemente como insignificantes.

Palabras clave: Compuesto biodegradable; Polímero; Bambú; Inventario del Ciclo de Vida.

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1 INTRODUCTION

Bamboo, an important grass massively present in the American and Asian continents, is known for its resistance characteristics and low specific mass (Poznyakov; Stolz; Qualharini, 2023). However, in the context of advanced environmental management tools, its property as a carbon sequestrator stands out, since it uses carbon dioxide present in the atmosphere, in the form of CO2, for its mass gain and conversion into C6H12O5 cellulose (Poznyakov; Stolz; Qualharini, 2023).

Considering bamboo use as an element in the sustainable chain in environmental management, it is verified that other factors must also be observed if the fullness of its potential is objective, in addition to environmental factors (Hernandes, 2015). When comparing the emissions for the transport of Chinese bamboo floors, it was possible to observe that 28,1% of the entire carbon sequestration potential was compromised when compared to 1,4% for the Brazilian eucalyptus floor, in direct analysis (Hernandes, 2015). This points to the need for the planning and management of environmental resources.

Projects and studies prove that management in the efficient use of resources is feasible by using environmental costs associated with the extraction of resources and their consequent processing (Perini; Palombini; Cidade, 2025). Such processes can be combined with the development of biopolymers and environmental management tools to reduce the consumption of natural resources and waste generation (Oliveira; Carbonari; Toralles, 2026).

Alongside waste management, there are other correlated factors. Social, by rethinking the issues, for example, of irregular waste disposal in housing areas (Tebaldi; Machado; De Abreu, 2025), in addition to technological factors related to project management tools, systemically considering the chain of resources and relative actions (Unes; Yamanaka; Araujo, 2025).

In order for the planning and management of environmental resources to fully occur and satisfactorily to the actors and the environment involved, there is a need for tools aimed at efficient management (Nobrega et al., 2019). Analyses of specific environmental impacts from life cycle analysis (LCA) make it possible to contribute to the identification and mapping of stages that have margins for improvement and potential given a managerial focus (Nobrega et al., 2019).

LCA then emerges as an intersection between design planning, engineering, logistics, and environmental development (Silva; Damineli, 2026). The application of this tool, analyzing quantitatively and qualitatively, allows an integration of steps for the feasibility of eco-efficient solutions (Silva; Damineli, 2026).

The integration also allows LCA to create structured and integrated models for the analysis of its metrics (Fernandes. Sousa, 2026). In conjunction with Building Information Modeling (BIM), for example, quantitative decarbonization metrics can be estimated throughout the development, in the design phase, of the construction stages of a project (Fernandes. Sousa, 2026).

Based on the mapping enabled by LCA, improvements can be identified in the management and use of resources across various production processes, including the manufacture of boards and panels (Freire et al., 2015). The literature points to a tendency, in the studies, to use the LCA method, so that it is possible to

evaluate the environmental impacts related to the production of the panels, also focusing on the extraction of the raw materials necessary for production, use of the panel and its final disposal (Freire et al., 2015).

In the use of raw materials, when considering the evaluation allowed by LCA, the construction sector meets with a large amount of funding and use of resources, in three major areas (Rey-Álvarez; Sánchez-Montañés; García-Martínez, 2026). In the chemical composition of materials, where many resources are based on natural inputs; in structures, where large volumes are required, and in the operationalization of constructions, where the technical operation reproduces a high energy and environmental demand (Rey-Álvarez; Sánchez-Montañés; García-Martínez, 2026).

From the perspective of the demand for natural resources used, it is then necessary to combine LCA with plant fibers (Enarevba; Thiele; Haapala, 2026). The LCA carried out for the structural use of hemp fiber, based on the inventory, considering logistics, consumption, and post-use stages, pointed to the feasibility of using emerging biobased materials: high volumetric generation yield, low processing energy demand, and large associated carbon capture (Enarevba; Thiele; Haapala, 2026).

