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ORIGINAL

Interpretive analysis of bamboo for the design and production of residential furniture in the Libertador Bolívar Commune: Ancestral techniques and a local development perspective

Análisis interpretativo del bambú para el diseño y elaboración de mobiliarios para uso residencial en la Comuna Libertador Bolívar: Técnicas ancestrales y perspectiva de desarrollo local

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ABSTRACT

Introduction: this study aims to evaluate the potential of bamboo as a sustainable material for residential furniture design in the Libertador Bolívar Commune, Ecuador, integrating technical properties, sociocultural perceptions, and socioeconomic feasibility within the local context.
Method: a non-experimental, descriptive-interpretative design using mixed methods was applied. Data were collected over four months from 127 participants comprising 89 furniture users, 23 artisans, and 15 community leaders. Instruments included structured surveys, semi-structured interviews, focus groups, and structured observation.
Results: technical analysis showed that 78,3 % of artisans rated bamboo's mechanical strength as adequate for basic furniture, with an estimated durability of 8–15 years when properly treated. Sociocultural findings indicated a higher aesthetic acceptance among younger participants (mean=4,12) compared to older ones (mean=3,22, $p<0,001$), though traditional perceptions still influence overall acceptance. Economically, 73,6 % of households allocated $50–200 annually for furniture, and 78,3 % of artisans expressed interest in bamboo-related training. Housing conditions favored multifunctional and adaptable furniture designs compatible with bamboo's properties.
Conclusions: bamboo presents promising technical qualities for residential furniture but faces sociocultural barriers and economic constraints. Its successful adoption requires integrated strategies involving technical training, cultural repositioning, and participatory community models to overcome local limitations and promote sustainable furniture production.

Keywords: Bamboo Furniture; Sustainable Design; Rural Development; Traditional Techniques; Community-Based Production.

RESUMEN

Introducción: este estudio tuvo como objetivo evaluar el potencial del bambú como material sostenible para el diseño de mobiliario residencial en la Comuna Libertador Bolívar, Ecuador, integrando propiedades técnicas, percepciones socioculturales y factibilidad socioeconómica en el contexto local.
Método: se aplicó un diseño no experimental, descriptivo-interpretativo con enfoque mixto. Durante cuatro meses, se recolectaron datos de 127 participantes: 89 usuarios de mobiliario, 23 artesanos y 15

líderes comunitarios, mediante encuestas estructuradas, entrevistas semiestructuradas, grupos focales y observación estructurada.
Resultados: el análisis técnico mostró que el 78,3 % de los artesanos calificaron la resistencia mecánica del bambú como adecuada para muebles básicos, con una durabilidad estimada de 8 a 15 años cuando se encuentra tratado adecuadamente. En el aspecto sociocultural, se observó una mayor aceptación estética en participantes jóvenes (media=4,12) frente a adultos mayores (media=3,22, p<0,001), aunque las percepciones tradicionales siguen influyendo. Económicamente, el 73,6 % de los hogares destina entre $50 y $200 anuales para mobiliario, y el 78,3 % de los artesanos mostró interés en capacitaciones sobre bambú. Las condiciones habitacionales favorecen diseños modulares y adaptables compatibles con las características del bambú.
Conclusiones: el bambú presenta cualidades técnicas prometedoras para el mobiliario residencial, pero enfrenta barreras socioculturales y limitaciones económicas. Su adopción exitosa requiere estrategias integradas que incluyan capacitación técnica, revalorización cultural y modelos participativos comunitarios para superar las limitaciones locales y promover una producción sostenible.

Palabras clave: Mobiliario de Bambú; Diseño Sustentable; Desarrollo Rural; Técnicas Tradicionales; Producción Comunitaria.

INTRODUCTION

The design and development of sustainable furniture has become an urgent necessity in the face of the global environmental crisis and the search for ecological alternatives within the furniture industry. According to the *Global Environmental Outlook* report by the United Nations Environment Programme (UNEP), the production and consumption of industrial products—including furniture—account for approximately 30 % of urban solid waste and a significant proportion of greenhouse gas emissions. In Latin America, the transition toward sustainable production models remains a challenge, particularly in rural contexts where natural resources such as bamboo are available but underutilized.

