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# SUSTAINABILITY OF BAMBOO BUSINESS IN SAN ANTONIO BOMBON CAMARINES SUR

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## Abstract

This study examined the sustainability of bamboo enterprises in Barangay San Antonio, Bombon Camarines Sur, focusing on their economic, environmental, and social conditions. Using the Triple Bottom Line framework (People, Planet, and Profit), the study described the long-term sustainability potential of this long-standing community industry, which faces issues such as limited capital, restricted market access, and decreasing bamboo resources. The study was conceptually anchored with Social Capital Theory, Triple Helix Model of Innovation Theory, and Ecological Modernization Theory, which provided theoretical support in understanding community participation, institutional support, and environmental sustainability practices in the bamboo industry. A total of fifteen (15) bamboo entrepreneurs answered a structured questionnaire that gathered information about their years of operation, capital, ownership, production volume, market reach, and resources used. These findings showed that the bamboo business in San Antonio, Bombon, Camarines Sur remains culturally strong and resilient, passed on from generation to generation. However, its sustainability is affected by low income, lack of capital, a small market, and limited product or material variety. The industry's small capital and limited workforce also make it vulnerable to supply shortages and prevent modernization. Key challenges include low capitalization, a small labor force, and limited market access, while opportunities lie in raising awareness about the bamboo industry, diversifying products, and improving access to financial support. This study proposed measures and recommended strategies to enhance the sustainability of the bamboo industry in San Antonio, Bombon, Camarines Sur, including prioritizing market expansion initiatives, improving access to micro-lending programs, and institutionalizing knowledge transfer mechanisms to support the long-term viability and sustainable development of bamboo-based enterprises.

## Keywords:

*Bamboo Industry, Sustainability, Economic Development, Market Expansion.*

 

## INTRODUCTION

"From Silent Grove to Sustained Life". Bamboo, often called a "super grass," was recognized as one of the most valuable non-timber forest products in the Philippines. Due to its rapid growth and versatility, bamboo played a significant role in environmental protection and economic development. Ecologically, it contributed to carbon absorption, soil erosion prevention, and biodiversity support. For generations, bamboo had been deeply embedded in Filipino culture, serving as a material for handicrafts, furniture, and construction, thereby reflecting its enduring utility and cultural significance.

In the Bicol Region, particularly in Camarines Sur, bamboo craftsmanship remained an important livelihood. Barangay San Antonio, Bombon, Camarines Sur was widely recognized for its bamboo craft industry, where community-based and family-run enterprises produced a variety of bamboo products. These small-scale enterprises highlighted local creativity and contributed to the economic and cultural identity of the area. Bamboo was considered an environmentally friendly and socially inclusive resource for the community.

Despite its long-standing presence, the sustainability of the bamboo industry in Bombon had become increasingly uncertain. Sustainability was viewed in terms of economic viability, social equity, and environmental responsibility, three essential dimensions that determined the industry's capacity for long-term continuity. Internal challenges such as limited capitalization and restricted market access, combined with external concerns including declining bamboo resources and increasing competition, placed considerable pressure on the industry's stability.

This study supported the University of Nueva Caceres' thrust on social equity and development, as well as its goals related to poverty reduction, improved health, quality education, and equality promotion. Using a descriptive quantitative approach, the study examined the sustainability of bamboo enterprises in San Antonio, Bombon, Camarines Sur by describing the socio-economic conditions of entrepreneurs, the level of sustainability of bamboo enterprises, and the challenges encountered in the industry. The findings provided an evidence-based foundation for strengthening livelihood opportunities and promoting bamboo as an affordable, environmentally sustainable, and socially inclusive resource for the local community.

## RESEARCH OBJECTIVES

This study aimed to assess the sustainability of bamboo-based enterprises in Bombon, Camarines Sur. Specifically, it sought to determine the following:

1. To determine the socio-economic profile of bamboo entrepreneurs in San Antonio, Bombon, Camarines Sur, including years of operation, capitalization, type of ownership, number of workers, and production volume.
2. To assess the level of sustainability of bamboo enterprises using selected economic, social, environmental, and innovation indicators.
3. To identify the challenges in terms of sales and supplies in the bamboo business.

4. To propose recommendations and strategies for improving the sustainability and long-term development of bamboo-based enterprises through ordinance of the municipality.

## SCOPE AND DELIMITATION

This study focused on assessing the sustainability of bamboo enterprises operating within San Antonio, Bombon, Camarines Sur. It covered three main dimensions of sustainability, namely economic, social, and environmental, to describe how bamboo businesses contributed to local development and resource management.

The respondents of the study consisted of fifteen (15) bamboo entrepreneurs who were actively engaged in bamboo product manufacturing, trading, or processing during the period of data collection. The study examined their years of operation, capitalization, source of capital, type of ownership, number of workers, production volume, target market, types of bamboo crafts produced, and resources utilized to provide a comprehensive description of the current status of the industry.

The study was conducted exclusively in Barangay San Antonio, Bombon, Camarines Sur. This barangay was selected because it is among the areas in the province that actively engage in bamboo-related activities and demonstrate strong potential for bamboo-based enterprise development. The area is known for its availability of natural bamboo resources, existing local craftsmanship, and an emerging market for bamboo products. These characteristics made San Antonio, Bombon a relevant and strategic location for describing the sustainability conditions, challenges, and opportunities of the bamboo industry.

## LITERATURE REVIEW

This study reviewed local and international literature and studies related to the sustainability of the bamboo industry, bamboo crafts, and small-scale enterprises.

According to the published article of Amitava Sil in 2024, *Critical Review of Bamboo as a Structural Material*, bamboo is often referred to as “green steel” due to its versatility and ecological benefits. Its rapid regeneration rate, ability to sequester carbon, and capacity to prevent soil erosion make it an exceptional sustainable resource and a viable alternative to traditional wood. Because of these characteristics, bamboo has gained global recognition as an environmentally friendly material with applications in construction, furniture production, handicrafts, and bio-based products.

In the Philippines, the bamboo industry plays a vital role in environmental conservation and rural development. Established in 2010 through Executive Order No. 879, the Philippine Bamboo Industry Development Council (PBIDC) oversees the development and promotion of the industry. The government has implemented several initiatives to promote its growth, such as the Philippine Bamboo Industry Development Plan (PBIDP) and the One Town, One Product (OTOP) program, which encourage local industries to specialize in bamboo-based products. Despite these efforts,

the country continues to face a shortage in the supply of bamboo poles, posing challenges to meeting the growing domestic and export demand.

The bamboo industry has gained increased attention in recent years due to its economic, environmental, and social significance. Economically, bamboo is recognized as a fast-growing and versatile resource that supports livelihood generation and entrepreneurial opportunities (Smith & Lee, 2020). Studies indicate that small- and medium-scale bamboo enterprises contribute to income generation and rural development (Garcia et al., 2019).

From a social perspective, bamboo enterprises often rely on strong community networks and collaborative practices. Studies grounded in Social Capital Theory emphasize that trust, cooperation, and knowledge-sharing among stakeholders enhance enterprise resilience and support sustainable development (Putnam, 2000; Lin, 2001). Community involvement in bamboo production and marketing has been found to strengthen social cohesion and collective capacity-building.

Environmental sustainability remains a key concern in bamboo production. Ecological Modernization Theory supports the adoption of environmentally responsible harvesting and processing practices, emphasizing that economic development and environmental protection can complement each other (Leite, 2022). Research highlights that proper bamboo resource management reduces deforestation, conserves biodiversity, and contributes to climate change mitigation (Lobovikov et al., 2012).

Innovation also plays a crucial role in the bamboo sector. The Triple Helix Model of Innovation emphasizes collaboration among universities, industry, and government to promote technological advancement, product innovation, and market competitiveness (Cai & Amaral, 2021). Recent studies show that innovation in bamboo processing, product design, and marketing enhances value addition and enterprise sustainability (Zhao et al., 2021).

Several studies have examined the bamboo industry in Camarines Sur and the broader Bicol Region. Gonzales (2024), in *Rooted in Bamboo: Uncovering the Lives of Rinconada's Craft Community and Unlocking Its Global Potential*, highlighted the socio-economic profiles of bamboo craft producers in municipalities such as Bula and Bato, as well as ongoing challenges related to raw material quality and availability. Findings indicated that many producers rely heavily on naturally growing bamboo stands, which are often insufficient to meet production demands. Limited access to managed plantations and modern processing technologies was also identified as a constraint to industry growth and product consistency.

Beyond the bamboo sector, studies on traditional handicraft and weaving enterprises in the Philippines revealed common sustainability issues, including difficulties in transferring skills and traditional knowledge to younger generations, as many youth pursue alternative livelihoods or migrate for employment opportunities.

Collectively, these studies provided a strong foundation for understanding the economic, social, and environmental dimensions of bamboo enterprise sustainability in San Antonio, Bombon, Camarines Sur and supported the application of the Triple Bottom Line, Social Capital Theory, Triple Helix Model of Innovation, and Ecological Modernization Theory in this study.

