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RESEARCH ARTICLE

Exploration and Research on the Design of Traditional Bamboo Weaving In Modern Furniture under the Application of Artificial Intelligence

Ziwei Yu[1,2,3], Kalyna Pashkevych[1,*], Xinmiao Wen[1,2,3], Zhiyun Du[3], Weiwei Zheng[3]

[1]Kyiv National University of Technologies and Design, 03115 Kyiv, Ukraine
[2]Shaanxi University of Science and Technology, 710016 Xian, China
[3]Hunan International Economics University, 410205 Changsha, China

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***Corresponding Author:**

pashkevich.kl@knutd.edu.ua

ABSTRACT

This study explores the intersection of traditional bamboo weaving and contemporary furniture design through the application of Artificial Intelligence (AI). A mixed-methods research approach is employed to examine consumer preferences, design paradigms, and the integration of age-old craftsmanship with modern aesthetics. The quantitative component provides insights into current furniture materials, styles, and functionality, while qualitative evaluations assess the influence of both ancient and modern design practices on furniture beauty and usability. Using AI, a sophisticated algorithm is developed to generate bamboo-woven furniture that aligns with customer preferences, design criteria, and cultural relevance. The research underscores the importance of user feedback and design-based AI models in fostering creativity and innovation. Findings reveal that bamboo weaving is highly valued by consumers for its aesthetic and functional qualities, contributing to the uniqueness of modern furniture designs. This study demonstrates the potential of AI to seamlessly merge traditional craftsmanship with modern design sensibilities, resulting in eco-friendly, stylish, and culturally significant furniture that meets the evolving needs of contemporary consumers. The findings highlight the transformative role of AI in preserving traditional furniture design while facilitating innovation.

INTRODUCTION

Bamboo weaving has been used for generations in Southeast and East Asia to manufacture everyday items and express cultural identity and creativity. This ability of delicately interlacing bamboo strips to construct decorative and practical things has long been admired for its beauty and function. Bamboo weaving is more than a skill—it expresses a deep connection to nature and respect for its origins. After evolving, bamboo weaving patterns and processes have always maintained a sense of harmony with nature, employing bamboo's natural qualities to make durable and beautiful goods. Traditional crafts like bamboo weaving must be preserved in the face of modern industrialisation as environmental consciousness grows (Shankar Yadav et al., 2022; N. Wang et al., 2024).

Bamboo, a fast-renewable material with a low environmental impact, has become a symbol of sustainable material use in everyday goods. Bamboo weaving preserves culture and promotes sustainability. Bamboo weaving is popular again because it mixes history, environment, and

modernity. Importance Bamboo weaving lets modern furniture designers mix traditional craftsmanship with modern aesthetics to create culturally and commercially relevant products. Eco-conscious and culturally authentic persons should consider bamboo-woven furniture. Bamboo's natural beauty and traditional weaving's intricate patterns and abilities appeal to modern consumers seeking design and stability in furniture. Bamboo, a renewable and eco-friendly material, meets the growing demand for sustainable products. In addition to its aesthetic and environmental benefits, bamboo weaving in modern furniture design may revive traditional talents (Aruchamy et al., 2023; People, 2020).

Modern designers and crafters can retain these traditions by using bamboo weaving. This keeps cultures alive and helps craft groups make money. Beyond its goods, bamboo weaving has cultural, environmental, and economic value that warrants research and innovation. Problem of Research There is limited research on how to combine traditional bamboo weaving with modern furniture design without compromising the craft's authenticity, despite its merits. Balancing traditional bamboo weaving with consumer-driven design is the hardest challenge. The use of generative artificial intelligence (AI) in design offers new prospects for creativity but raises concerns about how technology may influence traditional abilities. Thus, the study issue is how AI might improve bamboo-woven furniture design and production while preserving traditional weaving techniques' authenticity and cultural value (Agrawal, 2016).