Bamboo, due to its mechanical properties, rapid growth, and low environmental impact, presents itself as a viable and sustainable alternative for furniture production. Unlike conventional woods, bamboo can reach maturity in less than five years, making it an efficient renewable source. However, its effective implementation in residential furniture design requires a deep interpretive analysis that considers both the technical characteristics of the material and the sociocultural and economic specificities of the surrounding context, such as the Libertador Bolívar Commune, located on the Ecuadorian coast.

The relevance of this research lies in the growing demand for sustainable housing solutions and the need to develop furniture proposals that are responsive to local realities. Studies on bamboo furniture from the perspective of Design for Sustainability (D4S) have shown that this approach allows for the integration of environmental, social, and economic principles into product development, establishing methodologies that maximize the sustainable potential of the material.[1] This systemic approach is key to understanding the multidimensional implications of using bamboo in specific residential contexts.

Recent scientific literature has addressed multiple dimensions of bamboo use as a furniture material. Fundamental design elements that characterize contemporary bamboo furniture have been identified, establishing a theoretical framework regarding functionality, aesthetics, and technical feasibility.[2] Likewise, the integration of traditional techniques with modern approaches has been explored, demonstrating the technical and aesthetic viability of incorporating historical bamboo weaving methods into contemporary products,[3] which becomes particularly relevant when considering cultural and generational perceptions in design.[4]

Additionally, bamboo weaving technology in specific regions such as Sichuan, China, has been documented using ethnographic approaches that systematize traditional methods and tools.[5] This methodological framework is especially relevant for contexts like the Libertador Bolívar Commune, where ancestral knowledge related to working with natural materials may exist.

From a comprehensive technical perspective, knowledge about the properties, treatments, and regulatory standards of bamboo as a construction material has been consolidated,[6] complemented by studies demonstrating the feasibility of laminated bamboo as a high-performance structural material.[10] Conceptual frameworks have also been proposed to articulate traditional technical knowledge with contemporary design methodologies,[7] enabling effective knowledge management among actors involved in furniture design projects.

Technological innovation in bamboo processing has included the development of automated CNC technologies[8] and parametric design based on traditional weaving techniques[18] which enables the translation of artisanal structures into digital design parameters. From a business perspective, innovation management models in furniture manufacturing companies have been analyzed, identifying effective strategies to enhance industry competitiveness.[9]

In terms of cultural preservation, methodologies have been developed to integrate traditional techniques into contemporary contexts,[11] as well as the use of design to strengthen the sustainability of intangible cultural heritage, particularly in bamboo basketry,[12] also documenting intergenerational knowledge transmission processes.[13]

Moreover, bamboo has proven to be a viable solution in diverse contexts, including outdoor furniture designed for adverse environmental conditions,[14] and as a furniture solution in disaster zones and remote regions of Indonesia.[15] At a more advanced level, the physical and mechanical properties of laminated hybrid bamboo composites have been characterized,[16] highlighting their potential as reinforcement materials in sustainable structural applications.[17] Integration with interactive technological elements in furniture design has also been explored.[19]

In line with these questions, the general objective of this research is to determine the potential of bamboo as a sustainable material for the design of residential furniture in the Libertador Bolívar Commune, integrating technical, cultural, and economic criteria from the local context. This objective reflects an integrative approach that aims to propose viable, context-sensitive, and relevant design solutions, contributing to the development of sustainable furniture from a holistic perspective.

METHOD

This study adopts a non-experimental, descriptive-interpretative research design with a mixed-methods approach that integrates qualitative and quantitative techniques. The interpretative paradigm guides the investigative process, allowing for the exploration of subjective meanings, technical perceptions, and community experiences regarding the use of bamboo as a material for residential furniture in the Libertador Bolívar Commune. The research aims to generate contextualized knowledge that can be replicated in rural or semi-rural communities with similar characteristics.

The research was conducted over a period of four months, from June to September 2024, in the Libertador Bolívar Commune, located in the Santa Elena Province of Ecuador. The project focused on a segment of the community with an estimated population of 2 847 households. The study universe consisted of adult residents of the commune, while the study population included residential furniture users, local artisans, and community leaders. The sample was determined through a mixed sampling strategy: stratified probabilistic sampling was applied to furniture users, and purposive sampling was used for artisans and leaders based on their experience and recognition within the community.