## THEORETICAL FRAMEWORK

Theoretical frameworks provided the foundation for understanding the key concepts in this study. They guided the research by offering insight into the economic, social, environmental, and innovative aspects of bamboo enterprises. In this study, relevant theories such as the Triple Bottom Line, Social Capital Theory, Triple Helix Model of Innovation, and Ecological Modernization Theory were used to frame the analysis of sustainability, community engagement, innovation, and environmental responsibility within bamboo-based businesses.

The Triple Bottom Line (TBL) Theory asserts that true sustainability is achieved when organizations balance three key dimensions: Economic, Social, and Environmental performance. In this study, the Social (People) dimension emphasized human and cultural aspects, including livelihood opportunities, transfer of traditional skills, the well-being of artisans such as health concerns from the physical demands of bamboo crafting, and preservation of cultural heritage. The Environmental (Planet) dimension focused on ecological responsibility, including sustainable sourcing of bamboo culms, proper waste management, and minimizing environmental impacts from harvesting and production. The Economic (Profit) dimension addressed financial and operational factors such as business viability, profitability, market competitiveness, efficiency along the value chain, and access to capital and technology, which were critical for the long-term sustainability and growth of bamboo enterprises.

The TBL framework provided the foundational perspective for evaluating the sustainability impacts of bamboo enterprise operations and related policies.

Social Capital Theory (Van Bakel & Horak, 2024) emphasizes the strategic role of social networks, trust, and institutional relationships in fostering resilience, innovation, and sustainable development within communities and enterprises. The 2024 perspective incorporates modern dynamics such as digital networks, knowledge-sharing platforms, and collaborative governance. In the context of the bamboo business, Social Capital Theory suggests that strong relationships among entrepreneurs, suppliers, local communities, and government agencies enhance business performance and sustainability. Collaboration and knowledge sharing enable efficient sourcing, skill development, and innovation, while trust and community participation ensure long-term viability. This theory provides a framework for understanding how social interactions and networks contribute to the growth and resilience of bamboo enterprises.

The Triple Helix Model of Innovation Theory (Cai & Amaral, 2021) emphasizes collaboration among government, industry, and academic institutions. Government involvement through policies, ordinances, and program support strengthens environmental protection and entrepreneurial development. Industry participation facilitates commercialization, product

improvement, and market integration, while academic institutions contribute through research, technology development, and training. This collaborative structure supports the adoption of innovation and improved sustainability outcomes across the bamboo value chain. This theory provides a framework for examining how bamboo-based innovation and sustainability practices contribute to economic growth, community welfare, and environmental resilience. Through this theoretical lens, the study aimed to describe factors influencing sustainable bamboo enterprise development and propose strategies to enhance innovation-driven socioeconomic and environmental benefits.

Ecological Modernization Theory (Leite, 2022) proposes that economic development and environmental protection can coexist through technological innovation and institutional reforms. It emphasizes that modernization and industrial progress do not need to harm the environment if industries adopt green technologies and improved production processes.

Applied to bamboo businesses, Ecological Modernization Theory supports the adoption of eco-friendly production methods, sustainable resource management, and modern processing technologies. It provides a framework to understand how bamboo enterprises can reduce environmental impact while improving efficiency and market opportunities.

Theoretical Framework

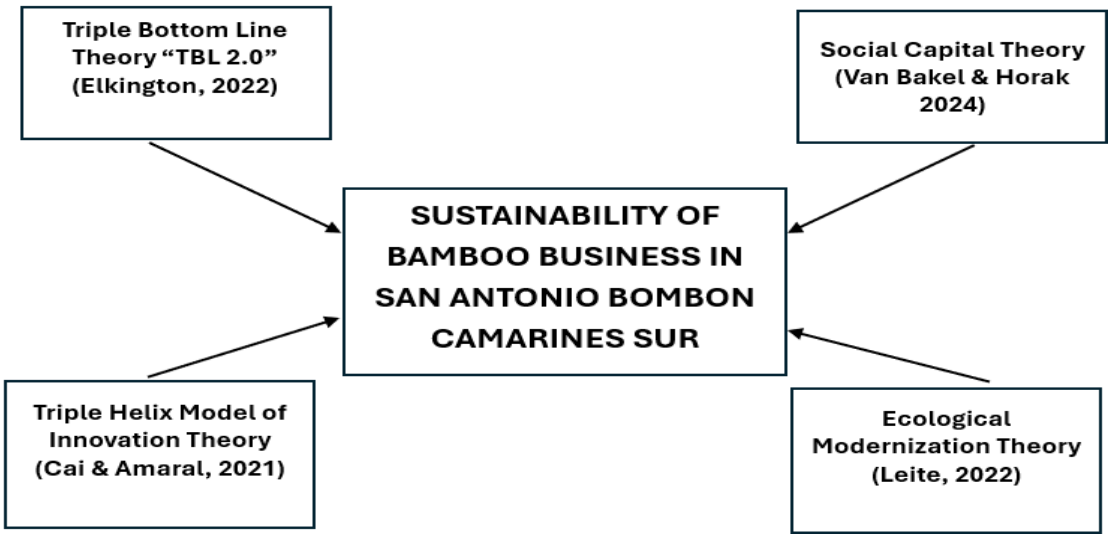


***Figure 1: Theoretical Paradigm***

## CONCEPTUAL FRAMEWORK

This study was anchored on a descriptive conceptual framework that illustrated the key components involved in assessing the sustainability of bamboo-based enterprises in Barangay San Antonio, Bombon, Camarines Sur. The framework aligned with the specific research objectives of the study and focused on describing the current condition of bamboo enterprises rather than examining causal relationships among variables.

The first component of the framework was the socio-economic profile of bamboo entrepreneurs, including years of operation, capitalization, type of ownership, number of workers, and production volume. This component provided baseline information on the characteristics of bamboo enterprises and served as the foundation for understanding their business context.

The second component focused on the level of sustainability of bamboo enterprises, assessed using selected indicators across four dimensions: economic, social, environmental, and innovation. These indicators described the extent to which bamboo businesses demonstrated profitability and stability, contributed to employment and community welfare, practiced environmentally responsible operations, and adopted innovations in production and marketing.

The third component of the framework identified the challenges encountered by bamboo enterprises, particularly in terms of sales and supply. These challenges included market competition, climate-related risks, limited access to funding and technology, and regulatory compliance. This component highlighted the common difficulties faced by bamboo operators in sustaining their businesses.

Based on the findings from the socio-economic profile, sustainability assessment, and identified challenges, the final component of the framework involved the formulation of recommendations and strategies aimed at improving the sustainability and long-term development of bamboo-based enterprises. These recommendations served as inputs for proposed municipal ordinances and policy interventions supporting bamboo entrepreneurs through appropriate programs, capacity-building initiatives, and institutional support.

Overall, the conceptual framework presented a systematic approach to assessing the sustainability of bamboo enterprises by organizing descriptive variables and guiding the analysis toward practical and policy-oriented solutions.

