

From Invasive Species to Interior Innovation: Feasibility and Market Acceptance of ‘Lake Board’ Composites

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Abstract---The aggressive proliferation of invasive aquatic weeds, such as Water Hyacinth (*Eichhornia crassipes*) and Cattail (*Typha spp.*), creates a major ecological challenge and generates a substantial organic waste stream with limited current value. The conversion of this abundant lignocellulosic biomass into composite boards for interior finishes, marketed as ‘Lake Board,’ presents a promising pathway toward ecological remediation and circular-economy material innovation. Existing research, however, predominantly focuses on basic mechanical feasibility while overlooking the interior-specific performance metrics—such as surface finishability, machinability, and long-term hygroscopic stability—that are crucial for market adoption by designers and manufacturers. The aim of this research is to evaluate the technical viability of Cattail and Water Hyacinth as raw materials for interior-grade composite boards by analyzing their structural potential and market suitability. A preliminary user survey established a strong 90% positive interest in the Lake Board concept, driven primarily by the material’s potential for lake restoration. Critically, user adoption is conditional on material performance, with Strength and Durability (52.6% priority) and mitigation of Moisture Damage (45% concern) identified as the highest priorities for consumer trust, surpassing the eco-friendly factor alone. This paper validates the need for empirical material testing to meet industry performance standards, which is necessary to translate strong market curiosity into successful commercial adoption.

Index Terms---Water Hyacinth; Cattail; Lignocellulosic Composites; Interior Design; Circular Economy; Material Viability

Introduction

The interior finishes and construction industries are under increasing pressure to adopt materials that reduce embodied carbon and minimize reliance on virgin resources. Engineered wood products, such as Medium-Density Fiberboard (MDF) and particleboard, remain staple materials but contribute to global resource depletion. Concurrently, environmental issues caused by the aggressive proliferation of invasive aquatic weeds—particularly *Eichhornia crassipes* (Water Hyacinth) and *Typha spp.* (Cattail)—have led to ecological disruption and the generation of significant amounts of waste biomass from large-scale removal operations.

This waste biomass contains lignocellulosic fibers comparable to those used in conventional composite board manufacturing. The potential to repurpose this ecological nuisance into a

sustainable, bio-based interior panel, conceptually named ‘Lake Board,’ offers a significant opportunity to link environmental restoration with sustainable material innovation.

The core challenge is a research gap between proven material *feasibility* and commercial *acceptability*. While basic structural potential has been noted, there is a lack of empirical evidence regarding the specialized material finish and performance properties required by the interior design market. To achieve commercial acceptance, the board’s performance must be quantitatively benchmarked against commercial standards for interior applications, focusing on metrics such as Modulus of Rupture (MOR), Internal Bond (IB), and Thickness Swelling (TS).

Aim and Objectives

The primary aim of this research is to scientifically evaluate the technical and market viability of Cattail and Water Hyacinth biomass as raw materials for the fabrication of interior-grade composite boards. The main objectives are to:

- Characterize the chemical and physical properties of the raw fibers.
- Develop prototype composite boards using optimized fiber–resin ratios.
- Conduct comprehensive mechanical, physical, and hygroscopic testing (MOR, MOE, IB, TS) per IS/ASTM standards.
- Evaluate surface finishability, machinability (fastener holding), and suitability for lamination.
- Benchmark the weed-based boards against established commercial MDF/particleboard.

Literature Review and Gap Analysis

Foundational studies have established the basic technical viability of utilizing aquatic weeds in composite materials. Research by Guna et al. (2020) confirmed that Water Hyacinth fibers can be used to produce boards that achieve acceptable mechanical properties for low-load applications, although they specifically highlighted a major limitation: high Moisture Absorption and Thickness Swelling (TS) [1]. Similarly, Cattail fiber possesses a high percentage of cellulose and hemicellulose, with isolated fibers exhibiting high tensile strength, suggesting structural comparability to conventional wood fiber [2]. The literature supports that using a hybrid formulation (Cattail + Water Hyacinth) and applying chemical pre-treatment can improve fiber-resin interfacial bonding and lead to superior composite properties [3].

Identified Research Gap

Despite positive indications, a critical research gap remains: the lack of focus on interior-specific, design-oriented metrics. Existing work fails to provide sufficient data on:

- **Aesthetic and Finishability Metrics:** Quantitative analysis of surface roughness, paint/veneer adhesion, and finish quality.
- **Machinability:** Empirical data on fastener-holding capacity and edge machining performance—essential for cabinet and furniture construction.
- **Benchmarking:** Comprehensive composite-level validation where the final board’s performance is directly tested and compared to commercial MDF/Particleboard products under relevant IS/ASTM standards.

