

A closer look at willingness to pay: An economic perspective on the Gringsing weaving cultural industry

Desak Made Marysha Dewi*; Ida Ayu Nyoman Saskara

Department of Economics, Faculty of Economics and Business, Universitas Udayana, Indonesia

*To whom correspondence should be addressed. Email: desakmarysha73@gmail.com

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Abstract.

Gringsing weaving from Tenganan Village is renowned for its distinctive indigo blue dye, derived from the *tawum* tree. However, traditional *awig-awig* (customary regulations) prohibit dyeing within the village due to environmental concerns, particularly the risk of groundwater contamination. As a result, dyeing activities are relocated to neighboring Bugbug Village, where local rivers are used for washing and saltwater soaking—processes that enhance the quality of the dye. This relocation has led weavers to outsource dyeing services, prompting an investigation into the factors influencing their willingness-to-pay (WTP). This study employs Focus Group Discussions (FGDs) with Gringsing weavers and relevant government stakeholders, supported by MICMAC (Matrix of Cross-Impact Multiplications Applied to a Classification) and Bayesian Belief Network (BBN) analyses. The MICMAC results identify cultural capital and *awig-awig* as primary driving factors shaping WTP. BBN analysis further highlights the significant influence of Communal Intellectual Property Rights (CIPR) and income stability. These findings suggest that willingness to pay is shaped not only by economic considerations but also by deeply embedded cultural and institutional factors. To ensure the long-term sustainability of the Gringsing weaving tradition, interventions must integrate cultural revitalization, environmental responsibility, and financial empowerment. Strengthening intellectual property protections, promoting income-generating opportunities, and respecting traditional regulatory frameworks are essential to preserving both the cultural integrity and economic viability of the Gringsing weaving industry.

Keywords: *Awig-Awig, Cultural capital, Gringsing weaving, Intellectual property rights, Willingness to pay*

JEL Classification: A14, B55, C87, D24

INTRODUCTION

Tenganan Pegringsingan Village in Karangasem, Bali, is renowned for *Tenun Gringsing*, a rare and sacred double-ikat textile. Unlike single-ikat techniques, double-ikat weaving involves binding and dyeing both warp and weft threads before weaving, making it one of the most intricate textile-making processes in the world (Disperindag Kabupaten Gianyar, 2019). This technique is globally rare, practiced only in Tenganan

Pegringsingan (Indonesia), Gujarat and Orissa (India), and Japan (Sudarmanto, 2022). Beyond its technical complexity, *Tenun Gringsing* holds profound philosophical and spiritual meaning. The name *Gringsing* translates to "free from sickness" and is believed to offer protective properties to its wearer (Sukmadewi et al., 2021). Traditionally, the textile's red, black, and white hues—derived from natural dyes—symbolize balance in Hindu cosmology (Darmawati et al., 2016).

Despite its cultural and economic significance, the sustainability of *Tenun Gringsing* faces considerable challenges due to environmental and regulatory constraints. One of the most pressing issues is the prohibition of tarum cultivation, the primary source of indigo dye. This ban arises from concerns that tarum depletes soil fertility and disrupts the local ecosystem (Sakakibara & Udiana, 2012). Additionally, the fermentation process required for indigo production emits a pungent odor, prompting further local restrictions (Kadariah et al., 2022). As a result, artisans must outsource the dyeing process to Bugbug Village, where high-salinity water enhances dye absorption (Putriani, 2017). However, this outsourcing introduces economic burdens, logistical challenges, and potential disruptions to production continuity. These factors raise critical questions about artisans' willingness to pay (WTP) for outsourced indigo dyeing services despite higher costs and increased operational complexity.

In light of these constraints, this study aims to analyze the determinants of WTP among *Tenun Gringsing* artisans, with a particular focus on balancing cultural preservation, economic viability, and environmental sustainability. Previous studies have examined WTP in creative industries using the Contingent Valuation Method (CVM) and multiple linear regression (Krisnawati et al., 2024; Hidayaningtyas et al., 2021). However, these methods have not adequately explored the interdependencies among influencing variables. This research introduces a mixed-method approach, combining MICMAC analysis to identify dominant variables with Bayesian Belief Networks (BBN) to model causal relationships and simulate scenario-based impacts.

The novelty of this study lies in its methodological integration and its specific focus on *Tenun Gringsing* artisans. Unlike earlier studies that broadly assessed WTP in the creative sector, this research highlights eight key influencing factors: aesthetic value, spiritual significance, symbolic meaning, financial capital, creativity, communal intellectual property rights (HKIK), cultural capital, and customary law (*awig-awig*). Through MICMAC and BBN analyses, the study aims to develop a comprehensive understanding of how these factors interact, ultimately offering policy recommendations to sustain the *Tenun Gringsing* industry without compromising its cultural and environmental integrity.

Accordingly, this study addresses the following central question: What factors influence *Tenun Gringsing* artisans' willingness to pay for indigo dyeing services, and how do the interrelationships among these factors shape their decision-making?

METHODS

This study, conducted in Tenganan Pegringsingan Village, analyzes the factors influencing the willingness to pay (WTP) for indigo dyeing services among *Tenun Gringsing* weavers, utilizing both primary and secondary data. Primary data were collected through questionnaires, interviews, and focus group discussions (FGDs). The selection of 19 respondents was deemed appropriate due to the homogeneous nature of the population, wherein individual characteristics are relatively uniform. This homogeneity minimizes variability, allowing for the extraction of representative insights

without requiring a large sample size. Consequently, the research process was made more efficient in terms of time and resources, while still capturing the key variables relevant to the study.