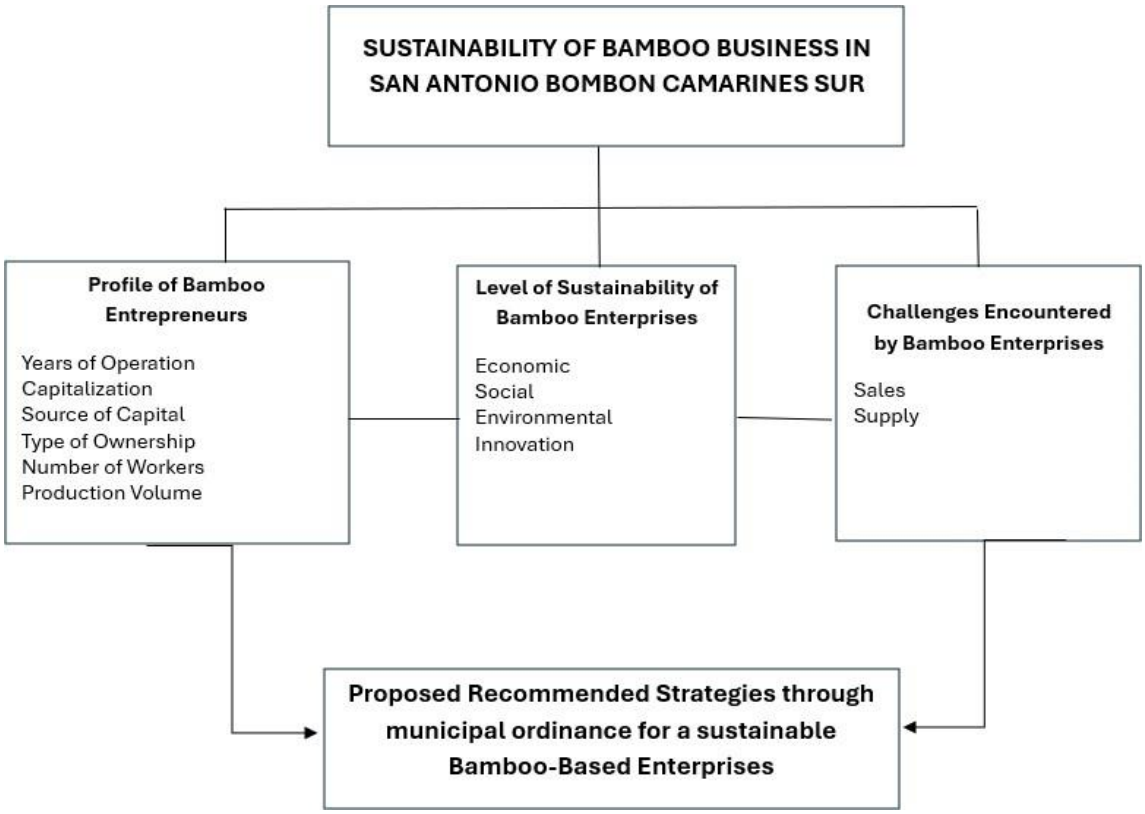


***Figure 2: Conceptual Paradigm***

## METHODOLOGY

### Research Design

This study employed a descriptive-quantitative research design to assess the sustainability of the bamboo enterprises in San Antonio, Bombon, Camarines Sur. The descriptive aspect of the research design focused on determining the current status and conditions of the bamboo industry, particularly regarding the socio-economic profile of entrepreneurs, the level of economic, social, environmental, and innovation sustainability of bamboo enterprises, and the challenges encountered in the area, which served as the basis for proposing recommended strategies. The research was conducted between September to October 2025 in San Antonio, Bombon, Camarines Sur, a municipality recognized for its emerging bamboo industry. The location was considered strategic for the study due to its active engagement in bamboo production, processing, and trade, as well as the increasing interest in sustainable practices within the local community. The study included both urban and rural bamboo operators to capture a holistic perspective of business operations and sustainability.

### Methods and Procedures

This study employed a descriptive-quantitative research method to assess the sustainability of bamboo enterprises in San Antonio, Bombon, Camarines Sur. The method focused on describing

and evaluating the current sustainability status of bamboo enterprises based on four key dimensions: economic, social, environmental, and innovation. It also identified and ranked the challenges encountered by bamboo operators according to their impact on sustainability. The approach provided a systematic description of business conditions and guided the formulation of practical recommendations for improving the long-term viability of bamboo-based enterprises.

## Respondents of the Study

A total of fifteen (15) respondents participated in the study. These included bamboo growers, processors, furniture makers, and business owners directly involved in bamboo-related operations. The respondents were selected through purposive sampling, ensuring that only individuals with actual involvement and knowledge about the bamboo industry were included in the survey.

The respondents consisted of bamboo entrepreneurs, craftsmen, and business operators within Bombon. The purposive sampling technique allowed for the inclusion of participants directly engaged in bamboo production, processing, selling, and marketing. Table 1 presents the profile of bamboo business respondents in Bombon, showing 100% compliance in survey responses.

This study utilized a structured survey questionnaire with a 5-point Likert scale to measure the level of sustainability and rank the severity of challenges encountered in bamboo business operations. Respondents rated each indicator based on the four dimensions: economic, social, environmental, and innovation, using a scale from 1 (Not Sustainable) to 5 (Highly Sustainable). Respondents also ranked major challenges affecting the sustainability of bamboo operations using the same 5–1 scale, where 5 represented challenges that were manageable and sustainable, and 1 indicated areas that were difficult to sustain and required urgent intervention.

## Data Gathering Tools

A structured survey questionnaire was utilized as the main data-gathering tool. It was divided into three sections corresponding to the People (Social), Planet (Environmental), and Profit (Economic) dimensions of sustainability. Each item was rated using a 5-point Likert scale, measuring the respondents' perceptions of sustainability practices and challenges in bamboo enterprise operations. Respondents also ranked major challenges affecting the sustainability of bamboo operations using the same 5–1 scale, where 5 represented challenges that were manageable and sustainable, and 1 indicated areas that were difficult to sustain and required urgent intervention.

This approach provided a systematic and standardized method to describe the current sustainability status of bamboo enterprises and to identify the most critical challenges affecting their long-term viability. The collected data served as the basis for analyzing business conditions and formulating practical recommendations for improving sustainability in bamboo-based enterprises.

## Data Gathering Procedure

The data gathering process for this study was conducted systematically to ensure accuracy, reliability, and relevance of information related to the sustainability of the bamboo business in San Antonio, Bombon, Camarines Sur. The following steps were undertaken:

**Preparation Stage.** The researcher first prepared the research instruments, including the structured survey questionnaire designed to measure sustainability using a 5-point Likert scale. The questionnaire underwent content validation by academic experts and bamboo industry practitioners to ensure clarity, relevance, and appropriateness of items.

**Approval and Coordination.** A formal request letter for research approval was submitted to the Local Government Unit (LGU) of Bombon and the Barangay Office of San Antonio. Upon approval, coordination was made with local bamboo business operators and associations to schedule distribution and collection of survey responses.

**Identification and Selection of Respondents.** A total of fifteen (15) respondents were purposively selected based on their direct involvement in bamboo cultivation, processing, and business operations. This ensured that only knowledgeable individuals with relevant experience participated in the study.

**Distribution of Survey Questionnaires.** The validated survey questionnaires were personally distributed to the 15 identified respondents. The instrument contained items assessing economic, social, environmental, and digital sustainability factors. Respondents rated each item using the following scale: 5 – Highly Sustainable and 1 – Not Sustainable.

**Data Collection and Retrieval.** Respondents were given sufficient time to accomplish the questionnaire. Completed forms were retrieved personally by the researcher to ensure a 100% response rate and verify completeness and accuracy of entries.

**Compilation and Tabulation of Data.** All responses were carefully checked, encoded, and organized into data tables. Numerical results were processed using frequency, percentage, ranking, and weighted mean calculations to determine the level of sustainability and rank the challenges faced by bamboo operators.

**Data Review and Validation.** The researcher reviewed and validated the tabulated data to ensure correctness and consistency. Any unclear or missing responses were clarified directly with the respondents.

## Data Analysis Technique

The data gathered from the respondents were analyzed using quantitative techniques to determine the level of sustainability of bamboo enterprises and to rank the challenges encountered in their operations. The analysis focused on four major dimensions of sustainability: economic, social,

environmental, and innovation. Survey results were processed using frequency, percentage, ranking, and weighted mean calculations to determine sustainability levels and identify the most pressing challenges.

Responses from the survey questionnaire, which utilized a five-point Likert scale ranging from 5 (Highly Sustainable) to 1 (Not Sustainable), were encoded, organized, and tabulated to facilitate interpretation. Quantitative data were processed using frequency and percentage distributions to describe respondents' profiles and summarize their perceptions regarding the sustainability indicators across the economic, social, environmental, and innovation dimensions of bamboo business operations.

The weighted mean was employed to determine the overall sustainability level of each dimension, allowing the study to identify areas demonstrating strong performance and aspects that required improvement. Ranking was also applied to determine the most critical challenges affecting sustainability, organizing them from the most difficult to sustain to the least pressing, thereby providing a basis for prioritizing interventions.

In addition to quantitative measures, qualitative data obtained from key informant interviews and focus group discussions were analyzed using thematic analysis. Recorded responses were transcribed, coded, and grouped into emerging themes to identify patterns, insights, and contextual explanations that reinforced and supported the numerical findings.

Through these analytical procedures, the study presented a holistic assessment of bamboo enterprise sustainability and generated evidence-based interpretations to guide policy formulation, local planning, and industry development initiatives.

## Ethical Considerations

This study strictly adhered to ethical standards in the conduct of research to ensure the protection, dignity, and rights of all participants. Prior to data collection, a formal request for approval was sought from the Local Government Unit of Bombon and the Barangay Office of San Antonio to secure authorization to conduct the study within the community. The researcher also coordinated directly with bamboo business operators and stakeholders to explain the purpose and procedures of the research.

Informed consent was obtained from all respondents before administering the survey questionnaire and conducting interviews. Participants were informed that their involvement was entirely voluntary and that they could withdraw at any time without any negative consequences. They were also assured that participation posed no physical, emotional, or financial risks.

Confidentiality and anonymity were strictly maintained throughout the research process. Respondents' identities were not disclosed, and their responses were coded and presented collectively rather than individually. Personal information was excluded from the study results

and kept secure, accessible only to the researcher. All data collected were used solely for academic and research purposes.

Furthermore, the research ensured honesty, accuracy, and fairness in data collection, analysis, and reporting. The researcher refrained from manipulating or misrepresenting data, thereby maintaining scientific integrity. Ethical standards regarding proper citation of sources and avoidance of plagiarism were strictly observed.