This study is designed to bridge this gap, moving beyond basic feasibility toward establishing the quantitative performance and aesthetic acceptance required for successful entry into the interior design market.

Research Methodology

Proposed Lake Board Fabrication Process

The theoretical material processing for Lake Board involves four distinct steps to transform raw aquatic weed biomass into a durable composite panel for interior use. This process is the operationalization of the circular-economy model for this material.



Fig. 1. Schematic outline of the proposed circular-economy process for converting invasive aquatic weed biomass into value-added composite Lake Board panels.

Table 1. Four-Step Process for Lake Board Composite Fabrication

Four-Step Process for Lake Board Composite Fabrication
1. Harvest and Dry: Mechanical harvesting of Water Hyacinth and Cattail, followed by natural or controlled drying to a stable moisture content.
2. Shred and Bind: Mechanical defibrillation of the fibers, application of an optional chemical pre-treatment (e.g., Alkali Wash) to improve bonding, and thorough blending with a low-VOC, non-toxic resin system.
3. Press and Cure: Hot-pressing of the fiber-resin mat under optimized parameters (temperature, pressure, time) to achieve the target density and mechanical strength.
4. Finish and Protect: Trimming, calibration sanding to achieve the desired surface smoothness, and application of protective surface coatings or laminates to enhance moisture, fire, and termite resistance.

Market Viability Survey and Hypotheses

An initial market viability survey targeted a balanced audience, including Interior Designers (30%) and Home Owners (30%), to measure initial interest, adoption drivers, application preferences, and primary concerns. This data forms the basis for the following testable hypotheses.

- **H1 (Performance):** Lake Board will show strength comparable to commercial MDF/Plywood for interior applications. *Testability: Measured by MOR, MOE, and screw-holding capacity.*
- **H2 (Moisture Resistance):** Lake Board will show acceptable moisture resistance for interior applications. *Testability: Measured by Water Absorption %, Thickness Swelling (TS%), and IB strength after immersion.*
- **H3 (User Acceptance):** Designers and homeowners will accept Lake Board if quality matches MDF/Plywood. *Testability: Measured by user preference ratings based on technical data and aesthetic evaluation.*
- **H4 (Environmental Benefit):** The environmental benefit of removing lake weeds will increase the willingness to use Lake Board. *Testability: Measured by survey responses on the influence of sustainability on adoption, which was supported by 75% of respondents strongly agreeing.*

Results and Discussion

Market Interest and Environmental Drivers

Despite 65% of respondents being initially unfamiliar with the material concept, there was an overwhelmingly positive initial reaction, with 90% expressing “Very interesting” or “Needs more info.” This strong initial interest is fundamentally driven by the environmental narrative. The core motivator for potential adoption was identified as the material’s positive environmental impact (100% Yes), with the name ‘Lake Board’ successfully conveying ‘Eco-friendly’ (60%) and ‘Affordable alternative’ (25%). This finding confirms that the ecological restoration aspect is a crucial and powerful external driver for market engagement.

Performance Priorities and Adoption Conditions

The market survey data reveals a crucial requirement for commercial success: performance must meet sustainability. When asked about the critical factors for final adoption, Strength and Durability was the top priority, selected by 52.6% of respondents, while the Eco-friendly factor was selected by only 15.8%. This disparity indicates that while sustainability attracts attention, robust technical performance determines the purchase decision. The top three intended applications—Wall Panelling (30%), Wardrobes (30%), and Kitchen Cabinets (25%)—all confirm the requirement for an interior-grade, non-load-bearing panel that offers a good surface finish and adequate fastener holding.

Table 2. Summary of Critical Adoption Priorities and Concerns from the Market Survey

Factor	Adoption Priority (%)	Concern (%)
Strength and Durability	52.6% (Top Priority)	45% (Top Concern)
Moisture Damage	N/A	45% (Top Concern)
Eco-friendly	15.8%	N/A
Termite Safety	N/A	20%



Fig. 2. Market validation of research objectives, showing that users prioritize performance (Strength/Durability) and are most concerned about material instability (Moisture Damage).

The highest user concerns—long-term strength (45% concern) and moisture resistance (45% concern)—directly validate the focus of the planned laboratory research (H1 and H2). Furthermore, 40% of users conditioned their adoption on the completion of long-term testing and the provision of Lab Test Results and Real-life Project Examples. This underscores the necessity of a data-driven approach to technical validation before scaling.

Survey Analysis

1. Strong Environmental Appeal. The survey confirms high market readiness, with 90% of respondents expressing strong interest, driven almost entirely by the ecological benefit of lake restoration. The “restorative” nature of the material serves as its primary differentiator in the market.