Key methodological definitions used in this study were as follows. Perception was understood as the subjective interpretation and evaluation of bamboo in its use as furniture material. Technical viability was defined as the extent to which bamboo meets the functional and structural requirements necessary for furniture design. Sociocultural acceptance refers to the community's willingness to adopt bamboo-based alternatives in their daily lives. Finally, socioeconomic feasibility was conceptualized as the accessibility, affordability, and productive potential of the material within the local economic conditions.

The methodological design process was organized into four phases. The first phase, contextualization, involved a literature review and field exploration that allowed for the adjustment of methodological tools. The second phase, instrument design, included the development and validation of a structured survey, semi-structured interviews, focus group guides, and observation protocols. The third phase consisted of fieldwork with coordinated application of instruments across the five geographical zones of the commune, supported by community organizations. Lastly, the fourth phase focused on systematization and data analysis, including data entry, processing, triangulation, and interpretation.

Data collection was carried out with a total of 127 participants, distributed across three groups: 89 residential furniture users (70,1 %), 23 artisans and natural materials workers (18,1 %), and 15 community leaders or local representatives (11,8 %). The structured survey was applied to the 89 furniture users and consisted of 47 items organized into perception scales, preference classifications, and open-ended questions. Its objective was to assess knowledge, attitudes, and usage practices related to bamboo. Content validity was verified through expert judgment, and internal consistency was established via a pilot test. Semi-structured interviews were conducted with 23 artisans to explore their technical knowledge, production experiences, and perceptions regarding bamboo's viability. These interviews were audio-recorded with prior informed consent. Focus groups were held with the 15 community leaders, covering topics related to socioeconomic dynamics, environmental sustainability, and feasibility of implementing productive alternatives. Each session lasted approximately 60 minutes and was guided by a thematic script. Additionally, structured observations were conducted in 37 selected homes using a 31-item protocol that documented furniture conditions, usage patterns, and adaptations to the physical environment.

The collected data were digitally stored and coded using NVivo and SPSS software. Qualitative data were transcribed and analyzed through thematic analysis, identifying emerging categories and patterns. Quantitative data were processed using descriptive statistics and contingency tables. Methodological triangulation was

applied to ensure reliability by comparing information from different sources and instruments. Inter-rater reliability for the observation protocol reached a Cohen's kappa coefficient of 0,78.

The study's main variables were organized into three dimensions. The technical dimension included indicators such as perceived mechanical strength, estimated durability, ease of processing, and bamboo's adaptability to functional designs. The sociocultural dimension encompassed aspects such as cultural associations, aesthetic acceptance, environmental awareness, and willingness to substitute conventional materials. The socioeconomic dimension evaluated factors such as purchasing capacity, feasibility of local production, availability of tools and raw materials, and willingness to invest in sustainable furniture.

Ethical aspects were addressed according to protocols established by the corresponding institutional ethics committee. All participants were properly informed about the study's objectives, scope, and procedures, as well as its voluntary nature. Informed consent forms were signed prior to data collection. Anonymity and confidentiality of participants were guaranteed throughout all phases of the study, and the information was stored in encrypted files accessible exclusively to the research team.

RESULTS

Technical Characterization of Bamboo as Furniture Material

The analysis of the technical dimension of bamboo revealed differing perceptions among the participant groups. Among the surveyed artisans (n=23), 78,3 % considered that bamboo has adequate mechanical strength for basic residential furniture, while 21,7 % expressed doubts about its durability in complex structural applications. The estimated durability assessment showed that 65,2 % of artisans rated the lifespan of properly processed bamboo between 8 and 15 years, compared to 5 to 8 years for untreated bamboo, according to 82,6 % of respondents.

Regarding ease of processing, 91,3 % of participating artisans considered that bamboo requires only basic tools readily available locally and is significantly easier to work with than traditional hardwoods. Local availability of the material showed important variations: 43,5 % identified bamboo sources within a 15-kilometer radius of the commune, while 34,8 % reported the need to obtain it from areas 15 to 50 kilometers away.

Adaptability to functional designs was positively evaluated by 87,0 % of artisans, who highlighted the material's flexibility to create curved forms and lightweight structures. However, 69,6 % pointed out limitations for applications requiring complex structural joints without the use of complementary metal components.