## RESULTS AND DISCUSSION

**Table 1**

**Demographic Profile of Respondents**

| Indicators | Responses | Weightage |
|---|---|---|
| **Years of Operation** | | |
| 1 year and below | 1 | 7% |
| 2–5 years | 2 | 13% |
| 6–10 years | 4 | 27% |
| 10–20 years or more | 8 | 53% |
| **Total** | 15 | 100.00% |
| **Capitalization** | | |
| ₱50,000 and more | 0 | 0% |
| ₱20,001 – ₱50,000 | 4 | 27% |
| ₱5,001 – ₱20,000 | 9 | 60% |
| Below ₱5,000 | 2 | 13% |
| **Total** | 15 | 100.00% |
| **Monthly Gross Sales** | | |
| ₱20,001 – ₱50,000 | 2 | 13% |
| ₱5,000 – ₱20,000 | 8 | 53% |
| Below ₱5,000 | 5 | 33% |
| **Total** | 15 | 100.00% |
| **Production Volume (pieces/month)** | | |
| 501–1,000 | 3 | 20% |
| 201–500 | 7 | 47% |
| Below 200 | 5 | 33% |
| **Total** | 15 | 100.00% |
| **No. of Workers** | | |
| 20 or more | 0 | 0% |
| 11–20 workers | 3 | 20% |
| 6–10 workers | 3 | 27% |
| 1–5 workers | 9 | 53% |
| **Total** | 15 | 100.00% |
| **Type of Ownership** | | |

| | | |
|---|---|---|
| Sole Proprietor | 15 | 100% |
| Partnership | 0 | 0% |
| Corporation | 0 | 0% |
| **Total** | 15 | 100.00% |

Table 1 presents the demographic and operational profile of bamboo business owners in San Antonio, Bombon, Camarines Sur, highlighting their years of operation, capitalization, income, workforce size, and ownership type. Despite long years of operation ranging from 10 to 20 years, bamboo enterprises in San Antonio, Bombon, Camarines Sur remain predominantly small-scale, family-run, and capital-constrained. Limited capitalization, modest sales, and low production volumes indicate restricted growth capacity. In addition, training ranks lowest among development needs, and there are persistent concerns regarding workplace hazards and environmental safety.

In terms of years of operation, most of the respondents (53%) have been in the bamboo business for 10–20 years, while only 7% have operated for one year or less. This longevity is further illustrated by the case of Simeon Baita Jr., who has been involved in bamboo crafting since 1969, having learned the trade from his parents at a young age. His sole proprietor enterprise, Jun Baita Bamboo Craft, exemplifies the intergenerational transfer of skills and knowledge that sustains bamboo enterprises in the community. Longevity in operation reflects accumulated craftsmanship and market familiarity; however, the absence of product diversification and weak access to finance hinder competitiveness. Sole proprietorship dominance limits investor participation and access to institutional support. Low prioritization of training contributes to slow adoption of modern techniques, safety practices, and environmental safeguards, reinforcing labor-intensive and low-yield operations.

Regarding capitalization, the results reveal limited financial capacity among bamboo entrepreneurs. Most respondents (60%) operate with capital ranging from ₱5,001 to ₱20,000, while none reported capitalization beyond ₱50,000. This suggests that bamboo businesses in the area function primarily as micro-enterprises with restricted access to larger funding sources. Such limited capital constrains production volume, technology acquisition, and expansion opportunities. Without introducing new or improved bamboo products, enterprises risk market stagnation and declining relevance. Continued informality and weak capitalization deter potential investors, both financial and in-kind such as materials and equipment.

The modest capitalization corresponds with the reported monthly gross sales levels, where more than half of the respondents (53%) earn between ₱5,000 and ₱20,000, and 33% earn below ₱5,000. Only a small portion (13%) reaches income levels above ₱20,000. Similarly, most enterprises operate with one to five workers, indicating reliance on family labor and small manpower. This reinforces the idea that bamboo production remains labor-intensive and small in scale, with limited capacity for large-scale commercialization.

To enhance sustainability and growth, it is recommended that bamboo enterprises should introduce at least two (2) new or improved bamboo products within the next 12 months to expand

market reach and increase monthly sales by a measurable margin. Given their 10–20 years of operational experience, owners are encouraged to formally incorporate or register upgraded business structures within 1–2 years, enabling them to attract at least one potential investor providing either financial capital or material inputs such as tools and raw materials. Since training ranks lowest, it is recommended that all enterprises participate in at least one skills and management training program annually, with modules explicitly covering product innovation, occupational safety, hazard prevention, and environmental protection. Environmental and workplace safety campaigns should be conducted semi-annually, aiming to reduce reported work-related hazards and material waste. Finally, to address capital constraints, entrepreneurs should be oriented and linked to at least two microfinance institutions or cooperative financing programs within the next year, with the goal of securing affordable financing to support production expansion and technology acquisition.

## Economic Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur

### Table 2.1

### Level of Economic Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. The income from bamboo business production is sufficient on daily expenses. | 3.93 | 5 | Sustainable |
| 2. The daily production consistently meets client orders and deadlines, showing stable productivity (materials are always available). | 3.67 | 4 | Sustainable |
| 3. The demand for bamboo products in the market is consistent, strong, allowing stable production and income. | 3.87 | 2 | Sustainable |
| 4. The access to credit or financial support from the bamboo business is generally accessible and sufficient to help sustain operations (lending, loans from cooperatives, government loans). | 3.80 | 3 | Sustainable |
| 5. The business is developing new bamboo products to meet market needs. | 4.33 | 1 | Sustainable |
| **OVERALL** | **3.92** | | **Sustainable** |

**Note:** 4.51–5.00 Highly Sustainable; 3.51–4.50 Sustainable; 2.51–3.50 Moderate Sustainable; 1.51–2.50 Less Sustainable; 1.00–1.50 Not Sustainable

Table 2.1 presents the level of economic sustainability of bamboo businesses in Barangay San Antonio, Bombon, Camarines Sur. The overall mean rating of 3.92 indicates that the bamboo enterprises are generally sustainable in terms of income generation, financial access, and market performance. Economic sustainability is a critical concern for bamboo enterprises in San Antonio, Bombon, Camarines Sur, as these businesses largely operate on a small scale with limited capital

and resources. Assessing whether income sufficiency, production stability, market demand, access to credit, and product development can sustain long-term operations is necessary to understand their economic condition.

The overall mean rating of 3.92, interpreted as Sustainable, indicates that bamboo businesses are generally able to maintain their operations economically. Among the indicators, the development of new bamboo products to meet market needs ranked highest (Mean = 4.33), suggesting strong adaptability and innovation among entrepreneurs. Consistent market demand (Mean = 3.87) and sufficient income to meet daily expenses (Mean = 3.93) further demonstrate that bamboo enterprises can generate regular income, albeit at a modest level.

While economic sustainability is evident, the relatively lower mean ratings for production stability (Mean = 3.67) and access to credit (Mean = 3.80) imply vulnerability to supply disruptions and financial constraints. Income is generally sufficient for daily needs but may not support savings, reinvestment, or expansion. This condition may limit the ability of enterprises to scale up operations and withstand economic shocks.

These findings are based on self-reported perceptions of respondents and a limited sample size, which may affect the accuracy and generalizability of the results. Variations in seasonal demand, pricing, and availability of raw materials were not fully captured and may influence sustainability levels. The inconsistency in daily production directly affects income stability and limits the full utilization of available financial resources. Even with access to credit, production inefficiencies can lead to delayed orders, reduced customer satisfaction, and missed income opportunities. This finding implies that financial sustainability alone is insufficient if operational systems are not strengthened to support consistent production.

To further strengthen economic sustainability, bamboo enterprises should continue and expand product innovation efforts to capture wider markets. Access to credit and financial support should be improved through stronger linkages with cooperatives, microfinance institutions, and government lending programs. Additionally, enhancing production efficiency and resource management can help stabilize output, increase income beyond daily subsistence, and support long-term business growth.

## Social Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur

**Table 2.2**

**Level of Social Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur**

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. The bamboo business contributes to providing employment in the community regularly, offering stable jobs to several residents. | 4.07 | 3 | Sustainable |
| 2. The business strongly fosters cooperation and unity among all members in the community. | 4.07 | 2 | Sustainable |
| 3. Bamboo businesses preserve and highlight cultural traditions and hand-made local crafts. | 4.53 | 1 | Highly Sustainable |
| 4. The bamboo business significantly improves the family's quality of life of workers and business owners. | 4.07 | 4 | Sustainable |
| 5. The programs and trainings initiated by LGUs and NGOs help enhance production skills. | 3.27 | 5 | Moderate Sustainable |
| **OVERALL** | **4.08** | | **Sustainable** |

**Note:** 4.51–5.00 Highly Sustainable; 3.51–4.50 Sustainable; 2.51–3.50 Moderate Sustainable; 1.51–2.50 Less Sustainable; 1.00–1.50 Not Sustainable

The social sustainability of bamboo businesses in San Antonio, Bombon, Camarines Sur is generally high, with an overall weighted mean of 4.08. This indicates that the industry contributes positively to community welfare, social cohesion, and cultural continuity. Social sustainability is essential in evaluating the long-term contribution of bamboo enterprises to community welfare in San Antonio, Bombon, Camarines Sur. This includes employment generation, community cohesion, cultural preservation, quality of life, and the effectiveness of institutional training support.

