Empowering Indigenous Craft Sustainability: Eco-Friendly Dyeing in Bamboo Weaving by the Teduray Women of Maguindanao, Philippines

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ABSTRACT

This study investigated the sustainability of bamboo dyeing enterprises led by the Teduray Women's Organization in Barangay Bugawas, Datu Odin Sinsuat, and Maguindanao del Norte. Emphasizing local bamboo craft preservation, this research identifies critical socioeconomic and environmental challenges that impact the long-term viability of these traditional practices. The study systematically reviews relevant literature using a qualitative research design and content analysis, assessing sustainable strategies within indigenous weaving and eco-friendly dyeing techniques. Anchored by the Natural Resource-Based View (NRBV) Theory, the research explores sustainable development by aligning natural resource management with community-driven environmental stewardship. Findings reveal that Teduray's cultural heritage, transmitted through generational knowledge and sustainable resource use, is vital for both the resilience of local ecosystems and the economic stability of the bamboo dyeing industry. The study highlights the roles of the Ministry of Science and Technology-BARMM and local government units in fostering a supportive policy framework to enhance market access, product stewardship, and waste reduction. Recommendations include integrating modern ecological knowledge with traditional practices, promoting collaborations between Teduray weavers and government stakeholders, and establishing policies that ensure renewable resource use. This framework aims to empower the Teduray community to sustain its cultural legacy while contributing to regional economic growth and environmental conservation efforts, aligning with global sustainable development goals.

Keywords: Sustainable bamboo dyeing, Indigenous entrepreneurship, Teduray women's organization, cultural heritage preservation, eco-friendly crafts, traditional bamboo weaving, resource-based sustainability, BARMM environmental strategy, Maguindanao local crafts, environmental stewardship in crafts, sustainability frameworks for rural economies

BACKGROUND OF THE STUDY

The global literature on bamboo crafts and sustainability reveals significant gaps in addressing the specific needs of small, indigenous communities like the Teduray. Zhang et al. (2019) focus on design interventions in China's bamboo sector but neglect the social and cultural nuances essential for community-led sustainability. Similarly, Steffen et al. (2013) emphasize industrial-scale bamboo dyeing, offering little insight into localized, eco-friendly practices. Murhadi and Alfath (2022) focus on Indonesia's tourism-driven bamboo craft industry but overlook critical environmental concerns such as sustainable dyeing methods, which are crucial for Teduray. Borowski et al. (2022) highlight bamboo's industrial uses but fail to address the ecological needs of small-scale crafts. Lastly, Waite (2009) focuses heavily on technical fiber production and chemical processes, providing limited guidance on community-level sustainability.

A review of national literature related to bamboo crafts in the Philippines reveals significant gaps that impact the sustainability of the bamboo dyeing industry, especially in Indigenous communities like the Teduray. De Julian Jr. (2023) examines the challenges bamboo craft makers face, particularly highlighting labor and

resource issues exacerbated by the COVID-19 pandemic, but it does not provide long-term sustainability solutions. Razal and Guerrero (2014) discuss non-timber forest products (NTFPs) and the importance of bamboo in the green economy but fail to address local ecological concerns and effective dyeing techniques for small-scale producers. Sharma (1980) presents a broad perspective on bamboo cultivation in the Philippines but focuses mainly on larger production systems, leaving small craftspeople without clear guidance on sustainable practices. These studies often prioritize large-scale industry or theoretical frameworks, neglecting practical, community-driven strategies.

While the government has implemented a short-term capacity development program to promote the Teduray community's dyeing-bamboo sheets handicraft business in Bugawas, Datu Odin Sinsuat, Maguindanao del Norte, the sustainability of this local entrepreneurial activity remains unaddressed. No comprehensive local study has been conducted through the review and analysis of the related literature and studies to explore sustainable practices for the dyeing-bamboo sheets industry for the mentioned area that needs further analysis and interpretation.

The study is especially relevant to the current socio-political context of the Bangsamoro Autonomous Region in Muslim Mindanao (BARMM), which continues to transition from decades of conflict toward inclusive development. Promoting environmentally sustainable indigenous crafts like the Teduray bamboo dyeing practice aligns with BARMM's regional development goals, peacebuilding framework, and cultural preservation agenda. By integrating traditional knowledge with science-based practices, this study contributes to strengthening community resilience, regional identity, and local governance participation. At the national level, it resonates with broader efforts to empower Indigenous Peoples (IPs) in accordance with the Indigenous Peoples' Rights Act (IPRA), and supports the Philippine Development Plan's focus on environmental sustainability, regional equity, and livelihood development. As the BARMM government, alongside national institutions, navigates challenges of inclusive growth, localized studies such as this are essential for policy formulation, grassroots innovation, and sustainable resource governance.

However, several gaps are evident in the literature on bamboo and sustainable practices in the BARMM, particularly regarding local craft industries such as bamboo dyeing. Banik (1997) addresses the limitations of bamboo taxonomy and its sustainable utilization but fails to offer practical solutions for small-scale, community-driven industries like the Teduray weavers. Similarly, Sharma (1980) discusses the challenges of bamboo processing but focuses on more significant commercial production, neglecting the socio-environmental context of indigenous communities. Moreover, Kedan (2013) highlights limitations in traditional craft literature but omits detailed strategies for integrating sustainable dyeing practices that align with local resources.

These studies overlook crucial aspects such as eco-friendly dyeing techniques, the role of local government, and the sustainability frameworks needed to support the long-term viability of the Teduray bamboo handicraft industry. Thus, this research is conducted to review the relevant literature with analysis and interpretation to draw a framework design for sustainable strategies and recommend practical sustainability efforts, focusing on the significant roles of the Teduray weavers, the Ministry of Science and Technology-BARMM, and local government units in environmental protection.

