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Indigenous Knowledge System in Gringsing Weaving: the Lubeng Motif

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ABSTRACT

Gringsing weaving with the Lubeng motif in Tenganan Pegringsingan Traditional Village constitutes a living knowledge system that integrates ecological knowledge, double-ikat technology, motif geometry, cosmology, ritual practices, and customary governance. This study aims to explain the structure and operational mechanisms of the indigenous knowledge system that sustain Gringsing weaving. The study employed a qualitative ethnographic approach from an emic perspective. Data were obtained through in-depth interviews with 12 weavers and customary leaders, participant observation, audiovisual documentation, examination of awig-awig, and supporting archives and literature. Data were analyzed through interactive data reduction and display, domain-taxonomic-cultural-theme analysis, and symbolic interpretation. The findings reveal five interconnected layers of knowledge: material-ecological ethnoclassification, technical knowledge embodied in the body, geometric and symbolic knowledge, ritual-spiritual knowledge, and governance knowledge. At the geometric-symbolic layer, the Lubeng motif displays a configuration of Kalajengking/Teledu, Tapak Dara, Panggal Asu, Surya, Sasih, Cakra, Srigading, and Tridatu as a visual codex that can be read at personal, communal, and cosmological levels. The novelty of this study lies in modeling Gringsing as an indigenous knowledge system rather than merely as a textile product or cultural symbol. The model demonstrates that preservation takes place through the reproduction of relationships among material, body, cosmos, ritual, and community rules.

KEYWORDS

Indigenous Knowledge System, Gringsing; Lubeng Motif, Tenganan Pegringsingan

Introduction

Gringsing weaving with the Lubeng motif occupies a distinctive position in the culture of the Bali Aga community of Tenganan Pegringsingan Traditional Village. The cloth cannot be understood merely as a textile product, craft commodity, or ritual ornament because its making embodies a body of knowledge concerning materials, the environment, techniques, the body, symbols, rituals, and customary governance. The field research report underlying this article shows that Gringsing is treated as a living heritage transmitted through practice, particularly

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through mastery of the double-ikat technique, the selection of natural dye materials, rules governing its use, and its connections with community rituals [1]. Thus, what is actually transmitted is not merely the cloth but the knowledge system that enables the cloth to be produced, endowed with meaning, used appropriately, and recognized as legitimate by the community.

From an ethnoscientific perspective, this knowledge can be understood as the outcome of processes of observation, classification, experiential testing, and decision-making that have developed within a particular cultural environment. Material classification does not stop at plant names but encompasses the origin and quality of materials, technical functions, processing methods, ecological implications, and contexts of use. The findings show that kapas keling cotton, mengkudu root (Morinda citrifolia), tarum/indigo (Indigofera tinctoria), and candlenut (Aleurites moluccanus) form part of an integrated knowledge network [1]. This view is consistent with Frake's notion of cultural cognitive systems, in which local classification provides a way for communities to organize their environment and actions [2]. Accordingly, ethnoscience in Gringsing is not simply a matter of finding equivalents in modern scientific terminology; rather, it involves interpreting the logic of knowledge that has developed from the community's lived experience.

Previous studies have examined Gringsing from the perspectives of legal protection and Geographical Indications, spatial cosmology, sustainability and education, the impacts of the pandemic, and the preservation of customary practices [3] [7]. These studies are important, but they tend to focus on a single dimension. A gap remains in explaining how material knowledge guides technique, how technique shapes motifs, how motifs gain legitimacy through ritual, and how the entire sequence is maintained through awig-awig and adaptive strategies. This gap motivates the present study to shift the focus from "weaving as an artifact" to "weaving as a knowledge system," thereby enabling the relationships among its components to be explained as a living epistemic architecture that is continuously reproduced [1].

The Lubeng motif provides a strategic entry point for reading this system because its visual composition contains elements associated with protection, balance, village space, and the cosmic order. The research data identify the symbols of Kalajengking/Teledu, Tapak Dara, Panggal Asu, Surya, Sasih, Cakra, and Srigading, together with the Tridatu palette, as an interconnected constellation of signs [1]. In this reading, the motif functions as a visual codex that stores knowledge and as a performative medium when the cloth is worn in ritual contexts. The relationship among form, color, space, body, and ritual indicates that the materiality of Gringsing possesses agency: the cloth is not merely "worn" by people but also helps shape how people inhabit sacred space and define communal identity.

On this basis, the study aims to analyze the indigenous knowledge system that constitutes Gringsing weaving with the Lubeng motif through three main questions: how is ethnoscientific knowledge formed and embodied in materials and technology; how is this knowledge translated into symbolic language and ritual practice; and how is the system protected and negotiated amid modernization? The novelty of the study lies in a systemic model that connects five layers: material-ecological, technical-embodied, geometric-symbolic, ritual-spiritual, and governance-adaptive. The model emphasizes that the sustainability of Gringsing depends on

the sustainability of the knowledge network rather than on the physical preservation of cloth alone.

Methods

The study employed a qualitative approach with an ethnographic design and an emic perspective to understand the indigenous knowledge system from within the lifeworld of the Tenganan Pegringsingan community. An ethnographic approach was selected because much of the knowledge surrounding Gringsing is tacit, embodied, contextual, and embedded in practice. Accordingly, the unit of analysis was not limited to verbal narratives but included materials, bodily actions, work sequences, local terminology, visual motifs, production spaces, rituals, customary rules, and knowledge-transmission practices. This orientation is consistent with ethnographic research that places direct engagement and thick description at the center of contextual cultural interpretation [8], [9].