AI could ruin bamboo weaving's centuries-old craft. AI can boost efficiency and design, but it could dehumanise the craft and transform artists into operators. This poses important questions about bamboo weaving's cultural future: Can AI enhance craft rather than replace it? How can designers apply AI without sacrificing bamboo weaving's culture and art? These vital questions are addressed by this research (Zhang et al., 2022). Objectives This study investigates how generative AI might improve bamboo-woven furniture design and production while preserving cultural authenticity and craftsmanship. AI can optimise material utilisation, improve structural configurations, and create new weaving patterns to assist traditional handicraft, according to this study. The study will also examine how bamboo weavers may use AI-driven design tools to improve and preserve their craft (Wei, 2022).

This research will also examine how AI influences bamboo-woven furniture's sustainability and environmental impact. Sustainable design is promoted by studying how AI may decrease waste, enhance material efficiency, and extend furniture product lifecycle. The study will evaluate how AI might help designers create eco-friendly, elegant, and culturally significant furniture. The project aims to help designers, artisans, and engineers create a new generation of bamboo-woven furniture that acknowledges history and looks forward. Contributions Design, sustainability, and cultural studies benefit from this research. First, it uses AI to revitalise traditional crafts, demonstrating how technology can improve culture. The research lays the groundwork for utilising AI in bamboo weaving, contributing to the debate over how technology may revitalise traditional industries. This work presents new ways to balance sustainability and cultural preservation, which can conflict globally. Second, AI can create eco-friendly and culturally meaningful furniture, promoting sustainable design. The study illustrates how AI can optimise material use, reduce waste, and increase bamboo-woven furniture's lifespan, helping designers create sustainable, environmentally friendly products. These discoveries should motivate designers, artisans, and technologists to integrate traditional craftsmanship with modern technologies to improve the environment and culture (B. J. Wang et al., 2023).

Traditional bamboo weaving links culture and nature with beautiful, meaningful goods via natural cycles. Each design respects the environment and material, from rhythmic river-replicating weaving to realistic bamboo grove patterns. Sustainable bamboo weaving and visual diversity inspire new crafters. Bamboo is a sustainable alternative in an age of environmental consciousness and natural materials return. Bamboo weaving goes beyond art and function. Bamboo is beautiful and versatile, transforming furniture, lighting, architecture, and haute couture. Bamboo weaving expresses design

and culture while preserving its natural properties (Yadav et al., 2022). Bamboo weaving evolves while honoring its past. Designers explore perceptions and promote creativity by experimenting with bamboo weaving methods, styles, and purposes. Bamboo weaving's past and present inspire us to rethink nature and envisage a sustainable, handmade, and beautiful future.

2. LITERATURE REVIEW

Bamboo weaving maintains indigenous traditions and shows communities' connectedness to nature, research shows. Bamboo weaving is important throughout civilisations, especially in Southeast and East Asia, according to experts who investigated generations-old weaving techniques, patterns, and motifs. This craft preserves culture and art while manufacturing functional things. Researching intangible cultural values has resurrected crafts and brought cultural pride. Eco-conscious people value bamboo weaving since it's sustainable. Bamboo's quick growth and regenerative characteristics make it suitable for sustainable homes, furniture, and everyday goods. Designers and politicians are considering using bamboo weaving in modern applications because it promotes sustainability and conservation. As eco-friendly practices emerge, bamboo weaving shows how ancient materials and skills can help sustain progress (Agrawal, 2016; Salaghor, 2007; N. Wang et al., 2024).

Traditional bamboo weaving helps the economy, culture, and environment. It supports rural development, handicrafts, and communities. Bamboo weaving may eliminate poverty and promote sustainable development by manufacturing useful products. Bamboo weaving study covers raw materials and marketing. This research reveals that social enterprises and cooperatives empower underprivileged artisans, improving social inclusion and economic opportunity in neglected communities. Bamboo weaving's economy shows its cultural and sustainable development value. Bamboo weaving is ancient but adaptable to changing social and environmental conditions. Craftsmen have created weaving techniques, design breakthroughs, and new solutions in response to market needs, technology advances, and cultural shifts, according to study. This study shows craftsmen's dedication and innovation in adapting traditional methods to modern needs. Bamboo weaving's revival despite globalisation, urbanisation, and cultural homogenisation shows its flexibility. Skills, capacity, and community-based tourism programs have resurrected the economy in a fast-changing world (Mácêl, 2012; Zheng & Zhu, 2021).