Purpose of the study:

This study explores sustainable practices that can ensure the long-term viability of the dyeing-bamboo sheets handicraft business industry in the Teduray community of Bugawas, Maguindanao del Norte.

Objectives of the Study:

1. To comprehensively review existing literature on sustainable strategies in environmental protection, particularly within the context of traditional weaving practices among the Teduray community.
2. To analyze and interpret the review of the related literature and the roles of the Teduray weavers, the Ministry of Science and Technology-BARMM, and local government units in promoting sustainability within the region.

3. To design a framework highlighting practical strategies for enhancing environmental sustainability in indigenous weaving practices, drawing on interdisciplinary insights from the reviewed literature.
4. To recommend actionable sustainability efforts integrating traditional practices, government support, and scientific innovation for environmental protection, focusing on empowering the Teduray weavers and fostering collaboration among relevant stakeholders.

Research Central Question:

1. What sustainable strategies in environmental protection are discussed in existing literature, particularly with traditional weaving practices among indigenous communities such as the Teduray?
2. How do the roles of the Teduray weavers, the Ministry of Science and Technology-BARMM, and local government units contribute to regional sustainability efforts as identified in the related literature?
3. What framework can be developed to enhance environmental sustainability in indigenous weaving practices, and how can insights from various disciplines be incorporated to support this framework?
4. What specific sustainability efforts can be recommended to integrate traditional practices, government initiatives, and scientific innovations for environmental protection, particularly to empower the Teduray weavers and strengthen collaboration among relevant stakeholders?

Significance of the Study

The study is significant for preserving the Teduray weavers' cultural heritage in Bugawas, Datu Odin Sinsuat, by developing sustainable strategies that support economic resilience and artistic preservation. It offers critical insights for the Ministry of Science and Technology-BARMM, aligning with their goals to tailor support to the local context and boost regional economic development. The research also complements the UNDP's agenda for inclusive growth, Holy Cross Davao College's mission to address local challenges, and frameworks like Cross 5.0 for governance and social cohesion. Furthermore, it aligns with national and international goals, including the United Nations Sustainable Development Goals (SDGs), by fostering sustainable livelihoods and providing a valuable resource for future research on indigenous cultures, sustainable development, and local handicrafts.

Theory Base

The study is anchored to the theory of the Natural Resource-Based View (NRBV) Theory, introduced by Stuart L. Hart in 1995, which provides a framework for businesses to integrate environmental considerations directly into their strategies. This theory proposes that companies can achieve long-term success by aligning their operations with sustainable practices, focusing on natural resource management and environmental impact reduction. NRBV emphasizes three fundamental principles: pollution prevention, product stewardship, and sustainable development, each directly supporting sustainable industry practices that minimize environmental harm. Pollution prevention focuses on reducing waste and emissions, ensuring that production processes have minimal adverse ecological effects. In the bamboo dyeing industry, pollution prevention would encourage local craftspeople to explore natural dyes and waste-reduction methods, aligning their work with environmentally sound practices. The second principle, product stewardship, encourages designing safe and sustainable products throughout their life cycles. Applying this to bamboo dyeing, this principle advocates for creating dyed bamboo sheets that are durable, eco-friendly, and biodegradable, ensuring a product lifecycle that minimizes waste and environmental burden. Finally, sustainable development within NRBV promotes using natural resources to maintain their availability for future generations. In BARMM, this is particularly relevant as sustainable bamboo harvesting and dyeing could support long-term regional economic growth without depleting resources.

Given the identified gaps in sustainable practices research for bamboo dyeing in BARMM, NRBV provides a suitable theoretical framework to support further studies and guide sustainable practices in the industry. This framework aligns well with local industry needs. It can inform policies and initiatives that benefit both the environment and the community, encouraging sustainable practices that are culturally and regionally relevant.

METHODOLOGY

Research Design

This study employs a qualitative research design grounded in content analysis approaches appropriate for exploring the intersection of environmental sustainability and traditional weaving practices within the Teduray community. The initial phase involves a systematic literature review to uncover existing sustainable strategies in environmental protection, particularly in Indigenous craftsmanship, as informed by scholarly frameworks such as those suggested by Creswell (2014) for qualitative data collection. This literature review focuses on contextual and sustainable practices (Patton, 2015). It offers a foundational understanding of the Teduray weavers' roles and interactions with key regional bodies like the Ministry of Science and Technology-BARMM and local government units. The second phase leverages thematic analysis to synthesize findings from the literature review, examining the contributions of governmental and community stakeholders in supporting sustainability. In doing so, the study aligns with Alvesson and Sköldberg's (2017) principles of reflexive methodology, ensuring a nuanced interpretation of cultural and governmental interplay in sustainability. A framework is developed using an interdisciplinary approach, drawing from environmental studies, cultural preservation, and public policy (Silverman, 2016). This framework emphasizes actionable strategies for integrating traditional practices with modern sustainability measures, spotlighting the roles of governmental and scientific bodies in empowering Indigenous communities. The final component recommends sustainability efforts based on collaborative governance models (Emerson et al., 2012) to support environmental conservation through Teduray traditional weaving.

