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Sustainable Business Model Development from Cultural Heritage: A Study of Apatani Traditional Costume Practices

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Abstract

Contemporary research on sustainable business practices and business model innovation increasingly emphasises the need to identify new, inclusive pathways for circular enterprise development. There is growing interest in alternative knowledge systems for their potential to support innovative and inclusive business model development. Although indigenous clothing traditions are widely acknowledged for their cultural significance, their potential to contribute to contemporary business model innovation, particularly through adaptive reuse strategies, remains insufficiently examined. Most existing literature addresses cultural or aesthetic aspects, with limited empirical research investigating how traditional clothing systems can be transformed into viable, scalable, and sustainable enterprises, supported by both qualitative and quantitative evidence.

A mixed-method research design was employed, integrating qualitative approaches with quantitative and descriptive analysis. Ethnographic fieldwork was conducted in Ziro, Arunachal Pradesh, the Apatanis' homeland, where most community members have ancestral roots. Additionally, Itanagar, the capital city, was selected for its significant Apatani population, enabling comparative insights from both traditional and urban contexts. Consumer perspectives are incorporated to assess market relevance and adoption potential, particularly among younger demographics. A structured survey was administered to the target age group (18 to 55 years) using snowball sampling. The survey collected quantitative data on usage frequency, perceived barriers, sustainability awareness, and openness to contemporary adaptations. Data were analysed using thematic analysis supported by basic statistical techniques.

This study demonstrates how indigenous clothing practices of the Apatani tribe of Arunachal Pradesh can contribute to the evolution of sustainable and circular business models within the fashion and creative industries, and facilitate sustainable business model innovation through adaptive reuse, circular design strategies, and community-based value creation. The study conceptualises these practices as embedded knowledge systems that demonstrate resource efficiency, adaptive reuse of materials, and community-based production logic.

The research presents an empirically grounded framework connecting cultural heritage to scalable and resource-efficient enterprise models. The resulting business model offers actionable insights for designers, entrepreneurs, and policymakers aiming to establish heritage-led circular enterprises while preserving cultural integrity. These findings apply to other indigenous and craft-based contexts, supporting sustainable growth, innovation, and broader societal impact within the creative economy.

Keywords: Apatani Tribe, Circular Economy, Community-Based Enterprises, Heritage-Led Innovation, Sustainable Business Models, Indigenous Knowledge Systems, Sustainable Fashion

1. Introduction

As industries adapt to become environmentally conscious, depending not only on new technologies but also on transforming how value is created, how materials circulate, and how enterprises function, circular economy frameworks are now widely positioned as a primary systems approach for enabling this transition toward resource-efficient and regenerative production models. Within this discourse, business model innovation for sustainability is positioned as a key tool that enables enterprises to operationalise circular principles beyond product eco-design, encompassing value chains and business structures.

The fashion and textile industry has become a focal sector in circular economy research due to its high production volume, short product lifecycles, globalised supply chains, and significant environmental footprint. Circular fashion studies have expanded to incorporate recycling systems, resale platforms, rental models, product-service systems, repair ecosystems, and circular businesses. Recently, zero-waste fashion design, which eliminates textile waste at the pattern and cutting stage through geometric planning and full-material utilisation, has emerged as an important circular design strategy. However, most circular fashion and zero-waste models remain rooted in industrial, platform-based, or technology-driven frameworks.

There is comparatively limited investigation into indigenous clothing systems as operational circular and zero-waste models and their potential to inform contemporary sustainable enterprise design. Indigenous clothing traditions often evolved under conditions of ecological constraint, material scarcity, localised production, and social accountability. As a result, many such systems demonstrate inherent circular characteristics including localised material sourcing, low-waste production, modular construction, repair traditions, intergenerational transfer, symbolic durability, and adaptive reuse. In several cases, garment construction itself follows implicit zero-waste logic, where textile dimensions, loom width, and pattern geometry are coordinated to minimise or eliminate cutting waste. Yet these systems are typically studied through anthropological, cultural, or heritage lenses rather than business model, circular design, or enterprise innovation frameworks.

This study addresses that gap by examining the traditional clothing practices of the Apatani tribe of Arunachal Pradesh, North-east India, as a living circular and low-waste system, and by exploring how these practices can contribute to sustainable and circular business model innovation.

