

From Plantation Byproduct to Heritage Craft: A Systemic Design Approach to Micro-Circularity in Malay Wedding Artifacts

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ABSTRACT

The Malay wedding industry's reliance on synthetic materials exacerbates environmental waste and erodes traditional ecological knowledge, while vast agricultural byproducts like rubber leaves remain underutilized. This study aims to develop a systemic design framework for micro-circularity, transforming rubber plantation biomass into heritage-grade ceremonial artifacts (bunga telur and hantaran). Employing a theory-driven methodology, the research synthesizes literature across systemic design, structural botany, and behavioral theories. The findings reveal that bridging the intention-behavior gap in sustainable ceremonial consumption relies on enhanced product experience, driven by identity congruence, social norms, and observational learning. Furthermore, by detailing the chemical maceration process, we demonstrate how the structural durability of *Hevea brasiliensis* leaf venation matches the functional and aesthetic prestige required to replace plastics. The proposed framework concludes with a robust roadmap for empirical validation, offering significant implications for policymakers and artisans to mitigate agricultural waste, boost smallholder income, and preserve intangible cultural heritage in emerging economies.

Keywords — Micro-circularity, Systemic design, Agricultural biomass, Sustainable consumption, Intangible cultural heritage

INTRODUCTION

The global handicraft and textile sectors face mounting scrutiny for their reliance on synthetic materials, a practice that concurrently increases environmental footprints and erodes traditional ecological knowledge. As global industries pivot toward circularity, shifting from linear production to regenerative, closed loop systems has become an ecological imperative (Ellen MacArthur Foundation, 2017). Within the realm of cultural heritage, this challenge is dual faceted: mass produced synthetics increasingly marginalize traditional artisanal practices, while vast quantities of untapped agricultural residues exacerbate the global biomass waste crisis (Niinimäki et al., 2020). Consequently, scholars advocate for micro circularity, a localized approach that transforms regional biowaste into high value cultural artifacts, effectively decoupling economic growth from environmental degradation (Despeisse et al., 2017; Shirvanimoghaddam et al., 2020).

In Malaysia, the intersection of agricultural production and cultural tradition presents a unique landscape for this systemic innovation. The nation's extensive plantation sector generates massive volumes of underutilized byproducts, ranging from pineapple leaves to palm fronds (Mohammed et al., 2011). Concurrently, the traditional Malay wedding industry has embraced a disposable culture where essential heritage artifacts, such as bunga manggar and hantaran accessories, are now predominantly plastic. This shift intensifies the national waste management crisis while diluting the symbolic value and emotional durability of these cultural crafts

(Halidi et al., 2022). As a leading producer of natural rubber managing approximately 1.1 million hectares of plantations, Malaysia generates substantial rubber leaf litter. Transforming these leaves into heritage grade artifacts represents a vital juncture between agricultural waste mitigation and artisanal revitalization. This transition not only aligns with the Malaysia Plastics Sustainability Roadmap 2021 to 2030 but also allows artisans to tap into a premium eco luxury market that values culturally authentic, sustainable experiences (Liu et al., 2024).

Despite a burgeoning interest in circularity, a pronounced disconnect remains between environmental values and actual consumption in the wedding sector. While artifacts composed of natural materials possess significantly higher emotional durability (Chapman, 2015), Malaysian consumers' purchasing decisions for ceremonial items are still largely dictated by entrenched social norms and perceived aesthetic prestige (Joshi & Rahman, 2015). This intention behavior gap is widened by a lack of viable bio based alternatives that satisfy the functional and sensory requirements of traditional crafts (Mugge et al., 2010; Niinimäki & Koskinen, 2011). Furthermore, existing literature tends to isolate agricultural waste management from artisanal craft, leaving a significant research gap regarding the application of systemic design within the niche of intangible cultural heritage.