It is also important to consider that the dimension of the need to rethink demands for resources and tools to analyze them transcends to the present and is corroborated in many of the areas of human experience (Kannan, et al., 2026). Using artificial intelligence (AI), disposable biodegradable wet wipes were designed from recycled fruit and vegetable waste and their respective fibers, and had their characterizations analyzed by AI, resulting in the feasibility of creating large-scale bioproducts with low environmental impact, for a circular approach to waste disposal (Kannan, et al., 2026).

With analyses of production processes and considering the use of bamboo, it is important to ensure the essentially sustainable nature of materials known as biomaterials. The analysis on the diffusion of bamboo in the civil construction sector, as a potential strategy for mitigating the impact of climate change, given its ecological character and appeal, highlights the importance of considering more robust models, interpolated through LCA, for the evaluation, analysis and verification of long-life biomaterials, based on bamboo, characterized as those employed in the civil construction sector and industries with similar potential (Caldas et al., 2020).

Therefore, the general objective of the present study is to carry out a qualitative life cycle inventory, limited to theoretical methodology and evaluate impacts of the production process of recycled and biodegradable bamboo boards. This is achieved through: building the inventory of environmental aspects involved in the production process of recycled and biodegradable bamboo boards; evaluating the environmental impacts of the production process of these plates; and correlating the assessment of impacts with the Sustainable Development Goals (SDGs).

2 METHODS

The methods adopted followed those set out in ISO 14040 (2006) and 14044 (2006) standards, in addition to the evaluation and management provisions in SGA Unisinos (2008), methodology certified according to the Environmental Management System (EMS) through ISO 14001.

Initially, the items that make up the scope of the production process were established, containing: i. Functional unit; ii. Type of border; iii. Process flowchart; iv. Inputs and outputs; v. Type of data and vi. Data sources. Considering, also, that for items v. and vi., a qualitative approach was adopted.

For the construction of the flowchart, the input and output processes were adopted, with a list of resources, raw materials and products generated. From the flowchart, it was possible to establish the input and output aspects related to each stage of the production process, through the flows and processes.

Based on the output aspects, environmental impacts were identified according to the criteria of comprehensiveness, severity and frequency (Table 1, 2 and 3). From the arithmetic sum of the scores of each item evaluated, the results of the impacts were obtained and classified (Table 4) as Negligible, Moderate and Critical.

From the levels of impacts obtained, it was possible to correlate the process and its impacts with the Sustainable Development Goals (SDGs) for a systemic understanding and for the construction of the Discussions.

Tabela 1 – Criteria used to evaluate Comprehensiveness.

Classification	Example	Score
May cause a localized impact around the place of occurrence	Generation of odors and domestic sewage; all aspects associated with the impact Health risk	1
May cause an impact that goes beyond the place of occurrence, but restricted to the limits of the industrial facility	Fire caused by flammable chemicals and chemical leakage/spillage	2
May cause regional impact, exceeding the limits of the industrial facility up to 100 km from its surroundings	Consumption of gases, use of materials, generation of waste, use of flammable chemicals	3
May cause regional impact exceeding 100 km from the limits of the industrial facility	Water and energy consumption and waste generation	4

Fonte: EMS Unisinos (2008).

Tabela 2 – Criteria used to evaluate Severity.

Classification	Score
Causes no damage	1
It causes slight damage with parameters above limits established by legislation or standards, however the impact ceases with the adequacy of the aspect via operational control	2
It causes severe damage with parameters above the limits established by legislation or standards, however, although the impact ceases with the adequacy of the aspect via operational control, the damage caused is irreversible and/or requires a structure external to the Industrial Facility in order to recover or mitigate the impact	4

Fonte: EMS Unisinos (2008).

Tabela 3 – Criteria used to evaluate Frequency.

Classification	Score
Periodicity of occurrence Semiannual or Greater	1
Frequency of occurrence Monthly	2
Frequency of occurrence Weekly	3
Frequency of occurrence Daily	4

Fonte: EMS Unisinos (2008).

Tabela 4 – Evaluation of impact scores and their results.