The research site was Tenganan Pegringsingan Traditional Village, Manggis District, Karangasem Regency, Bali. The study was conducted over seven months in 2025, covering preparation, primary and secondary data collection, preliminary analysis, validation, report preparation, and dissemination [1]. Primary data consisted of in-depth interviews with 12 weavers and customary leaders/Kelian Adat, participant observation of Gringsing production stages, audiovisual documentation, and examination of practices and rules governing the use of the cloth. Secondary data were drawn from awig-awig, motif archives, cultural documents, and previous research literature.

Data were collected through participant observation, semi-structured interviews, focused discussions relevant to the younger generation, and documentation. Observation focused on material selection, fiber preparation, tying, coloring, dyeing, yarn arrangement, weaving, and the use of the cloth in ritual contexts. Interviews explored technical knowledge, local terminology, motif histories, symbolic meanings, mechanisms of intergenerational transmission, and community responses to market demands. Documentation covered artifacts, tools, materials, motifs, and the spatial context of production. These procedures followed the logic of triangulation, enabling the researcher to compare what was said, done, and normatively regulated [1], [10]. Data analysis was conducted in three interrelated stages. First, the interactive model of Miles, Huberman, and Saldaña was used for data reduction, data display, conclusion drawing, and verification [11]. Second, Spradley's ethnographic analysis was used to identify domains, taxonomic relationships, and cultural themes emerging from material lexicons, production stages, ritual practices, and customary rules [12]. Third, symbolic analysis was used to connect the visual elements of the Lubeng motif with personal, communal, and cosmological meanings. The final synthesis did not stop at a list of findings but mapped the relationships among the layers as an indigenous knowledge system.

Data trustworthiness was maintained through source triangulation, method triangulation, member checking, an audit trail, and researcher reflexivity. Information was compared across weavers, customary leaders, cloth users, and available documents. Validation addressed interpretations of techniques, symbols, ritual functions, and customary protection mechanisms. Because some ritual knowledge may be restricted, this article limits publication to information

recorded in the research materials and considered appropriate to share as academic knowledge. This approach reconciles the demands of scientific rigor with respect for community authority [13], [14].

Result

1. Structure of the Indigenous Knowledge System in the Gringsing Lubeng Motif

The synthesis shows that the Indigenous Knowledge System (IKS) of Gringsing consists of layered but interconnected forms of knowledge. Materials provide the entry point; technology serves as the mechanism for transforming materials; motifs function as a visual language; rituals provide legitimacy and function; and customary rules determine boundaries, authority, and continuity. These five layers form reciprocal relationships. Knowledge therefore does not exist "outside" the cloth but is embodied in how the cloth is made, understood, used, and protected. Conceptually, this pattern can be formulated as: material and environment → embodied technique → form and color → ritual function → governance → knowledge regeneration.

Table 1. Layers, Main Components, Forms of Knowledge, and Functions of Indigenous Knowledge Systems (IKS)

IKS Layer	Main Components	Form of Knowledge	Function
Material-ecological	Kapas keling; mengkudu; tarum/indigo; candlenut; material locations; material quality	Ethnoclassification, ethnobotany, geo-ecological knowledge	Determines materials that are legitimate, high-quality, and suitable for production needs
Technical-embodied	Double ikat; warp-weft tying; dyeing; cag-cag weaving	Procedural and tacit knowledge	Ensures motif precision and cloth quality
Geometric-symbolic	Scorpion, Tapak Dara, Panggal Asu, Surya, Sasih, Cakra, Srigading; Tridatu	Visual knowledge, ethnomathematics, cosmology	Stores identity, protection, balance, and cosmic order
Ritual-spiritual	Usaba Sambah, Mekare-kare, life-cycle rituals, offerings, taboos	Performative and spiritual knowledge	Transforms cloth into a sacred artifact and a medium of symbolic communication
Governance-adaptive	Awig-awig, use boundaries, Geographical Indication, product differentiation, digital adaptation	Normative knowledge and adaptive strategies	Protects authenticity and enables controlled economic participation

2. Material Ethnoscience: Ethnoclassification, Ecology, and Material Knowledge

The first finding shows that the Tenganan community has developed a mode of material classification that is broader than botanical taxonomy. Materials are assessed simultaneously according to several attributes: type, origin, quality, color-producing capacity, suitability for different production stages, impacts on the living environment, and relationship to customary rules. Kapas keling is positioned as an ideal fiber standard; mengkudu root as a source of red

dye; tarum/indigo as a source of blue or black; and candlenut as an important element in fiber preparation and base coloration [1]. This knowledge is the result of accumulated experience maintained through practice rather than merely memorized information.

In the case of mengkudu root, the research data connect material quality with geographic origin. Roots considered to be of high quality come from certain areas and produce a better red color. From an ethnoscientific perspective, this knowledge demonstrates the community's ability to read the relationship between growing location, material properties, and dyeing outcomes. The research data also indicate that indigo processing has traditionally been carried out in Bugbug Village. This spatial division is interpreted as a form of socio-ecological knowledge because production techniques are considered together with the effects of fermentation and the comfort of the living environment [1]. Thus, the environment is not merely a supplier of materials but part of the technological decision-making system.