To address these shortcomings, this study moves beyond top-down ecological regulation toward design-led solutions that resonate with local cultural identities by integrating five complementary theoretical perspectives. Systemic Design Theory and Circular Economy Theory serve as the primary macro-frameworks, mapping a micro-circular flow where the rubber plantation and the Malay wedding ceremony operate as an integrated, closed loop. At the micro-behavioral level, Social Cognitive Theory is utilized to understand how environmental factors and customary norms shape behavior, demonstrating how observational learning can shift the perception of rubber leaf artifacts from agricultural waste to prestigious heritage. Furthermore, Identity-Based Motivation is essential for understanding material selection, positing that individuals prefer identity-congruent products. By framing skeletal rubber leaves as authentic Malay craft, sustainability becomes a natural byproduct of expressing cultural identity, a transition finalized by the Theory of Planned Behaviour, which bridges the gap between personal attitudes, social pressures, and actual purchasing decisions. Synthesis of the latest evidence suggests that the intention-behavior gap is driven not merely by price, but by a lack of sensory durability and perceived prestige in existing eco-friendly alternatives. Ultimately, this research proposes a comprehensive framework and an empirical validation roadmap to demonstrate how micro-circularity in the wedding industry offers a scalable template for emerging economies.

LITERATURE REVIEW

Product experience is no longer just about how things work or look. Today, it includes how products make us feel, what they mean, and how they connect us to others. In Malay weddings, bunga telur and hantaran are more than just decorations. They are meaningful items that represent fertility, sharing, social bonds, and respect between families. People give bunga telur as gifts to guests and exchange hantaran between families. These items use their physical form to share social meaning. Therefore, when artists turn rubber leaves from the *Hevea brasiliensis* tree into skeletal crafts, the leaf itself becomes a key part of the experience.

Product experience theory shows that people understand products through touch, the story behind them, and personal identity, rather than just usefulness. To make these crafts, makers remove the soft part of the leaf but keep the veins. This creates a clear structure resembling lace. It looks beautiful and invites people to touch it carefully. The delicate nature of the leaf changes how people act. Plastic decorations are tough and easy to throw away. However, skeletal leaves require gentle handling. Because people cannot just throw them away, buyers become protectors of cultural meaning rather than just shoppers.

The story behind the rubber leaf adds to this experience. Malaysia produces a lot of natural rubber. As a result, plantations leave behind many fallen leaves every year. By using these leftover leaves for wedding items, artists bring an environmental message into the celebration. The product shows agricultural wealth, local identity, and care for nature all at once. People no longer see the upcycled leaf as waste. Instead, it becomes a symbol of local tradition.

Recent studies on emotional connection show that natural materials help people feel attached to products. This happens because these materials look unique and have a rich story. In weddings, this feeling grows stronger because the item is part of an important life event. The skeletal rubber leaf has natural flaws and visible veins. This makes it very different from mass produced plastic decorations. This difference makes the item feel unique and adds value to the ceremony. Therefore, the product experience is not just about looks. It includes touch, environmental storytelling, and cultural history.

Importantly, this change shows a shift toward small scale recycling. Instead of sending raw materials away and buying imported plastic, people use local plant waste for local rituals. The value of the product connects directly to this recycling idea. Buyers do not just buy a decoration. They join a system that helps nature and protects culture. In the end, the rubber tap leaf is both the material and the message.

Understanding the shift from plastic wedding items to natural crafts requires a complete theoretical view. No single idea can fully explain how nature, culture, and buyer habits work together. Because of this, we must look at five connected ideas working as one. These are Systemic Design Theory, Circular Economy Theory, Identity Based Motivation Theory, Social Cognitive Theory, and the Theory of Planned Behaviour.

The research will start by looking at the big picture using Systemic Design Theory and Circular Economy Theory. Systemic design shows how making and buying things connect to nature and society. Instead of seeing rubber farms and the wedding industry as totally separate worlds, this view sees them as parts of a closed loop network. This idea matches the goals of the Ellen MacArthur Foundation. They focus on reusing materials and finding new value in waste. In this situation, making rubber leaves into crafts is a small scale recycling effort. Farm waste directly becomes a valuable material for cultural art. The value comes from the creative skills of local artists, not just from giant factory recycling. Therefore, systemic design explains how communities can successfully turn plant waste into beautiful products for local creative markets.

Moving from the large system to the personal buyer, Identity Based Motivation Theory explains why people choose or reject green products. Wedding items are powerful symbols of identity. They show family status, cultural pride, and good taste. If people only see rubber leaf crafts as recycled trash, they might think the crafts look cheap or inappropriate for a grand event. However, if artists present them as authentic heritage art, buyers view them as a point of Malay cultural pride. This theory is very important in collectivist societies. In these cultures, following group traditions and gaining social respect heavily guide buying choices. People buy green products because these items show who they want to be and how they want others to see them, rather than solely because they care about saving the earth.