Data Gathering Procedure

This study employs a structured content analysis as the primary data-gathering method, specifically designed to analyze secondary sources relevant to sustainable environmental practices in indigenous weaving. Content analysis, a systematic and objective method for transforming qualitative data into meaningful insights, is highly suited for this research as it allows for extracting and categorizing key themes and patterns from the literature (Krippendorff, 2018). In alignment with the study objectives, relevant sources on sustainability strategies, the Teduray weaving practices, and stakeholder roles were initially identified through an extensive review of academic databases, government reports, and cultural studies journals. Using inductive coding, texts are analyzed to uncover themes concerning the interplay of traditional knowledge, scientific innovation, and governmental roles, as recommended in Hsieh and Shannon's (2005) framework for qualitative content analysis. This approach is convenient for assessing implicit meanings and values related to environmental sustainability (Elo & Kyngäs, 2008), making it possible to design a targeted framework for sustainable weaving practices that respect cultural and ecological priorities. Following the initial coding, key themes are synthesized to inform actionable recommendations for collaborative sustainability efforts, ensuring the integration of traditional practices and modern innovations in line with the study's objectives.

Scope and Limitation

The scope of this study is confined to the application of content analysis in examining existing literature on sustainable environmental strategies within traditional weaving practices, with a specific focus on the Teduray community. Content analysis, recognized for its systematic approach to categorizing textual data, enables the study to critically assess the roles of cultural practices, governmental support, and scientific innovation in promoting environmental sustainability (Krippendorff, 2018). This method limits the analysis to secondary sources, including academic articles, policy documents, and cultural reports, providing insights into how traditional practices and government initiatives intersect to support sustainable weaving practices.

By focusing solely on content analysis, the study is restricted in its ability to gather real-time, empirical data directly from the Teduray weavers or other stakeholders; instead, it relies on interpretations of documented insights, which may not fully capture evolving practices or firsthand perspectives (Elo & Kyngäs, 2008). Additionally, the research faced practical constraints, particularly related to the limited time frame and ongoing security issues in parts of the BARMM region. These challenges prevented field visits and direct community engagement during the conduct of this academic study. As a result, important non-documented local

knowledge, including gendered experiences, community-based innovations, and evolving weaving practices, may not have been fully represented.

Despite these limitations, content analysis offers a solid framework for synthesizing interdisciplinary insights and proposing a sustainable development model for the indigenous bamboo dyeing industry. For future research or derivative studies, incorporating primary data through interviews with Teduray women weavers, focus groups, and participant observations is strongly encouraged. These methodologies would provide deeper contextual understanding, enhance data triangulation, and foster a richer dialogue between theory and community-based practices.

Data Analysis

This study applies qualitative content analysis to systematically interpret and categorize information from existing literature on sustainable environmental strategies and traditional weaving practices within the Teduray community. Following the method outlined by Hsieh and Shannon (2005), the analysis begins with inductive coding to identify recurring themes and concepts relevant to the study objectives, particularly the roles of cultural, governmental, and scientific stakeholders in promoting sustainability. Each text is reviewed to extract explicit and implicit content, providing insights into traditional weaving's ecological impact and alignment with broader sustainability efforts. Categories are then developed to reflect the interactions between the Teduray weavers, government bodies, and scientific institutions, helping to highlight the contributions and responsibilities of each in environmental protection efforts. By categorizing and synthesizing the literature, the analysis aims to produce an integrated framework of sustainable practices and to derive recommendations that are culturally resonant and practically feasible for the Teduray community. Content analysis is chosen for its ability to distill complex interdisciplinary insights into meaningful, actionable knowledge, strengthening the study's foundation in traditional and contemporary sustainability practices (Krippendorff, 2018).

Ethical Considerations

In conducting this content analysis, the study adheres to ethical standards across several key areas, including informed consent, privacy and confidentiality, risk assessment, research design, and conflict of interest. Since this research relies exclusively on secondary data from existing literature, it does not require informed consent from individuals or direct participants; however, careful attention is given to represent and respect the sources accurately used, particularly those documenting indigenous practices and cultural knowledge (Hsieh & Shannon, 2005). Privacy and confidentiality are managed by ensuring that all secondary data sources comply with copyright and citation standards, thus safeguarding the original authors' intellectual contributions. This study is low-risk in risk assessment, as it does not interact with human subjects but instead engages with published information, reducing the potential for harm or cultural misrepresentation (Krippendorff, 2018). The research design remains strictly within the scope of content analysis, promoting transparency and neutrality by avoiding subjective interpretations that might misrepresent the cultural context of the Teduray community. To prevent any conflict of interest, the researcher commits to impartial analysis, ensuring that no affiliations or biases influence the interpretation of literature or formulation of recommendations. These ethical measures collectively enhance the credibility of the study's findings, supporting the development of a culturally and scientifically sound sustainability framework for traditional weaving practices.

RESULTS AND DISCUSSION

Ecological Stewardship through Traditional Knowledge

Teduray weaving exemplifies ecological stewardship by integrating locally sourced, renewable materials and traditional environmental knowledge. Studies by Ahlawat (2018), Zhan et al. (2017), and Life College, Inc. (2022) consistently emphasize the use of low-impact, biodegradable resources in indigenous crafts, aligning with the Teduray's practices of sustainable material harvesting. These crafts not only reduce ecological strain but also maintain a cultural relationship with the land.

Sustainable design principles—articulated by Papanek (1995), Fletcher (2013), and Niinimäki (2011)—further validate the ecological soundness of Teduray weaving. The emphasis on minimal waste, durability, and closed-

loop systems in these frameworks reflects the existing practices of the community, where weaving is inherently low-emission and non-industrial. In this sense, the Teduray serve as active agents of environmental responsibility, demonstrating that ancestral craft techniques can mirror or even exceed the objectives of modern sustainable design.

The alignment of place-based environmental management with cultural identity is also reinforced in the works of Kanene (2016), Escobar (2001), and Andrade-Sánchez et al. (2021). These studies demonstrate how communities like the Tonga, Kumeyaay, and Teduray embed ecological ethics into their traditional knowledge systems. Tools such as indigenous mapping and selective harvesting are not only environmentally practical but also expressions of cultural sovereignty and resilience.