Candlenut reveals another relationship among time, material, and technique. The soaking of materials and oil processing are carried out over an extended period before the fiber is ready for the next stage. This duration indicates that the community works according to the rhythm of the material rather than simply imposing production speed. This knowledge is important for understanding ethnoscience as an epistemology emerging from human-material interaction: the chemical and physical characteristics of materials become "teachers" that set limits on human action. In the context of sustainability, the ability to read materials also functions as a filter against substitutions that may alter the properties, meanings, and authenticity of the cloth.

3. Embodied Knowledge and Double-Ikat Technology

Production Knowledge Chain and Bodily Skills

The Gringsing production chain shows that Indigenous Knowledge does not operate as a fixed recipe but as a continuously calibrated decision-making system. At each stage, weavers read the condition of the material and determine the next step based on experience. In this logic, skill is not merely the ability to operate tools but the ability to recognize when materials are ready to be processed, when dyes have reached the appropriate condition, and how the arrangement of ties must be maintained. The research identifies the stages of ngantih, ngelikas, fiber preparation using candlenut, nganyinin, medbed, dyeing, and nunun as components of the production sequence [1].

From an ethnoscientific perspective, this sequence demonstrates procedural knowledge concerning time, order, proportion, and cause-and-effect relationships. Such knowledge is acquired through repetition and correction. Weavers do not need to formulate a formal equation to know that a small change in the position of a tie can alter the alignment of the motif when the warp and weft are brought together. Such precision demonstrates that ethnoscientific knowledge can exist as embodied practical competence without first being translated into the language of modern science.

Intergenerational transmission is therefore a performative pedagogical process. Knowledge is transmitted through watching, imitating, touching, repeating, and receiving correction. The research report also identifies regeneration as a major challenge because the complexity and

duration of production may lead younger generations to choose other economic sectors [1], [7]. The implication is that regeneration programs cannot rely solely on short-term training; they require learning spaces that foster bodily habits while also cultivating an understanding of the values that explain why particular techniques must be maintained.

The second layer is evident in double-ikat technology. This knowledge cannot be fully transferred through written description because its success depends on hand skills, eye-hand coordination, sensitivity to yarn tension, the ability to read tie positions, and the capacity to make corrections during the process. The technique brings together warp and weft threads that have undergone tying and dyeing so that the motif emerges only when the two pattern systems meet precisely [1], [15]. In terms of embodied knowledge, the weaver's body becomes both the repository and processor of knowledge.

This complexity makes the production process a knowledge chain. Each stage presupposes the success of the previous stage: ngantih produces yarn; ngelikas organizes the structure; preparation with candlenut establishes the condition of the fibers; the tying process encodes the motif; dyeing adds layers of color; and nunun brings all the information back together in the form of cloth. An error at one stage may disrupt subsequent stages. Technical knowledge is therefore cumulative and relational rather than a collection of isolated procedures.Dependence on the bo

dy also explains why the regeneration of weavers cannot be achieved simply by introducing procedures in a short format. Competence must be developed through repetition, observation, correction, and long-term experience. Research findings on regeneration indicate that the challenges faced by younger generations involve not only interest but also time demands, process complexity, and changing economic orientations [1], [7]. Therefore, preserving the technology requires a learning ecosystem that enables tacit knowledge to be transmitted together with the values, work discipline, and cosmology that accompany it.

4. Geometric Knowledge and the Symbolic Codex of the Lubeng Motif

a. The Lubeng Motif as Visual Memory and a Knowledge Codex

The Lubeng motif on Gringsing cloth does not merely function as a decorative ornament; it appears as a visual text or codex that condenses the ecological, social, philosophical, and cosmological knowledge of the Bali Aga community. Additional data show that lines, shapes, direction, repetition, and color form a symbolic grammar that can be transmitted through visuality. Thus, what is reproduced when artisans weave the Lubeng motif is not only the appearance of the cloth but also a set of rules concerning position, proportion, relationships among elements, and contexts of meaning. In this sense, the motif becomes the community's "visual memory."



Figure 1. Gringsing Lubeng Motif
Source: Researcher, 2025.

The motif configuration can be read at multiple levels. At the personal level, the motif may convey identity, courage, balance, and protection; at the communal level, it marks spatial structure, boundaries, and social cohesion; while at the cosmological level, it connects human beings with nature, time, and the spiritual order. Thus, documentation of the motif that preserves only its form without explaining the cultural grammar that accompanies it risks producing superficial preservation.

b. Protective Iconography: Kalajengking/Teledu and the Jaga Satru Concept

The most distinctive visual element in the Lubeng motif is the scorpion form, which is not presented realistically but distilled into a geometric pattern composed of dots, lines, and planes. At the personal level, the scorpion is interpreted as strength, courage, and masculinity for the wearer. At the communal and cosmological levels, this symbol is associated with guarding the four village entrances corresponding to the four cardinal directions and with the defensive structure known as Jaga Satru. The village is understood as a sacred space that must be protected from physical and spiritual threats. The scorpion thus shifts from a representation of fauna to an apotropaic, or protective, symbol guarding the threshold between sacred space within the village and profane space outside it.

