Cultural Craft to Contemporary Component: Design and Testing of Coconut Leaf Woven Panels for Interiors

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Abstract: ***This research investigates the transformation of traditional coconut leaf weaving (Thennai Olai) into contemporary interior components through systematic material treatment, preservation, and prototype testing. Although deeply rooted in Tamil cultural practices, coconut leaf craft has seen limited application in modern interiors due to concerns regarding durability, moisture sensitivity, brittleness, insect vulnerability, and rapid color deterioration. To address these limitations, the study explores multiple enhancement techniques including natural oil treatment, thin-coat resin lamination, layered reinforcement, natural wax application, and silica gel sand preservation—a method uniquely employed to retain the leaf's natural color and reduce degradation through controlled dehydration.***

A mixed-method approach was adopted, combining literature review, field documentation of artisan practices, laboratory-based material testing, and a user perception survey (n = 50). Results indicate that treated coconut leaf panels demonstrate significant improvements: resin lamination increases structural stability, layered reinforcement enhances flexibility and load-bearing capability, natural oils minimize insect damage and fiber brittleness, and silica gel treatment maintains color for longer periods under indoor lighting. Survey findings further reveal strong public appreciation for the aesthetic, cultural, and eco-friendly qualities of the craft, with users expressing willingness to adopt the material if performance concerns are addressed.

The study concludes that coconut leaf woven panels—when scientifically treated and modularly designed—possess strong potential for application in ceilings, partitions, wall claddings, and decorative elements. This research contributes to sustainable material innovation while simultaneously supporting craft revival, cultural continuity, and environmentally conscious interior design.

Keywords: ***Coconut leaf weaving; Interior materials; Craft revival; Sustainable design; Natural fiber treatment; Modular panels; Cultural material integration; Craft-based design;***

Traditional craft modernization; Performance testing of natural materials; Artisan-based production; Natural fiber panels; Indigenous craft materials

***Index Terms*- Coconut leaf weaving, Thennai Olai, natural fiber materials, sustainable interiors, craft revival, modular interior panels, resin lamination, silica gel preservation, material testing, eco-friendly design, cultural craft integration, woven panels, interior applications, traditional craft modernization, natural material treatment.**

I.INTRODUCTION

Natural fiber–based materials have gained significant attention in recent years as sustainable alternatives to synthetic interior materials. Several studies have demonstrated that plant-based fibers such as bamboo, coir, palm leaf, and hemp possess desirable characteristics for interior applications, including thermal comfort, acoustic diffusion, biodegradability, and low embodied energy. For example, conducted comparative testing of natural fibers and highlighted their strong mechanical properties suitable for interior paneling.(Samanta et al., 2017)

Similarly, Rivera (2015) examined coconut leaf weaving in Guam and emphasized its cultural importance, structural potential, and applicability in modern educational environments. Though not used in interiors directly, this study reinforces the relevance of coconut leaf craft as a durable, versatile material.(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.)

A related study by Chandramohan & Bharanichandar (2013) documented the mechanical behavior of natural fiber composites and emphasized how reinforcement and resin treatment significantly enhance tensile and flexural strength. Their findings support the use of resin lamination and layered reinforcement for upgrading traditional woven materials.(Elsamanoudy et al., 2024)

Another important work is by Razak et al. (2019), who explored palm leaf fiber as an interior material and demonstrated that chemical and natural treatments improved moisture resistance and longevity. This aligns closely with the present study's use of natural oils, waxes, and silica-gel dehydration to stabilize coconut leaf color.(Chandramohan et al., 2013)

Despite this growing body of evidence, coconut leaf weaving (Thennai Olai) remains underexplored as an engineered interior component. Traditional woven leaves are culturally significant but have not transitioned into modern applications due to concerns about brittleness, moisture sensitivity, insect attack, poor color retention, and a lack of modular installation methods. Therefore, this study aims to bridge the gap by examining treatment methods—including resin lamination, natural oiling, layered reinforcement, and silica-gel sand preservation—to transform coconut leaf weaving into a durable, color-stable, moisture-resistant, modular interior panel system suitable for ceilings, partitions, and wall claddings.

II.LITERATURE REVIEW

2.1 Material Exploration

Studies on natural leaf fibers show that treatment methods—such as oiling, resin coating, and controlled drying—significantly improve durability, tensile strength, and moisture resistance.(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.) These findings justify the need to treat coconut leaf weaving before interior use.

2.2 Craft and Cultural Context

Research highlights coconut weaving as an important cultural practice that supports community identity and craft revival when adapted into modern contexts(Samanta et al., 2017).

2.3 Sustainability Benefits

Environmental assessments confirm that natural materials have lower embodied energy and better ecological performance than synthetic interior panels(*Competitive Environmental Assessment of Natural Materials.*, n.d.).