Collectively, these findings illustrate that Teduray weaving is more than a livelihood—it is a form of ecological governance. As indigenous practices increasingly gain recognition within global sustainability dialogues, the Teduray's weaving system offers a replicable model for climate-sensitive craft production rooted in community-based ecological ethics.

Cultural Continuity and Intergenerational Learning

The preservation of cultural identity through intergenerational transmission is a defining aspect of Teduray weaving. As shown in the studies of Hwang and Huang (2019) and Life College, Inc. (2022), traditional weaving functions as a bridge between generations, allowing Indigenous knowledge to be passed down within families and communities. This process not only sustains the craft but fortifies the Teduray's social and cultural fabric.

Escobar (2001) and Andrade-Sánchez et al. (2021) extend this argument by highlighting the role of community-based learning initiatives, such as informal education and participatory training, in reinforcing identity and ecological memory. For the Teduray, the act of weaving is inseparable from their history, rituals, and worldview, thereby serving as a medium for cultural reproduction and knowledge continuity.

Moreover, frameworks like the United Nations Sustainable Development Goals (UNCTAD, 2014; WCED, 1987) support the idea that cultural heritage is a cornerstone of sustainable development. In this context, Teduray weaving exemplifies how Indigenous traditions can advance environmental goals while reinforcing cultural continuity, a dual imperative emphasized in global development discourse.

Thus, weaving not only preserves heritage—it enacts it. By maintaining traditional methods and intergenerational pedagogy, the Teduray demonstrate that cultural continuity is a living, adaptive process that directly supports long-term ecological and communal resilience.

Economic Sustainability through Market and Policy Integration

Economic viability is essential for sustaining traditional crafts like Teduray weaving, particularly in rural and Indigenous contexts. Literature by Farsani et al. (2011), Richards (2021), and Sanchis et al. (2016) underscores how integrating handicrafts into ecotourism provides a synergistic pathway for cultural preservation and income generation. For the Teduray, weaving could become both an emblem of heritage and a livelihood tool within sustainable tourism frameworks.

Policy and infrastructure also play crucial roles. Bessiere et al. (2013) and Braedt & Standa-Gunda (2000) stress the need for resource regulation to prevent ecological degradation, a concern that resonates with the Teduray's dependence on local bamboo and dyes. Supportive government policies, market linkages, and access to eco-certifications could enhance the sustainability and profitability of weaving enterprises.

Further, economic sustainability is underpinned by indigenous knowledge systems, as emphasized by Singh (1989) and Vuletić et al. (2009). Embedding local ecological wisdom within the production and marketing process not only adds cultural value but also ensures that income is generated without compromising ecological integrity.

Therefore, economic resilience for Teduray weaving is not just a matter of commerce—it is a function of policy, culture, and environmental ethics. Building sustainable market systems that honor these dimensions can empower Indigenous artisans and support long-term community development.

Stakeholder Collaboration for Sustainable Development

The sustainability of Teduray weaving hinges on multi-stakeholder collaboration involving local communities, government institutions, and scientific partners. Le et al. (2016) and Bayoumi et al. (2020) point out that enhancing artisanal methods through design support and eco-training can elevate both cultural impact and environmental responsibility.

The integration of scientific tools—like indigenous mapping described by Andrade-Sánchez et al. (2021)—presents opportunities for improved environmental governance. These methods could be applied to Teduray bamboo sourcing, enabling more efficient, community-led resource monitoring.

In addition, Maditsi and Materechera (2021) emphasize Indigenous Communities of Practice (iCoPs) as critical for environmental learning and resilience. For Teduray weavers, this suggests that peer-based and cooperative platforms could facilitate sustainable innovations, cultural exchange, and policy influence.

In sum, sustainable development for the Teduray weaving tradition depends on dynamic cooperation between actors who bring complementary strengths: local knowledge, policy frameworks, and scientific innovation. Such collaboration fosters inclusive resilience while preserving cultural authenticity.

Structural Challenges to Sustainability

Despite the ecological, cultural, and economic potential of Teduray weaving, several structural barriers hinder its long-term viability. One major challenge is unequal access to markets and infrastructure, which limits the ability of Teduray weavers to scale production, reach urban buyers, or participate in export-oriented craft fairs. As Bunting and Mitchell (2001) emphasize, access to infrastructure—such as transport, digital connectivity, and supply chains—is critical for rural artisans to achieve financial sustainability. Without targeted investment, Teduray products risk remaining confined to local markets with limited purchasing power.

Another pressing issue is land insecurity, particularly in Indigenous territories within BARMM. Land tenure disputes and unclear legal recognition of ancestral domains complicate bamboo harvesting and resource management, directly affecting material access for weaving. As highlighted in studies on Indigenous communities across Southeast Asia (Kanene, 2016; Johnson et al., 2016), unresolved land conflicts undermine ecological sustainability and weaken cultural sovereignty.

Moreover, legal and bureaucratic obstacles persist. Weavers often lack formal recognition as micro-entrepreneurs or cooperatives, limiting their eligibility for government programs, financial services, or eco-certifications. This exclusion from formal support systems places Indigenous artisans at a disadvantage compared to mainstream industry actors. Without institutional mechanisms to protect intellectual property rights and culturally embedded craft practices, traditional knowledge is also at risk of commodification or appropriation.

Addressing these structural limitations requires not only cultural sensitivity but also legal reforms, inclusive development planning, and sustained support from local and national institutions. Recognizing the Teduray weavers not just as artisans but as cultural custodians and environmental stewards is essential to embedding sustainability in both policy and practice.