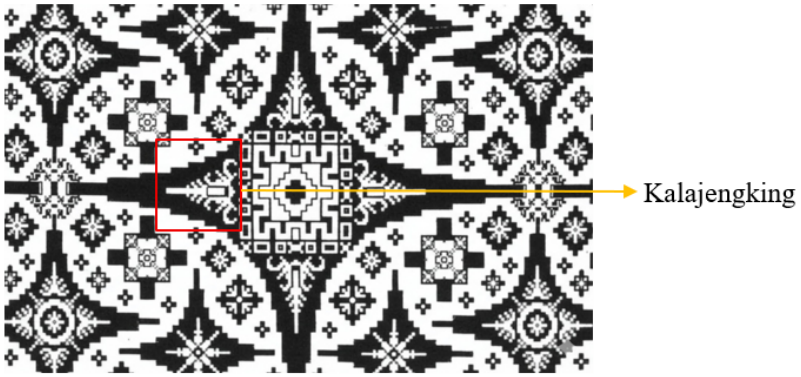


Figure 2. Digitalization of Gringsing Lubeng: Scorpion/Teledu Iconography
Source: Researcher, 2025.

This protective meaning is reinforced by the etymology of Gringsing, which the research data explain through gring (illness) and sing (not), meaning "without illness" or protection against misfortune. In this context, cloth bearing the Lubeng motif can be understood as a wearable symbolic shield. Knowledge of its protective function does not stand alone but is embedded in knowledge of village space, customary rules, cloth usage, and communal identity.

c. Axis of Balance: Tapak Dara and the Philosophy of Tri Hita Karana

In addition to the scorpion/teledu, the Lubeng motif consistently features Tapak Dara, the plus sign (+), as one of its main visual frameworks. Additional data position Tapak Dara as an axis of universal balance. The vertical line is read as the relationship between humans and God (parahyangan), while the horizontal line articulates relationships among people (pawongan) and ecological relationships with nature (palemahan). This reading makes Tapak Dara a concise yet conceptually dense visual form for understanding Tri Hita Karana.



Figure 3. Digitalization of Gringsing Lubeng: Tapak Dara Axis
Source: Researcher, 2025.

Tapak Dara also emphasizes the relationship between the upper world (swah loka) and the lower world (bhur loka), or between the human microcosm and the cosmic macrocosm. Therefore, this symbol is not merely a geometric form but a mnemonic device that helps recall the principle of balance. The research data also associate it with Rwa Bhineda: dualities such as day and night and good and bad need to be managed harmoniously. Here, ethnomathematics and cosmology converge because precision of axes, symmetry, proportion, and pattern repetition function simultaneously as spatial operations and carriers of meaning.

d. Integrated Cosmic Map: Panggal Asu and the Elements of the Universe

When these elements are read as a single configuration, the Lubeng motif reveals a function as an integrated cosmological and social map. The quadrilateral structure known as Panggal Asu represents Tenganan Village as a structured and protected social unit, while the four scorpions reinforce the interpretation of boundary protection. Within this structure, Tapak Dara serves as the foundation of balance. Additional data also identify Surya (sun), Sasih (moon), Cakra (cycle/circulation), and Srigading as elements that broaden the reading toward time, nature, and the spiritual dimension. The Tridatu palette reinforces this structure through its association

with natural elements and the Trimurti: Brahma as creator, Vishnu as preserver, and Shiva as destroyer.

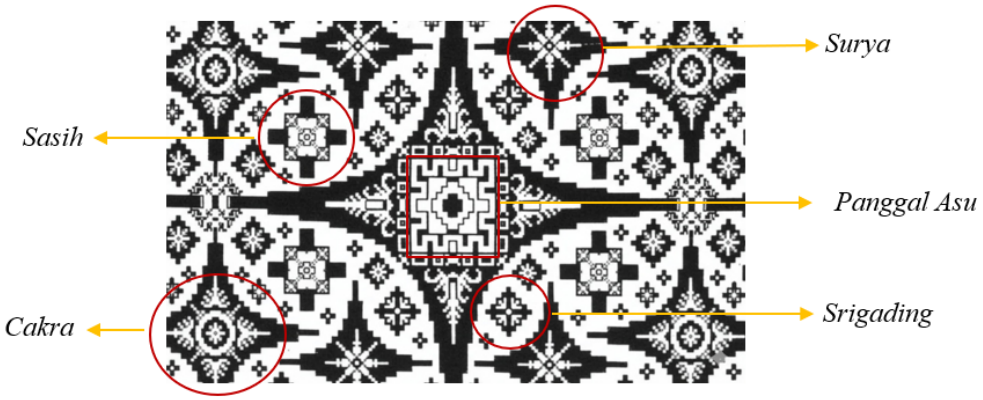


Figure 4. Digitalization of Gringsing Lubeng: Integrated Cosmic Map
Source: Researcher, 2025.

This synthesis allows the Lubeng motif to be understood as a wearable cosmogram. The village's spatial-defensive structure is represented through Panggal Asu and the Scorpion; the philosophical structure through Tapak Dara and Tri Hita Karana; while the theological-cosmic structure is embodied in Tridatu and the Surya-Sasih-Cakra-Srigading elements. Wearing Gringsing with the Lubeng motif can therefore be understood as a performative act: individuals symbolically place themselves within the Bali Aga cosmic order while affirming their communal position and identity. Additional data also record that the Lubeng motif was featured on the Rp75,000 banknote, which the study positions as a form of national recognition of the depth of its symbolism.

e. Synthesis of Ethnomathematics and the Knowledge System

From an ethnomathematical perspective, the precision with which warp and weft patterns meet, the repetition of forms, balance of fields, symmetry, sequencing, and visual correction demonstrate complex spatial operations. This study does not claim that weavers use formal mathematical terminology, but it emphasizes that knowledge of proportion and position operates precisely through practice. Thus, the Lubeng motif demonstrates how conceptual knowledge can live within manual skills without first being formulated in the language of modern academic disciplines. The geometric-symbolic layer is subsequently connected to ritual and governance, so the visual form is not the endpoint of the knowledge process but a node linking material, body, space, cosmos, and community rules.