The study investigates eight key variables: aesthetic value, spiritual value, symbolic value, financial capital, creativity, communal intellectual property rights (HKIK), cultural capital, and *awig-awig* (customary law), adapted from Parameswara (2024). These were analyzed using the Matrix of Cross-Impact Multiplications Applied to a Classification (MICMAC) and Bayesian Belief Network (BBN) methods to assess their influence on the WTP of *Tenun Gringsing* artisans. Each variable is intrinsically linked to the cultural and economic value of *Tenun Gringsing*: aesthetic value influences consumer preference and market pricing (Hasanah, 2019); cultural capital is essential for preserving traditional techniques and expanding market reach (Purwanto, 2013); *awig-awig* regulates the sustainable use of natural resources; and HKIK protects cultural heritage and enhances product value. Additionally, spiritual value reflects the textile's deep religious significance within Balinese culture; symbolic value reinforces cultural identity and motivates artisans to maintain high quality; financial capital affects the artisans' capacity to afford indigo dyeing; and creativity enhances product uniqueness and market competitiveness (Lodra, 2015).

Data analysis was conducted in two stages. In the first stage, MICMAC was used to map the influence-dependence relationships among the variables affecting WTP. This analysis was performed using MICMAC software through the following steps: (1) identification of relevant variables based on literature and expert input; (2) construction of an influence matrix to evaluate how strongly each variable affects the others; (3) classification of variables into four categories—autonomous, dependent, linkage, and independent—based on influence-dependence scores; and (4) identification of key variables characterized by high influence and low dependence, which were prioritized for further analysis.

The second stage employed Bayesian Belief Network (BBN) analysis using Netica software to model causal relationships among the key variables under conditions of uncertainty. The procedure included: (1) data preprocessing to ensure analytical readiness; (2) development of a network structure in the form of a Directed Acyclic Graph (DAG), with nodes representing variables and arrows indicating causal links; (3) construction of Conditional Probability Tables (CPTs) to quantify probabilistic dependencies; (4) integration of a Joint Probability Distribution (JPD) to model the combined behavior of all variables; and (5) computation of posterior probabilities to enable scenario-based inference, demonstrating how changes in variables (e.g., cultural capital or customary law) affect WTP outcomes.

Through this two-stage approach, MICMAC identified the primary drivers of WTP. At the same time, BBN offered deeper insights into the causal dynamics among variables, thereby informing policy development and strategic decision-making to support the sustainable preservation of *Tenun Gringsing*.

The operational definitions and measurement scales for all variables analyzed in this study are presented in Table 1.

Table 1. Operational definition of variables

Variable	Conceptual definition	Operational definition / Indicator	Measurement scale
Willingness to Pay (WTP)	The extent to which artisans are willing to contribute financially to ecological sustainability.	The amount artisans are willing to pay for indigo dyeing to support environmental preservation.	MICMAC: FGD-based weight (numeric)BBN: Less than 500 / More than 500
Aesthetic Value	The visual appeal of <i>Tenun Gringsing</i> influences consumer preferences and market price.	Perceived beauty, uniqueness, and design appeal of the textile.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak
Spiritual Value	The religious and ceremonial importance of <i>Tenun Gringsing</i> in Balinese culture.	Belief in the sacred meaning and ritual use of the textile.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak
Symbolic Value	<i>Tenun Gringsing</i> as a representation of cultural identity and heritage.	Recognition of the cloth as a symbol of identity and tradition.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak
Financial Capital	The financial resources available to artisans for production purposes.	Availability of funds to cover indigo dyeing and related production costs.	MICMAC: FGD-based weight (numeric)BBN: High / Low
Creativity	The artisans' capacity for innovation in design and technique.	Novelty and uniqueness in weaving patterns and production methods.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak
Cultural Capital	Preservation and transmission of traditional weaving knowledge and skills.	Continuity of weaving practices across generations.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak
Awig-Awig	Local customary law regulates weaving practices and natural resource management.	Existence and enforcement of community rules on production and sustainability.	MICMAC: FGD-based weight (numeric)BBN: Strong / Weak

Note: During the BBN analysis, additional variables—Income, Incentives, and Traditional Institutions (*Lembaga Adat/cipr*)—emerged as supporting nodes. Although not part of the original eight variables, they provided valuable context for interpreting causal relationships and scenario outcomes.

RESULTS AND DISCUSSION

To provide a comprehensive understanding, the results are presented in two main stages of analysis. The first stage involves the use of MICMAC to identify the relative influence and dependence of the eight core variables shaping artisans' willingness to

pay (WTP). This is followed by a detailed examination of how these variables interact in determining key quadrants of influence. The subsequent stage applies the Bayesian Belief Network (BBN) to explore causal relationships and simulate scenario-based outcomes. Together, these analyses offer both a structural mapping and a probabilistic interpretation of the determinants of WTP.

MICMAC Analysis Findings

Influence of Key Quadrants on Willingness to Pay

The Matrix of Cross-Impact Multiplications Applied to a Classification (MICMAC) analysis is used to examine interdependencies among variables and to identify the most influential factors affecting willingness to pay (WTP) (Zhao et al., 2024). This section presents the results of the direct influence–dependence mapping for eight core variables influencing Tenun Gringsing weavers’ willingness to pay for indigo dyeing services. These variables include Communal Intellectual Property Rights (CIPR), customary village law (*awig-awig*), cultural capital, symbolic value, financial capital, creativity, aesthetic value, and spiritual value. As illustrated in Figure 1, the MICMAC analysis generates a direct influence–dependence map that classifies these variables into four quadrants according to their relative influence and dependence.