Integrated Framework for Sustainable Practices in Teduray Weaving

The findings highlight a sustainable development model for Teduray weaving rooted in the synergy between ecological stewardship, cultural continuity, and economic resilience. Teduray weavers uphold environmental

ethics through traditional practices and the use of local renewable resources, while simultaneously preserving cultural identity across generations. Government support reinforces this model through enabling policies, market access initiatives, and ecotourism programs that integrate traditional crafts into the regional economy. Scientific institutions contribute by introducing tools like indigenous mapping and ecological monitoring, which enhance sustainable resource management. Together, these actors form a cohesive, adaptive framework that elevates Teduray weaving from cultural heritage to a dynamic, sustainable livelihood. This integrated model offers a pathway for long-term community resilience, aligning cultural preservation with environmental responsibility and inclusive economic development.

Recommendations for Sustainable Practices in Teduray Weaving

To support the long-term sustainability of Teduray weaving, a coordinated strategy is essential across cultural, ecological, and economic dimensions.

First, community-led stewardship of local resources should be formalized through sustainable harvesting practices and ecological monitoring in partnership with scientists.

Second, market integration must be enhanced through cultural ecotourism, product innovation, and cooperative organization, empowering weavers to access broader markets and secure fair pricing.

Third, policy advocacy is needed to establish conservation zones and legal protections that safeguard both natural resources and cultural rights.

Fourth, educational and archival initiatives, including school curricula and craft documentation—will ensure intergenerational knowledge transmission.

Finally, regular monitoring and cross-sector knowledge-sharing platforms should be institutionalized to continuously assess impact, refine strategies, and adapt to evolving conditions. These collective efforts, led by the Teduray community with support from the Ministry of Science and Technology-BARMM, Holy Cross of Davao College, and allied institutions, will reinforce ecological resilience, cultural identity, and economic viability.

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this research paper, "Empowering Indigenous Craft Sustainability: Eco-Friendly Dyeing in Bamboo Weaving by the Teduray Women of Maguindanao, Philippines." The research was conducted independently, without any financial or personal relationships that could inappropriately influence or bias the content.

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APPENDIX

Appendix: Synthesized Thematic Tables from Results and Discussion

Table 1. Themes Related to Ecological Resource Stewardship in Teduray Weaving

Label	Code	Emerging Theme
Low-Impact Materials and Conservation	Use of locally sourced, renewable materials (Ahlawat, 2018; Zhan et al., 2017)	Ecological Resource Stewardship
Sustainable Design Principles	Alignment with eco-friendly frameworks (Papanek, 1995; Fletcher, 2013)	Ecological Impact and Sustainability
Environmental Management	Indigenous conservation strategies (Kanene, 2016; Escobar, 2001)	Ecological Governance

Table 2. Cultural Continuity and Intergenerational Learning Themes

Label	Code	Emerging Theme
Intergenerational Knowledge Transfer	Passing traditional knowledge across generations (Life College, Inc., 2022; Hwang & Huang, 2019)	Cultural Sustainability
Cultural Identity and Resilience	Cultural expression through weaving (Escobar, 2001)	Knowledge Preservation
Community-Based Learning	Education through practice (Andrade-Sánchez et al., 2021)	Cultural Transmission

Table 3. Economic Sustainability and Stakeholder Roles

Label	Code	Emerging Theme
Economic Support through Ecotourism	Weaving integrated with local tourism (Farsani et al., 2011; Richards, 2021)	Cultural and Economic Preservation
Policy and Resource Sustainability	Regulation to prevent depletion (Bessiere et al., 2013)	Resource Management
Market Access and Infrastructure	Connection to external markets (Bunting & Mitchell, 2001)	Economic Viability
Cultural Knowledge Integration	Embedding Indigenous knowledge in production (Singh, 1989)	Economic and Cultural Resilience
Ecological Education and Collaboration	Joint efforts between government and community (Johnson et al., 2016)	Environmental Stewardship

Appendix 2: Full Set of Thematic Tables from the Results and Discussion

Table 1

No.	Source	Key Insight	Citations
1	[Ahlawat (2018)]	Indigenous crafts use local, sustainable materials supporting cultural conservation	1
2	[Life College, Inc. (2022)]	Tagbanua weaving highlights ecological and generational knowledge in Indigenous practices	2
3	[Zhan et al. (2017)]	Indigenous crafts as ecological vessels that promote sustainable practices	1
4	[Kanene (2016)]	Cultural conservation practices in Tonga resonate with Teduray's resource use	1
5	[Andrade-Sánchez et al. (2021)]	Kumeyaay weavers' use of Indigenous mapping for resource management echoes sustainable weaving practices	1

Table 2

No.	Source	Key Insight	Citations
1	UNCTAD, 2014; WCED, 1987	Emphasis on resource conservation and sustainable development principles	2
2	Fletcher, 2013; Niinimäki, 2011	Highlights low-impact materials in sustainable design	2
3	Escobar, 2001	Place-based knowledge in cultural identity	1
4	Hwang & Huang, 2019	Intergenerational learning and cultural preservation through weaving	1
5	Richards, 2021; Farsani et al., 2011	Economic development via traditional crafts and tourism	2
6	Papanek, 1995	Advocates for eco-friendly, sustainable design	1

Table 3

No.	Source	Key Insight	Citations
1	Farsani et al., 2011; Richards et al., 2021	Ecotourism's role in economic support and cultural preservation	2
2	Bessiere et al., 2013; Braedt & Standa-Gunda, 2000	Policy and resource sustainability for traditional crafts	2
3	Bunting & Mitchell, 2001	Market access as a driver for rural economic sustainability	1
4	Singh, 1989; Vuletić et al., 2009	Economic resilience through local knowledge in crafts	2
5	Johnson et al., 2016; Sandoval-Rivera, 2020	Government-supported ecological education	2