The overall mean rating of 4.08, interpreted as Sustainable, indicates that bamboo businesses contribute positively to the social well-being of the community. Preservation and promotion of cultural traditions ranked highest (Mean = 4.53), reflecting the strong role of bamboo enterprises in sustaining local heritage and handmade craftsmanship. Employment generation, community cooperation, and improved quality of life all obtained sustainable ratings (Mean = 4.07), demonstrating that bamboo enterprises provide meaningful social benefits beyond income generation.

The strong cultural sustainability highlights bamboo enterprises as vital carriers of local identity and tradition. However, the relatively lower rating for LGU- and NGO-led programs and trainings (Mean = 3.27) suggests that institutional support is not fully maximizing its potential to enhance skills and productivity. Without strengthened training initiatives, opportunities for skills upgrading and social empowerment may remain limited.

The limited effectiveness of training programs affects workers' productivity, innovation capacity, and long-term livelihood security. Without adequate skills development, bamboo workers may struggle to adopt new production techniques, improve product quality, or respond to changing market demands. This gap weakens the potential social benefits of the industry despite its strong cultural and community foundations. The assessment relies on respondents' perceptions and a limited number of participants, which may not capture the full scope of social impacts. Differences in access to training programs and varying levels of participation were not deeply examined and may influence responses.

To enhance social sustainability, it is recommended that LGUs and NGOs intensify and regularize training programs, ensuring broader participation and relevance to current production needs. Community-based initiatives that reinforce cooperation, cultural preservation, and inclusive employment should be sustained. Strengthening partnerships among bamboo entrepreneurs, local institutions, and support organizations can further improve skills development, social cohesion, and overall community well-being. Expanding access to these programs, aligning them with local needs, and encouraging participation from youth and new entrants will enhance skills development, productivity, and long-term social sustainability. Strengthened training programs will not only support individual livelihood improvement but also reinforce community cohesion and the cultural legacy of bamboo craftsmanship.

## Environmental Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur

**Table 2.3**

**Level of Environmental Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur**

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. Replanting or reforestation is systematically and widely practiced, ensuring long-term sustainability. | 3.73 | 3 | Sustainable |
| 2. Bamboo harvesting is carefully managed, fully sustainable, and ensures long-term resource preservation. | 3.60 | 2 | Sustainable |
| 3. Bamboo plays a major role in protecting the environment and preventing hazards (flood control, land erosion). | 4.53 | 1 | Highly Sustainable |
| 4. Bamboo waste is fully utilized, recycled, or repurposed, minimizing environmental impact. | 4.00 | 2 | Sustainable |
| 5. There is strong awareness and active compliance with all environmental policies and guidelines. | 3.07 | 5 | Moderate Sustainable |
| **OVERALL** | **3.79** | | **Sustainable** |

**Note:** 4.51–5.00 Highly Sustainable; 3.51–4.50 Sustainable; 2.51–3.50 Moderate Sustainable; 1.51–2.50 Less Sustainable; 1.00–1.50 Not Sustainable

Table 2.3 presents the level of environmental sustainability of bamboo businesses in San Antonio, Bombon, Camarines Sur. Environmental sustainability is vital to the continued viability of bamboo enterprises in San Antonio, Bombon, Camarines Sur, as these businesses depend directly on natural resources. Ensuring responsible harvesting, reforestation, waste management, and compliance with environmental policies is necessary to prevent resource depletion and environmental degradation.

The overall mean rating of 3.79, interpreted as Sustainable, indicates that bamboo enterprises generally practice environmentally responsible activities. The highest-rated indicator is the role of bamboo in environmental protection and hazard prevention (Mean = 4.53), classified as Highly Sustainable, highlighting bamboo's effectiveness in flood control and erosion prevention. Waste utilization and recycling also received a sustainable rating (Mean = 4.00), suggesting growing awareness of minimizing environmental impact. Replanting and harvesting practices obtained sustainable ratings (Means = 3.73 and 3.60), indicating that conservation practices are present but not yet fully optimized.

While environmental sustainability is generally achieved, the relatively low rating for awareness and compliance with environmental policies (Mean = 3.07) suggests gaps in knowledge, monitoring, or enforcement. Inadequate compliance may expose enterprises to environmental risks and regulatory issues, potentially undermining long-term sustainability despite positive ecological contributions.

This assessment is based on self-reported perceptions and a limited sample size, which may not fully reflect actual compliance levels or environmental outcomes. Variations in local enforcement, access to information, and reforestation capacity were not extensively examined. Weak compliance with environmental policies may limit the long-term sustainability of bamboo resources. Without sufficient training and regulatory awareness, practices such as unregulated harvesting and inadequate replanting could threaten bamboo supply and ecosystem balance. This gap underscores the need for institutional support to translate existing environmental practices into standardized and sustainable systems.

To strengthen environmental sustainability, it is recommended that environmental education and compliance training be intensified, particularly on existing policies and guidelines. Structured replanting and reforestation programs should be institutionalized in partnership with LGUs and environmental agencies. Additionally, sustainable harvesting standards and waste management practices should be reinforced to ensure consistent implementation and long-term protection of bamboo resources.

## Technology and Innovation Sustainability in Bamboo Business in San Antonio Bombon Camarines Sur

**Table 2.4**

**Level of Technology Integration and Innovative Practices in Sustainable Development**

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. Modern tools and technology are widely available, fully accessible, and greatly enhance bamboo processing efficiency and quality. | 3.00 | 4 | Moderate Sustainable |
| 2. Digital platforms are extensively used, maximizing promotion, market reach, and sales of bamboo products. | 3.27 | 2 | Moderate Sustainable |
| 3. Bamboo products are highly competitive, offering excellent quality at attractive prices, consistently outperforming alternatives in the market. | 3.07 | 3 | Moderate Sustainable |
| 4. Attend trainings and seminars conducted by the government organization and non-government. | 3.47 | 1 | Moderate Sustainable |
| 5. Consistently seeks innovative ideas from the internet (e.g., YouTube and other online tutorials). | 2.80 | 5 | Moderate Sustainable |
| **OVERALL** | **3.12** | | **Moderate Sustainable** |

**Note:** 4.51–5.00 Highly Sustainable; 3.51–4.50 Sustainable; 2.51–3.50 Moderate Sustainable; 1.51–2.50 Less Sustainable; 1.00–1.50 Not Sustainable

Table 2.4 presents the level of technology integration and innovative practices in the bamboo business in San Antonio, Bombon, Camarines Sur. Technology integration and innovative practices are essential for improving productivity, competitiveness, and long-term sustainability of bamboo enterprises in San Antonio, Bombon, Camarines Sur. However, small-scale operations and limited resources may restrict access to modern tools, digital platforms, and continuous skills development.

The overall mean rating of 3.12, interpreted as Moderately Sustainable, indicates that technology use and innovation are present but not yet fully integrated into bamboo business operations. Attendance in trainings and seminars ranked highest (Mean = 3.47), suggesting willingness among entrepreneurs to learn and upgrade skills. Use of digital platforms for marketing (Mean = 3.27) reflects emerging adoption of online promotion, although still limited in scope. Competitiveness of bamboo products (Mean = 3.07) and access to modern tools and technology (Mean = 3.00) remain moderate, indicating constraints in equipment investment and technological upgrading. The lowest-rated indicator is the consistent search for innovative ideas

through online sources (Mean = 2.80), showing limited exposure to continuous innovation practices.

Moderate levels of technology integration may restrict production efficiency, product quality, and market expansion. Limited use of digital tools and modern equipment can hinder competitiveness against mass-produced or alternative products. Without consistent innovation and learning, bamboo enterprises may struggle to adapt to changing consumer preferences and technological advancements.

Low engagement in online innovation limits exposure to new designs, production techniques, and marketing strategies that could improve efficiency and product competitiveness. Without actively seeking digital knowledge, bamboo enterprises may struggle to adapt to changing market trends and technological advancements. This gap restricts the full potential of technology-driven sustainability despite existing training participation. The assessment relies on self-reported perceptions and does not measure actual levels of technology use or digital engagement. Differences in internet access, digital literacy, and availability of training opportunities were not fully examined and may influence the results.

To enhance technology integration, it is recommended that access to modern bamboo-processing tools and equipment be improved through shared facilities or financial support programs. Digital literacy and online marketing training should be strengthened to maximize the use of social media and e-commerce platforms. Continuous innovation-oriented training, including the use of online resources and tutorials, should be encouraged to improve product competitiveness and support sustainable development of the bamboo industry. By combining technological skills with safety and environmental awareness, bamboo enterprises can enhance production efficiency, protect natural resources, and achieve long-term resilience while expanding their market reach in line with the Triple Helix Model of Innovation.