Score	Result
3	Negligible
4 to 6	Moderate
7 to 12	Critical

Fonte: EMS Unisinos (2008).

3 RESULTS AND DISCUSSIONS

3.1 Inventory scope and process flowchart

The scope of the inventory is seen in Table 5.

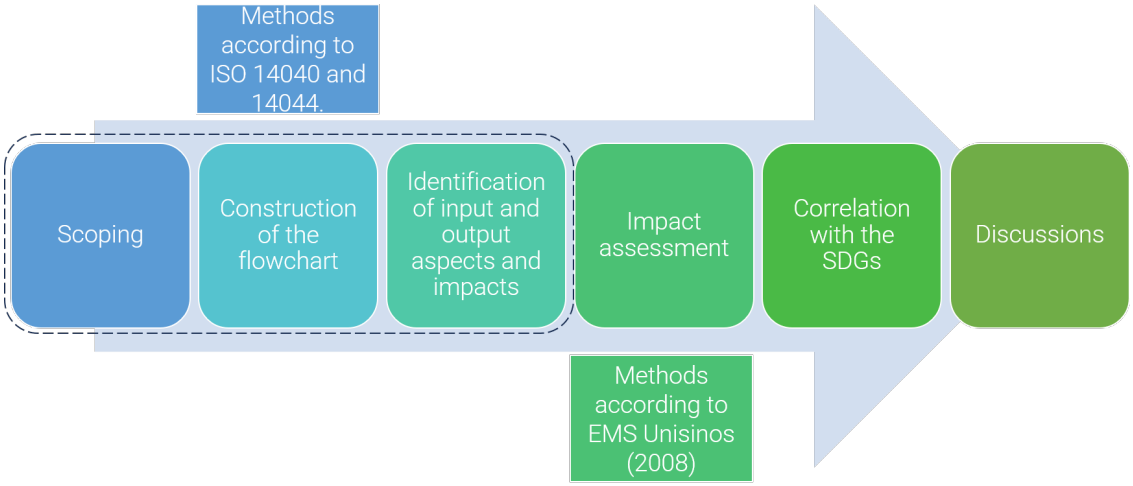
Tabela 5 – Scope of the inventory with information on the production process.

Data	Information
Functional Unit	Production of 1 m² of recycled composite
Border type	Cradle-to-gate (until the product board ready)
Process Flow Chart	Elaborated
Inputs and Outputs	Input and output aspects
Type of Data	Qualitative
Data sources	Qualitative

Fonte: EMS Unisinos (2008).

The process flowchart is seen in Figure 2. The raw materials, the bamboo in natura, the discarded chopsticks and the adopted polymer are expressed. The system border, as well as the product and outputs, is related to the resources, materials and energies used, as well as to the processes and flows identified in the analysis in question.

Figura 1 – Synthesis of the steps of the methods adopted



Source: Author (2025).

3.2 Input and output aspects

From the flowchart of Figure 2, the spreadsheet of input and output aspects was made, correlated through the relationship between input aspects, process performed, product generated and the output aspect referred to. Table 6 explains the aspects.