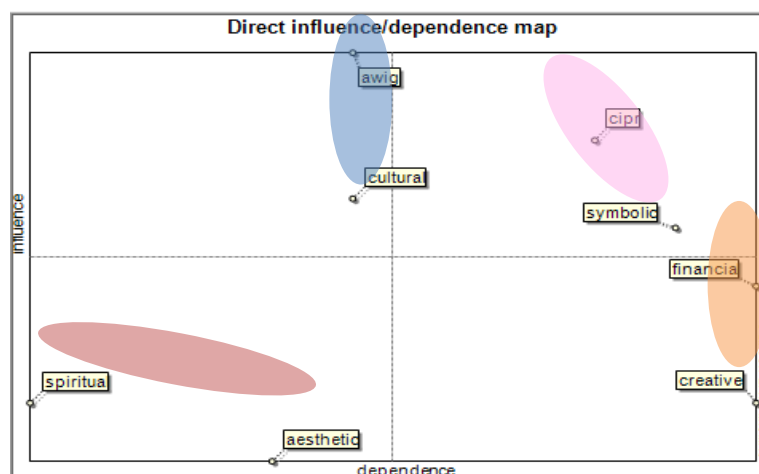


Figure 1. Direct influence–dependence map results

The results reveal four key quadrants influencing Gringsing weavers’ willingness to pay for indigo dyeing.

- Quadrant I includes cultural capital and traditional village regulations (*awig-awig*), which function as driving factors. These variables exert a strong influence but exhibit low dependence on other factors. This finding suggests that enhancing cultural awareness and reinforcing adherence to customary village laws can effectively increase weavers’ willingness to pay (Benjumea-Arias et al., 2016).
- Quadrant II contains CIPR and symbolic value, both of which demonstrate substantial influence while being highly dependent on other variables. This indicates that safeguarding communal intellectual property and emphasizing its cultural relevance can significantly affect payment decisions, although their effectiveness depends on supporting factors.
- Quadrant III comprises financial capital and creativity, which are highly dependent yet exert limited direct influence on willingness to pay (Kumar et al., 2020). While these aspects are important, they do not serve as primary motivators in payment decisions.

- Quadrant IV includes spiritual and aesthetic values, which display both low influence and low dependence. Although these values are meaningful to the weavers, they do not play a substantial role in shaping their willingness to pay for dyeing services.

Variable interactions and their impact

The MICMAC analysis provides a structured mapping of the direct influence and dependence among variables shaping artisans’ willingness to pay (WTP) for indigo dyeing in Tenun Gringsing. By constructing a cross-impact matrix, the relationships among variables are quantified and categorized according to their degree of influence, ranging from minimal to substantial. Figure 2 presents the direct influence–dependence relationships among the variables identified through the MICMAC analysis.

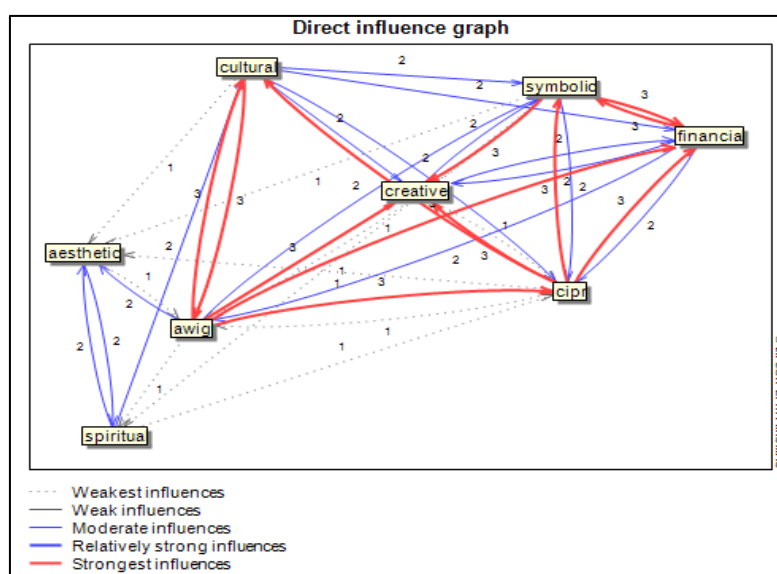


Figure 2. Direct influence relationship between variables

The diagram shows that factors such as awig-awig (customary regulations), cultural values, and symbolic value exert the strongest influence, as indicated by thick red lines. These elements play a critical role in shaping the weavers’ decisions and overall system dynamics (Chandra & Shukla, 2024). Symbolic value, human capital, and CIPR significantly impact creativity and financial capital, thereby facilitating the development of innovative design and sound financial management. The directional arrows represent the interdependent relationships among variables, with varying intensities illustrated by different line types (e.g., dashed lines for weaker links, thick red lines for stronger ones). Collectively, these interactions contribute to the economic and cultural sustainability of Gringsing weaving (An & Whitcom, 2024).

Implications of key influencing factors on willingness to pay

The MICMAC analysis identifies cultural capital and customary village regulations (*awig-awig*) as the primary driving factors influencing willingness to pay (WTP) among Gringsing weavers. This finding is supported by *Awig-Awig* Pasal VII, which explicitly prohibits the cultivation of *tarum* (indigo) trees. Although *tarum* is essential for producing indigo dye, it emits an unpleasant odor, prompting its regulation within *Desa Adat Tenganan Pegringsingan*. The formal inclusion of this restriction in the village’s customary law, along with associated sanctions, demonstrates the community’s deliberate effort to balance cultural preservation with environmental and social considerations. Through such institutionalized regulations, the *awig-awig* not only protects traditional

weaving practices but also indirectly shapes weavers’ attitudes and decisions regarding the acquisition and use of indigo dye (Adnyani et al., 2022).