The Apatani community of Ziro, Arunachal Pradesh, is widely recognised for its ecological intelligence and resource-conscious material culture rooted in long-term environmental stewardship (Varuni, 2023). Their wet rice cultivation combined with pisciculture, known as the Aji system, demonstrates a closed-loop resource logic wherein rice and fish mutually sustain each other through nutrient cycling, eliminating the need for chemical inputs or modern machinery (Meghana, Naik and Gowda, 2023). The energy efficiency of this system, measured at an input-to-output ratio of 1.70, surpassing that of Japan and the United States at 1.01, confirms that indigenous resource optimisation can outperform modern industrial approaches (Meghana, Naik and Gowda, 2023). Scholarly documentation of Apatani agricultural practices confirms that their sustainable methods are not a response to contemporary environmental discourse but an inherited operational logic developed over centuries under conditions of ecological constraint (Meghana, Naik and Gowda, 2023). Crucially, this logic has persisted without the adoption of modern tools, chemical fertilisers, or mechanised farming, demonstrating that resource efficiency, adaptive reuse of organic waste, and closed-loop material flows are structurally embedded in Apatani culture across

multiple domains (Meghana, Naik and Gowda, 2023). This study argues that a parallel systems-level circular logic is similarly embedded in Apatani clothing practices.

The Apatani traditional costume is distinguished by its straightforward design and is made from narrow-width, handwoven textiles produced on backstrap looms. The construction of Apatani traditional garments is fundamentally rooted in rectilinear geometry and differs from Western tailoring in that it does not use curved cuts and darts to sculpt cloth, which creates off-cut waste. Instead, it follows a Loom-to-Body philosophy. The textile's dimensions are determined by the width of the weaver's backstrap loom, and garments are constructed by stitching these loom-finished panels together without cutting, ensuring 100% fabric utilisation.

Adhering to zero-waste construction and free-size configurations, the one-garment-fits-all principle reduces textile waste and promotes long-term usability, effectively validating material efficiency, adaptive reuse, and socially responsible production networks.

Rather than treating indigenous clothing solely as heritage artefacts, this study conceptualises them as embedded circular knowledge systems with enterprise translation potential. Using a mixed-method research design combining ethnographic fieldwork and quantitative consumer survey analysis, the study develops an empirically grounded Heritage-to-Circular Enterprise Framework linking indigenous zero-waste and circular clothing logic to scalable, culturally grounded enterprise models. In doing so, the study contributes to circular economy, sustainable business model innovation, and circular fashion scholarship by introducing indigenous clothing systems as operational prototypes for circular enterprise development.

This study contributes to existing circular economy and sustainable business model scholarship in three ways. First, it reframes indigenous clothing systems as operational circular models rather than cultural artefacts, extending circular business model discourse beyond industrial and technology-driven contexts. Second, it introduces the Heritage-to-Circular Enterprise Framework (HCEF) as a structured translation model linking cultural-ecological practices to enterprise-level circular strategies. Third, by integrating empirical field observations, user perception data, and enterprise translation logic, the study demonstrates how cultural continuity and contemporary adoption can coexist within sustainable business model innovation. Together, these contributions position heritage-based knowledge systems as viable sources of circular enterprise development.

2. Literature Review

2.1 Circular Economy and Circular Business Model Innovation

The Circular Economy (CE) seeks to replace linear take-make-dispose production methods with models built on closed loops, extending the life of products through reuse, repair, remanufacturing, and recycling. Rather than focusing solely on waste reduction, circular economy thinking changes how the economy works by keeping value over a long time, making resources more productive, and shifting materials throughout their lifespan [1, 2]. CE definitions remain conceptually fragmented, requiring clearer operational framing (Nobre and Tavares, 2021) [3]. However, conceptual analyses indicate that CE is shaped by various intellectual practices, including industrial ecology, cradle-to-cradle design, and performance economy, and is most effectively interpreted as a multidimensional transformation framework that influences design, production, consumption, and governance structures [3, 4].

Recent research highlights that the adoption of CE depends significantly on the evolution of business models rather than just product redesign. Circular business model innovation (BMI4CE) restructures value propositions, value creation networks, and value capture mechanisms to support durability, access-over-

ownership, service orientation, and lifecycle stewardship [5, 6]. Established circular business model paradigms encompass product life extension models, product-service systems, resource recovery models, sharing platforms, and circular supply models (Urbinati, Chiaroni and Chiesa, 2017) [5]. Heritage discourse increasingly engages with material reuse and waste reduction as part of broader sustainability transitions. These models shift revenue logic away from volume throughput toward performance, longevity, and reuse cycles.

Empirical studies show that firms pursuing circular models frequently redesign supply relationships, customer interfaces, and revenue streams simultaneously (Geissdoerfer, Vladimirova and Evans, 2018) [6]. However, CE business model literature remains heavily weighted toward industrial firms, technology startups, and platform-based enterprises. Reviews indicate that socially embedded, craft-based, and community production systems are inadequately represented in BMI4CE research, despite their potential significance to distributed and low-resource circular models [4, 7]. This gap indicates the necessity to explore other production cultures as potential origins of circular business model logic.