Table 1. Technical Evaluation of Bamboo by Artisans (n=23)

Technical Feature	Positive	Neutral	Negative	Total
Adequate mechanical strength	18 (78,3 %)	-	5 (21,7 %)	23 (100 %)
Durability 8–15 years (processed)	15 (65,2 %)	5 (21,7 %)	3 (13,1 %)	23 (100 %)
Ease of processing	21 (91,3 %)	2 (8,7 %)	-	23 (100 %)
Local availability (<15 km)	10 (43,5 %)	8 (34,8 %)	5 (21,7 %)	23 (100 %)
Adaptability to functional designs	20 (87,0 %)	2 (8,7 %)	1 (4,3 %)	23 (100 %)
Complex structural limitations	16 (69,6 %)	4 (17,4 %)	3 (13,0 %)	23 (100 %)

Sociocultural Perceptions of Bamboo

The analysis of the sociocultural dimension revealed different acceptance patterns based on participant demographics. Aesthetic acceptance of bamboo as a furniture material showed a mean of 3,64 (SD = 0,89) on a 1–5 Likert scale, with significant differences across age groups. Participants under 35 years (n=34) had higher aesthetic acceptance (M = 4,12, SD = 0,76) compared to participants over 50 years (n=41), who showed lower aesthetic appreciation (M = 3,22, SD = 0,94), a statistically significant difference ($t = 4,73$, $p < 0,001$).

Cultural associations with bamboo revealed that 62,4 % of participants associate the material with traditional rural constructions, while 28,1 % link it to decorative artisanal products. Only 9,5 % previously associated bamboo with modern residential furniture. Regarding the influence of local traditions, 71,7 % of surveyed residents did not identify specific community traditions related to bamboo work, although 45,2 % expressed interest in developing these skills.

Willingness to switch from conventional materials showed a heterogeneous distribution: 41,6 % were willing to replace conventional furniture with bamboo alternatives, 35,4 % expressed conditional willingness depending on price and quality, and 23,0 % showed resistance to replacing traditional materials. Environmental values received a high mean score of 4,23 (SD = 0,67), indicating strong appreciation for bamboo's ecological benefits, with 89,9 % considering the use of sustainable materials at home to be important.

Table 2. Sociocultural Perceptions of Bamboo by Age Group (n=127)

Variable	<35 years (n=34)	35-50 years (n=52)	>50 years (n=41)	Total
Aesthetic acceptance	4,12 ± 0,76	3,68 ± 0,82	3,22 ± 0,94	3,64 ± 0,89
Cultural associations				
- Rural constructions	18 (52,9 %)	33 (63,5 %)	28 (68,3 %)	79 (62,2 %)
- Artisanal products	12 (35,3 %)	14 (26,9 %)	10 (24,4 %)	36 (28,3 %)
- Modern furniture	4 (11,8 %)	5 (9,6 %)	3 (7,3 %)	12 (9,4 %)
Willingness to change				
- Willing	18 (52,9 %)	22 (42,3 %)	13 (31,7 %)	53 (41,7 %)
- Conditional	11 (32,4 %)	19 (36,5 %)	15 (36,6 %)	45 (35,4 %)
- Resistant	5 (14,7 %)	11 (21,2 %)	13 (31,7 %)	29 (22,9 %)
Environmental valuation	4,41 ± 0,51	4,19 ± 0,68	4,12 ± 0,78	4,23 ± 0,67

Socioeconomic Feasibility of Implementation

The analysis of the socioeconomic dimension revealed complex conditions for the implementation of bamboo as a furniture alternative. Purchasing capacity for furniture showed that 73,6 % of surveyed households allocate between $50 and $200 annually for furniture acquisition or repair, while 18,0 % spend between $201 and $400, and only 8,4 % exceed $400 annually.

Willingness to pay a premium for sustainable alternatives revealed that 54,8 % of participants would be willing to pay a 10–20 % markup for bamboo furniture compared to similar-quality conventional alternatives. However, 67,4 % conditioned this willingness on the availability of durability warranties and after-sales service. 31,5 % said they would only pay equal or lower prices than conventional alternatives.

Assessment of local production feasibility showed promising results. 78,3 % of participating artisans expressed interest in receiving training to work with bamboo, while 52,2 % considered it feasible to establish furniture workshops with moderate initial investment. The estimated income generation potential indicated that 65,2 % of artisans considered it viable to generate complementary income equivalent to 25–40 % of their current income through bamboo furniture production.