2. Pragmatic Adoption. Despite the ideological appeal, adoption is conditional. 52.6% of respondents prioritize durability over sustainability, indicating that while the environmental story generates interest, mechanical reliability determines the purchase. The market demands empirical proof of moisture resistance and strength to overcome “eco-material” skepticism.

3. Defined Use Case. Respondents view Lake Board primarily as a non-structural finishing material. 60% favor it for wall panelling and wardrobes, showing a clear hesitation to use it in structural or high-moisture applications without further technical validation.

Conclusion. *The study validates that Lake Board is commercially viable only if laboratory testing confirms it meets standard performance benchmarks. The market is ready to adopt, but requires physical evidence to bridge the gap between interest and trust.*

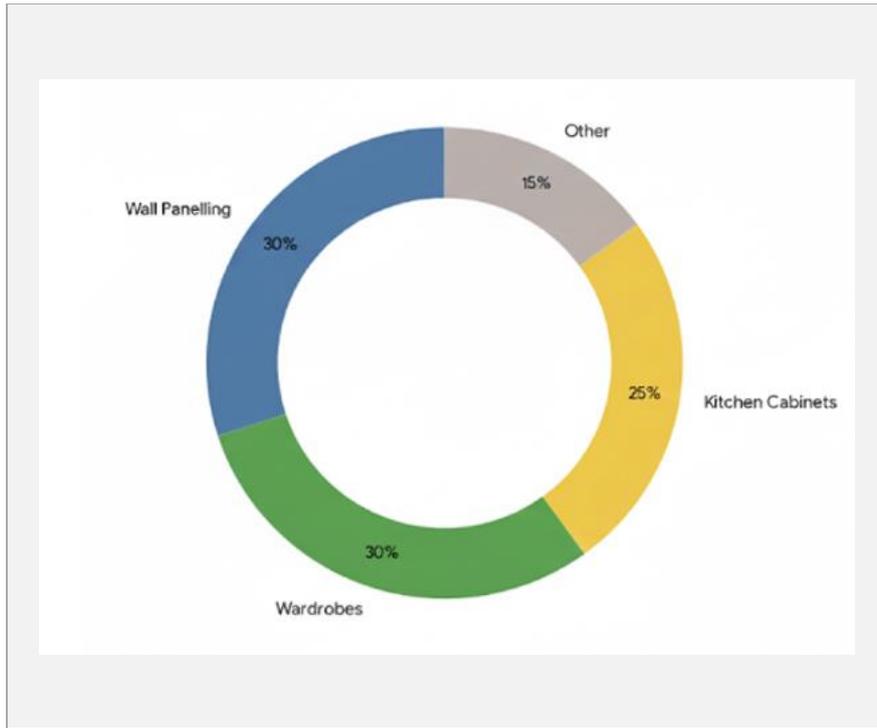


Fig. 3. Donut chart showing preferred applications: 60% of users prefer Lake Board for Wardrobes and Wall Panelling, confirming its fit as a non-structural interior material.