From a supply-and-demand perspective, the prohibition on cultivating *tarum* reduces the local availability of raw materials for indigo dye production, as the supply becomes constrained while demand for high-quality natural dyes remains stable or increases. Consequently, the price of indigo dye is likely to rise (Watari et al., 2021). This outcome is consistent with the law of supply and demand, where scarcity contributes to higher costs, thereby affecting WTP (Menegaki et al., 2007). Moreover, cultural capital enhances demand by reinforcing the symbolic and aesthetic value of traditionally dyed textiles, encouraging weavers to prioritize authenticity despite elevated prices. Consequently, the interaction between regulatory constraints (on the supply side) and cultural significance (on the demand side) generates a market dynamic in which WTP is influenced not only by economic considerations but also by deeply embedded cultural values.

BBN scenario analysis

BBN network structure and key influential variables

The MICMAC analysis identified eight variables as critical to understanding the sustainability of Gringsing indigo dyeing practices. Among these, *awig-awig* (customary regulations) and cultural values emerged as the most influential, serving as foundational elements that guide community behavior and decision-making. These variables reflect the intrinsic connection between traditional norms and everyday choices (Chen & Li, 2024).

Figure 3 presents the Bayesian Belief Network (BBN) developed for this study, illustrating the structure of key variables influencing willingness to pay (WTP) among Gringsing weaving artisans.

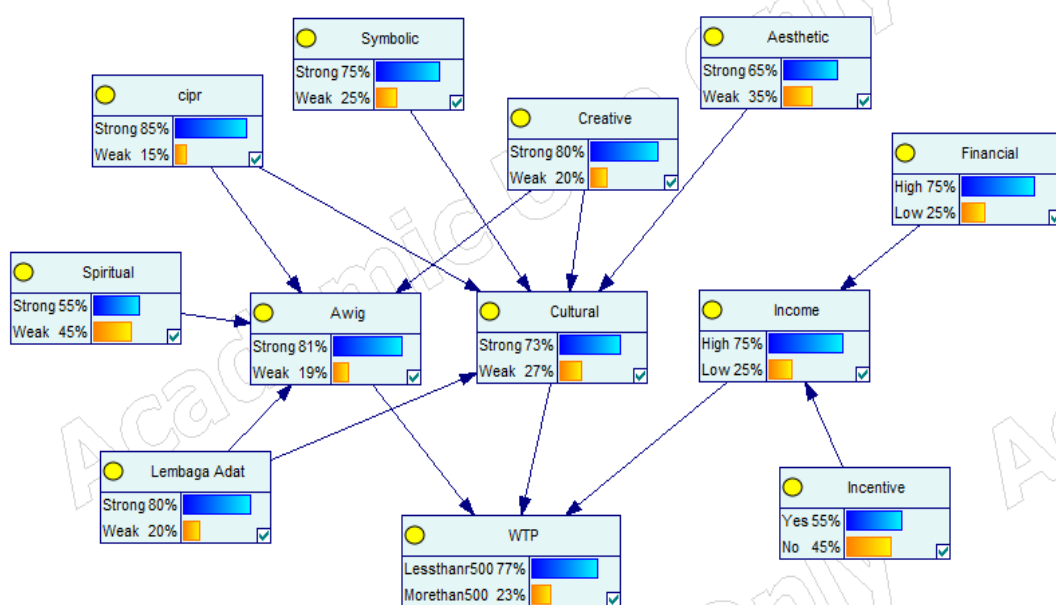


Figure 3. WTP variable of gringsing weaving artisans for indigo blue dyeing

The analysis reveals additional influential factors derived from in-depth interviews and focus group discussions (FGDs), including traditional institutions, income, and incentives. These supplement the core cultural variables and broaden the understanding

of WTP, showing that it is not solely driven by tradition but also shaped by economic support and local institutional engagement. The dynamic interplay among these variables suggests that WTP encompasses not only monetary commitment but also cultural appreciation, economic recognition, and incentive structures that promote sustainable practices.

Structural strength and influence of BBN on WTP

Building upon the MICMAC findings, the BBN analysis offers a probabilistic and causal framework to assess how changes in one variable influence others, particularly regarding artisans’ WTP for indigo dyeing. Unlike MICMAC’s static influence–dependence mapping, BBN incorporates conditional probabilities and joint distributions to simulate multiple scenarios under uncertainty.

Figure 4 presents the structural strength of the Bayesian Belief Network (BBN), highlighting the dominant variables and pathways that exert the strongest influence on artisans’ willingness to pay (WTP).