Access to raw materials presented significant challenges. Although 43,5 % identified local availability of bamboo, 78,3 % of artisans indicated the need for training in cutting, drying, and treatment techniques. Regarding tools, 82,6 % stated that the basic necessary tools are locally available, but 69,6 % identified the need for specialized equipment for professional-quality finishes.

Table 3. Socioeconomic Feasibility of Bamboo Implementation

Socioeconomic Indicator	Category	Residents (n=89)	Artisans (n=23)
Annual purchasing capacity			
- $50–200	66 (74,2 %)	16 (69,6 %)	-
- $201–400	16 (18,0 %)	5 (21,7 %)	-
- >$400	7 (7,8 %)	2 (8,7 %)	-
Willingness to pay 10–20 % premium			
- Willing	49 (55,1 %)	12 (52,2 %)	-
- With warranty	60 (67,4 %)	18 (78,3 %)	-
- Only equal/lower price	28 (31,5 %)	7 (30,4 %)	-
Productive viability			
- Interest in training	-	18 (78,3 %)	-
- Workshop feasibility	-	12 (52,2 %)	-
- Income potential (25–40 %)	-	15 (65,2 %)	-
Resource accessibility			
- Basic tools available	-	19 (82,6 %)	-
- Needs technical training	-	18 (78,3 %)	-
- Requires specialized equipment	-	16 (69,6 %)	-

Analysis of Current Housing Conditions

Structured observation of housing conditions (n=89 homes) revealed specific patterns in space usage and

existing furniture. 67,4 % of observed homes feature multifunctional spaces where furniture must adapt to various uses, favoring modular and lightweight designs such as those made with bamboo.

Existing furniture showed a predominance of conventional materials: 78,7 % processed wood, 34,8 % metal elements, and 23,6 % plastic materials, with multiple responses possible per household. Furniture condition showed that 45,2 % of items displayed moderate to severe deterioration, suggesting a medium-term need for replacement.

Local adaptations included structural modifications in 52,8 % of observed furniture, mainly to adjust to humidity, limited space, or specific uses not considered in the original design. These adaptations underscore the importance of flexible and modular designs enabled by bamboo.

Recorded environmental conditions showed relative humidity levels between 65 % and 85 % in 73,0 % of homes, average temperatures between 24°C and 28°C, and variable exposure to direct sunlight. These conditions require specific considerations for bamboo treatment and finishing in furniture applications.

Table 4. Housing Conditions and Existing Furniture (n=89 homes)

Observed Characteristic	Frequency	Percentage
Spatial configuration		
- Multifunctional spaces	60	67,4 %
- Specialized spaces	29	32,6 %
Predominant furniture materials		
- Processed wood	70	78,7 %
- Metal elements	31	34,8 %
- Plastic materials	21	23,6 %
Furniture condition		
- Good	34	38,2 %
- Fair	36	40,4 %
- Moderate/severe deterioration	40	44,9 %
Local adaptations		
- With structural modifications	47	52,8 %
- Without modifications	42	47,2 %
Environmental conditions		
- Relative humidity 65–85 %	65	73,0 %
- Temperature 24–28°C	72	80,9 %
- Direct sunlight exposure	54	60,7 %

Identification of Priority Furniture Needs

The analysis of priority furniture needs identified specific demands from the community. The most requested furniture items were: multifunctional tables (mentioned by 78,7 % of participants), modular storage systems (67,4 %), stackable or foldable chairs (61,8 %), and items for organizing small spaces (54,0 %).

The most valued functional characteristics included: ease of cleaning and maintenance (89,9 %), adaptability to small spaces (82,0 %), resistance to humidity (78,7 %), and the possibility of reconfiguration according to needs (65,2 %). These characteristics align with the potential properties of bamboo as a furniture material.

Focus groups with community leaders (n=3 groups, avg. 5 participants) identified opportunities for gradual implementation, suggesting beginning with simple furniture items such as benches, side tables, and basic storage systems, progressing toward more complex furniture as acceptance and experience grow.

Community willingness toward collaborative projects showed that 71,7 % of participants would be interested in joining community furniture-making workshops, while 45,2 % expressed willingness to participate in collective purchasing schemes to reduce the cost of raw materials and specialized tools.