## Key Challenges in Bamboo Business at San Antonio, Bombon Camarines Sur

### Table 3.1

### Extent of Challenges Encountered in Bamboo Business in Sales at San Antonio Bombon Camarines Sur

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. Lack of Capital | 4.82 | 1 | Extremely Challenging |
| 2. Shortage of Materials | 3.87 | 5 | Very Challenging |
| 3. Transportation and Delivery Issue | 4.27 | 3 | Very Challenging |
| 4. Low Customer Demand | 4.07 | 4 | Very Challenging |
| 5. Price Fluctuations at the market | 4.53 | 2 | Extremely Challenging |
| **OVERALL** | **4.05** | | **Very Challenging** |

**Note:** 4.51–5.00 Extremely Challenging; 3.51–4.50 Very Challenging; 2.51–3.50 Moderately Challenging; 1.51–2.50 Slightly Challenging; 1.00–1.50 Not Challenging

Table 3.1 presents the extent of challenges encountered by bamboo businesses in sales in San Antonio, Bombon, Camarines Sur. Bamboo enterprises in San Antonio, Bombon, Camarines Sur face several operational and market-related challenges that threaten their sustainability and growth. Identifying the severity of these challenges is necessary to determine priority areas for intervention and support.

The overall mean rating of 4.05, interpreted as Very Challenging, indicates that bamboo entrepreneurs experience substantial difficulties in sustaining their operations. The most critical challenge is the lack of capital (Mean = 4.82), ranked first and classified as Extremely Challenging, highlighting severe financial constraints. Price fluctuations in the market ranked second (Mean = 4.53), also considered Extremely Challenging, reflecting vulnerability to unstable input and output prices. Shortage of materials (Mean = 4.27) and transportation and delivery issues (Mean = 4.07) were rated as Very Challenging, suggesting logistical and supply chain limitations. Low customer demand (Mean = 3.87), while still very challenging, ranked lowest among the identified constraints.

Severe capital shortages and market price instability restrict production capacity, limit technology adoption, and reduce the ability of enterprises to expand or innovate. Logistical constraints further increase costs and delay deliveries, affecting customer satisfaction. These challenges collectively weaken competitiveness and threaten long-term sustainability despite strong cultural, social, and environmental contributions of the bamboo industry.

The dominance of capital-related challenges suggests that financial limitations have a cascading effect on other problem areas. Without adequate funding, businesses struggle to secure materials, adopt efficient technologies, and improve marketing strategies, including the use of online platforms to reach broader markets. This finding aligns with the Triple Bottom Line Theory, where weak economic sustainability can negatively influence both social and environmental performance.

To address these challenges, it is recommended that access to capital be strengthened through microfinance institutions, cooperatives, and government lending programs. Price stabilization mechanisms, such as collective purchasing and cooperative marketing, should be explored to reduce market volatility. Improving raw material supply management and transportation support through partnerships with LGUs can help lower costs and improve efficiency. Finally, market development and promotion initiatives should be intensified to stimulate demand and improve income stability for bamboo enterprises.

**Challenges Faced by Bamboo Business Owners in Supplies of Raw Materials in San Antonio, Bombon Camarines Sur**

**Table 3.2**

| Indicator | Mean / Rating | Rank | Interpretation |
|---|---|---|---|
| 1. Availability of bamboo raw materials | 3.80 | 2 | Very Challenging |
| 2. Weather and Environmental Risk (Typhoon, Flood, Drought, Pests) | 4.07 | 1 | Very Challenging |
| 3. Delivery of materials / logistics | 3.13 | 5 | Moderately Challenging |
| 4. Quality of bamboo product | 3.80 | 2 | Very Challenging |
| 5. Restoration of bamboo production | 3.60 | 4 | Very Challenging |
| **OVERALL** | **3.68** | | **Very Challenging** |

**Note:** 4.51–5.00 Extremely Challenging; 3.51–4.50 Very Challenging; 2.51–3.50 Moderately Challenging; 1.51–2.50 Slightly Challenging; 1.00–1.50 Not Challenging

Table 3.2 presents the challenges faced by bamboo business owners in the supply of raw materials in San Antonio, Bombon, Camarines Sur. Bamboo enterprises in San Antonio, Bombon, Camarines Sur face significant production- and environment-related constraints that directly affect supply continuity, product quality, and operational stability. These challenges threaten the sustainability of bamboo businesses that rely heavily on natural resources and stable production systems.

The overall mean rating of 3.68, interpreted as Very Challenging, indicates that production and environmental constraints pose serious difficulties for bamboo entrepreneurs. Weather and environmental risks ranked highest (Mean = 4.07), highlighting the vulnerability of bamboo production to typhoons, floods, droughts, and pest infestations. The availability of bamboo raw materials (Mean = 3.80) and product quality issues (Mean = 3.80) were also rated very challenging, suggesting supply shortages and inconsistencies in processing and handling. Restoration of bamboo production (Mean = 3.60) reflects difficulties in regenerating bamboo resources after harvesting or environmental damage. Delivery and logistics (Mean = 3.13), while still challenging, ranked lowest and were considered moderately challenging.

High exposure to environmental risks and raw material shortages may lead to production delays, increased costs, and inconsistent product quality. Without effective restoration and risk-mitigation strategies, bamboo enterprises may experience long-term resource depletion and reduced competitiveness. These constraints further compound existing financial and technological challenges identified in earlier findings.

The difficulty in restoring bamboo production has a cascading effect on other supply challenges. Without proper regeneration and plantation management, the availability and quality of raw

materials decline, making businesses more vulnerable to climate risks and production delays. This finding aligns with resource-based and sustainability management theories, which emphasize that consistent access to high-quality natural resources is essential for operational stability and long-term business growth.

To address these constraints, it is recommended that climate-resilient bamboo farming and pest management practices be strengthened through training and LGU support. Community-based bamboo replanting and restoration programs should be institutionalized to ensure sustainable raw material supply. Improving quality control training and processing techniques can enhance product consistency. Lastly, logistics coordination and shared delivery systems may help reduce material delivery challenges and operational costs.

## Market, Supply Chain and Innovation Opportunities in Bamboo Business

The bamboo industry in San Antonio, Bombon, Camarines Sur is presented with several promising opportunities that can significantly enhance its growth and competitiveness. In terms of sales, the increasing demand for bamboo products reflects a rising appreciation for locally crafted and eco-friendly items. This growing volume of orders provides producers with steady market prospects and encourages expansion of production capacity. Moreover, the accessibility of online and export markets opens new avenues for bamboo entrepreneurs to reach customers beyond the local community, allowing their products to gain visibility in both national and international platforms. Collaborations with major establishments such as hotels, restaurants, and shopping malls further strengthen these opportunities by offering potential partnerships for large-scale supply agreements and long-term business relationships.

Opportunities are also evident in supplies. The cultivation of fast-growing bamboo species provides a sustainable solution for maintaining a reliable raw material base, ensuring that future production demands can be consistently met. The bamboo industry also benefits from its natural appeal as a sustainable and eco-friendly product, allowing producers to capitalize on green branding and tap into environmentally conscious consumer markets. Additionally, access to contract farming arrangements and partnerships with suppliers strengthens the stability of material sourcing, reduces production delays, and improves overall supply chain efficiency.

In the field of digital transformation, the bamboo industry stands to gain significant advantages. The rise of digital platforms has made product selling and online marketing more accessible than ever, enabling local producers to promote their products with ease and minimal cost. Through social media posting and digital engagement, the market reach widens considerably, allowing bamboo products to be discovered by larger audiences and potential buyers from different regions. This digital exposure enhances competitiveness and creates new pathways for growth, especially for micro and small enterprises.

Collectively, these opportunities demonstrate that the bamboo industry is well-positioned to expand its market presence, strengthen its resource base, and embrace technological advancements that support long-term sustainability and development. Beyond the existing

opportunities identified in sales, supplies, and digital transformation, the bamboo industry in San Antonio, Bombon, Camarines Sur can also explore several emerging prospects that can further strengthen its sustainability and competitiveness.

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**Proposed Recommendations and Strategies for Improving the Sustainability and Long-Term Development of Bamboo-Based Enterprises through Municipal Ordinance**

Based on the findings from Objectives 1 to 3—particularly the challenges encountered by bamboo-based enterprises such as limited capital, lack of technical training, unstable market demand, and insufficient government support—this study proposes a set of policy-driven recommendations anchored on a Municipal Bamboo Development Ordinance. These strategies aim to ensure sustainability, improve productivity, and promote long-term economic growth of the bamboo industry in the municipality.