This focus on social respect leads directly into Social Cognitive Theory. Albert Bandura created this theory to show how personal thoughts, surroundings, and actions all affect each other. It places a huge focus on learning by watching others. For example, when famous wedding planners, top designers, or social media stars show off skeletal rubber leaf hantaran, the material suddenly gains respect and desirability. In this context, high visibility removes the negative thoughts people usually have about farm waste. The theory explains that copying admired people can quickly change social rules. This effectively turns nature based crafts into an ecological luxury rather than an ecological compromise.

Finally, the Theory of Planned Behaviour clarifies the final step between what a person plans to do and what they actually buy. Icek Ajzen proposed that buying green products depends on three main things. These are personal attitudes, social pressures, and how easy the action feels. Many Malaysian buyers say they care about the environment. However, they will only buy green options if those items are easy to find and accepted by their community. Rubber leaf crafts can improve all three of these areas. First, they build positive attitudes because they look incredibly beautiful. Second, they use social pressure well because they are highly visible at important ceremonies. Third, they make buyers feel in control because they are locally available and very easy to customize.

Research Gaps and Synthesis of Findings

While these theoretical frameworks explain the mechanisms of adoption, a critical synthesis of recent literature reveals three major gaps in the current academic discourse. First, circular economy research predominantly concentrates on industrial upcycling and textile waste. There remains a limited examination of biowaste integration within ceremonial or heritage contexts. Consequently, the wedding industry remains undertheorised despite its substantial material footprint. Second, cultural heritage studies often treat artisanal craft as an exercise in static preservation rather than dynamic ecological innovation. The intersection between intangible cultural heritage and agricultural residue valorisation is still conceptually fragmented. Few studies explore how systemic design principles can be effectively operationalised at the microcultural level. Third, while the gap between intention and behaviour in sustainable consumption is widely documented, emerging evidence suggests that in ceremonial contexts, the primary barrier is not cost, but perceived prestige. Synthetic materials persist because they symbolise modernity and social status. Sustainable alternatives frequently fail when they do not match this necessary symbolic capital. This review therefore argues that rubber tap leaf craft represents a strategic convergence point addressing these gaps. It mitigates ecological waste, reinforces cultural symbolism, and offers high sensory value. The integration of systemic design with identity driven behavioural theories provides a robust and necessary framework for analysing such adoption pathways.

In conclusion, the transformation of rubber plantation biomass into bunga telur and hantaran artefacts demonstrates that sustainability transitions in emerging economies must be culturally embedded rather than purely regulatory. Policy instruments, such as Malaysia’s plastics roadmap, are necessary but insufficient on their own. Interventions led by design that enhance experiential richness and identity congruence are far more likely to succeed. Microcircularity within the wedding industry offers a replicable model, illustrating how regional agricultural byproducts can be transformed into enduring cultural capital through artisanal innovation. Future research should empirically test consumer responses to skeletal rubber leaf products, examine their long term emotional durability, and quantify the resulting environmental impact reductions. By bridging ecological systems, behavioural theory, and cultural heritage, this domain provides fertile ground for advancing both sustainability scholarship and practical application.

Table 1: Summary of Key Literature Supporting Material and Cultural Integration

Author(s)	Year	Title	Methodology	Key Findings
Liu et al.	2024	A thematic review on traditional handicraft from design perspective publications from 2002–2022: Analysis of trends for future studies.	Thematic Review	Found that traditional handicrafts are threatened by mass-produced alternatives; integrating design and cultural heritage significantly increases their perceived value and ensures their market survival.
Shi et al.	2022	Scaling relationships of leaf vein and areole traits versus leaf size for nine Magnoliaceae species differing in venation density.	Empirical Structural Analysis	Proved that hierarchical reticulate venation patterns (the leaf veins) possess immense structural durability, making extracted leaf skeletons highly suitable for 3D manipulation once soft tissues are removed.
Ruttanayom et al.	2020	Assessing the effect of rubber (Hevea brasiliensis) leaf chemical composition on some soil properties of differently aged rubber tree plantations.	Field Assessment & Chemical Analysis	Quantified the massive volume of seasonal leaf fall from rubber trees in Southeast Asia, confirming the leaves possess strong structural chemical compositions (polysaccharides) and constitute a massive, untapped biomass.