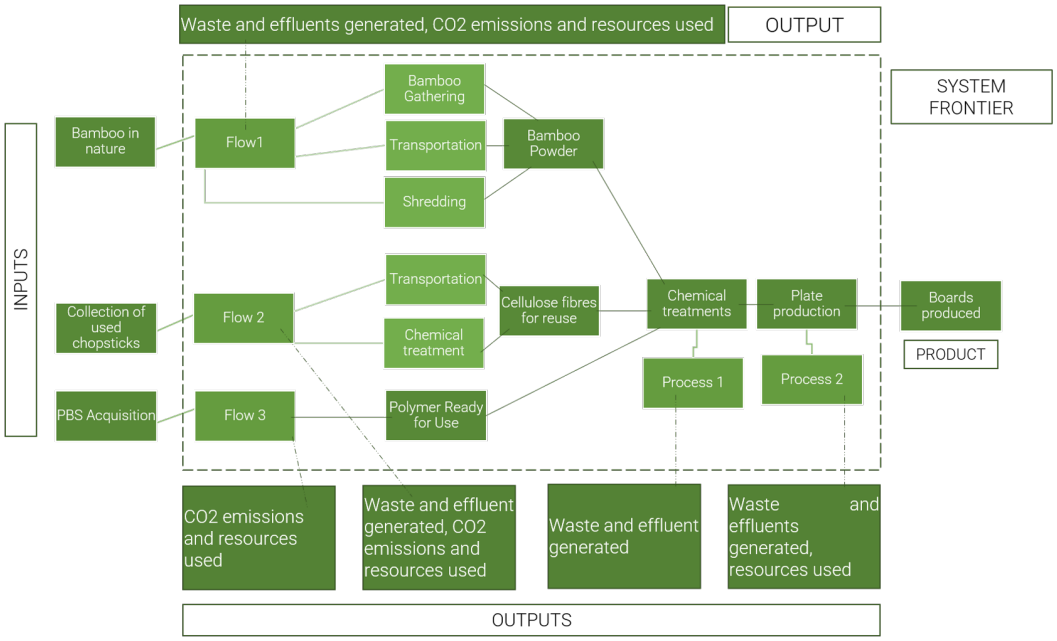
Tabela 6 – Input and output aspects for each identified process.

Input Aspect	Process	Product	Output Aspect
Fresh bamboo	Bamboo Gathering	Bamboo poles and culms	CO_2 emissions
Electricity	Bamboo Gathering	Bamboo poles and culms	Particulate matter emissions
Fuel	Bamboo Gathering	Bamboo poles and culms	Plant organic waste
Fuel	Bamboo Gathering	Bamboo poles and culms	Energy consumption
Fuel	Transportation	Transported material	CO_2 emissions
Electricity	Shredding	Shredded bamboo chips	Particulate matter emissions
Electricity	Shredding	Shredded bamboo chips	Energy consumption
Electricity	Shredding	Shredded bamboo chips	Plant organic waste
Discarded chopsticks after use	Chopstick collection and transport	Chopsticks collected and transported	Solid waste
Fuel	Chopstick collection and transport	Chopsticks collected and transported	CO_2 emissions

Input Aspect	Process	Product	Output Aspect
Storage Materials	Chopstick collection and transport	Chopsticks collected and transported	CO_2 emissions
Chemical Reagents	Chemical treatment	Cellulose fibres for reuse	Effluents
Chopsticks collected	Chemical treatment	Cellulose fibres for reuse	Solid waste
Chopsticks collected	Chemical treatment	Cellulose fibres for reuse	Energy consumption
Water	Chemical treatment	Cellulose fibres for reuse	CO_2 emissions/chemical vapours
Electricity	Chemical treatment	Cellulose fibres for reuse	Particulate matter emission
Fuel	Acquisition of Polybutylene succinate (PBS) and transport	PBS Ready to Use	CO_2 emissions
Electricity	Acquisition of Polybutylene succinate (PBS) and transport	PBS Ready to Use	Energy consumption
Raw material (bamboo powder, cellulose fibers and PBS)	Pre-production chemical treatments	Treated fibers ready for board production	Effluents
Electricity	Pre-production chemical treatments	Treated fibers ready for board production	Solid waste
Chemical Reagents	Pre-production chemical treatments	Treated fibers ready for board production	CO_2 emissions/chemical vapours
Chemical Reagents	Pre-production chemical treatments	Treated fibers ready for board production	Energy consumption
Water	Pre-production chemical treatments	Treated fibers ready for board production	Particulate matter emission
Electricity	Boards production	Recycled biopolymer boards	Effluents
Electricity	Boards production	Recycled biopolymer boards	Energy consumption
Water	Boards production	Recycled biopolymer boards	Solid waste
Raw material (bamboo powder, cellulose fibers and PBS)	Boards production	Recycled biopolymer boards	Particulate matter emission

Source: Authors (2025).

Figura 2 – Process flowchart with inputs, outputs, and product



Source: Author (2025).