Table 4

No.	Source	Key Insight	Citations
1	Max-Neef (1992)	Emphasizes the role of "indigenized" crafts in rural revitalization, integrating cultural values to support cultural preservation and economic stability.	1
2	Le et al. (2016)	Highlights the potential for refining artisanal processes to enhance ecological conservation and cultural heritage, supporting Teduray's sustainable practices.	1
3	Johnson & Bryden (2012)	Addresses energy needs for rural crafts, which is crucial for the sustainable production capacity of the Teduray weaving community.	1
4	Bunting & Mitchell (2001)	Market access and infrastructure development are vital to enhancing economic sustainability for rural artisans like Teduray.	1
5	Sanchis et al. (2016)	Highlights crafts' job creation and social cohesion benefits are integral to rural tourism and economic stability, thus reinforcing the Teduray weaving's economic potential.	1
6	Bayoumi et al. (2020)	Discusses crafts to promote environmental sustainability and local identity, underscoring Teduray's interaction with heritage and ecological preservation.	1
7	Maditsi & Materechera (2021)	Analyzes the role of Indigenous Communities of Practice (iCoPs) in fostering environmental resilience and cultural sustainability, validating collaborative knowledge sharing among the Teduray.	1
8	Andrade-Sánchez et al. (2021)	Demonstrates how indigenous mapping in resource management fosters sustainable practices, potentially applicable for Teduray weaving.	1
9	Anjali & Reddy (2023)	Links indigenous artistic forms to ecological wisdom and cultural identity, aligning with Teduray weaving's role in environmental awareness.	1

Table 5

Label	Code	Pattern	Emerging Theme
Low-Impact Materials and Conservation	"Prioritize low-impact materials sourced locally" and "Environmental conservation through renewable resources" (Ahlawat, 2018; Zhan et al., 2017).	Recurring emphasis on local, sustainable resource use as foundational in indigenous crafts and Teduray weaving for environmental stewardship.	Ecological Resource Stewardship
Sustainable Design Principles	"Sustainable design frameworks by Papanek (1995) and Fletcher (2013)" to reduce environmental impact.	Indigenous weaving aligns with recognized sustainable design frameworks, highlighting connections between traditional practices and ecological awareness.	Ecological Impact and Sustainability
Environmental Management	"Integrates place-based environmental management, as seen in the Kumeyaay and Tonga communities" (Life College, Inc., 2022; Kanene, 2016).	Indigenous knowledge forms conservation strategies that are adaptable across communities, positioning Teduray with other Indigenous groups to steward local resources.	Ecological Resource Stewardship
Intergenerational Knowledge Transfer	"Importance of passing down cultural and ecological knowledge across generations" (Life College, Inc., 2022; Hwang & Huang, 2019).	Crafts serve as tools for cultural transmission, preserving identity and resilience through generational knowledge exchange.	Cultural Sustainability and Knowledge Transmission
Cultural Identity and Resilience	"Weaving functions as a socioeconomic driver and sustains cultural knowledge tied to environmental stewardship" (Escobar, 2001; Vuletić et al., 2009).	Teduray weaving is a cultural anchor, integrating ecological values and ensuring resilience through unified cultural practices.	Cultural and Identity Resilience
Community-Based Learning Initiatives	"Traditional practices preserved through familial and community-based learning" (Escobar, 2001; Andrade-Sánchez et al., 2021).	Community structures support learning and knowledge sharing, reinforcing traditional practices and cultural values across generations.	Cultural Transmission and Community-Based Learning
Government Support in Ecotourism and Market Access	"Market access and policy support to sustain livelihoods" through ecotourism initiatives (Bessiere et al., 2013; Vuletić et al., 2009).	Policies supporting tourism and handicraft markets ensure economic sustainability, linking government roles with economic resilience in Teduray weaving.	Economic Resilience and Policy Support
Policy and Resource Management	"Need for regulation to prevent resource depletion" in craft trade (Bessiere et al., 2013).	Governmental policy frameworks align with resource conservation, underscoring the necessity of regulatory support for sustainable weaving practices.	Governmental Role in Sustainable Practices
Scientific Institutions and Environmental Knowledge Integration	"Indigenous mapping for resource management" as seen in the Kumeyaay (Andrade-Sánchez et al., 2021).	Scientific methods, such as mapping, strengthen environmental knowledge and resource management, suggesting roles for scientific institutions in sustainable practices.	Collaborative Support and Scientific Integration