Böttger et al.	2016	Valorisation of proteins from rubber tree (<i>Hevea brasiliensis</i>).	Biorefinery & Valorization Analysis	Confirmed that utilizing the non-latex parts of the rubber tree (specifically leaves and seeds) provides critical secondary value and "waste-to-wealth" economic opportunities for the agricultural sector.
Hari, N.	2021	Three simple methodologies for the microanatomical study of dicot leaf samples.	Laboratory Experimental Comparison	Detailed an optimized method for skeletonizing leaves: abandoning slow water-retting in favor of immersing leaves in a 5% Sodium Hydroxide (NaOH) solution to rapidly clear fleshy tissue while leaving structural veins perfectly intact.

The integration of rubber leaf biowaste into the artisanal market represents a significant shift toward a circular economy within the agricultural sector. As summarized in **Table 1**, recent research highlights a multidimensional approach to elevating this material, turning plantation waste into high-value cultural artifacts like bunga telur and hantaran. The foundation of this craft lies in the skeletonization of the leaf, a process that has improved drastically due to recent experimental methods. Hari (2021) detailed a move away from traditional water-retting, which can take weeks to finish, in favor of a controlled chemical maceration using a 5% Sodium Hydroxide (NaOH) solution. This reduces production time to just a few hours, providing the technical efficiency required to meet the high-volume demands of the wedding industry, where large events often require hundreds of units at once. The choice of the rubber leaf (*Hevea brasiliensis*) over other species is not accidental. Shi et al. (2022) demonstrated that hierarchical reticulate venation patterns (the leaf veins) possess immense structural durability. These features provide the integrity needed for 3D manipulation, allowing artisans to fold, wire, and shape the extracted leaf skeletons into complex decorations without the material tearing. Building on this physical durability, Liu et al. (2024) emphasized that while traditional handicrafts are threatened by mass-produced alternatives, integrating them with authentic cultural design significantly increases their perceived value.

This cultural branding allows an agricultural byproduct to successfully compete in luxury gift markets that previously relied on synthetic materials. Furthermore, scaling this craft offers a sustainable solution to a major agricultural issue. Ruttanayom et al. (2020) quantified the massive volume of seasonal leaf fall from rubber plantations in Southeast Asia, confirming it constitutes a vast, untapped biomass easily capable of supporting a year-round artisanal industry. This transition from waste to wealth yields direct socio-economic benefits. As Böttger et al. (2016) noted, utilizing the non-latex parts of the rubber tree provides critical secondary value, offering smallholders new economic opportunities and secondary income streams. Finally, as Busalim et al. (2025) observed, overcoming innovation resistance in sustainable products heavily relies on the sensory experience. The delicate and lace like texture of the skeletonized rubber leaf appeals to modern consumers. This proves that beauty is a powerful tool in heritage crafts. Elevating the physical appearance of biowaste is often more effective than just using the moral argument of sustainability.