2.2 Circular Fashion, Zero-Waste Design, and Lifecycle Extension

The fashion and textile industry has been a prominent area of interest for CE research since it consumes large quantities of materials, has short consumption cycles, and has a significant environmental impact. Recent scholarship increasingly positions heritage systems as active contributors to sustainability transitions through adaptive reuse and circular resource strategies (Foster, 2020) [8]. Circular fashion frameworks advocate for solutions including reuse, resale, rental, repair, remanufacturing, and recycling, in addition to product-service systems and take-back initiatives [1, 9]. Research increasingly acknowledges that initial lifecycle extension and reuse options generally result in superior circular value retention compared to subsequent recycling, due to lower energy consumption and the preservation of inherent labour and material value. In circular fashion, business model experimentation includes resale platforms, clothing rental systems, subscription wardrobes, repair services, and refurbishing models. Research focused on startups indicates that circular fashion businesses often focus on closed-loop material flows and value propositions that emphasise reuse, frequently supported by digital platforms and traceability tools (Ostermann, Nascimento and Zen, 2021) [10]. Most circular fashion models, however, remain technology-based and focused on urban markets, with only limited integration with traditionally low-waste garment systems. Circular economy frameworks increasingly recognise cultural heritage as a domain capable of supporting lifecycle extension and adaptive reuse strategies beyond preservation-oriented approaches (Foster, 2020) [8].

Zero-waste fashion production is gaining prominence as a way to reduce textile waste during the pattern generation and cutting stages through geometry-based layout planning (Rissanen and McQuillan, 2016) [11]. Methods used include rectangular construction, tessellated pattern layouts, and multi-use components that ensure almost all textile input is turned into final products. Scholars describe zero-waste design as requiring both technical pattern innovation and creative design reframing [12, 13].

Sustainable fashion design literature positions zero-waste construction as a frontier method for reducing upstream textile waste and improving material yield [14, 15]. Most zero-waste literature, however, focuses on modern designer-led experimentation and educational frameworks. There is comparatively limited recognition that similar material-efficiency and low-waste construction logics have historically existed in traditional and indigenous garment systems shaped by loom width constraints, textile labour intensity, and material scarcity. Integrating these heritage practices into circular fashion theory expands both the empirical and conceptual scope of zero-waste design research.

2.3 Indigenous Clothing Systems, Cultural Durability, and Heritage-Led Enterprise Models

Indigenous knowledge systems demonstrate how ecological resource management and cultural continuity can operate simultaneously, offering alternative models for sustainability transitions (Berkes, 1999) [16]. Recent studies on Apatani textiles further highlight ecological symbolism and biomimetic design thinking embedded in local weaving practices (Anu et al., 2025).

Circular economy thinking has increasingly expanded into cultural heritage management, highlighting the role of cultural assets in sustainability and value circulation (Nikolic and Petrovic, 2023) [17]. Traditional clothing systems developed under ecological constraint and localised production conditions often demonstrate circular characteristics including low-waste material use, modular assembly, repair traditions, adaptive reuse, and intergenerational transfer. Heritage value can be sustained through reuse processes rather than preservation alone, suggesting that circular reuse strategies may coexist with cultural continuity (Ross, 2020) [18].

Adaptive reuse and do-it-yourself (DIY) customisation, including self-dyeing, modular garment adjustment, and motif-based personalisation, shift users from passive consumers to active lifecycle participants, thereby reinforcing circular use patterns. At the same time, heritage enterprise scholarship emphasises that culturally grounded product development must include artisan co-creation, narrative transparency, and equitable value distribution to avoid extractive commercialisation (Barrere and Delabruyere, 2011) [19].

The literature on circular business models has only recently started to recognise the social and cultural aspects of circularity, and community governance is still largely missing from CE frameworks (Homrich, Galvao, Abadia and Carvalho, 2018) [4]. Similarly, adaptive reuse, recognised as a high-value circular strategy because it preserves embedded material and labour, is often discussed in technical design terms rather than as a culturally embedded practice. Indigenous clothing systems provide empirical contexts where adaptive reuse, modularity, zero-waste tendencies, and cultural durability operate together as an integrated circular logic.

The Apatani cultural landscape of Ziro Valley, Arunachal Pradesh, represents one of the most thoroughly documented indigenous knowledge systems in South Asia, recognised on the UNESCO Tentative List for World Heritage Sites for its exceptional resource management, ecological sustainability, and the harmonious interdependence between community practices and the natural environment [20, 21]. Scholarly documentation confirms that this ecological intelligence is not incidental but structurally embedded across multiple domains of Apatani life, from the closed-loop Aji rice-cum-fish cultivation system to land management, water conservation, and forest governance, all of which operate without chemical inputs or mechanised intervention [21, 22]. If such systems-level circular logic permeates Apatani agricultural and ecological practice, it is reasonable to propose that a parallel logic of resource efficiency, adaptive reuse, and minimal waste is similarly embedded in their material culture, including traditional clothing practices. Yet this domain remains largely unexamined within circular economy and sustainable business model scholarship, representing a significant gap this study seeks to address.

