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Eco-efficiency Measures for Sustainability

Introduction

Bloem capsule was developed with the focus on using renewable materials, reducing waste, and creating a product that supports both people and the environment. Sustainability in this context means not only lowering environmental impact but also ensuring that the product remains useful, durable, and beneficial over time.

The Bloem project aligns with several United Nations Sustainable Development Goals (SDGs) **[1]** (see Figure 1).



Figure 1: All SDGs

Table 1 shows the United Nations Sustainable Development Goals that Bloem aligns with.

Table 1: Bloem SDGs

SDG	**Rationale**
SDG 3 — Good Health and Wellbeing	The capsule supports mental health and stress reduction by providing a dedicated space for relaxation and meditation.
SDG 8 — Decent Work and Economic Growth	It improves productivity by allowing users to recharge in work environments.
SDG 11 — Sustainable Cities and Communities	Designed for urban spaces, it promotes healthier and more human-centered environments.
SDG 12 — Responsible Consumption and Production	The capsule uses recyclable materials such as, and biodegradable materials like cork and hemp. Components can be recycled instead of becoming mixed waste.
SDG 13 — Climate Action	Materials such as cork and hemp help reduce carbon emissions due to their low embodied energy and carbon absorption properties.

Environmental

While considering the environmental performance of Bloem, priority was given to natural and renewable materials such as *cork*, *wood*, and *hemp*, all of which have significantly lower environmental impact compared to synthetic alternatives.

- Cork insulation is a key element, as it is harvested without cutting down trees, making it a highly renewable resource. It also absorbs carbon dioxide during its lifecycle and is fully recyclable and biodegradable. In addition, cork provides excellent thermal and acoustic insulation, which reduces the need for extra energy use inside the capsule.
- Hemp insulation further strengthens the environmental profile. It is a fast-growing, low-impact crop that requires minimal resources to produce. Hemp is fully biodegradable, recyclable, and breathable, helping regulate humidity and improve indoor air quality while preventing mold formation.
- The material layering is designed to maximize performance while minimizing environmental impact. Hemp is placed in the middle layer, where it is used to maximize the insulation of the capsule. Cork is used in the inner layer, where its superior acoustic and thermal insulation enhance user comfort while reducing the need for additional energy input, also it gives the inside of the capsule a very calming natural look. This combination improves efficiency without introducing extra materials or complexity
- Wooden framing and plywood components are also renewable and have a low carbon footprint. Wood stores carbon throughout its life and can be reused or recycled at the end of its use. Flexible plywood was specifically chosen for the shell because it allows curved shapes with minimal material waste, which is ideal for the capsule’s form.

Economical

From an economic perspective, Bloem is designed to be both cost efficient and durable. The selected materials, such as wood, cork, and hemp, are not only sustainable but also relatively affordable and widely available, which helps control production costs. Based on global market data, cork insulation typically ranges between 17 €/m² to 22 €/m², while hemp insulation is around 10–25 €/m², depending on thickness and supplier. Timber is commonly priced at approximately 400 €/m³ to 800 €/m³, which translates into low-cost structural elements when processed into smaller sections. These values are consistent with industry data reported by organizations such as GreenMatch **[2]** and Timberlot **[3]**.

Durability plays a major role in economic sustainability. Materials like plywood and solid wood provide strong structural performance, ensuring a long lifespan for the capsule. This reduces the need for frequent replacements and lowers long-term costs.

The modular design also contributes economically by allowing easy maintenance and part replacement. Instead of replacing the entire unit, individual components can be repaired or swapped, saving both materials and costs over time.

By combining multiple functions such as insulation, structure, and comfort into a limited number of materials, the design avoids unnecessary complexity and reduces overall resource consumption, making the product both economically and environmentally efficient.

Social

Bloem capsule is designed to create a positive and inclusive experience while supporting key social aspects such as community, education, equality, justice, social resources, health, well-being, and quality of life.