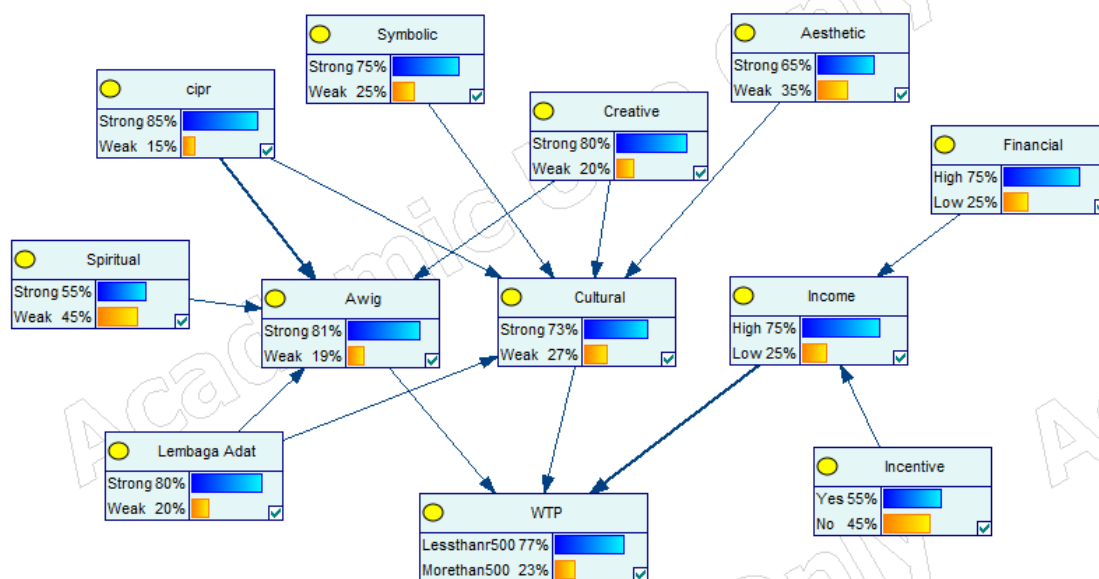


Figure 4. The influence of BBN structural strength on WTP

The results show that awig-awig and cultural values remain the central influencers, shaping both WTP and the dynamics among other key variables such as traditional institutions, income, and incentives (Yang et al., 2023). This framework highlights how deeply rooted norms and cultural expectations influence financial decisions, reinforcing a commitment to sustainable cultural practices. Awig-awig, as a codified set of traditional rules, functions as a guiding principle that aligns community actions with cultural values. This alignment reinforces community cohesion and promotes the maintenance of traditional practices. In parallel, cultural values strengthen the community’s collective identity and heritage, fostering pride and responsibility that underpin the willingness to invest in sustaining these traditions.

Furthermore, variables such as symbolic value and Communal Intellectual Property Rights (CIPR) demonstrate strong interconnections within the BBN framework. These elements highlight the cultural and intellectual aspects of Gringsing weaving, elevating its status from utilitarian products to cultural artifacts that represent community identity. Symbolic value enhances the creative and aesthetic appeal of traditional designs, while CIPR ensures the protection of these cultural expressions.

Economic variables—such as income and financial support—also play a critical role in enabling artisans and community members to support these practices financially. Greater financial stability facilitates the allocation of resources toward traditional products, ensuring the viability of artisanal work (Dalal et al., 2024). Incentives further complement this ecosystem by offering tangible rewards that encourage sustained participation in culturally significant practices. Together, these elements form an integrated system in which economic, cultural, and institutional factors collectively shape and sustain the WTP for Gringsing weaving traditions.

Influence strength measurement and interaction among variables

To complement the structural visualization provided by the Bayesian Belief Network (BBN), the strength of influence between variables was quantitatively assessed. This quantification offers a more detailed understanding of how each parent variable affects its corresponding child variable, measured in terms of average, maximum, and weighted influence values. These metrics are essential for identifying the most influential pathways that shape artisans’ willingness to pay (WTP) and support the sustainability of indigo dyeing practices. The detailed results are presented in Table 2.

Table 2. Strength of influence between parent and child variables

Parent	Child	Average	Maximum	Weighted
Aesthetic	Cultural	0.1875	0.3	0.1875
Awig	WTP	0.05	0.1	0.05
cipr	Awig	0.2125	0.3	0.2125
cipr	Cultural	0.06875	0.25	0.06875
Creative	Cultural	0.1	0.2	0.1
Creative	Awig	0.075	0.15	0.075
Cultural	WTP	0.1	0.2	0.1
Financial	Income	0.2	0.2	0.2
Incentive	Income	0.1	0.3	0.1
Income	WTP	0.225	0.3	0.225
Lembaga Adat	Awig	0.05	0.2	0.05
Lembaga Adat	Cultural	0.09375	0.25	0.09375
Spiritual	Awig	0.0875	0.2	0.0875
Symbolic	Cultural	0.075	0.15	0.075

The influence strength data in Table 2 provide critical insights into the network of interactions that support or drive Gringsing weavers’ WTP for indigo dyeing (Carrodano, 2024). The weighted influence scores, in particular, offer a concise measure of how decisively each parent variable affects its child nodes.

Notably, Community Intellectual Property Rights (CIPR) exerts a substantial influence on both *awig-awig* (weighted = 0.2125) and cultural values (weighted = 0.06875). This highlights the role of CIPR not only in reinforcing customary regulations but also in anchoring cultural identity. Its recognition and protection can enhance community cohesion and strengthen adherence to traditional practices, reinforcing a collective sense of ownership over cultural heritage.

While the direct influence of *awig-awig* on WTP is relatively modest (0.05), its structural role remains significant, as it provides a normative framework that contextualizes economic decisions. Cultural values, in turn, directly impact WTP (0.1), emphasizing the importance of shared identity and tradition in shaping financial commitments.

Economic factors, particularly income (weighted = 0.225), demonstrate a strong

influence on WTP. This underscores the critical role of financial stability in enabling artisans to invest in high-quality indigo dyeing, thereby sustaining the cultural practice. Financial capital and incentives also influence income levels, indirectly contributing to increased WTP and broader cultural sustainability.

Additionally, creative expression, symbolic value, and spiritual dimensions—although showing lower direct influence scores—serve as foundational components of cultural capital. These elements support the transmission of traditional knowledge and reinforce the symbolic richness of Gringsing textiles. Their cumulative impact contributes to a layered and interdependent structure in which economic empowerment and cultural reinforcement are mutually supportive.