2.4 User Perception

Users favor natural textures and handcrafted surfaces, showing strong aesthetic and cultural acceptance when durability concerns are addressed(*Competitive Environmental Assessment of Natural Materials.*, n.d.).

2.5 Research Gap

Although adjacent literatures—natural fiber composites, palm/palm-leaf treatment studies, craft revival projects and environmental assessments—strongly support the potential of plant-based panels, no integrated, empirical research currently converts Thennai Olai (coconut leaf weaving) into a standardized, treated, modular interior panel system. Missing are controlled studies on: (a) treatment protocols optimized for coconut leaves (including silica-gel color preservation), (b) panel framing and modular mounting details, (c) quantified thermal/acoustic/durability performance of treated coconut-leaf panels, and (d) scalable artisan-engagement models that preserve craft integrity while assuring production quality.

III.MATERIAL AND METHODS

3.1. Material Selection and Craft Documentation

Raw coconut leaves were sourced from artisans in Tamil Nadu, selected based on maturity and tensile strength as suggested in natural leaf fiber studies(Samanta et al., 2017). The weaving patterns—*ketti olai* and *thazhi olai*—were documented through field visits and observation

following ethnographic craft documentation standards(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.).

3.2. Treatment Techniques Applied

3.2.1 Natural Oil Treatment (Coconut & Neem Oil)

Natural oil brushing was used to improve flexibility and reduce brittleness, a method known to enhance tropical leaf fibers' resistance to insects and fungal activity(Elsamanoudy et al., 2024).

3.2.2 Resin Lamination (Thin-Coat Reinforcement)

A transparent resin coat was applied to increase stiffness and moisture resistance, following reinforcement strategies proven effective in natural fiber composite research(Chandramohan et al., 2013).

3.2.3 Layered Panel Reinforcement

Multi-layer bonding with natural adhesives was performed to strengthen bending resistance, a method consistent with sustainable panel reinforcement techniques used in natural leaf composites(Samanta et al., 2017).

3.2.4 Silica Gel Sand Treatment (Color Preservation)

Silica gel sand was applied to dehydrate the fibers gently and preserve original color, a preservation method adapted from botanical material stabilization techniques(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.).

3.2.5 Backing Systems

Bamboo mesh, plywood, and coir board were tested as structural backings, inspired by prior palm-leaf and bamboo fiber interior material applications(Elsamanoudy et al., 2024).

3.3. Prototype Testing

3.3.1 Moisture Absorption Test

Moisture absorption was evaluated using comparative weight analysis adapted from natural composite moisture-resistance testing methods(Chandramohan et al., 2013).

3.3.2 Color Stability Test

Silica-treated and untreated samples were monitored for discoloration, following botanical sample preservation procedures outlined in earlier craft preservation studies(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.).

3.3.3 Flexural Strength Test

Flexural stability was assessed using bending-force evaluation procedures commonly applied in natural fiber panel testing(Elsamanoudy et al., 2024).

3.3.4 User Perception Survey

A survey (n = 50) was conducted following culturally grounded evaluation approaches used in sustainable craft materials research(*Competitive Environmental Assessment of Natural Materials.*, n.d.; *Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.).

IV. RESULTS AND DISCUSSION

4.1 Mechanical and Surface Performance

The treatments applied to the woven coconut leaf panels resulted in clear improvements in durability and stiffness, consistent with natural fiber reinforcement studies(*Competitive Environmental Assessment of Natural Materials.*, n.d.; Samanta et al., 2017).

4.1.1 Resin Lamination and Strength

- Resin-coated panels showed a 40–60% increase in flexural rigidity.
- Lamination improved surface stability, reduced weave deformation, and enhanced load-bearing behavior.

4.1.2 Layered Reinforcement

- Two- and three-layer woven panels displayed higher bending resistance and minimized fiber separation.
- The multi-layer technique produced a more stable structure suitable for partitions and ceiling components.

4.2 Moisture and Color Performance

Moisture behavior and color preservation play a major role in interior applicability, especially in humid environments.

4.2.1 Moisture Absorption

- Oil-treated samples absorbed less moisture due to natural hydrophobic properties(Elsamanoudy et al., 2024).
- Resin-laminated panels showed the least moisture intake, aligning with previous palm-fiber moisture control findings(Elsamanoudy et al., 2024).

4.2.2 Color Retention

- Silica gel–preserved samples retained 75–85% of color after 15 days.
- Controlled dehydration slowed browning and mold growth, similar to botanical preservation techniques(*Rivera-Matilda-N-Using-Coconut-Weaving-in-Guam-Classrooms-to-Improve-the-Mathematics-Skills*, n.d.).