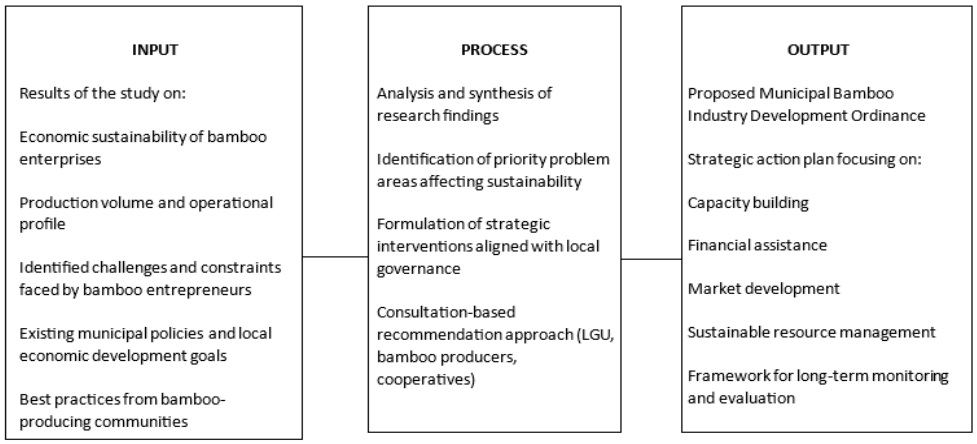


**Table 4**

**Proposed Action Plan for Bamboo Industry Development**

| Key Areas | Proposed Strategies | Responsible Agency | Timeline | Expected Outcome |
|---|---|---|---|---|
| **Policy Support** | Enact a Municipal Bamboo Development Ordinance; Allocate annual budget | LGU, Municipal Council | Year 1 | Legal and financial backing for bamboo enterprises |
| **Capacity Building** | Conduct skills development training, workshops, and technical assistance programs for bamboo entrepreneurs | LGU, NGO, DTI, TESDA | Bi-annual, Year 1–3 | Improved production efficiency, product quality, and innovation adoption |
| **Financial Assistance** | Facilitate access to micro-loans and grant programs for bamboo entrepreneurs | LGU, Rural Banks, Cooperative Associations | Year 1–3 | Increased capitalization and ability to scale operations |
| **Market Expansion** | Establish online platforms, participate in trade fairs, and link with commercial partners | LGU, DTI, Industry Associations (Local Bamboo Producers' Associations, Chamber of Commerce or Trade Associations, PBIDC | Year 1–2 | Wider market reach, improved sales, and income growth |

| | | | | |
|---|---|---|---|---|
| | | Partners, Cooperative or Farmers' Associations) | | |
| **Environmental Sustainability** | Implement bamboo replanting programs, sustainable harvesting practices, and proper waste management | DENR, LGU, Farmers' Associations, NGOs | Year 1–3 | Enhanced long-term ecological sustainability and resource availability |
| **Monitoring and Evaluation** | Create a Bamboo Industry Council for regular assessment, tracking system, and policy review | LGU, Researchers, Industry Associations (PBIDC) | Quarterly, Year 1–3 | Sustained implementation and accountability |

Table 4 presents the proposed action plan for improving the sustainability and long-term development of bamboo-based enterprises in San Antonio, Bombon, Camarines Sur. The action plan outlined strategic policy, capacity-building, financial, market, and environmental interventions designed to address the key challenges identified in the preceding objectives. Through coordinated efforts among the Local Government Unit and partner agencies, the proposed strategies aimed to strengthen institutional support, enhance productivity, expand market opportunities, and ensure sustainable bamboo resource management.

The proposed recommendations and action plan served as concrete research outputs directly addressing the challenges identified in the study. Through the enactment of the municipal ordinance, bamboo-based enterprises were expected to be strengthened, ensuring their long-term sustainability and contribution to local economic development.

## Proposed Municipal Ordinance Highlights

The proposed ordinance was designed to strengthen the bamboo industry in San Antonio, Bombon, Camarines Sur and enhance the sustainability of bamboo-based enterprises. Key provisions of the ordinance included:

1. Recognition of bamboo as a priority industry in the municipality.
2. Allocation of annual budget for bamboo enterprise development.
3. Provision of incentives to registered bamboo entrepreneurs.
4. Institutionalization of training, financing, and marketing assistance programs.
5. Promotion of sustainable bamboo harvesting and replanting practices.

## Recommendation for Future Study

Future studies were recommended to focus on the lowest-ranked indicators identified in this research, particularly production consistency, effectiveness of training programs, compliance with environmental policies, limited use of online innovation platforms, and capital accessibility. Expanding the sample size and geographic coverage to include multiple municipalities or provinces would allow researchers to compare how these weaker areas varied across locations and determine context-specific factors affecting sustainability.

Further research could specifically examine the effectiveness and impact of LGU- and NGO-led training programs, as these consistently emerged as low-performing indicators across social, environmental, and technological dimensions. Evaluating training frequency, relevance, accessibility, and outcomes through mixed-method approaches can help determine why such programs remain weak and how they can be improved to better support bamboo entrepreneurs.

Future studies should also investigate technology adoption gaps, particularly the low engagement in seeking innovative ideas through online platforms. Research focusing on digital literacy, internet access, and barriers to self-directed online learning can provide insights into why bamboo enterprises underutilize digital resources and how e-commerce and online innovation tools can be better integrated into the industry.

Given that capital limitations and production-related constraints are ranked as major challenges, future researchers may conduct in-depth financial and operational analyses, including cost–benefit studies, production cycle efficiency, and access to credit mechanisms. Longitudinal studies are encouraged to assess how improvements in capital access and production systems influence business stability over time.

Lastly, future research may further explore the role of the Triple Helix Model (Government–Industry–Academe) in addressing these lowest-ranked areas by assessing how collaborative interventions such as financing programs, technical training, policy enforcement, and innovation support can effectively strengthen the weakest aspects of bamboo business sustainability in San Antonio, Bombon, Camarines Sur.

## Summary of Findings

This study assessed the sustainability of bamboo-based enterprises in San Antonio, Bombon, Camarines Sur by examining the socio-economic characteristics of bamboo entrepreneurs, evaluating sustainability across economic, social, environmental, and innovation dimensions, identifying key operational challenges, and determining appropriate strategies to enhance long-term industry development. Findings are discussed in alignment with the stated research objectives.

In relation to the first objective, which sought to determine the socio-economic profile of bamboo entrepreneurs in San Antonio, Bombon, this study found that most bamboo enterprises operated

on a small-scale basis and were predominantly managed as sole proprietorship businesses. The years of operation varied widely, indicating both long-standing enterprises and relatively new entrants in the industry. Capitalization levels remained generally low, limiting the capacity of business owners to invest in advanced machinery, product diversification, and market expansion. Employment generation was modest, with enterprises typically hiring a small number of workers, often from within the local community. Production volume was likewise limited and largely dependent on the availability of raw bamboo materials. Despite these constraints, bamboo enterprises played a crucial role in supporting household income and providing livelihood opportunities, particularly for artisans and skilled workers in the municipality.

Regarding the second objective, which focused on assessing the level of sustainability of bamboo enterprises using selected economic, social, environmental, and innovation indicators, the findings revealed a moderate overall level of sustainability. Economically, bamboo enterprises contributed positively to local income generation and employment; however, their financial stability was challenged by limited access to credit, fluctuating demand, and dependence on local markets. Social sustainability remained relatively strong, as the bamboo industry fostered community participation, preserved traditional craftsmanship, and encouraged the transfer of skills across generations. The enterprises served as a platform for social cohesion and shared economic activity within the community. Environmental sustainability was inherently supported by the renewable nature of bamboo; however, the absence of formalized replanting programs, structured plantation management, and standardized waste disposal practices posed risks to long-term ecological balance. In terms of innovation, the study found that most enterprises relied on traditional production methods, with minimal integration of modern processing technologies, research-based treatment methods, and digital marketing strategies, thereby limiting competitiveness and market reach.

In addressing the third objective, which aimed to identify the challenges encountered by bamboo entrepreneurs in terms of sales and supply, the study revealed several interrelated constraints. A major challenge was the inconsistent supply of raw bamboo, largely due to the absence of organized plantations and sustainable harvesting systems within the locality. Entrepreneurs also experienced difficulties in marketing their products beyond local markets, resulting in unstable sales and limited income growth. High transportation costs, lack of standardized product quality, insufficient product innovation, and weak market linkages further hindered business expansion. Additionally, limited institutional support and inadequate access to training and technical assistance contributed to the persistence of these challenges.

Relative to the fourth objective, which sought to propose strategies for improving the sustainability and long-term development of bamboo-based enterprises, the findings indicate a strong need for an integrated implementation and evaluation framework. The study emphasizes the importance of continuous monitoring, assessment, and feedback mechanisms following the enactment of supportive local ordinances. A one-year monitoring period was identified as essential to track progress, evaluate performance outcomes, identify emerging challenges, and ensure alignment with sustainability goals. Strengthening resource management, capacity building, financial support, innovation, and multi-sectoral collaboration emerged as key strategic

directions for fostering a resilient and sustainable bamboo industry in San Antonio, Bombon, Camarines Sur.