Table 5. Priority Needs and Valued Furniture Features (n=127)

Category	Item/Feature	Frequency	Percentage
Priority furniture items			
- Multifunctional tables	100	78,7 %	
- Modular storage systems	86	67,7 %	
- Stackable/foldable chairs	78	61,4 %	

- Small space organization	69	54,3 %
- Beds/resting bases	45	35,4 %
Valued functional characteristics		
- Ease of cleaning/maintenance	114	89,8 %
- Adaptability to small spaces	104	81,9 %
- Humidity resistance	100	78,7 %
- Reconfigurability	83	65,4 %
- Lightweight/mobility	76	59,8 %
Willingness for collaborative projects		
- Community furniture	91	71,7 %
- Collective purchasing schemes	57	44,9 %
- Participation in co-design	68	53,5 %
- Group technical training	82	64,6 %

DISCUSSION

The results of this research partially confirm the initial hypothesis regarding the viability of bamboo as furniture material in the Libertador Bolívar Commune, revealing a complex landscape where significant technical opportunities converge with sociocultural and socioeconomic challenges specific to the local context. The positive technical perception of bamboo among participating artisans (78,3 % consider its mechanical resistance adequate) aligns with reported findings [6] about the favorable structural properties of bamboo as a sustainable construction material. This convergence between local perception and scientific evidence suggests that the technical characteristics of bamboo do not constitute the main barrier for its implementation in residential contexts.

The estimated durability evaluation of 8 to 15 years for properly processed bamboo coincides with the ranges reported in specialized technical literature, although it significantly contrasts with the perception of untreated bamboo durability (5 to 8 years according to 82,6 % of artisans). This difference underscores the critical importance of treatment processes, an aspect extensively documented [10] in analyses of engineered bamboo for structural applications. The gap between treated and untreated bamboo represents both an opportunity and a challenge, as it requires investment in technical training and access to treatment processes currently unavailable locally.

The sociocultural analysis revealed marked generational patterns in the aesthetic acceptance of bamboo, with participants under 35 years showing significantly higher appreciation (M=4,12) compared to those over 50 years (M=3,22, $p<0,001$). This generational differentiation is consistent with previous findings [4] documenting how younger consumers exhibit greater openness to traditional patterns reinterpreted in contemporary contexts. However, the predominant association of bamboo with “traditional rural constructions” (62,2 % of participants) suggests persistent perceptions that could limit its acceptance as modern furniture material, a phenomenon requiring specific cultural repositioning strategies.

The absence of specific local traditions related to bamboo work (71,7 % of participants did not identify community traditions) contrasts with documented contexts [5] where traditional techniques constitute a solid foundation for contemporary developments. This contextual difference implies that implementing bamboo in the Libertador Bolívar Commune requires more intensive capacity-building approaches, without relying on pre-existing traditional knowledge as occurs in other geographic contexts.

Willingness to change from conventional materials showed heterogeneous results, with 41,6 % of participants willing to replace, a figure in the mid-range compared to similar studies in developing contexts. The conditionality expressed by 35,4 % of participants regarding price and quality factors reflects a pragmatic economic rationality that must be considered in implementation strategies. This conditional willingness aligns with innovation adoption patterns in similar socioeconomic contexts, where economic viability is a more decisive factor than environmental considerations.

The high valuation of environmental aspects (M=4,23, SD=0,67) apparently contrasts with the limited willingness to change, suggesting a gap between declared values and actual adoption behaviors. This pattern is consistent with literature on pro-environmental behavior, where favorable attitudes do not necessarily translate into behavioral changes when economic or accessibility barriers exist.

Socioeconomic findings reveal significant limitations for mass implementation of bamboo as a furniture alternative. Limited purchasing power (73,6 % of households invest between $50-200 annually in furniture) imposes important restrictions on developing local markets, especially considering that 67,4 % of participants condition the price premium for sustainability on durability guarantees. This economic situation contrasts with

contexts where successful implementation of bamboo furniture has been documented, generally characterized by higher purchasing power or supportive public policies.

The interest expressed by 78,3 % of artisans in receiving training to work with bamboo represents a significant opportunity for developing local capacities. However, the identification of technical training needs (78,3 % require processing training) and specialized equipment (69,6 % need tools for professional finishing) highlights initial investment requirements that could constitute barriers for autonomous implementation of local production processes.