2.4 Research Gap

There is an abundance of research on circular economy theory and sustainable business models; however, there is a lack of sufficient empirical investigations that examine indigenous clothing systems as sources of new business concepts. To fully understand how ancestral traditions might be translated into sustainable and scalable enterprises, it is essential to combine cultural study with market-focused empirical evidence. This research addresses this gap by employing a mixed-method approach to examine Apatani traditional

costume practices.

While circular business model innovation literature has primarily evolved from industrial manufacturing, platform economies, and technology-driven transitions, emerging studies suggest the need to expand conceptual boundaries toward socially embedded and culturally grounded production systems. Indigenous and craft-based knowledge systems may therefore represent under-theorised but operationally relevant circular models, where resource efficiency, lifecycle extension, and value stewardship are structurally embedded rather than strategically added. Positioning such systems within circular business model discourse enables a shift from viewing heritage practices solely as cultural preservation to understanding them as potential sources of circular innovation logic. This study responds to that theoretical gap by examining Apatani traditional clothing as a transferable circular knowledge system capable of informing sustainable enterprise design and business model evolution.

2.5. Objectives of the Study

1. Examine Apatani costume practices as a basis for circular and sustainable business model innovation
2. Develop a heritage-led enterprise framework integrating adaptive reuse and community-based value creation

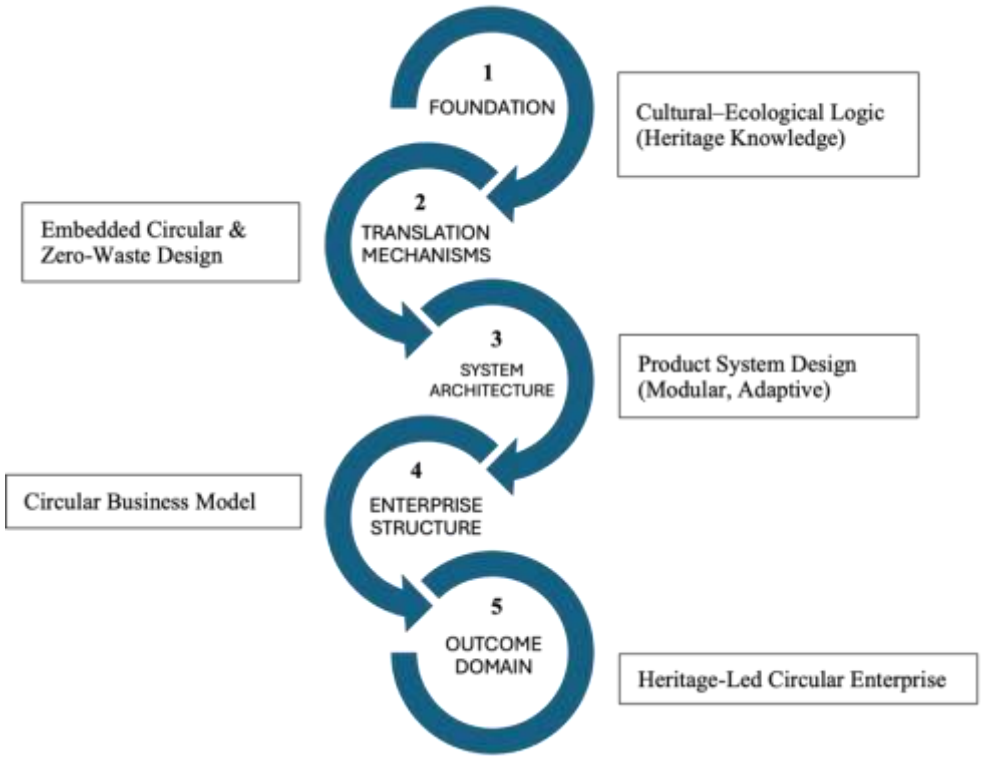
3. Conceptual Framework

Circular business model innovation frameworks emphasise the reconfiguration of value creation, delivery, and capture mechanisms to operationalise circularity within enterprise systems (Urbinati, Chiaroni and Chiesa, 2017) [5]. This study constructs a conceptual framework that brings together circular economy theory, circular business model innovation, zero-waste design, and indigenous clothing systems into a cohesive heritage-to-enterprise translation paradigm.