In sum, the quantification of influence strengths reveals a multifaceted ecosystem where cultural, economic, and institutional variables interact dynamically. Strategic interventions targeting both economic capacity and cultural reinforcement are likely to produce synergistic effects, promoting a more holistic and sustainable approach to preserving the Gringsing weaving tradition.

Bayesian scenario testing and variable sensitivity analysis

Bayesian scenario testing enables the exploration of how changes in key variables—referred to as “evidence nodes”—affect the interconnected factors influencing Gringsing weavers’ willingness to pay (WTP) for indigo dyeing. In this study, four evidence nodes were selected based on their strong influence in the preceding MICMAC and Bayesian Belief Network (BBN) analyses: *awig-awig* (customary regulations), cultural values, income, and Communal Intellectual Property Rights (CIPR). Figure 5 presents the Bayesian network structure with indicated evidence variables, showing how selected nodes were fixed at specific values to simulate their downstream effects.

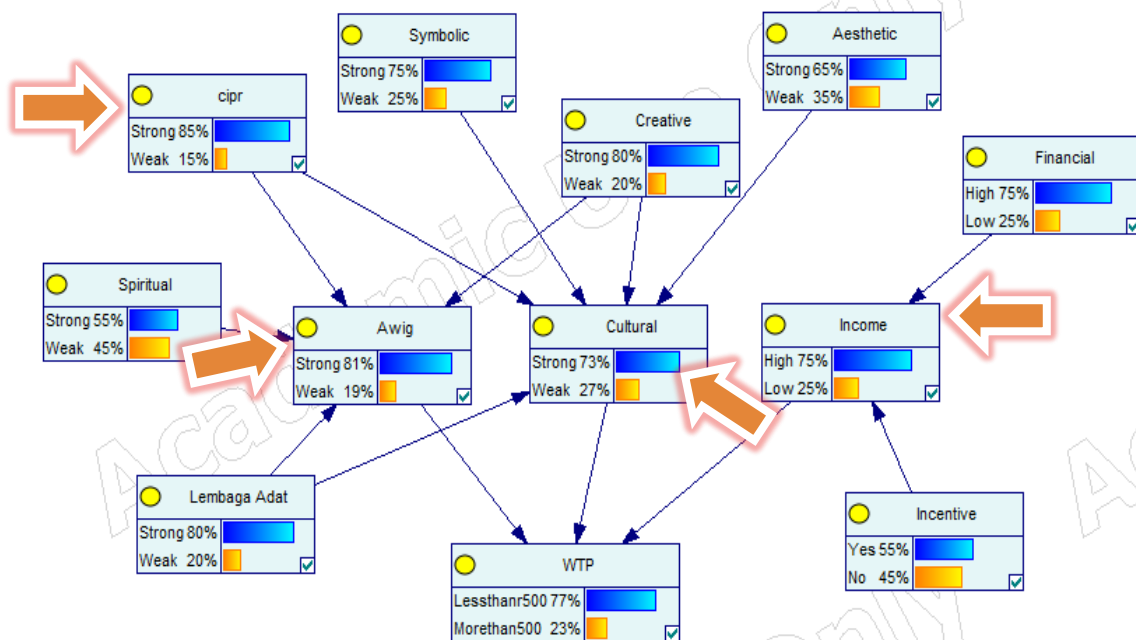


Figure 5. Bayesian network structure with indicated evidence variables

The analysis demonstrates that setting these evidence variables allows the network to project how shifts in cultural and economic factors influence WTP and related outcomes (Kitson et al., 2023). For instance, when *awig-awig* is set to a high influence level, the model reinforces cultural adherence and potentially increases WTP by

emphasizing the preservation of traditional weaving practices. Similarly, increased income reflects improved financial capacity, enabling weavers to afford high-quality natural dyes and thus enhancing the sustainability of their craft. Setting CIPR as evidence further reveals its potential to strengthen cultural pride and commitment to maintaining product quality through intellectual property protection.

Table 3 summarizes the posterior probability changes under scenario testing for the four selected evidence variables.

Table 3. Posterior probability changes under scenario testing

Variable	Prior Probability (%)	Posterior Probability	Posterior Probability in WTP (%)	Change (%)
cipr	85	100	77	0
Awig	81	100	77	0
Cultural	73	100	80	3
Income	75	100	82	5

The results of the scenario analysis provide valuable insights into the dynamics of WTP among Gringsing weavers. CIPR and *awig-awig* exhibit no change in their influence on WTP, suggesting that these elements are already internalized within the community’s decision-making processes. Their stable posterior values underscore their role as enduring cultural and regulatory anchors that consistently shape the valuation of dyeing services.

In contrast, both cultural values and income show incremental increases in their influence on WTP, with income yielding the highest gain (+5%). These results indicate that enhancing cultural engagement and improving financial conditions may further encourage artisans to invest in high-quality dyeing practices. This sensitivity to economic and cultural variables suggests viable pathways for policy and programmatic interventions aimed at increasing WTP and, by extension, promoting the sustainability of the Gringsing weaving tradition.

Overall, the scenario analysis highlights that while traditional regulations and intellectual property rights remain core motivators, targeted efforts to strengthen cultural identity and economic well-being can amplify the positive impact on artisans’ willingness to pay. Such a multifaceted approach supports the long-term preservation and resilience of the Gringsing weaving heritage.

Sensitivity analysis of WTP determinants

To identify the most influential variables affecting artisans’ willingness to pay (WTP) for indigo dyeing, sensitivity analysis was applied to the Bayesian Belief Network (BBN). This analytical procedure identifies which nodes, when altered in terms of their probability distributions, exert the greatest impact on the outcome variable—WTP. In the BBN model, these sensitive nodes are visually marked in red to emphasize their significance within the causal network. Such visualization enables policymakers and stakeholders to prioritize interventions on the most critical factors, ensuring that strategies for sustaining Tenun Gringsing dyeing practices are both effective and targeted.