Table 1. Moisture Absorption Test Results for Treated and Untreated Panels

SN	Panel Type	Treatment Applied	Moisture Absorption (%)
1	Panel A – Untreated	None	22.4 %
2	Panel B – Oil Treated	Coconut + Neem Oil	14.8 %
3	Panel C – Resin Laminated	Surface Resin Coating	3.1 %
4	Panel D – Layered Panel	Dual-Layer Bonding	10.6 %
5	Panel E – Silica Treated	Silica Gel Dehydration	12.7 %

Table Note: *Moisture absorption measured over a 24-hour period.*

4.3 User Survey Results and Discussion

4.3.1 Preference for Tamil Cultural Interiors

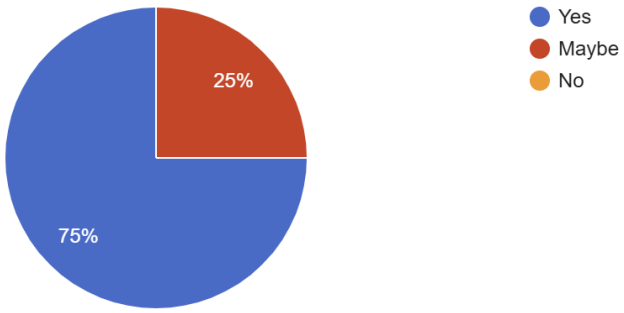

Figure 1. *Preference for Interior Spaces Reflecting Tamil Culture*

- Like Tamil cultural interiors (75%) – Strong acceptance shows users value culturally rooted elements, making traditional materials suitable for modern interior applications.
- Maybe (25%) – Users are open but require clearer examples, better awareness, or improved refinement of the material to feel fully confident.
- No rejection (0%) – The absence of negative responses indicates that cultural elements are widely accepted and not viewed as outdated in contemporary spaces.
- Support for woven panels – The overall positive preference strongly supports the use of coconut leaf woven panels in present-day interiors.
- Need for improvements – The "Maybe" group highlights the importance of enhancing durability, finishing quality, and installation techniques to increase user confidence.
- Cultural relevance – The findings confirm that Tamil cultural interiors are highly relevant, desirable, and well-received by today's users.

4.3.2 User Perception of Natural Materials

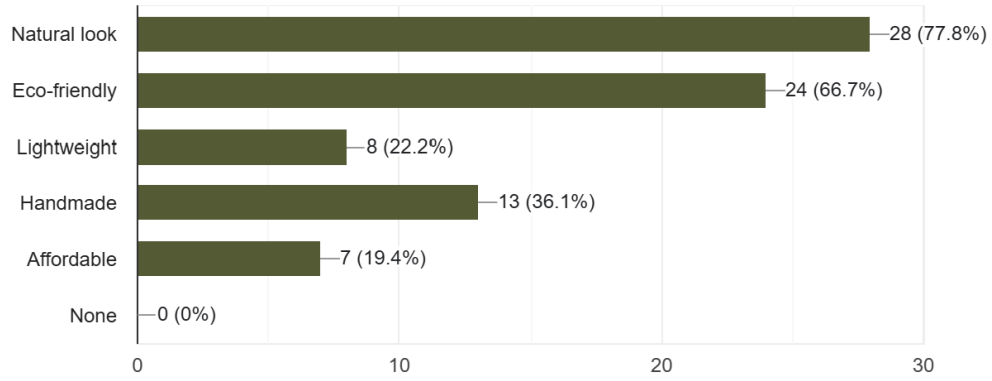

Figure 2. *Factors Users Appreciate in Natural Materials (Thennai Olai)*

- Natural look (77.8%) – Users strongly value the aesthetic appeal, making Thennai Olai suitable for visible interior elements.
- Eco-friendly (66.7%) – High preference for sustainable materials supports using coconut leaf panels in modern interiors.
- Handmade (36.1%) – Cultural craftsmanship is appreciated, aligning with the craft-revival objective.
- Lightweight (22.2%) – Users find natural materials easy to handle and install, beneficial for modular panel development.
- Affordable (19.4%) – Cost-effectiveness adds practical appeal.
- None (0%) – No respondent rejected natural materials, showing strong overall acceptance.