Table 2. Visual Elements and Multidimensional Symbolic Meanings in Balinese Cultural Representation

Visual Element (Icon)	Literal Representation/Local Name	Personal Symbolic Meaning	Communal/Social Symbolic Meaning	Cosmological Symbolic Meaning
Scorpion (distilled)	Kalajengking or Teledu	Strength, courage, and masculinity	Guardian of the four village entrances (Jaga Satru); a symbol	Guardian of the boundary between the sacred world

		for the wearer.	of communal protection from physical and spiritual threats.	(village) and the profane world (outside).
Plus Sign (+)	Tapak Dara or Tain Bikul	Inner balance and personal protection against misfortune.	Representation of Tri Hita Karana: vertical relationship (parahyangan) and horizontal relationships (pawongan, palemahan).	Axis of universal balance, meeting point of microcosm and macrocosm, and harmony of dualities (Rwa Bhineda).
Quadrilateral Structure	Panggal Asu	-	Representation of Tenganan Village as a structured and protected social unit.	Center of the local cosmos, a sacred space at the core of the Bali Aga cosmic order.
Three Main Colors	Tridatu (Red, Black, Yellow/White)	Balance of bodily elements to ward off illness (gring-sing).	Collective identity of the Bali Aga community that venerates the Trimurti.	Representation of the three deities of the Trimurti (Brahma, Vishnu, Shiva) and three fundamental elements of the universe (fire, water, air).
Other Elements	Surya, Sasih, Cakra, Srigading	-	-	Representation of natural elements of the universe (sun, moon, cycles of time) and spiritual elements that complete the cosmological map.

5. Ritual-Spiritual Knowledge and Material Agency

The fifth finding shows that the function of Gringsing in ritual cannot be separated from the production process. The name Gringsing, color, motif, technique, and context of use constitute an integrated field of meaning. The research data identify the function of the cloth in various life-cycle and communal rituals, including Usaba Sambah and Mekare-kare, as well as its use for protection, marking transitions, and expressing identity [1]. Thus, sacred value is not an

attribute added after the cloth is completed; it is constructed through a sequence of production practices, rules, and uses.

The concept of material agency helps explain this phenomenon. Dye materials have their own rhythms and chemical limits; double-ikat technique constrains production speed and demands precision; and the cag-cag loom integrates bodily work with the tool. Materials therefore participate in shaping human decisions. The research data even show how the long duration of production forms part of authenticity. From a resistance perspective, slowness is not merely a lack of efficiency but may function as a rejection of the logic of mass production [1], [10].

In ritual contexts, the cloth may be described as a "social skin" because it wraps the body while simultaneously marking the individual's position within the community's social order. When worn in ritual, the wearer's body is not a neutral body but one positioned within a network of symbols, rules, and collective memory. The cloth therefore becomes a medium of nonverbal transmission: younger generations learn meaning not only through explanations but also by observing who wears the cloth, when it is worn, in what space, and for what purpose.

Table 3. The Role of Gringsing Cloth in the Life Rituals of the Tenganan Pegringsingan Community

Ritual	Context	Role of Gringsing	Type of Knowledge Transmitted
Meketus Jambot	Life-cycle ritual	Protection and marker of initial identity	Meaning of the cloth is learned through participation
Metruna Nyoman / Medaha	Coming of age	Marker of readiness to undertake customary responsibilities	Transmission of norms through the body
Marriage	Social transition	Bonding and legitimation of the relationship	Relationship among individual, community, and ancestors
Death	End-of-life ritual	Guide and marker of transition	Continuity of cosmology
Usaba Sambah	Communal ritual	Fertility, protection, cohesion	Strengthening collective identity
Mekare-kare	Communal ritual	Solidarity, courage, and ancestral memory	Performative reproduction of tradition

6. Governance Knowledge: Awig-Awig, Geographical Indication, and Adaptation

a. Sacred-Profane Boundaries as Social Technology

One important finding is the separation between what must be preserved as sacred heritage and what can be negotiated for economic purposes. This separation can be understood as a form of social technology because the community establishes rules so that change does not erase the core of knowledge. Derivative products for the market provide a space for experimentation, whereas cloth associated with ritual functions receives stricter protection [1]. This strategy shows that cultural sustainability does not mean total rejection of the market but rather the capacity to define the boundaries of market participation.

Geographical Indication reveals another layer of governance. This instrument originates in the domain of state law but has been adopted to strengthen claims of origin and protect the name Gringsing from plagiarism. The research data indicate that the direct economic impact of the Geographical Indication remains limited, but symbolic recognition and bargaining power have increased [1], [3]. This demonstrates that an Indigenous Knowledge System can absorb external instruments without entirely losing internal authority, provided that the functions of such instruments can be negotiated in accordance with community interests.

The Gringsing Indigenous Knowledge System has a strong normative dimension. Awig-awig regulates relations among community members, relationships with the environment, and boundaries governing the use and production of Gringsing-related traditions. The research data record prohibitions on modifying sacred motifs for commercial purposes, regulations on cloth use, and rules intended to prevent certain forms of knowledge from easily leaving the community [1]. In this framework, customary law is not merely a social backdrop but a knowledge infrastructure that determines what is considered correct, appropriate, and legitimate.