## CONCLUSIONS

The findings of this study affirmed that the bamboo business in San Antonio, Bombon, Camarines Sur possesses strong potential as a sustainable local industry when examined through the lens of the Triple Bottom Line framework proposed by Elkington (2022), which emphasizes the balanced integration of economic viability, social equity, and environmental responsibility. Bamboo enterprises in the municipality serve as vital livelihood sources for many families, particularly in rural communities where employment opportunities are limited. Despite operating on a generally small scale, these enterprises contribute significantly to household income, employment generation, and the preservation of traditional craftsmanship. The persistence of bamboo entrepreneurs, even amid limited capitalization and production capacity, reflects the sector's importance to the local economy and its role in sustaining community-based livelihoods.

The study further revealed that the socio-economic characteristics of bamboo entrepreneurs shape both the strengths and limitations of the industry. Most enterprises are family-managed, labor-intensive, and reliant on traditional production methods. While these characteristics strengthen community involvement and cultural continuity, they also constrain business expansion and competitiveness. Limited access to capital, technology, and formal business support restricts the ability of entrepreneurs to scale up operations, diversify products, and penetrate wider markets. Nevertheless, the bamboo industry remains a resilient economic activity, demonstrating its capacity to support local employment and sustain micro-enterprises despite persistent structural and financial constraints.

In terms of sustainability, the bamboo industry in San Antonio, Bombon demonstrates an uneven but promising performance across economic, social, environmental, and innovation dimensions. Economically, bamboo enterprises provide a stable source of income; however, growth is constrained by unstable market demand, restricted access to financing, and dependence on localized markets. Social sustainability is particularly strong, as bamboo production fosters cooperation, knowledge sharing, and the transmission of skills across generations. These dynamics align with Social Capital Theory (Putnam, 1993; Bourdieu, 1986), which emphasizes the role of trust, shared norms, and collective action in sustaining community-based economic activities. Bamboo enterprises function not only as income-generating units but also as mechanisms of community cohesion and empowerment, strengthening local resilience and social continuity.

From an environmental perspective, the bamboo industry holds inherent advantages due to bamboo's renewable and fast-growing nature. The study confirms that bamboo production supports environmentally responsible livelihoods; however, the absence of structured replanting programs, sustainable harvesting guidelines, and systematic waste management practices poses long-term ecological risks. Without proper regulation and resource management, the environmental benefits of bamboo may not be fully realized. Innovation remains a critical gap

within the industry, as reliance on traditional tools and methods, combined with limited exposure to research-based processing techniques and digital marketing platforms, restricts product quality, market competitiveness, and value addition. This imbalance suggests that while the industry is socially grounded and environmentally favorable, stronger innovation mechanisms are required to achieve holistic sustainability.

The challenges faced by bamboo entrepreneurs further underscore the need for systemic support. Irregular supply of raw bamboo materials, driven by the lack of organized plantations and regulated harvesting practices, disrupts production continuity and increases operational costs. On the market side, entrepreneurs encounter fluctuating sales, limited customer reach, and weak promotional strategies, which hinder revenue growth and business stability. Additional constraints, including high transportation expenses, lack of standardized quality control, minimal product diversification, and limited access to training and institutional assistance, compound these challenges. These interconnected issues highlight that sustainability barriers are structural in nature and require coordinated, long-term solutions.

The study also highlights the importance of collaborative governance and institutional support in strengthening the bamboo industry. Drawing from the Triple Helix Model of Innovation (Cai & Amaral, 2021), the findings reveal insufficient interaction among government agencies, industry practitioners, and academic institutions. This lack of coordination limits opportunities for innovation, technology transfer, research application, and policy alignment. Strengthening these linkages is essential to transforming the bamboo industry from a traditional livelihood activity into a competitive and innovation-driven sector. The relevance of Ecological Modernization Theory (Huber; Mol; Leite, 2022) is likewise evident, as the study demonstrates that economic development and environmental protection in bamboo production are complementary rather than contradictory. Sustainable bamboo development can be achieved through responsible harvesting, replanting initiatives, waste utilization, and supportive policy frameworks that integrate ecological considerations into economic planning.

Overall, the study concludes that while the bamboo industry in San Antonio, Bombon, Camarines Sur already contributes meaningfully to local economic development, social cohesion, and environmental sustainability, its long-term viability depends on deliberate and coordinated interventions. Institutionalized policy support, continuous capacity building, improved access to financial and market resources, innovation adoption, and strengthened multi-sectoral partnerships are essential to sustaining and expanding the industry. By addressing existing limitations and leveraging the inherent strengths of bamboo as a renewable resource, the industry can evolve into a resilient, inclusive, and sustainable driver of local development that benefits both present and future generations.

## RECOMMENDATIONS

In view of the socio-economic realities of bamboo entrepreneurs in San Antonio, Bombon, Camarines Sur, this study strongly recommends the formulation and enactment of a comprehensive local ordinance that formally recognizes bamboo enterprises as a priority

livelihood sector in the municipality. Given that most bamboo businesses are small-scale, family-managed, and limited in capitalization, structured government support is essential to address financial, technical, and institutional constraints. The Local Government Unit (LGU) should take the lead in providing enabling policies, streamlined business permit processes, and coordinated livelihood assistance programs that reduce barriers to formalization and business growth. Through the institutionalization of a Municipal Bamboo Development Program, the LGU can ensure long-term planning, budget allocation, and implementation mechanisms that directly respond to the realities faced by bamboo entrepreneurs, enhancing income stability, employment generation, and overall economic resilience.

The following recommendations are proposed as key provisions of the Municipal Bamboo Development Ordinance, serving as the primary policy instrument for improving the sustainability and long-term development of bamboo-based enterprises in San Antonio, Bombon, Camarines Sur.

### Mandatory Business Registration and DTI Linkage

All bamboo enterprises should be formally registered and linked with the Department of Trade and Industry (DTI) to enable access to business development services, financing programs, market matching, product standardization, and entrepreneurial training. The LGU should actively assist informal bamboo businesses in completing registration requirements and transitioning into the formal sector.

### Improved Access to Capital and Financial Support

The LGU, in partnership with microfinance institutions, cooperatives, and government financing agencies, should develop accessible and low-interest financing schemes specifically tailored for bamboo micro-enterprises. Alternative investment arrangements, including material-based support such as tools, equipment, and raw materials, should also be encouraged to reduce upfront capital constraints.

### Strengthening Training and Capacity-Building Programs

Since training was ranked among the weakest sustainability areas, LGUs, DTI, TESDA, and NGOs should implement regular, needs-based training programs focusing on product innovation, business management, digital marketing, quality control, occupational safety, and environmental protection. Environmental hazard awareness and workplace safety measures should be fully integrated into all training modules.

From a social sustainability perspective, capacity-building initiatives must be prioritized to strengthen human capital, preserve traditional craftsmanship, and integrate modern business practices. The Technical Education and Skills Development Authority (TESDA), together with academic institutions and industry experts, should conduct structured and regular training programs on bamboo processing, quality standards, entrepreneurship, and digital marketing.

These programs should empower local artisans, encourage youth participation, and promote intergenerational knowledge transfer. Strengthening social networks and collaborative learning among bamboo operators will further enhance community cohesion and resilience.

### Cultural Promotion and Product Development through the National Commission for Culture and the Arts (NCCA)

Strong collaboration with the National Commission for Culture and the Arts (NCCA) is recommended to support the preservation, promotion, and commercialization of bamboo-based cultural products. Programs that recognize bamboo crafts as cultural heritage products can enhance market value while safeguarding traditional knowledge and artistic identity.

### Sustainable Resource Management and Environmental Protection

The Department of Environment and Natural Resources (DENR), in coordination with LGUs, should institutionalize community-based bamboo replanting, restoration, and sustainable harvesting programs. Clear environmental guidelines, monitoring mechanisms, and incentive systems for compliance should be strengthened to mitigate climate-related risks and ensure long-term availability of raw materials.

### Market Expansion and Supply Chain Development

Bamboo enterprises should be supported in expanding market access through digital platforms, e-commerce, trade fairs, and tourism-related markets. Cooperative-based supply chain systems, shared logistics services, and centralized storage facilities can help stabilize production costs, improve delivery efficiency, and reduce price volatility.

### Technology Adoption and Innovation Support

Government agencies, academic institutions, and private partners should collaborate to improve access to modern bamboo-processing equipment, shared production facilities, and innovation hubs. Continuous exposure to new product designs, online learning resources, and technology-driven production methods will enhance competitiveness, productivity, and value addition.

Overall, bamboo enterprises in San Antonio, Bombon, Camarines Sur possess strong cultural roots, environmental value, and community significance. With coordinated policy interventions, strengthened institutional linkages, innovation support, and sustainable resource management, the bamboo industry can evolve from subsistence-level enterprises into a competitive, resilient, and culturally grounded driver of local sustainable development.

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