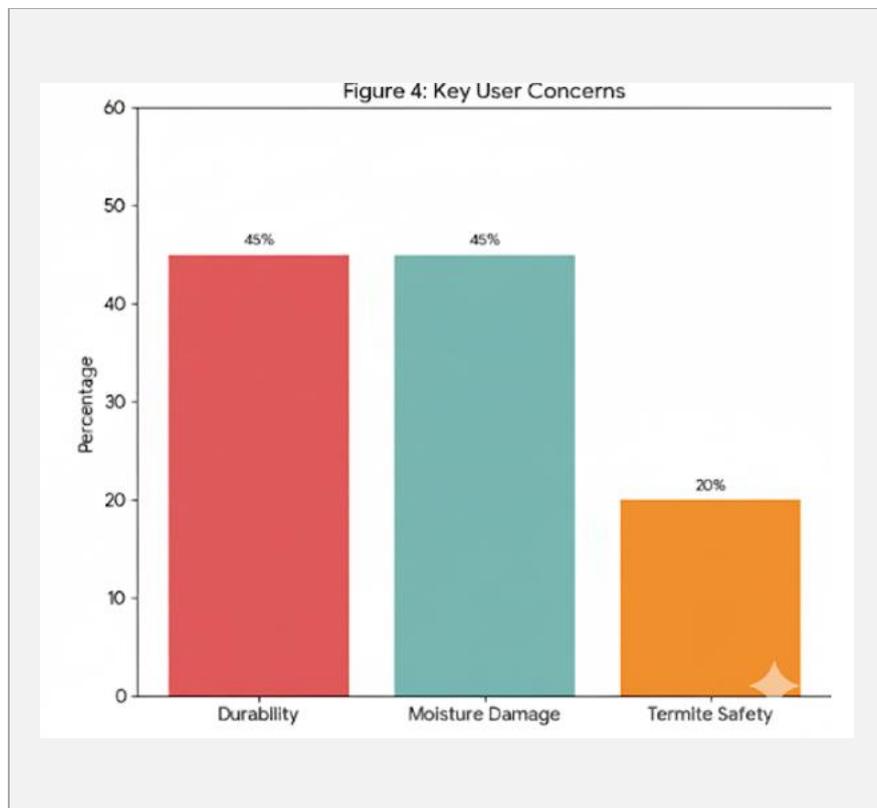


Fig. 4. Bar chart highlighting that Durability and Moisture are the top user concerns (45% each), directing focus of laboratory testing.

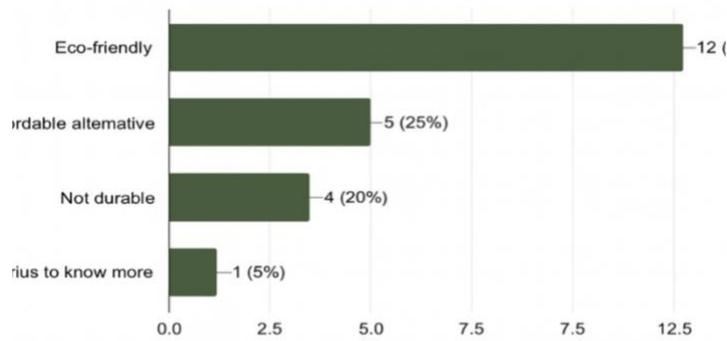


Figure 5: Initial Perception of Lake Board Among Users

Fig. 5. Key user concerns: 60% of respondents associated ‘Lake Board’ with being eco-friendly, showing strong positive perception of sustainable materials

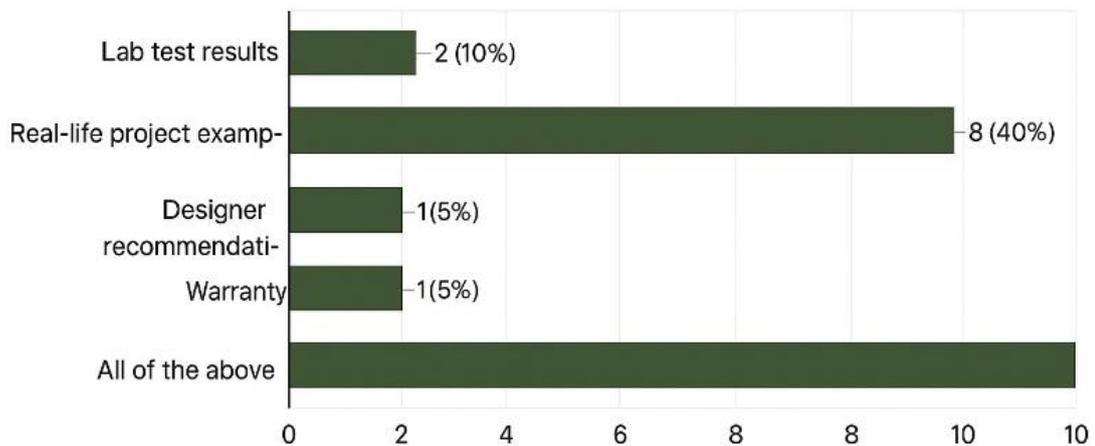


Figure 6 illustrates factors that respondents consider most important for trusting the new material. All of the above

Figure 6 illustrates the factors that respondents consider most important for trusting the new material. “All of the above” received the highest selection (50%), followed by real-life project examples (40%). Lab test results, designer recommendations, and warranty were selected by only a small proportion of respondents.

Conclusion

The initial market assessment for ‘Lake Board’ demonstrates a high degree of user interest and acceptance, strongly underpinned by the concept of utilizing invasive aquatic weeds for ecological restoration. This environmental narrative is a powerful tool for initial engagement.

However, the research confirms that this environmental advantage alone is insufficient for commercial success. The market demands that Lake Board must first meet or exceed the performance benchmarks of conventional interior materials. The critical user concerns regarding durability and moisture resistance provide clear direction for the subsequent technical phase of the research.

The next steps must focus on rigorous material characterization and mechanical testing of the hybrid Cattail and Water Hyacinth board formulations. Successful validation of performance metrics, including MOR, IB, and TS%, will allow Lake Board to transition from a promising sustainable concept into a viable, publishable, and commercially successful alternative for modern interior architecture.

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