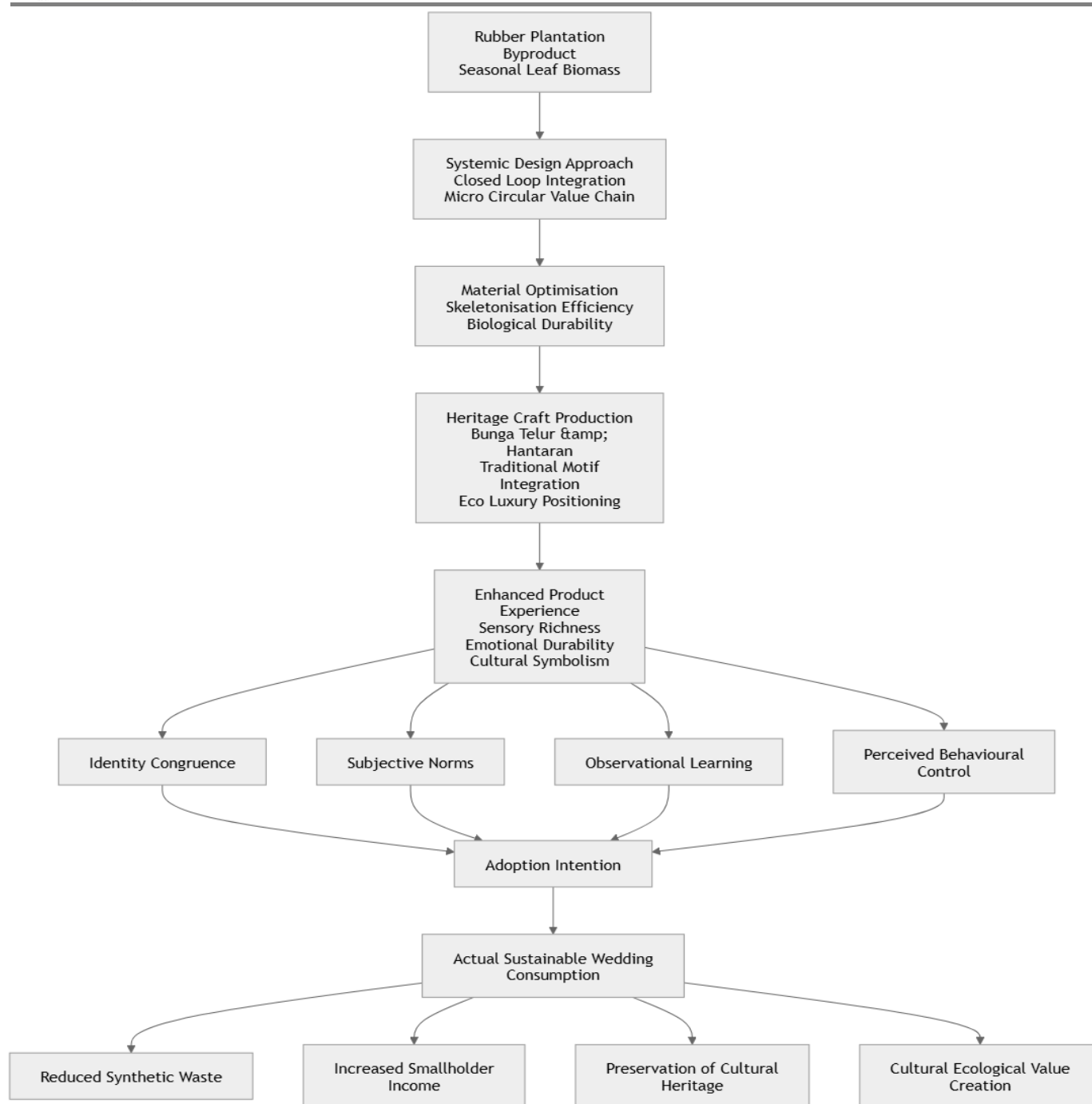


Fig. 1. Conceptual Framework Diagram

Figure 1 presents a multi-level conceptual framework that explains how rubber plantation byproducts can be transformed into sustainable Malay wedding artefacts through a systemic design approach. The model integrates macro-level circular design principles, meso-level material innovation, and micro-level behavioural mechanisms to illustrate how culturally embedded sustainability transitions can occur. At the macro level, the framework begins with seasonal rubber leaf biomass generated from plantation activities. Traditionally treated as agricultural waste, this biomass is reconceptualised through a systemic design approach that integrates the plantation sector with the wedding industry into a closed-loop micro-circular value chain. This reframing aligns agricultural residue with cultural production, transforming waste into a regenerative resource for heritage craft. At the meso level, material optimisation enables this transition. Advances in skeletonisation techniques and the inherent biological durability of rubber leaves support scalable and aesthetically refined craft production. These technical attributes facilitate the development of heritage-grade bunga telur and hantaran artefacts, enhanced through traditional motif integration and eco-luxury positioning. This stage ensures that ecological viability is matched with cultural legitimacy and market competitiveness. Central to the framework is enhanced product

experience, which functions as the primary mediating construct. Sensory richness, emotional durability, and cultural symbolism elevate skeletal rubber leaf artefacts beyond recycled materials into meaningful ceremonial objects. The model proposes that sustainability adoption in wedding contexts is driven not solely by environmental awareness, but by experiential and symbolic value. Enhanced product experience influences four behavioural determinants: identity congruence, subjective norms, observational learning, and perceived behavioural control. These mechanisms collectively shape adoption intention, which subsequently leads to actual sustainable wedding consumption. This behavioural pathway integrates insights from identity-based and social cognitive perspectives. The final stage of the framework demonstrates multidimensional outcomes, including reduced synthetic waste, increased smallholder income, preservation of cultural heritage, and cultural-ecological value creation. Overall, the model positions micro-circularity as a culturally embedded design strategy capable of transforming plantation biomass into enduring cultural capital.