Table 6

Label	Code	Pattern	Emerging Theme
Intergenerational Knowledge Transfer	"Crafts as integral to cultural identity and continuity" (Hwang & Huang, 2019)	Emphasizes weaving as bridging generational gaps, fostering cultural continuity, and passing on traditional knowledge within Indigenous communities.	Cultural Transmission and Knowledge Preservation
Resource Conservation and Cultural Sustainability	"Resource conservation principles supporting sustainable development" (UNCTAD, 2014; WCED, 1987)	Reflects adherence to sustainable practices aligned with UN principles, reinforcing that Teduray weaving upholds environmental sustainability and cultural heritage.	Sustainable Cultural Heritage
Low-Impact Materials and Ecological Consciousness	"Indigenous weaving uses renewable resources for environmental stewardship" (Fletcher, 2013; Niinimäki, 2011)	Recurring focus on sustainable material use, reinforcing that Teduray weavers integrate ecological consciousness in material sourcing.	Ecological Responsibility in Craftsmanship
Eco-Friendly and Sustainable Design Principles	"Advocates for eco-friendly and sustainable design" (Papanek, 1995)	Highlights alignment with sustainable design frameworks, positioning Teduray weaving within broader eco-friendly design movements that reduce environmental impact.	Environmentally Sustainable Practices
Place-Based Knowledge and Cultural Identity	"Traditional practices rooted in place-based knowledge reflect cultural identity" (Escobar, 2001)	Indigenous weaving embodies regional identity, emphasizing that the Teduray practice captures place-based ecological knowledge and strengthens community identity.	Cultural Identity through Environmental Practices
Economic Development through Traditional Crafts	"Traditional crafts stimulate economic growth and foster sustainable tourism" (Farsani et al., 2011; Richards, 2021)	Traditional crafts, including weaving, support economic resilience by opening market access and enabling sustainable tourism, thereby preserving cultural practices.	Economic Resilience through Craft-Based Tourism
Market Access and Local Resource Connection	"Market access and economic growth reinforce community identity and resource connection" (Bunting & Mitchell, 2001; Singh, 1989)	Ensures that Teduray weaving sustains relevance in modern economies while fostering a strong connection to local resources and cultural identity.	Economic and Cultural R

Table 7

Label	Code	Pattern	Emerging Theme
Economic Support through Ecotourism	"Ecotourism provides economic and cultural benefits by linking handicrafts with tourism" (Farsani et al., 2011; Richards et al., 2021)	Teduray weaving, as an attraction for sustainable tourism, offers dual benefits by generating income and preserving traditional crafts for community enrichment.	Economic and Cultural Preservation through Tourism
Policy and Resource Sustainability	"Policies prevent overuse of natural resources essential to Teduray weaving" (Bessiere et al., 2013; Braedt & Standa-Gunda, 2000)	Emphasizes the need for regulated support to maintain resource availability, ensuring sustainable craft production without environmental degradation.	Resource Preservation and Policy Support

Market Access and Infrastructure	"Connecting rural artisans to broader markets supports economic sustainability" (Bunting & Mitchell, 2001)	Market access and improved infrastructure for rural artisans can bolster the economic viability of Teduray weaving, fostering long-term resilience.	Economic Viability through Market Expansion
Cultural and Economic Resilience through Local Knowledge	"Local environmental knowledge in crafts fosters economic and cultural stability" (Singh, 1989; Vuletić et al., 2009)	Embedding indigenous knowledge within crafts like weaving strengthens economic resilience while preserving cultural identity and environmental respect.	Cultural Sustainability and Economic Resilience
Ecological Education and Community Collaboration	"Government-supported ecological education enhances sustainable practices in Indigenous communities" (Johnson et al., 2016; Sandoval-Rivera, 2020)	Emphasizes collaboration between government and community for ecological education, reinforcing Teduray weaving's role in cultural and environmental stewardship.	Environmental Stewardship and Cultural Transmission

Table 8

Label	Code	Pattern	Emerging Theme
Environmental Responsibility through Indigenous Knowledge Integration	"Refining artisanal processes enhances ecological conservation and cultural heritage" (Le et al., 2016).	Highlights the dual impact of traditional crafts in reducing environmental impact while preserving cultural heritage, encouraging Teduray's adoption of sustainable methods.	Sustainable Practices Through Indigenous Knowledge
	"Indigenous mapping fosters sustainable resource management" (Andrade-Sánchez et al., 2021).	Incorporating indigenous techniques, such as mapping, strengthens sustainable practices, indicating how Teduray weaving could benefit from similar environmental management tools.	Resource Stewardship through Indigenous Knowledge
	"Indigenous crafts reflect ecological wisdom and cultural identity" (Anjali & Reddy, 2023).	Emphasizes how weaving serves as a medium for cultural expression and environmental responsibility, aligning Teduray's craft with sustainable environmental practices.	Cultural Identity in Environmental Conservation
Infrastructure and Market Expansion	"Market access and infrastructure are crucial for economic sustainability" (Bunting & Mitchell, 2001).	Access to broader markets and infrastructure development are vital to making Teduray weaving economically viable within a competitive landscape.	Economic Resilience through Market Expansion
	"Crafts promote job creation and rural tourism, strengthening economic stability" (Sanchis et al., 2016; European Union, 2022).	Local tourism and crafts play significant roles in job creation, reinforcing economic resilience and providing sustained revenue opportunities for Teduray weaving.	Economic Growth and Tourism Support
Community Collaboration and Knowledge Sharing for Environmental Resilience	"Indigenous Communities of Practice foster cultural sustainability and environmental resilience" (Maditsi & Materechera, 2021).	Collaborative platforms enhance knowledge sharing on environmental issues, suggesting that Teduray can strengthen sustainability through community-led ecological practices.	Environmental and Cultural Sustainability through Collaboration

	"Crafts embody environmental sustainability and local identity" (Bayoumi et al., 2020).	Reinforces the role of traditional crafts in building local identity and ecological responsibility, helping the Teduray community preserve their heritage and sustainable practices.	Ecological Responsibility and Cultural Sustainability
	"Rural revitalization integrates cultural values to enhance economic stability" (Max-Neef, 1992).	Integrating cultural values into crafts supports rural economic growth and cultural preservation, affirming the socioeconomic role of Teduray weaving.	Cultural Values in Economic and Environmental Resilience