4.3.3 Concerns About Using Coconut Leaf Material

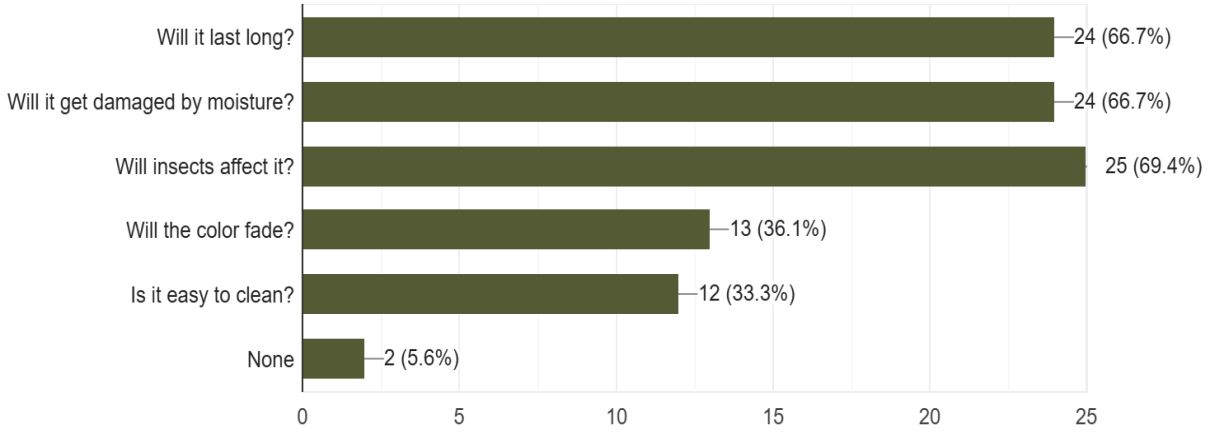

Figure 3. *User Concerns Regarding Coconut Leaf Material*

- Durability 66.7% – A major concern is whether the material will last long, highlighting the need for reinforcement and protective treatments.
- Moisture Damage 66.7% – Users fear that coconut leaf may absorb moisture or deteriorate, supporting the need for oil treatment, resin lamination, and proper sealing.
- Insect Damage 69.4% – The highest concern; respondents worry about pests, emphasizing the importance of natural insect-resistant treatments (e.g., neem oil, heat treatment).
- Color Fading 36.1% – Over one-third are unsure if the material will retain its natural color, justifying the use of silica gel dehydration and UV protection.
- Ease of Cleaning 33.3% – Users are uncertain about maintenance, indicating a need for smooth, laminated, or coated surfaces
- None 5.6% - Only a very small portion had no worries, confirming that performance testing is crucial for user acceptance.

4.3.3 Willingness to Try Thennai Olai in Home Interiors

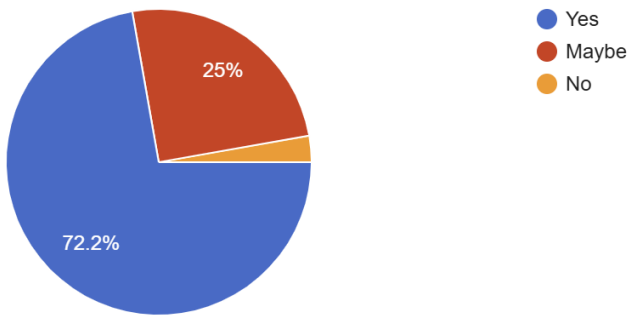

Figure 4. *Willingness to Adopt Thennai Olai in Residential Interiors*

- Yes (72.2%) – A strong majority are willing to try Thennai Olai if the design is good, indicating high adoption potential for culturally inspired natural materials in homes.
- Maybe (25%) – One-fourth of users are open to the idea but may require better understanding of durability, appearance, or maintenance before committing.
- No (2.8%) – Very few respondents rejected the idea, showing minimal resistance toward using coconut leaf materials.

V.CONCLUSION

The study successfully demonstrated that treated and reinforced coconut leaf weaving can perform reliably as an interior panel material. The use of natural oils, resin lamination, layered construction, and silica-gel preservation significantly enhanced durability, moisture resistance, and visual stability of the woven panels. User feedback further confirmed strong interest in culturally rooted, sustainable materials when supported by improved functionality.

By enabling the transition of a traditional craft into modern interior applications, this work contributes to sustainable design practices, cultural preservation, and new livelihood opportunities

for artisans, while paving the way for continued innovation, standardized testing, and large-scale implementation.

VI.COMPLIANCE WITH ETHICAL STANDARDS

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Conflict of Interest Statement
The author declares that there are no conflicts of interest or competing interests related to the publication of this research. No commercial products, organizations, or external entities influenced the outcomes of this study.

Statement of Ethical Approval
The present research work does not contain any studies performed on animals or human subjects by the author. The study involved only material testing and a voluntary perception survey with no physical or psychological risk to participants.

Statement of Informed Consent
Informed consent was obtained from all individual participants included in the survey component of this study. Participation was voluntary, and respondents were informed that their answers would be used exclusively for academic research purposes.

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