Material Optimisation, Chemical Maceration, and Mechanical Viability

The viability of micro-circularity in heritage crafts relies fundamentally on the mechanical and aesthetic properties of the agricultural biowaste. The production of skeletonized rubber leaves for bunga telur and hantaran requires replacing traditional, time-consuming water-retting with a controlled chemical maceration process. By immersing the *Hevea brasiliensis* leaves in a 5% Sodium Hydroxide (NaOH) solution, artisans can rapidly dissolve the fleshy mesophyll tissue within hours. Crucially, this alkaline treatment isolates the hierarchical reticulate venation without degrading its natural polymeric strength. Compared to the conventional synthetic plastics that currently dominate the Malay wedding industry and contribute to national waste, the chemically macerated rubber leaf offers highly competitive physical performance. The hierarchical reticulate veins possess immense structural durability, granting the extracted skeletons the integrity needed for complex 3D manipulation. Artisans can fold, wire, and shape these leaves without tearing, achieving the functional reliability of mass-produced synthetics while simultaneously providing a delicate, lace-like texture that appeals to modern consumers.

Understanding the shift from plastic wedding items to natural crafts requires examining the precise mechanisms of behavioural theories. Evidence suggests that the intention-behaviour gap in wedding contexts is not primarily driven by cost, but rather by perceived prestige, as synthetic materials persist largely because they symbolise modernity and social status. The proposed framework addresses this barrier through three distinct behavioural pathways:

1. **Identity-Based Motivation:** This theory dictates that consumers select products that are identity-congruent. By strategically framing rubber leaf crafts as authentic Malay heritage rather than mere agricultural waste, consumers adopt these eco-materials as a powerful expression of family status, cultural pride, and good taste.
2. **Social Cognitive Theory:** Consumer acceptance is heavily influenced by observational learning. When high-status figures, such as top wedding designers or social media influencers, adopt skeletal rubber leaf hantaran, the material is rapidly destigmatized and elevated from an ecological compromise to an ecological luxury.
3. **Theory of Planned Behaviour (TPB):** TPB bridges the final gap to actual consumption. While consumers may hold positive environmental attitudes, actual purchasing relies on subjective norms (community acceptance of the material at grand events) and perceived behavioural control (the local availability and ease of customising the leaf crafts).

METHODOLOGY

Research Design and Conceptual Orientation

This study adopts a theory-driven conceptual research design aimed at advancing scholarly understanding of micro-circularity within the context of Malay wedding artifacts. Unlike empirical investigations that rely on

primary data collection, this paper is non-empirical and focuses on theoretical integration and conceptual development. The objective is not to test hypotheses statistically, but to construct a coherent explanatory framework that bridges fragmented domains: agricultural waste valorization, systemic design, structural botany, cultural heritage craft, and sustainable consumption behavior. The conceptual orientation is interpretive and integrative. It draws upon established theoretical perspectives, including Systemic Design Theory, Circular Economy Theory, Identity-Based Motivation, Social Cognitive Theory, and the Theory of Planned Behaviour, to explain how plantation byproducts can be repositioned as heritage craft within a micro-circular system. The study is therefore positioned as a conceptual synthesis paper, contributing by clarifying constructs, identifying relationships among them, and proposing a structured framework that can guide future empirical validation.

Literature Identification and Selection Process

The literature review was conducted through a structured and systematic search strategy to ensure comprehensive coverage of relevant scholarship across multiple disciplines. Academic databases including Scopus, Web of Science, ScienceDirect, and Google Scholar were used to identify peer-reviewed journal articles, books, policy reports, and conference proceedings. Keywords and search strings were developed based on the research objectives and included combinations such as “micro-circularity,” “systemic design,” “agricultural waste valorisation,” “sustainable wedding consumption,” “identity-based motivation,” and “emotional durability.”

Crucially, the search process expanded beyond cultural sociology to include botanical and materials science literature (e.g., leaf venation durability and chemical maceration techniques) to empirically ground the proposed material transformations. Articles were screened in two stages: first for thematic relevance to byproduct utilization and heritage craft, and second for theoretical contribution and methodological rigor. In addition to academic literature, selected policy documents and industry reports were examined to contextualize the Malaysian plantation and wedding sectors.

Conceptual Analysis and Synthesis Process

Following literature selection, a thematic and comparative conceptual analysis was undertaken to identify recurring constructs and explanatory gaps across three primary domains: systemic design, material culture, and consumption behaviour. First, constructs related to waste valorization and regenerative systems were compared to determine how macro-level agricultural realities (such as massive seasonal leaf fall) could be managed at a micro-cultural level. Second, insights from product experience theory were examined alongside structural botany to understand how the physical properties of natural materials (like the reticulate venation of rubber leaves) directly influence symbolic and affective engagement. Third, behavioral theories were analyzed comparatively to clarify how identity congruence, subjective norms, observational learning, and perceived behavioral control interact to shape adoption intention.