Protection has also been extended through the Geographical Indication registered in 2016. The research data show that this instrument has not automatically increased productivity or sales volume, but it has strengthened the legitimacy of Gringsing's origin and its symbolic bargaining power [1], [3]. This finding is important because it demonstrates selective use of modern instruments: state legal technology need not be synonymous with unrestricted commercialization. It can be adopted as a mechanism to protect against plagiarism and decontextualization.

The community also differentiates between products maintained within the sacred domain and variants that may be developed for the market. In the research data, Idup Anak and Paplendoan are cited as examples of derivative products that provide economic space without directly placing sacred cloth within market logic [1]. This strategy demonstrates adaptive governance. The community does not simply reject modernity; rather, it establishes boundaries for participation in it. The use of digital media by younger generations is also increasingly directed toward strengthening narratives of authenticity and introducing the processes and history of Gringsing. This marks an important shift from storage-oriented preservation toward transmission-based preservation. Digitalization becomes valuable when it helps broaden access to knowledge that is legitimately shareable, rather than when it erases sacred boundaries. Accordingly, digital innovation should follow community governance rather than replace it.

Table 4. A Strategic Approach to Addressing Commercial Pressures and Modernization

Strategy	Pressure	Community Practice	IKS Function
Awig-awig	Commercialization and modification	Restricts use and alteration of motifs	Internal protection
Geographical Indication	Plagiarism and contestation of origin	Strengthens claims of origin and legitimacy	External formal protection
Product differentiation	Economic pressure	Separates sacred and commercial derivative products	Controlled economic participation

Controlled collaboration	Demand for innovation	Enables adaptation subject to community conditions	Cultural negotiation
Narrative digitalization	Changing transmission patterns	Expands education and documentation	Transmission-based preservation

7. Indigenous Knowledge System Model in Gringsing Weaving with the Lubeng Motif

Limits of Interpretation and the Ethics of Knowledge

Although this model integrates multiple dimensions, interpretation remains bounded. Not all customary knowledge can be treated as open data, especially ritual information that is subject to internal authority. Therefore, the proposed model is an analytical model of the knowledge accessible and documented in the study, not a claim to represent the entirety of Tenganan knowledge. This boundary is itself part of the indigenous knowledge system: the right to regulate access to knowledge is a form of governance that must be recognized in cultural research.

This ethical position also has implications for digitalization. A good digital archive does not simply make all information publicly available; it can employ access classifications based on community consent. General knowledge may be disseminated for educational purposes, whereas restricted knowledge requires community control. In this way, digital technology functions as an instrument of preservation rather than a mechanism for extracting cultural knowledge. The synthesis of the research findings produces a circular conceptual model of the indigenous knowledge system. The material-ecological layer generates initial conditions and physical constraints. The technical-embodied layer translates these conditions through the weaver's body. The geometric-symbolic layer transforms technical experience into a visual language that can be transmitted. The ritual-spiritual layer activates that meaning in contexts of use. The governance-adaptive layer then maintains legitimacy, establishes boundaries, and regulates adaptation. The resulting whole returns as a source of learning for the next generation. The system therefore operates as a cycle of knowledge reproduction rather than a linear chain.

The model shows that disruption in one layer can affect the others. Reduced access of younger generations to materials and production spaces can weaken technical knowledge; loss of symbolic understanding can alter ritual functions; weak governance can accelerate uncontrolled commercialization; while digitalization that is not grounded in customary authority can separate the motif from its context. Conversely, strengthening one layer can energize another. Good education, for example, should not only teach how to weave but also connect technique, geometry, ecology, ritual, and customary ethics into a holistic learning experience.

Based on these findings, the sustainability of Gringsing should be formulated as system sustainability, namely the community's capacity to maintain relationships among people, materials, knowledge, rituals, space, and rules. This formulation expands the meaning of preservation from object conservation to epistemic reproduction. In cultural policy, this

approach opens opportunities for knowledge-based documentation, intergenerational education, ethical digitalization, and legal protection, all while maintaining tradition-bearing community members as the primary authorities.

Table 5. System Architecture and Mechanisms for the Transmission of Traditional Knowledge

SYSTEM LAYER	MECHANISM
Material & Ecology	Local materials → classification → quality → space → ecological boundaries
Technology & Body	Double ikat → precision → experience → repetition → embodied skill
Geometry & Symbol	Lubeng motif → form/color → visual code → cosmology
Ritual & Spirituality	Use → performativity → identity → sacred legitimacy
Governance & Adaptation	Awig-awig → Geographical Indication → differentiation → digitalization → regeneration
System Outcome	Living knowledge system → cultural sustainability → community authority

Discussion

The research findings show that the Indigenous Knowledge System of Gringsing can be understood as an epistemic system connecting knowledge of nature with technical and social decisions. This extends ethnoscientific interpretation because the validity of knowledge is not determined by its conformity to formal scientific categories but by its ability to organize relationships among materials, actions, and sustainability within the community. Findings on material classification, quality, origin, and production space are consistent with the view of cultural cognitive systems [2], but the Tenganan context shows that classification also carries moral and normative consequences.

At the technological level, Gringsing demonstrates a form of knowledge embedded in the body. Gittinger positions traditional Indonesian textiles as an important medium for the transmission of tradition [15], while the present study adds that double-ikat technique can be understood as an infrastructure of bodily memory. Knowledge resides not only in “how to do” something but also in the ability to sense yarn tension, read shifts in patterns, make corrections, and maintain sequence. Therefore, digital documentation should not replace direct practice. Ideally, documentation should record movements, tempo, terminology, corrective decisions, and learning contexts so that tacit elements are not lost.