Figure 6 presents the Bayesian Belief Network (BBN) visualization highlighting the most sensitive nodes (in red), which represent the variables with the greatest influence on artisans’ willingness to pay (WTP).

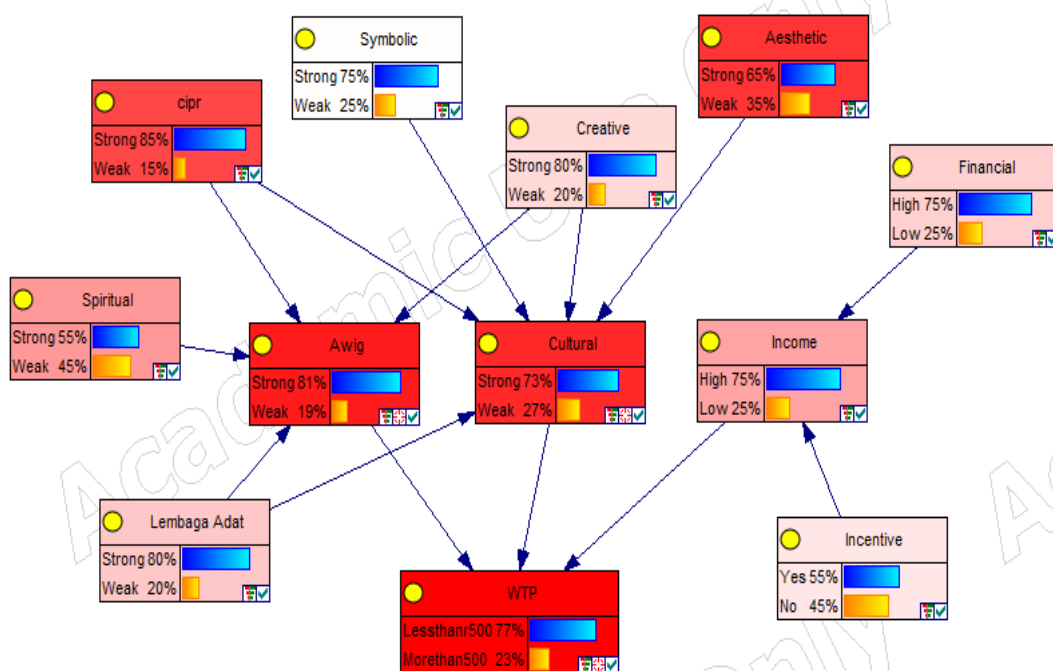


Figure 6. BBN visualization highlighting sensitive nodes (red)

The results show that cibr (Communal Intellectual Property Rights), awig-awig (customary law), cultural values, and income emerge as the most sensitive nodes, with high probabilities and strong causal links to WTP (Ballester-Ripoll & Leonelli, 2025; Sridhar, 2024). These factors are central to artisans’ economic decisions regarding dyeing services. Conversely, variables such as spiritual value, aesthetic value, and incentives exhibit more moderate or variable influence, functioning as secondary or contextual factors. While these aspects contribute to broader cultural sustainability, they exert less direct influence on WTP. This sensitivity analysis clarifies where strategic focus should lie—in particular, on strengthening cultural institutions and ensuring financial stability—as a means to enhance artisans’ WTP and sustain traditional practices (Ekici & Ekici, 2016; Dugstad et al., 2021).

Tornado diagram and scenario-based influence on WTP

To further refine the sensitivity analysis, a Tornado Diagram was employed to rank the relative influence of parent variables on WTP. This visual method presents the conditional impact of each variable on the target node in descending order of magnitude. The width of each bar in the diagram represents the extent to which changes in the input variable can alter the probability distribution of the outcome. This enables a clear comparison of which variables exert the greatest leverage over WTP.

Figure 7 presents the Tornado Diagram ranking the relative influence of parent variables on willingness to pay (WTP), based on scenario-based testing.