DISCUSSION

This conceptual study develops a systemic design framework that repositions rubber plantation byproducts as heritage craft within a micro-circular economy model for Malay wedding artifacts. Using skeletal rubber leaf bunga telur and hantaran as an illustrative case, the analysis demonstrates how agricultural residues can move beyond conventional waste valorization when embedded within a regenerative and culturally grounded design logic. The proposed framework successfully connects macro-level circular economy principles, meso-level material optimization, and micro-level behavioral determinants to explain how sustainable material innovation becomes socially adopted within ritual consumption contexts.

Crucially, the viability of this micro-circular model is anchored in both material science and cultural sociology. At the macro level, the sheer volume of seasonal leaf fall from *Hevea brasiliensis* provides a massive, untapped biomass capable of supporting a scalable artisanal industry (Ruttanayom et al., 2020). At the meso level, the transition from waste to heritage-grade material relies heavily on material optimization. As demonstrated by Hari (2021), rapid chemical maceration using Sodium Hydroxide (NaOH) allows for efficient skeletonization,

meeting the high-volume demands of the ceremonial market. Furthermore, the structural integrity of the rubber leaf's hierarchical reticulate venation (Shi et al., 2022) supports complex 3D artisanal manipulation without tearing. This physical durability allows ecological materials to match the functional requirements of synthetic plastics. When this structural resilience is combined with authentic cultural design, the perceived value of the artifact increases significantly, allowing it to compete in premium eco-luxury markets (Liu et al., 2024).

Central to this model is the enhanced product experience, encompassing aesthetic refinement, symbolic resonance, and emotional durability, which mediates the relationship between systemic material intervention and behavioral intention. These findings extend circular economy scholarship that traditionally emphasizes industrial upcycling and textile waste by situating closed-loop systems within a micro-cultural ceremonial domain. By integrating Systemic Design Theory with Identity-Based Motivation, Social Cognitive Theory, and the Theory of Planned Behaviour, the framework reinforces existing literature showing that sustainable consumption is shaped not only by environmental awareness but also by identity congruence, social norms, observational influence, and perceived behavioral control. Importantly, these behavioral mechanisms address a critical gap in sustainability research, which frequently overlooks the prestige-driven nature of ritual-based consumption. In the context of Malay weddings, sustainable alternatives succeed when they are framed through cultural identity and aesthetic prestige rather than ecological compromise.

Theoretically, this study contributes by synthesizing circular economy, heritage craft revitalization, experiential design, and behavioral theory into a coherent multi-level explanatory structure. It advances the concept of micro-circularity as a culturally embedded extension of systemic circular models. Practically, the framework offers strategic guidance for designers, policymakers, and craft entrepreneurs. It demonstrates how plantation biomass can be transformed into high-value ceremonial artifacts that generate simultaneous benefits: mitigating agricultural waste, preserving intangible cultural heritage, and providing critical secondary "waste-to-wealth" income streams for rubber smallholders (Böttger et al., 2016).

Crucially, the viability of this micro-circular model is anchored in both material science and cultural sociology. At the meso-level, the transition from waste to heritage-grade material relies heavily on material optimization. Rapid chemical maceration using Sodium Hydroxide (NaOH) allows for efficient skeletonization, meeting the high-volume demands of the ceremonial market. Furthermore, the structural integrity of the rubber leaf's hierarchical reticulate venation supports complex 3D artisanal manipulation without tearing. This physical durability allows ecological materials to functionally replace synthetic plastics, while the enhanced product experience mediates the relationship between this material intervention and behavioral intention. By addressing the prestige-driven nature of ritual-based consumption through Identity-Based Motivation and Social Cognitive Theory, the framework demonstrates that sustainable alternatives succeed when framed through cultural identity and aesthetic prestige rather than ecological compromise.