Limited local bamboo availability (43,5 % identify sources within 15 km) poses logistical challenges that could impact the economic viability of productive projects. This limitation contrasts with successful cases such as that documented by Liu and Zhang[14] in contexts with greater raw material availability, suggesting the need to evaluate supply strategies or consider alternatives such as local bamboo cultivation as an integral component of implementation projects.

Housing conditions analysis revealed patterns of space usage (67,4 % have multifunctional spaces) that favor bamboo's characteristics as a lightweight and adaptable material. The prevalence of structural adaptations in existing furniture (52,8 %) suggests demand for more flexible solutions, a feature bamboo can effectively offer according to findings by Liu et al.[2] on core design elements in bamboo furniture.

Recorded environmental conditions (relative humidity 65-85 % in 73 % of homes) require specific considerations for bamboo treatment, reinforcing the importance of adequate technical processes identified previously. These conditions are manageable according to technical literature but require specific protocols to be incorporated into training programs.

The identified priority needs (multifunctional tables 78,7 %, modular storage systems 67,4 %) align effectively with bamboo's capabilities as a material, suggesting market potential for specific products. The willingness for collaborative projects (71,7 % interested in community workshops) presents opportunities for participatory implementation models that could overcome some individual economic limitations.

This research presents methodological and contextual limitations that must be considered in interpreting the results. The cross-sectional design employed limits the ability to assess temporal changes in perceptions and conditions, especially relevant in innovation adoption processes requiring longer observation periods. The sample, although representative for the Libertador Bolívar Commune, presents generalization limitations to other rural or urban contexts with different socioeconomic characteristics.

The absence of direct technical evaluation of locally available bamboo constitutes a significant limitation, as results are based on artisan perceptions without validation through standardized mechanical property tests. This limitation is particularly relevant considering quality variability of bamboo depending on species, cutting age, and growth conditions.

The data collection period (four months) may not have captured seasonal variations in perceptions or material availability, limiting understanding of temporal factors that could influence implementation viability. Additionally, reliance on self-reports for socioeconomic information introduces possible social desirability biases, especially in questions about income and willingness to pay.

The findings suggest that successful implementation of bamboo as furniture material in the Libertador Bolívar Commune requires an integrated approach addressing technical, sociocultural, and socioeconomic aspects simultaneously. Future research should include direct technical evaluations of regionally available bamboo, using standardized tests to validate artisan perceptions and establish precise technical specifications for furniture applications.

Longitudinal studies documenting gradual bamboo adoption processes are required to evaluate how perceptions and behaviors evolve with exposure and direct experience with bamboo products. Such studies would help identify critical factors for the transition from declared interest to effective adoption.

Future research should explore participatory implementation models integrating technical training, development of local productive capacities, and community marketing strategies. These studies could include economic feasibility assessments of cooperative productive projects and local value chain analyses for bamboo furniture.

Finally, research on cultural repositioning strategies for bamboo is needed, employing communication and design approaches that transform traditional rural associations into perceptions of modernity and sustainability. This research line could include experimental studies on the effectiveness of different presentation and marketing strategies for bamboo products in similar contexts.

CONCLUSIONS

The research establishes that bamboo constitutes a strategic material resource for residential furniture design in specific contexts such as the Libertador Bolívar Commune, provided that a multidimensional approach addressing technical, sociocultural, and socioeconomic dimensions is integrated. This integration is essential to ensure the viability and sustainability of bamboo use, attending to the unique characteristics of the local

environment where solutions are implemented.

From a technical standpoint, building local capacities and strengthening training processes are fundamental to guarantee the quality, durability, and functionality of bamboo furniture. Developing skills and accessing appropriate technologies enable the transformation of the material's natural potential into value-added products that are relevant to the community.

In the sociocultural sphere, bamboo acceptance and appropriation depend on strategies aimed at cultural revaluation that recognize and integrate traditions, perceptions, and generational trends. Shifting images and associations toward a contemporary and sustainable conception facilitates its adoption as a valid and desirable alternative in residential design.

Finally, the socioeconomic dimension requires the design of collaborative and participatory models that optimize resources, enhance economic accessibility, and promote local productive inclusion. Coordinated community initiatives, technical training, and integrated marketing schemes enable the generation of sustainable economic benefits, contributing to regional development and the responsible use of renewable natural resources.

Together, these approaches establish a strategic framework that drives the successful implementation of bamboo in residential furniture, positively impacting community well-being, environmental preservation, and local economic development.

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