The literature on the circular economy shows that sustainability transitions need more than just waste management at the end of the process. They also need design changes from the start, longer lifecycles, and changes to business models. Research on circular business models shows that the ways value is created, delivered, and captured need to be changed to enable circular results. Zero-waste fashion design studies provide techniques for material efficiency throughout the design phase, while study on indigenous clothing demonstrates historically established low-waste and modular production systems. However, these domains remain largely disconnected in existing theory. Circular economy frameworks are increasingly understood as systemic transitions requiring integration across cultural, material, and business model dimensions (Geissdoerfer, Savaget, Bocken and Hultink, 2017) [1]. The proposed conceptual framework, the Heritage-to-Circular Enterprise Framework (HCEF), connects these domains through a multi-layer translation logic.

The model illustrates how cultural-ecological logic is translated into circular enterprise outcomes through sequential design and business model mechanisms.

Figure 1. Heritage-to-Circular Enterprise Framework (HCEF): Multi-Level Translation Model.



At the foundation level, cultural-ecological logic captures indigenous resource constraint adaptation and community accountability systems. This level recognises that circularity may emerge from long-standing ecological knowledge systems rather than technological intervention alone. The second level outlines design qualities that are built in and promote circular and zero-waste practices. Zero-waste fashion design principles demonstrate how material efficiency can be embedded within design logic rather than introduced as an external sustainability intervention (Rissanen and McQuillan, 2016) [11]. This level takes cultural practices and turns them into design rules. The third level turns these ideas into product system architecture, which includes zero-waste pattern logic, modular ornamentation systems, reversible attachment mechanisms, and multi-use garment configurations. The fourth level describes the framework of a circular business model, including production that maximises yield, made-to-order craft networks, repair and upgrade services, adaptive reuse product tiers, and dispersed value networks. The fifth level sets up rules for heritage value governance, ensuring that enterprise translation follows principles of cultural integrity, community participation, and benefit sharing. This conceptual model guides the empirical investigation that follows and structures the interpretation of qualitative and quantitative findings in this study.

The paradigm proposes that indigenous clothing systems serve as practical circular prototypes, wherein zero-waste construction, lifecycle extension, and reuse are integral design principles rather than additional sustainability features. Translating these factors into business models makes it possible to innovate in a circular way that is based on culture. The framework also allows assessment integration by using circular key performance indicator (KPI) mapping to connect measurements for design-stage zero waste, lifecycle indicators, reuse rates, and service-based revenue sharing to business performance evaluation.

Table 1. CE KPI Mapping Across the Heritage-to-Circular Enterprise Framework (HCEF)

HCEF Layer	Circular Principle	Enterprise Translation Focus	Example CE KPI Indicators
Layer 1: Cultural-Ecological Logic	Resource stewardship, cultural continuity	Heritage knowledge integration into enterprise design. Story-driven collection.	95% products co-created with community; artisan participation rate; cultural attribution compliance
Layer 2: Embedded Circular and Zero-Waste Design Features	Zero-waste design, material efficiency	Loom-aligned construction and small-batch low-waste production.	Fabric utilisation rate (99%); cutting waste reduction; material yield per garment
Layer 3: Product System Architecture	Modularity, lifecycle extension	Adaptive, repairable, and multi-use garment systems	Repair frequency rate; modular component usage; extended product lifespan
Layer 4: Circular Business Model Structure	Reuse, service models, circular value capture	Repair, adaptive reuse tiers, one-garment-fits-all principle.	Revenue share from repair/reuse services; resale/adaptive reuse ratio; inventory waste reduction
Layer 5: Heritage Value Governance	Ethical scaling and community value capture	Cultural integrity safeguards and benefit-sharing mechanisms ensuring ethical governance, transparency, and community benefit.	Revenue share returned to artisans/community; governance compliance score; transparency/traceability indicators

4. Methodology

This study employed a mixed-method research design to investigate Apatani traditional garment practices as embedded circular and low-waste systems while assessing their potential for enterprise adoption. The mixed-method approach enabled triangulation between observed craft practices, cultural meanings, and contemporary consumer perceptions. Qualitative methods included ethnographic field engagement, semi-structured interviews, and visual garment documentation to examine construction logic, lifecycle practices, and reuse systems. The quantitative component consisted of a structured survey generating measurable indicators related to usage frequency, reuse behaviour, sustainability perception, and openness to contemporary adaptation. Additional exploratory insights on enterprise translation pathways were collected through discussions with artisans, knowledge holders, and users, focusing on adaptive reuse, DIY customisation, co-created product development, modular garment customisation, self-dyeing practices, motif-based block customisation, and story-driven limited collections. These discussions also addressed preferred sales channels, attribution expectations, and revenue-sharing structures, informing the proposed circular heritage enterprise model and governance framework.