In terms of *community*, Bloem can be integrated into shared environments such as offices, universities, and public spaces, encouraging a culture that values mental health and mutual respect. It creates a supportive atmosphere where individuals feel encouraged to take breaks and recharge.

Regarding *quality education and quality of life*, the capsule provides a quiet space for focus, learning, and self-development. It can be used for mindfulness practices, or stress management, all of which contribute to improved learning conditions and overall life quality.

In terms of *equality* and *justice*, Bloem is designed as an accessible and universally usable space, offering equal opportunity for all users to benefit from rest and mental recovery, regardless of their role or background. This promotes fairness in shared environments.

The capsule also contributes to *social resources* by acting as a dedicated space that organizations can provide to support their users, improving the overall environment without requiring complex infrastructure.

A major focus is on *health* and *well-being*. Bloem directly supports mental health by reducing stress, fatigue, and burnout. The use of natural, non-toxic materials such as cork and hemp improves indoor air quality, creating a safe and comfortable environment for relaxation. Hemp is placed in the outer layer to enhance breathability and moisture regulation, while cork is used on the inner layer to improve acoustic insulation and thermal comfort, directly enhancing the user experience.

Overall, Bloem enhances quality of life by combining comfort, privacy, making it a socially sustainable solution that benefits individuals and communities alike.

Life Cycle Analysis

This Life Cycle Analysis (LCA) assessment of Bloem is guided by standardized LCA principles in accordance with ISO/TS 14072 **[4]**, ensuring a structured and consistent evaluation.

Raw material and production phase: The primary materials used wood, cork, and hemp are renewable and have relatively low embodied energy compared to synthetic alternatives. Cork and hemp contribute positively by absorbing CO_2 during growth, reducing the overall carbon footprint. Wood components also act as carbon storage throughout their lifespan. Additionally, the use of flexible plywood allows efficient shaping with minimal material waste. However, some impact is associated with processing (e.g., plywood manufacturing and adhesives), although this is limited by keeping material variety low.

Transportation and assembly: The lightweight nature of the selected materials reduces transportation emissions, minimizing the need for energy-intensive manufacturing processes and enabling easier distribution and installation.

Use phase: During operation, Bloem has minimal environmental impact. The combination of cork and hemp provides effective thermal and acoustic insulation, reducing the need for additional energy

input. The breathable hemp layer helps regulate humidity, while cork enhances comfort, contributing to a passive and energy-efficient system.

Maintenance and lifespan: The use of durable materials such as plywood and solid wood ensures a long product lifespan. The modular design allows individual components to be repaired or replaced instead of discarding the entire unit, reducing material consumption over time.

End-of-life phase: At the end of its life cycle, Bloem is designed for disassembly. Wood components can be reused, repurposed, or biodegraded; cork and hemp insulation are fully biodegradable or recyclable; and metal connectors can be recycled without loss of quality. The limited use of adhesives improves the ability to separate materials, supporting a circular lifecycle approach.

Overall, the LCA demonstrates that Bloem minimizes environmental impact through renewable materials, efficient design, low operational energy demand, and high end-of-life recoverability.

Summary

Bloem capsule demonstrates a balanced approach to sustainability by combining renewable materials, efficient design, and user-focused functionality. Its use of cork, hemp, and wood reduces environmental impact while ensuring durability, recyclability, and comfort.

Consequently, the team decided to design a solution with the following features: use of recyclable and biodegradable materials, efficient insulation to reduce energy use and more privacy. And in the next chapter we will discuss the ethical and deontological concerns Of Bloem.

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[1] Sustainable Development Goals. *UNDP*, 2025.
[2] Eco-Friendly Insulation Materials. *GreenMatch*, 2025.
[3] Joinery Timber Price List (3–40m3). *Timberlot*, 2025.
[4] ISO 14072:2024 | Environmental management — Life cycle assessment — Requirements and guidance for organizational life cycle assessment. *ISO*, 2024.

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