Reading the Lubeng motif as a visual codex also produces theoretical implications. The motif is not positioned as a text that merely “depicts” cosmology from the outside but as a device that materializes cosmology. Visual data show Kalajengking/Teledu, Tapak Dara, Panggal Asu, Surya, Sasih, Cakra, Srigading, and Tridatu as a single system of signs. The scorpion articulates protection and the sacred boundary; Tapak Dara connects vertical and horizontal balance; Panggal Asu condenses the spatial structure of the village; while the Surya-Sasih-Cakra-Srigading and Tridatu elements extend the reading toward time, nature, and cosmic theology. Thus, the Lubeng motif can be understood as a wearable cosmogram: cosmology is not merely discussed but worn and activated through the body. In this context, semiotic analysis needs to

be combined with ethnography because the meaning of signs cannot be separated from their use in community life [1], [9].

The ritual dimension strengthens the argument that cultural materials possess agency. Turner explains that ritual constructs social processes and liminality [16]; in Gringsing, ritual processes do not occur only during ceremonies but are already present in material selection and production. The cloth enters sacred space through the history of its making. Thus, "sacredness" is not an additional layer but the result of accumulated actions, prohibitions, materials, symbols, and uses that continuously produce legitimacy. The governance construction demonstrates that the Indigenous Knowledge System is institutionalized. Awig-awig establishes boundaries and authority; Geographical Indication extends protection into the state domain; product differentiation opens economic space; and digitalization expands the sphere of transmission. These strategies challenge the simplistic view that preservation must choose between the "traditional" and the "modern." Tenganan demonstrates the possibility of coexistence through selective adoption: not every innovation is accepted, but innovations that can be controlled and aligned with community authority can be used to strengthen sustainability [1], [3], [7].

James C. Scott's perspective helps explain why preserving complexity, slowness, and ritualization can be read as everyday resistance [10]. In the Gringsing context, resistance is not only a verbal rejection of the market but is enacted through decisions to maintain difficult techniques, use particular materials, and enforce rules that restrict modification. The findings also show that resistance is adaptive. The community uses modern instruments when they can strengthen cultural control. Thus, resistance and adaptation are not mutually exclusive poles but two strategies within the same system.

The main contribution of this study to ethnoscience and Indigenous Knowledge research lies in shifting the unit of analysis. The study does not stop at "local knowledge contained in the motif" but examines the system that produces, authorizes, uses, and reproduces that knowledge. The resulting five-layer model brings together material, body, visuality, ritual, and governance. This framework can be further developed for research on other traditional textiles, particularly in Indigenous communities that have their own knowledge boundaries, ritual systems, and protection mechanisms. The implications for preservation are also practical. Programs that merely photograph motifs or store cloth are insufficient to maintain the Indigenous Knowledge System. Documentation must follow the knowledge chain; education must connect technique with meaning; digitalization must apply access ethics; and economic policy must preserve boundaries between sacred products and derivative products. Within this framework, tradition-bearing communities are not merely data sources but holders of epistemic authority and rights to determine what may be transmitted, published, and developed.

System Perspective and Conceptual Contribution

From a systems perspective, the findings reveal feedback relationships. Materials and the environment influence technique, technique shapes motifs, motifs activate ritual functions, rituals reinforce legitimacy, and governance sustains the entire sequence. Yet the relationship also operates in reverse: rules determine which materials may be used; ritual functions

influence technical standards; symbols determine which components may not be altered; and economic pressures encourage the emergence of derivative products. This reciprocal pattern makes Gringsing more appropriately understood as a system of knowledge rather than merely a collection of local knowledge.

The concept of the indigenous knowledge system in this study also broadens the meaning of preservation. Preservation does not only mean maintaining the form of the cloth but sustaining the community's capacity to generate meaning and repeat practices authoritatively. Accordingly, indicators of preservation success should include the sustainability of the weaving community, material knowledge, mastery of technique, ability to read symbols, ritual participation, effective governance, and community control over digital representation. This framework can serve as a basis for developing cultural preservation evaluation instruments for other traditional textiles.

For education, these findings open opportunities for developing Indigenous Knowledge-based learning that goes beyond aesthetic appreciation. Gringsing can serve as a cross-disciplinary learning resource: ethnoscience through natural dyes and material classification; art through composition and double-ikat technique; mathematics through geometry and proportion; anthropology through knowledge transmission; and cultural education through ethics, ritual, and governance. However, such integration should follow the principle of community-based learning so that educational content does not separate techniques from their social context or claim community knowledge as ownerless, neutral knowledge. For digital preservation, the findings point toward an "authority-based digitalization" model. Visual documentation can strengthen collective memory, but metadata, narratives, access levels, and permissions for use must be determined together with the community. This approach also enables the creation of layered archives: a public layer for general information, an educational layer for learning materials, and a restricted layer for knowledge requiring specific consent. This principle is consistent with the need to maintain community authority while strengthening knowledge regeneration through contemporary media.