3.3 Impacts and evaluation

From Table 6, the output aspects guided the related impacts, the basis of the evaluation carried out according to the criteria mentioned above. The decision making regarding the weights related to each evaluation is presented in Table 7.

Table 7 shows that the criteria adopted for the evaluation of the impacts allowed the calculation of the evaluation of the impacts and their respective results. All of Frequency were considering a production process for up to 4 years, the frequency of each stage would be unitary per semester. The score and its respective impact assessment are shown in Table 6.

Table 8 is noteworthy that only two aspects, in multiple stages, presented negligible impacts: emission of particulate matter and plant organic residues. While one is justified by the minimum amount produced, the other is verified in terms of the organic nature of bamboo as a vegetable grass.

For all other impacts, moderate impact potentials were identified, requiring monitoring and control of production processes to ensure that their occurrence does not lead to the realization of the full range of potential impacts.

Tabela 7 – Criteria adopted for decision-making regarding the weights adopted.

Output Aspect	Impact	Scope	Severity
CO2 emissions	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored
CO2 emissions	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored
Particulate matter emissions	Changing air quality	The potential impact on air quality, due to quantity, is low	The quantity does not justify the need for monitoring
Particulate matter emissions	Health risk	The potential impact on health, due to the quantity, is low	The quantity does not justify the need for monitoring
Plant organic waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The quantity does not justify the need for monitoring
Plant organic waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The quantity does not justify the need for monitoring
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS Unisinos (2008)	The quantity does not justify the need for monitoring
CO2 emissions	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored
CO2 emissions	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored
Particulate matter emissions	Changing air quality	The potential impact on air quality, due to quantity, is low	The quantity does not justify the need for monitoring

Output Aspect	Impact	Scope	Severity
Particulate matter emissions	Health risk	The potential impact on health, due to the quantity, is low	The quantity does not justify the need for monitoring
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS Unisinos (2008)	The quantity does not justify the need for monitoring
Plant organic waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The quantity does not justify the need for monitoring
Plant organic waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The quantity does not justify the need for monitoring
Solid waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Landfill occupation	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
CO2 emissions	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored
CO2 emissions	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored

Output Aspect	Impact	Scope	Severity
Effluents	Water contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Effluents	Soil contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Solid waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Landfill occupation	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS Unisinos (2008)	The quantity does not justify the need for monitoring
CO2 emissions/chemical vapours	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored
CO2 emissions/chemical vapours	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored
Particulate matter emission	Changing air quality	The potential impact on air quality, due to quantity, is low	The quantity does not justify the need for monitoring
Particulate matter emission	Health risk	The potential impact on health, due to the quantity, is low	The quantity does not justify the need for monitoring

Output Aspect	Impact	Scope	Severity
CO2 emissions	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored
CO2 emissions	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS Unisinos (2008)	The quantity does not justify the need for monitoring
Effluents	Water contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Effluents	Soil contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Solid waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Landfill occupation	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
CO2 emissions/chemical vapours	Greenhouse effect	The potential for greenhouse impact, due to the nature of the gas, is moderate	Levels need to be controlled/monitored

Output Aspect	Impact	Scope	Severity
CO2 emissions/chemical vapours	Health risk	The potential impact on health, due to the quantity, is low	Levels need to be controlled/monitored
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS Unisinos (2008)	The quantity does not justify the need for monitoring
Particulate matter emission	Changing air quality	The potential impact on air quality, due to quantity, is low	The quantity does not justify the need for monitoring
Particulate matter emission	Health risk	The potential impact on health, due to the quantity, is low	The quantity does not justify the need for monitoring
Effluents	Water contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Effluents	Soil contamination	The potential impact of contamination, due to its chemical nature, is moderate	Levels need to be controlled/monitored
Energy consumption	Use of non-renewable or scarce natural resources	Adopted by similarity to the exemplified scope of the evaluation by EMS	The quantity does not justify the need for monitoring
Solid waste	Soil contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Water contamination	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes
Solid waste	Landfill occupation	The potential for contamination, due to the nature of the material, is low	The amount justifies the need for monitoring to avoid extremes

Output Aspect	Impact	Scope	Severity
Particulate matter emission	Changing air quality	The potential impact on air quality, due to quantity, is low	The quantity does not justify the need for monitoring
Particulate matter emission	Health risk	The potential impact on health, due to the quantity, is low	The quantity does not justify the need for monitoring

Source: Authors (2025).