Limitations and Future Research

While this conceptual study establishes a robust systemic design framework for micro-circularity, its primary limitation is the current absence of empirical validation. To transition these proposed relationships from theoretical synthesis to field evidence, future research must operationalise this framework through a comprehensive, mixed-methods empirical study. We propose a two-phase validation strategy to test the practical suitability and social adoption of chemically macerated rubber leaf products:

Phase 1: Experimental Material Testing

Quantitative experimental testing is required to validate the physical performance of the skeletonized *Hevea brasiliensis* leaves against conventional synthetic alternatives. Future laboratory studies should measure:

- Mechanical properties (e.g., tensile strength, fold endurance during 3D manipulation).
- Long-term durability (shelf-life and structural degradation over time).
- Environmental performance (life-cycle assessment and biodegradation rates of the NaOH-treated leaves).

Phase 2: Multi-Stakeholder Empirical Studies

To validate the behavioural and cultural dimensions of the framework, field research involving key stakeholders in the Malay wedding industry is essential:

- Artisans: Focus groups and workability trials with local craftspeople will assess the technical feasibility, economic viability, and production scaling of the NaOH maceration method.
- Consumers: Survey instruments grounded in the Theory of Planned Behaviour and Identity-Based Motivation will be deployed to measure consumer aesthetic evaluations, perceived prestige, and the shift in adoption intention when exposed to these heritage-grade artifacts.

By executing this empirical validation, future scholarship can definitively quantify the environmental impact reductions and socio-economic benefits of transforming plantation biomass into enduring cultural capital.

REFERENCES

1. Chapman, J. (2015). Emotionally durable design: Objects, experiences and empathy (2nd ed.). Routledge. <https://doi.org/10.4324/9781315738741>
2. Despeisse, M., Baumer, M., Brown, P., Charnley, F., Ford, S. J., Garmulewicz, A., Knowles, S., Minshall, T. H. W., Mortara, L., Reed-Tsochas, F. P., & Rowley, J. (2017). Unlocking value for a circular economy through 3D printing: A research agenda. *Technological Forecasting and Social Change*, 115, 75–84. <https://doi.org/10.1016/j.techfore.2016.09.021>
3. Ellen MacArthur Foundation. (2017). A new textiles economy: Redesigning fashion's future. <https://ellenmacarthurfoundation.org/a-new-textiles-economy>
4. Halidi, M. A., Legino, R., & Kamaruzaman, M. F. (2022). Variations throughout Malay wedding 'pelamin' decorations. *Environment-Behaviour Proceedings Journal*, 7(SI8), 123–127. <https://doi.org/10.21834/ebpj.v7iSI8.3925>
5. Joshi, Y., & Rahman, Z. (2015). Factors affecting green purchase behaviour and future research directions. *International Strategic Management Review*, 3(1-2), 128–143. <https://doi.org/10.1016/j.ism.2015.04.001>
6. Liu, H., Alli, H., & Md Yusoff, I. S. (2024). A thematic review on traditional handicraft from design perspective publications from 2002–2022: Analysis of trends for future studies. *Cogent Arts & Humanities*, 11(1), Article 2298084. <https://doi.org/10.1080/23311983.2023.2298084>
7. Mohammed, M. A. A., Salmiaton, A., Wan Azlina, W. A. K. G., Mohammad Amran, M. I., & Fakhrul-Razi, A. (2011). Air gasification of empty fruit bunch for hydrogen-rich gas production in a fluidized-bed reactor. *Energy Conversion and Management*, 52(2), 1555–1561. <https://doi.org/10.1016/j.enconman.2010.10.023> (Note: This author group is widely cited for Malaysian biomass utilization).
8. Mugge, R., Schifferstein, H. N. J., & Schoormans, J. P. L. (2010). Product attachment and satisfaction: Understanding consumers' relationship with durable products. *Asian Journal of Quality*, 11(3), 271–283. <https://doi.org/10.1108/15982681011090831>
9. Niinimäki, K., & Koskinen, I. (2011). I love this dress, it makes me feel beautiful! Empathic knowledge in sustainable design. *The Design Journal*, 14(2), 165–186. <https://doi.org/10.2752/175630611X12984592779962>
10. Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., & Gwilt, A. (2020). The environmental price of fast fashion. *Nature Reviews Earth & Environment*, 1(4), 189–200. <https://doi.org/10.1038/s43017-020-0039-9>
11. Shirvanimoghaddam, K., Motamed, B., Ramakrishna, S., & Naebe, M. (2020). Death by waste: Fashion and textile circular economy case. *Science of the Total Environment*, 718, Article 137317. <https://doi.org/10.1016/j.scitotenv.2020.137317>