Conclusion

Theoretical implication: The Gringsing Indigenous Knowledge System demonstrates that ethnoscience, symbolism, ritual, and governance constitute dimensions of a single epistemic system. Methodological implication: Indigenous Knowledge research needs to combine practice observation, interviews, material documentation, symbolic analysis, and examination of community rules because knowledge is distributed across multiple forms of data. Preservation implication: Preservation priorities should focus on the knowledge chain and regeneration rather than only on artifact collections or motif reproduction. Digital and educational implication: Technology can be used for transmission and documentation as long as it follows access boundaries, consent, and the authority of the community that owns the knowledge.

This study demonstrates that Gringsing weaving with the Lubeng motif constitutes an indigenous knowledge system operating through the interconnection of five layers of knowledge: material-ecological, technical-embodied, geometric-symbolic, ritual-spiritual, and governance-adaptive. Ethnoscience is evident in the community's ability to classify and select materials,

read environmental qualities, regulate processes, and develop precise techniques. At the geometric-symbolic layer, the additional data show that Kalajengking/Teledu, Tapak Dara, Panggal Asu, Surya, Sasih, Cakra, Srigading, and Tridatu are not a collection of separate ornaments but a network of signs that condenses knowledge about protection, balance, village space, time, nature, and the spiritual order. Indigenous Knowledge is present more broadly as a system that simultaneously governs how knowledge is transmitted, interpreted, sacralized, bounded, and negotiated in response to social change.

The novelty of the study lies in modeling Gringsing as a living knowledge system rather than merely a cultural artifact. The main implication is that preservation must be directed toward sustaining the knowledge network that connects materials, body, symbols, rituals, space, and community rules. Future strategies should therefore integrate ethnoscientific documentation, intergenerational education, ethical digitalization, strengthened legal protection, and controlled economic adaptation while continuing to position the Tenganan Pegringsingan community as the primary authority over its knowledge and cultural meanings.

References

[1] I. N. Juliawan and K. F. Nata, “Indigenous Knowledge Bali Aga dalam Gringsing Motif Lubeng: Ritus Sakral, dan Resistensi Identitas di Tenganan Pegringsingan, 2025.

[2] C. O. Frake, “The ethnographic study of cognitive systems,” in Anthropology and Human Behavior, T. Gladwin and W. C. Sturtevant, Eds. Washington, DC, USA: Anthropological Society of Washington, 1962, pp. 72–85.

[3] I. G. A. Kurniawan, “Geographical indication protection of Tenun Gringsing Bali fabric as a society cultural heritage in Tenganan Pegringsingan,” Jurnal Hukum & Pembangunan, vol. 51, no. 1, pp. 1–20, 2021.

[4] L. A. Utami, “Gringsing fabric as spatial cosmology and relation-making,” Journal of Material Culture, vol. 28, no. 4, pp. 450–468, 2023.

[5] I. G. A. V. Pryanka, “Potential sustainability scenarios for Gringsing weaving in Bali, Indonesia: How important is education?,” Journal of Cultural Heritage Management, vol. 14, no. 3, pp. 301–319, 2023.

[6] I. G. Sudarmanto, “Eksistensi Tenun Gringsing Bali dalam era new normal pandemi Covid-19,” Jurnal Ilmiah Pariwisata, vol. 27, no. 2, pp. 115–128, 2022.

[7] V. Wulansari, “Kelestarian budaya dan adat di Desa Tenganan Pegringsingan Karangasem Bali,” Jurnal Antropologi Sosial Budaya, vol. 9, no. 1, pp. 55–72, 2023.

[8] C. Geertz, The Interpretation of Cultures: Selected Essays. New York, NY, USA: Basic Books, 1973.

[9] N. K. Denzin and Y. S. Lincoln, The SAGE Handbook of Qualitative Research, 5th ed. Thousand Oaks, CA, USA: Sage Publications, 2018.

[10] J. C. Scott, Weapons of the Weak: Everyday Forms of Peasant Resistance. New Haven, CT, USA: Yale University Press, 1985.

[11] M. B. Miles, A. M. Huberman, and J. Saldaña, Qualitative Data Analysis: A Methods Sourcebook, 3rd ed. Thousand Oaks, CA, USA: Sage Publications, 2014.

[12] J. P. Spradley, The Ethnographic Interview. Long Grove, IL, USA: Waveland Press, 2016.

[13] M. Q. Patton, Qualitative Research & Evaluation Methods, 4th ed. Thousand Oaks, CA, USA: Sage Publications, 2015.

[14] Y. S. Lincoln and E. G. Guba, Naturalistic Inquiry. Beverly Hills, CA, USA: Sage Publications, 1985.

[15] M. Gittinger, Splendid Symbols: Textiles and Tradition in Indonesia. Washington, DC, USA: The Textile Museum, 2021.

[16] V. Turner, The Ritual Process: Structure and Anti-Structure. Chicago, IL, USA: Aldine, 1969.

[17] I. N. Dhana, "Ketaatan awig-awig sebagai resistensi budaya di Tenganan Pegringsingan," Jurnal Kajian Budaya, vol. 14, no. 2, pp. 112–128, 2023.

[18] I. W. Suardana, I. W. Arimbawa, and I. K. Suwendra, "Transmisi pengetahuan tenun Gringsing di kalangan generasi muda Tenganan," Jurnal Pendidikan dan Kebudayaan, vol. 12, no. 2, pp. 145–160, 2022.

[19] I. G. A. Atmaja, "Tenun Gringsing sebagai manifestasi pengetahuan lokal Bali Aga," in Kajian Kebudayaan Bali, 2018.

[20] UNESCO, "Intangible cultural heritage: Tenun Gringsing of Tenganan Pegringsingan," 2022.