Fieldwork was conducted across two contexts: Ziro Valley, the traditional homeland of the Apatani community, and Itanagar, the capital city of Arunachal Pradesh, representing an urban adaptation context with a significant Apatani population. A structured questionnaire was administered to respondents aged 18 to 55 years using snowball sampling across both sites. Survey variables included importance and frequency of traditional clothing use, ownership patterns, alteration and reuse behaviour, sustainability awareness, perceived barriers, openness to contemporary adaptations, willingness to adopt hybrid or modular designs, and awareness of low-waste construction and circular design logic. Qualitative data were analysed through thematic coding focusing on lifecycle duration, reuse pathways, zero-waste construction indicators, symbolic durability, and adaptation thresholds, while quantitative data were analysed using descriptive statistics and cross-tabulation to examine relationships between demographic patterns, usage behaviour, and adaptation acceptance.

The analysis was further strengthened through case observation of A Hundred Hands (AHH), observed between 13 and 15 February 2026 at the National Institute of Fashion Technology (NIFT) Bengaluru campus, which served as a reference model for heritage-based craft enterprise [23]. The observation enabled comparative reflection on community-driven production, design translation, and ethical value-capture mechanisms relevant to the proposed circular heritage enterprise framework. Field observations were documented through structured field notes, visual records, and comparative analytical reflection to ensure consistency in interpretation and to support triangulation with interview and survey findings. Together, these qualitative and quantitative inputs enabled the study to move beyond descriptive analysis toward theory-informed model development, supporting the conceptualisation of the Heritage-to-Circular Enterprise Framework as a transferable enterprise translation model.

This combined approach reduced single-method bias and enhanced analytical robustness, ensuring that framework development was grounded in both empirical observation and data-driven evidence.

5. Results

This section reports the survey and field findings related to Apatani traditional clothing practices and their relevance for circular enterprise development. Results are based on 76 valid survey responses and supporting qualitative field data. Findings are organised by wearing frequency and usage context, adaptation acceptance toward contemporary fashion, and interest in sustainable heritage-inspired collections. Detailed distributions are provided in the figures below, with key patterns highlighted in the accompanying text.

5.1 Wearing Frequency and Usage Context

Figure 2 shows that traditional Apatani attire is worn primarily on occasional or ceremonial occasions rather than as everyday clothing. The distribution indicates that while respondents maintain cultural engagement with traditional dress, routine usage remains limited. This pattern suggests that traditional garments currently function more as symbolic or event-specific attire than as daily functional clothing. The finding provides empirical grounding for the need to explore adaptive design and product system innovation within the Heritage-to-Circular Enterprise Framework (HCEF).

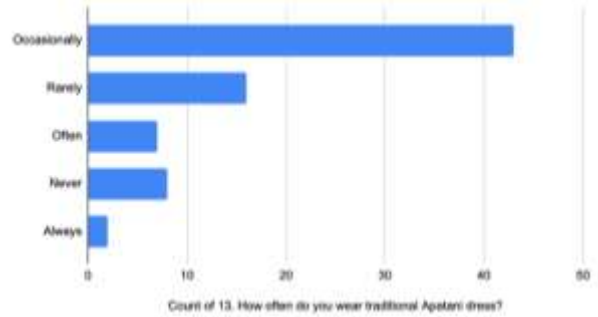


Figure 2. Distribution of Respondent Wearing Frequency of Traditional Apatani Dress.

5.2 Adaptation Acceptance toward Contemporary Fashion

Figure 3 (a) and (b) shows strong respondent support for adapting Apatani traditional costume to contemporary fashion contexts. Positive responses clearly outweigh neutral or resistant positions, indicating broad openness toward design adaptation. The data suggests that cultural preservation and contemporary innovation are not perceived as mutually exclusive by respondents. This finding supports the product system architecture and circular enterprise translation dimensions identified within the HCEF.

Figure 3 (a) and (b). Distribution of Respondent Attitudes toward Adaptation of Apatani Attire to Modern Fashion. of Traditional Apatani Dress.

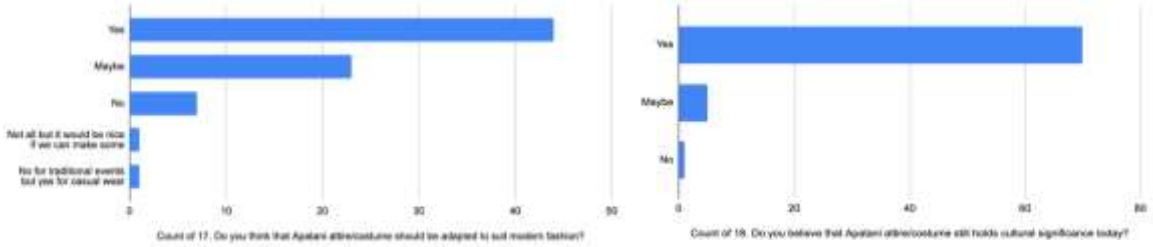


Figure 3 (a)

Figure 3 (b)

5.3 Interest in Sustainable Heritage-Inspired Collections

Figure 4 (a), (b), (c), and (d) demonstrates high interest in a modern, sustainable collection inspired by Apatani traditional dress. Respondents show clear alignment between sustainability awareness and acceptance of heritage-based design innovation. The results indicate potential market readiness for products that combine cultural inspiration with circular design principles. This outcome supports the enterprise-level application pathway proposed within the Heritage-to-Circular Enterprise Framework.