Tabela 8 – Impact assessment.

Output Aspect	Impacts	Abrasiveness	Severity	Frequency	Total	Result
CO2 emissions	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions	Health risk	1	2	1	4	Moderate
Particulate matter emissions	Changing air quality	1	1	1	3	Negligible
Particulate matter emissions	Health risk	1	1	1	3	Negligible
Plant organic waste	Soil contamination	1	1	1	3	Negligible
Plant organic waste	Water contamination	1	1	1	3	Negligible
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
CO2 emissions	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions	Health risk	1	2	1	4	Moderate

Output Aspect	Impacts	Abrasiveness	Severity	Frequency	Total	Result
Particulate matter emissions	Changing air quality	1	1	1	3	Negligible
Particulate matter emissions	Health risk	1	1	1	3	Negligible
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
Plant organic waste	Soil contamination	1	1	1	3	Negligible
Plant organic waste	Water contamination	1	1	1	3	Negligible
Solid waste	Soil contamination	1	2	1	4	Moderate
Solid waste	Water contamination	1	2	1	4	Moderate
Solid waste	Landfill occupation	1	2	1	4	Moderate
CO2 emissions	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions	Health risk	1	2	1	4	Moderate
Effluents	Water contamination	2	2	1	5	Moderate
Effluents	Soil contamination	2	2	1	5	Moderate
Solid waste	Soil contamination	1	2	1	4	Moderate
Solid waste	Water contamination	1	2	1	4	Moderate
Solid waste	Landfill occupation	1	2	1	4	Moderate

Output Aspect	Impacts	Abrasiveness	Severity	Frequency	Total	Result
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
CO2 emissions/chemical vapours	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions/chemical vapours	Health risk	1	2	1	4	Moderate
Particulate matter emission	Changing air quality	1	1	1	3	Negligible
Particulate matter emission	Health risk	1	1	1	3	Negligible
CO2 emissions	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions	Health risk	1	2	1	4	Moderate
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
Effluents	Water contamination	2	2	1	5	Moderate
Effluents	Soil contamination	2	2	1	5	Moderate
Solid waste	Soil contamination	1	2	1	4	Moderate
Solid waste	Water contamination	1	2	1	4	Moderate
Solid waste	Landfill occupation	1	2	1	4	Moderate

Output Aspect	Impacts	Abrasiveness	Severity	Frequency	Total	Result
CO2 emissions/chemical vapours	Greenhouse effect	2	2	1	5	Moderate
CO2 emissions/chemical vapours	Health risk	1	2	1	4	Moderate
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
Particulate matter emission	Changing air quality	1	1	1	3	Negligible
Particulate matter emission	Health risk	1	1	1	3	Negligible
Effluents	Water contamination	2	2	1	5	Moderate
Effluents	Soil contamination	2	2	1	5	Moderate
Energy consumption	Use of non-renewable or scarce natural resources	3	1	1	5	Moderate
Solid waste	Soil contamination	1	2	1	4	Moderate
Solid waste	Water contamination	1	2	1	4	Moderate
Solid waste	Landfill occupation	1	2	1	4	Moderate
Particulate matter emission	Changing air quality	1	1	1	3	Negligible

Output Aspect	Impacts	Abrasiveness	Severity	Frequency	Total	Result
Particulate matter emission	Health risk	1	1	1	3	Negligible

Source: Authors (2025).

3.4 Discussions

In light of the SDGs as basic and systemic elements for sustainable development, and considering the impacts, mostly observed as moderate of the production process in question, it is possible to weave the following constructions.