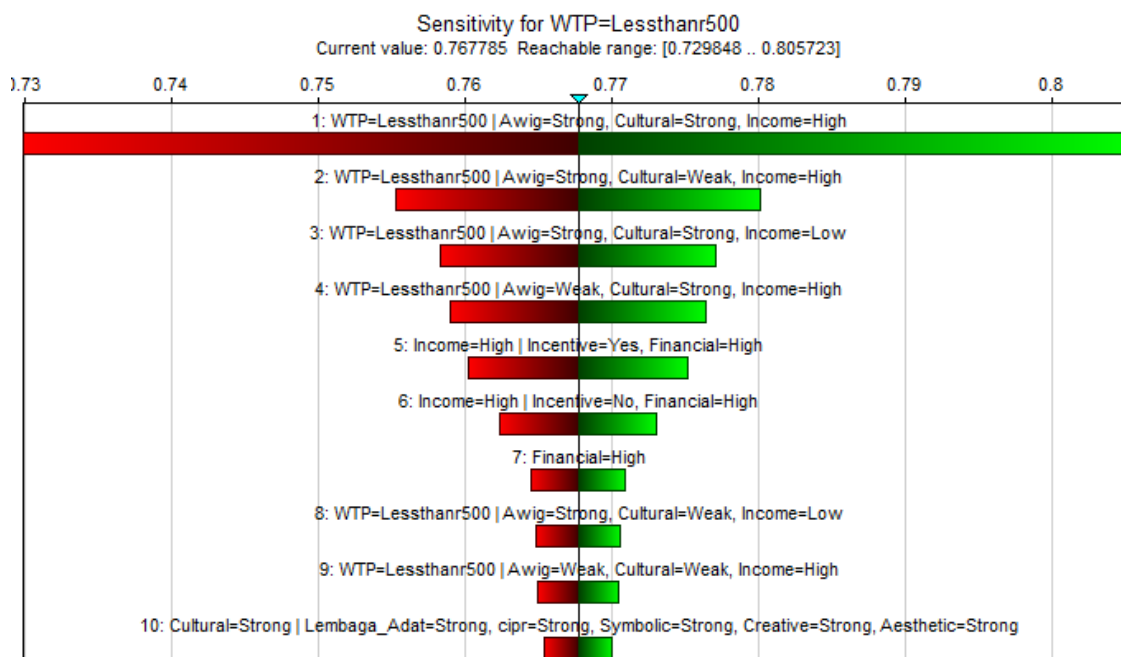


Figure 7. Tornado diagram: Sensitivity of WTP to key variables

The results indicate that the strongest effect occurs when awig, cultural engagement, and income are set to their highest levels, resulting in the greatest likelihood of WTP falling below IDR 500 (Zhou et al., 2021). This suggests that strong adherence to traditional regulations and values, coupled with stable income, leads artisans to prefer more moderate expenditure levels, possibly reflecting cost-conscious decisions informed by cultural expectations. In contrast, scenarios with weaker cultural or income levels yield reduced influence on WTP. Notably, variables such as financial support and external incentives rank lower, implying that while they provide some support, they do not substantially alter WTP. Overall, the Tornado Diagram highlights that reinforcing cultural identity and securing income stability are more effective strategies than relying solely on financial incentives.

Key Findings and Implications

The Bayesian Belief Network (BBN) analysis identifies *awig-awig* (customary regulations) and cultural values as the most influential determinants of Gringsing weavers' willingness to pay (WTP) for indigo dyeing. These findings underscore that demand for natural indigo dye is shaped not only by economic considerations but also by deeply rooted cultural and traditional commitments. While economic variables—such as income levels and financial incentives—positively influence WTP, cultural identity emerges as a more dominant force guiding purchasing decisions.

The results of the sensitivity analysis further support this conclusion, demonstrating that although financial improvements can enhance WTP, the most critical drivers are cultural norms and institutional support structures. This highlights the importance of a holistic understanding of demand that integrates economic rationality with cultural meaning and heritage preservation.

From a supply-and-demand perspective, increased WTP among artisans could, in theory, stimulate higher supply. However, given the artisanal and traditional nature of indigo dye production—characterized by limited resource availability, manual labor intensity, and time-consuming processes—supply remains relatively inelastic. This

structural limitation implies that price mechanisms alone may be insufficient to balance market dynamics.

As a result, policy interventions should prioritize cultural revitalization and institutional reinforcement over purely economic incentives. In particular, strengthening Community Intellectual Property Rights (CIPR) and enhancing the formal recognition of cultural heritage can foster both stable demand and sustainable supply. These measures can empower local communities, support cultural continuity, and ensure the long-term viability of indigo dyeing practices within the Gringsing weaving tradition.

CONCLUSION AND RECOMMENDATIONS

Conclusion

This study demonstrates that willingness to pay (WTP) for indigo dyeing among Gringsing weavers is strongly influenced by traditional values, cultural significance, and income stability. The analysis reveals that a firm adherence to cultural practices and customary regulations tends to keep WTP relatively low, reflecting a prioritization of heritage and community cohesion over market-based incentives. Importantly, economic incentives alone are insufficient to elevate WTP substantially. Instead, efforts to enhance WTP must integrate cultural preservation with financial empowerment.

The findings underscore the importance of embedding cultural identity within economic strategies. Effective initiatives should raise awareness and appreciation for traditional practices while simultaneously addressing income-related barriers. Collaborative engagement among stakeholders—including local government bodies, non-governmental organizations (NGOs), and the weaving community—can support the development of integrated programs that strengthen both cultural heritage and economic resilience. By cultivating an enabling environment that respects tradition and improves livelihoods, stakeholders can foster a sustainable future for indigo dyeing in the Gringsing community.

Despite its contributions, this study has several limitations. The relatively small and homogeneous sample size may limit the generalizability of the findings, potentially introducing selection bias. Moreover, the reliance on Focus Group Discussions (FGDs) as a primary qualitative method may be influenced by group dynamics, which could affect the objectivity and diversity of individual responses. These factors suggest the need for methodological expansion in future research.

Recommendations

To enhance WTP for indigo dyeing among Gringsing weavers, culturally grounded economic strategies should be prioritized. Financial assistance, such as government subsidies and cooperative purchasing models, can help reduce the cost burden of natural indigo dye, thereby making it more accessible to artisans. At the same time, strengthening awareness of the cultural and historical significance of indigo dyeing—through community workshops, heritage exhibitions, and digital outreach—can help preserve traditional knowledge and increase its perceived value.

Sustainable production practices, including the exploration of environmentally friendly dyeing methods, should also be promoted to align with contemporary ecological standards without compromising cultural integrity. Income stability must be supported through fair trade mechanisms, capacity-building initiatives, and market expansion efforts that allow artisans to diversify their products and access broader consumer bases. These measures can be effectively implemented through close collaboration among local

governments, NGOs, research institutions, and artisan cooperatives.

Future research should aim to overcome current limitations by increasing the sample size, incorporating a more diverse respondent pool, and utilizing advanced quantitative methodologies. Such efforts would enhance the robustness of findings and provide a more comprehensive understanding of the complex interplay between culture, economy, and artisan sustainability.

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