Figure 4. Respondent Interest in Sustainable Apatani-Inspired Fashion Collections. of Traditional Apatani Dress.

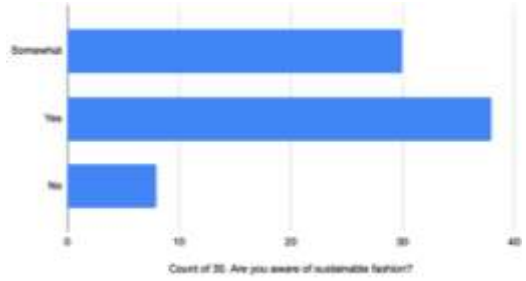


Figure 4 (a)

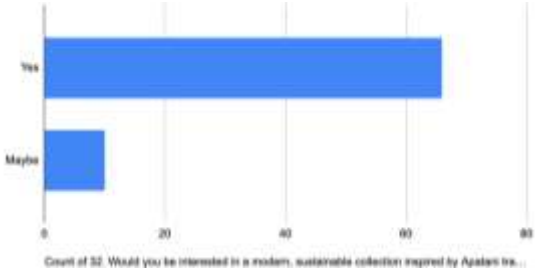


Figure 4 (b)

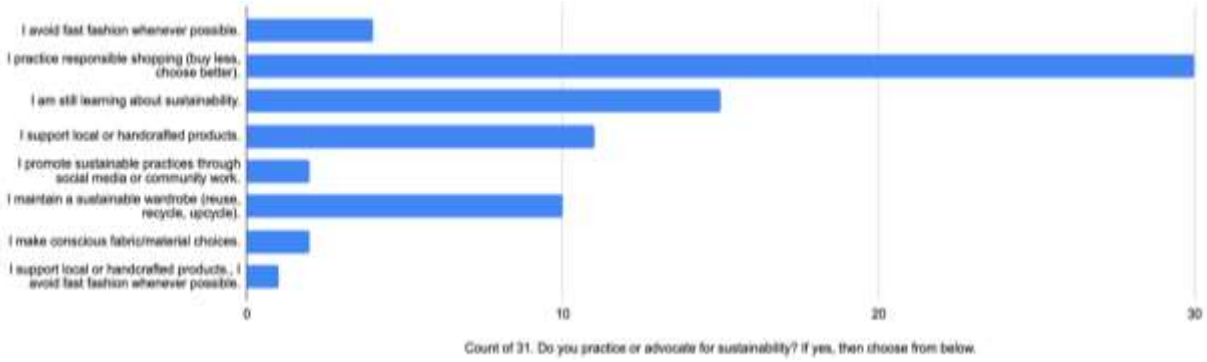


Figure 4 (c)

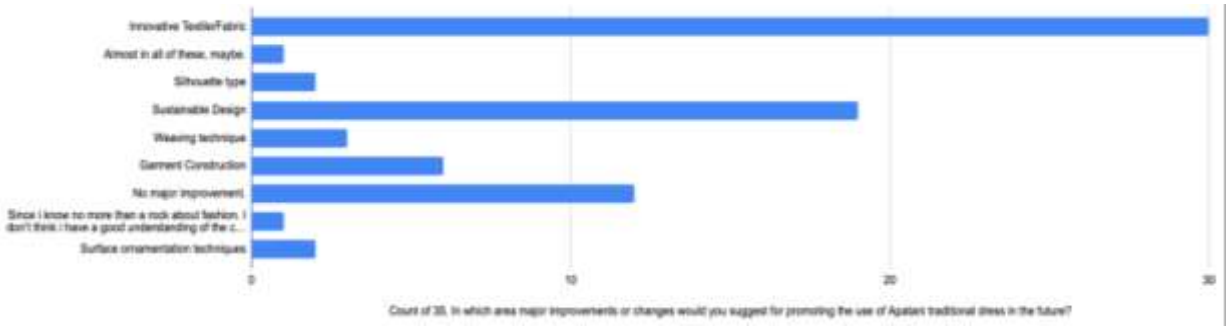


Figure 4 (d)

5.4 Summary of Quantitative Findings

Collectively, the survey results indicate strong cultural familiarity, adaptation readiness, and sustainability-oriented consumer attitudes. The convergence of occasional traditional use with high acceptance of contemporary reinterpretation suggests a measurable opportunity for design-led transition from heritage practice to circular enterprise models. These quantitative findings establish empirical support for the framework's core translation logic, linking cultural knowledge systems with adaptive product development and enterprise feasibility. Together, the results provide quantitative validation for the Heritage-to-Circular Enterprise Framework by confirming both user adaptation readiness and circular market potential.