In SDG 9 (Industry, Innovation and Infrastructure), LCI highlighted that the use of recycled and processed bamboo fiber encourages clean production technologies, here understood as having less impact, thus enabling the production of boards to become a sustainable innovation (lower impact) in the materials and biomaterials industry.

In SDG 11 (Sustainable Cities and Communities) it is verified that the boards can be applied in urban furniture, lightweight constructions and sustainable architectural solutions, strengthening ecological urbanization policies and local waste management, once considered the raw materials in question to obtain the boards and their possibilities of use as a recycled biodegradable polymer.

In SDG 12 (Responsible Consumption and Production) it was possible to notice that the LCI revealed the environmental impacts of all stages, from extraction to the final product. This allowed mapping the potential to reduce emissions, optimize energy and improve the use of bamboo waste, since only two impacts were evaluated as negligible, all the others need monitoring to avoid the related extreme potentiality. In this way, recycled boards transform waste into value-added products, giving evidence of responsible production (and consumption).

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5 CONCLUSIONS

The process of building the inventory, evaluating impacts and correlating with the SDGs was satisfactory. The assessment showed us to note the predominance of impacts that were later evaluated as moderate, while negligible impacts were a minority and critical impacts were not found. Correlating the impacts with the SDGs, it was possible to note that the aspects related to SDG 9, SDG 11 and SDG 12. It was also possible to draw correlations with findings from other studies, and impacts were identified that revealed greater effects during the logistics and biomaterial treatment stages.

6 REFERENCES

CALDAS, L. R.; RODRIGUES, L. O.; GOMES, B. M. C.; FILHO, R. D. T. Potential for mitigating climate change with the use of bamboo culms in Brazilian civil construction. **Latin American Journal in Life Cycle Assessment**, v.4, e45188, 2020. DOI: <https://doi.org/10.18225/lalca.v4i0.45188>.

ENAREVBA, D. R.; THIELE, H. C.; HAAPALA, K. R. Addressing life cycle inventory data gaps for industrial hemp products and processes. **International Journal of Life Cycle Assessment**, v.31, p.152, 2026. DOI: <https://doi.org/10.1007/s11367-026-02726-w>.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. **ISO 14040: Environmental management — Life cycle assessment — Principles and framework**. Geneva: ISO, 2006.

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION. **ISO 14044: Environmental management — Life cycle assessment — Requirements and guidelines**. Geneva: ISO, 2006.

FERNANDES, P. R. B.; SOUSA, C. S. M. de. Sustentabilidade e Design Circular: o ciclo de vida dos calçados na indústria da moda. **Mix Sustentável**, Florianópolis, v.12, n.2, p.95-114, 2026. DOI: <https://doi.org/10.29183/2447-3073.MIX2026.v12.n2.95-114>.

FREIRE, A. L. F.; FIGUEIRÊDO, M. C. B.; ROSA, M. F.; ARAÚJO JÚNIOR, C. P. Environmental impacts of wood panels and derivatives: a literature review. **Revista Espacios**, v.36, n.10, p.3, 2015.

KANNAN, S.; KANNAN, T.; MUTHUPANDI, M. B.; MARIMUTHU, K. AI-driven development of biodegradable flushable wet wipes from upcycled household organic waste: formulation, performance, and predictive optimization. **Nordic Pulp and Paper Research Journal**, v.41, n.2, p.343-359, 2026. DOI: <https://doi.org/10.1515/npprj-2025-0072>.

HERNANDES, T. Z. Chinese bamboo flooring vs. Brazilian eucalyptus flooring: a comparative case study of greenhouse gas emissions in transportation. **Built Environment**, Porto Alegre, v.15, n.1, p.7-16, jan./mar. 2015. ISSN 1678-8621. DOI: <http://dx.doi.org/10.1590/S1678-86212015000100002>.