Table 9

Category	Codes	Key Themes Reflected
Ecological Resource Stewardship	"Prioritize low-impact materials sourced locally"; "Environmental conservation through renewable resources" (Ahlawat, 2018; Zhan et al., 2017); "Integrates place-based environmental management" (Life College, Inc., 2022; Kanene, 2016)	Emphasizes sustainable resource use and environmental conservation within Teduray weaving, aligning traditional practices with broader ecological goals.
Cultural Sustainability and Knowledge Transmission	"Importance of passing down cultural and ecological knowledge across generations" (Life College, Inc., 2022; Hwang & Huang, 2019); "Traditional practices preserved through familial and community-based learning" (Escobar, 2001; Andrade-Sánchez et al., 2021)	Highlights the intergenerational transfer of cultural and ecological knowledge, safeguarding cultural identity and resilience within Teduray weaving.
Cultural Identity and Resilience	"Weaving functions as a socioeconomic driver and sustains cultural knowledge" (Escobar, 2001; Vuletić et al., 2009)	Weaving supports economic activity and strengthens cultural identity, tying ecological values to livelihood sustainability.
Economic Resilience and Policy Support	"Market access and policy support to sustain livelihoods" (Bessiere et al., 2013; Vuletić et al., 2009); "Need for regulation to prevent resource depletion" (Bessiere et al., 2013)	Connects government support and policy frameworks to economic stability and sustainability in Teduray weaving, mainly through ecotourism and regulated market access.
Collaborative Support and Scientific Integration	"Indigenous mapping for resource management" (Andrade-Sánchez et al., 2021)	Reflects the importance of scientific collaboration, such as mapping, for enhancing environmental knowledge and sustainable resource management.

Table 10

Category	Codes	Key Themes Reflected
Cultural Transmission and Knowledge Preservation	"Crafts as integral to cultural identity and continuity"	Weaving bridges generational gaps, emphasizing cultural continuity and traditional knowledge transfer within the community.
Sustainable Cultural Heritage	"Resource conservation principles supporting sustainable development"	Practices reflect adherence to sustainable development, reinforcing Teduray weaving as both environmentally and culturally sustainable.
Ecological Responsibility in Craftsmanship	"Indigenous weaving uses renewable resources for environmental stewardship."	Emphasis on renewable materials highlights ecological consciousness in sourcing fostering environmental stewardship.

Environmentally Sustainable Practices	"Advocates for eco-friendly and sustainable design"	Teduray weaving aligns with sustainable design principles, positioning it within eco-friendly, low-impact design movements.
Cultural Identity through Environmental Practices	"Traditional practices rooted in place-based knowledge reflect cultural identity."	Weaving embodies regional identity, capturing place-based ecological knowledge that strengthens community identity.
Economic Resilience through Craft-Based Tourism	"Traditional crafts stimulate economic growth and foster sustainable tourism."	Craft weaving bolsters economic resilience by enabling market access and sustainable tourism while preserving cultural practices.
Economic and Cultural Relevance	"Market access and economic growth reinforce community identity and resource connection."	Economic activity through weaving fosters community identity and connection to local resources, keeping traditional practices relevant.

Table 11

Category	Codes	Key Themes Reflected
Economic and Cultural Preservation through Tourism	"Ecotourism provides economic and cultural benefits by linking handicrafts with tourism."	Teduray weaving, featured in sustainable tourism, supports economic benefits and cultural preservation, enriching the community while promoting traditional crafts.
Resource Preservation and Policy Support	"Policies prevent overuse of natural resources essential to Teduray weaving."	Policies play a critical role in safeguarding resources necessary for Teduray weaving, ensuring sustainable craft production without causing environmental harm.
Economic Viability through Market Expansion	"Connecting rural artisans to broader markets supports economic sustainability."	Expanding market access and improving infrastructure for rural artisans fosters the economic resilience of Teduray weaving, ensuring its long-term viability.
Cultural Sustainability and Economic Resilience	"Local environmental knowledge in crafts fosters economic and cultural stability."	Integrating local environmental knowledge into weaving strengthens cultural identity and economic resilience, reinforcing environmental respect within the craft.
Environmental Stewardship and Cultural Transmission	"Government-supported ecological education enhances sustainable practices in indigenous communities."	Collaborative ecological education initiatives between government and community promote sustainable practices, supporting Teduray weaving's cultural and environmental roles.

Table 12

Category	Codes	Key Themes Reflected
Environmental Responsibility through Indigenous Knowledge Integration	Sustainable Practices Through Indigenous Knowledge	It highlights how artisanal processes in Teduray weaving reduce environmental impact by integrating ecological wisdom with cultural heritage conservation.
Environmental Responsibility through Indigenous Knowledge Integration	Resource Stewardship through Indigenous Knowledge	Emphasizes indigenous mapping and other techniques that promote sustainable resource management in Teduray weaving.
Environmental Responsibility through Indigenous Knowledge Integration	Cultural Identity in Environmental Conservation	Illustrates weaving as a medium for cultural expression and environmental responsibility, reinforcing Teduray's sustainable identity.

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Infrastructure and Market Expansion	Economic Resilience through Market Expansion	Underlines the need for broader market access and infrastructure to maintain economic viability for Teduray weaving in competitive markets.
Infrastructure and Market Expansion	Economic Growth and Tourism Support	We focus on crafts' role in job creation, rural tourism, and economic stability, generating revenue for the Teduray.
Community Collaboration and Knowledge Sharing for Environmental Resilience	Environmental and Cultural Sustainability through Collaboration	Showcases the potential for ecological and cultural resilience through community-led platforms for knowledge exchange.
Community Collaboration and Knowledge Sharing for Environmental Resilience	Ecological Responsibility and Cultural Sustainability	Confirms crafts' role in preserving ecological responsibility and local identity within the Teduray community.
Community Collaboration and Knowledge Sharing for Environmental Resilience	Cultural Values in Economic and Environmental Resilience	Highlights rural revitalization through integrating cultural values, reinforcing Teduray weaving's socioeconomic contributions.