6. Discussion

The findings indicate that Apatani traditional clothing practices function as an embedded circular and low-waste system and can be meaningfully translated into contemporary circular enterprise models. High cultural familiarity and strong heritage value recognition support what may be described as a cultural legitimacy base, which reduces adoption barriers often reported in circular fashion transitions. At the same time, wearing frequency is concentrated in occasional contexts, revealing a functional integration gap that presents a clear design and business model opportunity.

Strong acceptance of modern and sustainable adaptation, together with high interest in modular and DIY-oriented concepts, provides demand-side validation for circular product architectures based on modularity, repair, and adaptive reuse. These user preference signals align with established circular design and business model principles, indicating operational readiness rather than speculative potential.

An important implication of the proposed model lies in its potential to support cultural continuity by encouraging younger generations to engage with traditional dress through contemporary forms. Rather than positioning heritage clothing as ceremonial or static, the model enables adaptive reinterpretation that aligns with modern lifestyle preferences while maintaining cultural meaning. This approach creates pathways for intergenerational transmission of cultural knowledge through everyday use and market participation.

Convergence between field evidence, including repair culture, reuse pathways, and low-waste construction tendencies, and survey indicators strengthens construct validity and supports the proposed Heritage-to-Circular Enterprise Framework. The results extend circular business model discourse by positioning indigenous clothing systems not only as heritage assets but as practical circular innovation prototypes for culturally grounded sustainable enterprise development.

7. Scope and Limitations

This study should be interpreted within defined methodological boundaries. The quantitative component used snowball sampling within culturally connected networks, which is appropriate for exploratory heritage-focused research but does not support statistical generalisation beyond the sampled community. The survey sample size ($n = 76$) supports descriptive and relational analysis but limits advanced statistical modelling. Fieldwork was conducted in two locations, Ziro Valley and Itanagar, representing traditional and urban contexts; however, broader geographic and diasporic variation was not captured.

Circularity indicators, including zero-waste and reuse practices, were derived from observation and participant narratives rather than lifecycle assessment measurements, and enterprise outcomes are framework-based rather than pilot-tested. Accordingly, findings should be read as empirically grounded and exploratory. Future research should include larger samples, multi-site studies, lifecycle impact measurement, and pilot enterprise validation with community co-governance.

8. Conclusion

This study set out to examine whether indigenous clothing systems can contribute to contemporary circular enterprise development and sustainable business model innovation, using Apatani traditional costume practices as an empirical case. The mixed-method findings demonstrate that Apatani clothing practices function as a culturally embedded circular and low-waste system characterised by lifecycle extension, repair culture, adaptive reuse, modular construction tendencies, and material efficiency shaped by loom-based and resource-constrained production logic. These features align closely with core circular economy

and zero-waste design principles, indicating that circularity in this context is not an imposed innovation but an inherited operational logic. Survey evidence further shows high cultural familiarity, strong recognition of heritage value, widespread sustainability awareness, and high acceptance of contemporary and sustainable adaptation of Apatani-inspired designs. Strong interest in modular and DIY-oriented concepts provides additional support for circular product architectures and service-oriented heritage enterprises. Together, these results establish both practice-level circular foundations and perception-level market readiness.

The proposed Heritage-to-Circular Enterprise Framework and CE KPI mapping model translate these insights into a structured pathway for enterprise application by integrating zero-waste design, modular systems, repair and upgrade services, and heritage governance mechanisms. This study extends circular business model research by evidencing that heritage-embedded clothing systems can function as applied circular innovation templates rather than preservation-only artefacts. The model further contributes to cultural sustainability by enabling contemporary adoption pathways that may strengthen intergenerational continuity of traditional clothing practices.

Future research should extend this work through larger sample sizes, lifecycle impact measurement, and pilot enterprise implementations to further validate and operationalise heritage-led circular business models. Ultimately, the study argues that heritage-based systems should be viewed not as peripheral cultural remnants but as active design and enterprise resources capable of shaping future circular economy transitions.

Beyond its empirical context, this study positions the Heritage-to-Circular Enterprise Framework (HCEF) as a transferable model for translating indigenous and craft-based knowledge systems into measurable circular enterprise strategies, thereby extending circular business model theory beyond industrial and technology-driven contexts.

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