NÓBREGA, C. C.; CARVALHO, M.; GARCIA, H. R. M.; FORÉS, V. I.; BOVEA, M. D. Evaluation of the life cycle of selective collection of paper and cardboard in the Bessa nucleus, municipality of João Pessoa (PB), Brazil. **Sanitary and Environmental Engineering**, v.24, n.5, p.875-886, 2019. DOI: <https://doi.org/10.1590/S1413-41522019198702>.

KAMBLE, N. N.; KATE, G. K.; NAYAK, C. B. Sustainability Life Cycle Inventory for Residential Buildings: A Cradle to Grave Approach. **Macromolecular Symposia**, v.415, n.1, e70154, 2026. DOI: <https://doi.org/10.1002/masy.70154>.

OLIVEIRA, I. R. C.; CARBONARI, L. T.; TORALLES, B. M. Sustainable biopolymeric treatments in cementitious biocomposites: integrated review and technological perspectives. **Sustainable Mix**, Florianópolis, v.11, n.3, p.130-149, 2026. DOI: <https://doi.org/10.29183/2447-3073.MIX2025.v11.n3.131-150>.

PERINI, J. T.; PALOMBINI, F. L.; CIDADE, M. K. Sustainable Alloys in Contemporary Jewelry: a study on copper-silver compositions. **Sustainable Mix**, Florianópolis, v.11, n.3, p.83-94, 2025. DOI: <https://doi.org/10.29183/2447-3073.MIX2025.v11.n3.83-94>.

POZNYAKOV, K.; STOLZ, C. M.; QUALHARINI, E. Bambu – Environmental Impact as a carbon dioxide sequestrator. *In*: NATIONAL SYMPOSIUM ON URBAN ENGINEERING – SINGEURB, 4., 2023, Rio de Janeiro. Anais **[...]**. Rio de Janeiro: UFRJ, 2023.

REY-ÁLVAREZ, B.; SÁNCHEZ-MONTAÑÉS, B.; GARCÍA-MARTÍNEZ, A. A methodology for integrating toxic emission from building materials during the use stage into building life cycle assessment. **International Journal of Life Cycle Assessment**, v.31, p.131, 2026. DOI: <https://doi.org/10.1007/s11367-026-02703-3>.

RHARBI, N.; RADOINE, H.; EL ASLI, A.; ZGA, O.; MARTINEZ, A. G. Construction Materials' Inventory for Life Cycle Assessment in the African Context: Moroccan Case. 2026. **SIST**, v.113, p.275-285. DOI: <https://doi.org/10.1007/978-981-96-5069-9_24>.

RICO, M. A.; OLIVIERI, F.; BALAGUERA, A.; ZAPATA, L. F. Life Cycle Assessment of Green Wall Systems in the Built Environment: A Systematic Review of System Boundaries, Inventories, Methodological Gaps, and Design Implications. **Buildings**, v.16, n.13, e2627, 2026. DOI: <https://doi.org/10.3390/buildings16132627>.

SILVA, G. F. da; DAMINELI, B. L. Integração de BIM e ACV para Análises de Descarbonização: Método Simplificado aplicado a um Empreendimento de HIS. **Mix Sustentável**, Florianópolis, v.12, n.1, p.120-142, 2026. DOI: <https://doi.org/10.29183/2447-3073.MIX2026.v12.n1.120-142>.

TEBALDI, Y. N.; MACHADO, P. M.; DE ABREU, V. H. S. Irregular Disposal of Solid Waste in Offshore Areas: Its Problems and Perspectives. **Sustainable Mix**, Florianópolis, v.11, n.4, p.141-159, 2025. DOI: <https://doi.org/10.29183/2447-3073.MIX2025.v11.n4.141-159>.

UNES, J. A. C.; YAMANAKA, L.; ARAUJO, C. Environmental and social aspects in project management: an exploratory analysis based on the PMBOK and ICB guides. **Sustainable Mix**, Florianópolis, v.11, n.4, p.189-207, 2025. DOI: <https://doi.org/10.29183/2447-3073.MIX2025.v11.n4.189-207>.

UNIVERSITY OF VALE DO RIO DOS SINOS (UNISINOS). **Environmental Management System (EMS)**. São Leopoldo, 2008.