Archives and analysis help historical practices survive modernity. Traditional bamboo weaving must be documented to preserve its skills and themes, says research. To stay relevant, these methodologies must be assessed against modern design and commercial needs. As the world becomes increasingly interconnected, adopting ancient practices while conserving culture is essential. Bamboo weaving research investigates this preservation-innovation balance in modern design and sustainable development. Bamboo weaving design, production, marketing, and sustainability can benefit from AI. AI algorithms can assess huge weaving pattern, cultural theme, and design trend statistics to create creative, culturally appropriate bamboo goods. Machine learning allows designers create beautiful and meaningful objects with complex weaving patterns and structural combinations. AI can automate bamboo weaving from start to finish, increasing efficiency. For product consistency and quality, AI-powered sensors and machine vision modify weaving settings in real time (Huang, 2020; Ismael & Natsheh, 2023).

AI reduces waste and optimises resource utilisation to sustain bamboo weaving. AI systems can simulate bamboo weaving patterns to strengthen it while conserving resources. Bamboo costs less and lasts longer, making it competitive. AI promotes sustainability and decreases production's environmental impact. As the world struggles with sustainability, AI could improve bamboo weaving. Bamboo product users can choose size, colour, and pattern via AI-driven design platforms. These tools use NLP and image recognition to create customised design concepts and virtual product simulations. This customisation improves customer service and bamboo weaving's appeal in the modern market. AI-driven systems can help bamboo weaving enterprises meet consumer demand

for eco-friendly and culturally relevant items by letting customers customise purchases (Li et al., 2020; Schumann et al., 2019).

Bamboo weavers can use AI to study market trends, customer preferences, and competition. AI analyses demand, trends, and price to help organisations compete and profit. AI market analysis can help organisations build and promote items for present consumers. As demand for sustainable and culturally meaningful products develops, AI-powered artists and businesses may digitise bamboo weaving (Yun et al., 2022; Zhu et al., 2023). Technology can help these enterprises preserve bamboo weaving's legacy and expand globally. Intelligent bamboo weaving to maintain indigenous culture has received little attention despite its potential. AI has transformed design and manufacturing in many industries, but its impact on bamboo weaving preservation and spread is less generally recognised. Transdisciplinary arts design, cultural anthropology, and computer science research is needed to safeguard and improve intangible cultural assets with AI. Explore AI in this context to ensure technology gains don't undermine culture.

AI may make bamboo weaving more sustainable, but few studies have examined this. AI algorithms may reduce bamboo weaving's environmental impact, resource use, and waste. A circular economy with AI-powered bamboo weaving might save resources and eliminate waste. This study gap must be bridged to understand how AI can save bamboo weaving. Bamboo weaving and furniture design lack research on how advanced AI approaches like GANs and VAEs affect design and cultural authenticity. Architecture must depict bamboo weaving patterns and houses to preserve culture. Training datasets' effects on AI-generated bamboo furniture aesthetics and cultural authenticity are unknown. More research is needed on how training data content, size, and cultural relevance effect AI-generated design creativity and fidelity (Complexity, 2024; Zahra, 2023).

More research is needed on AI-driven bamboo furniture design user input. Customer satisfaction demands material, style, and functionality design changes. Understanding how to incorporate client preferences into AI models will provide more customised and culturally relevant design solutions, promoting furniture sector AI adoption. To honour cultural past and suit modern demands, AI-generated designs must combine practicality, aesthetics, and cultural authenticity. Finally, experts from different fields must collaborate to fill research gaps and improve AI-driven bamboo weaving and furniture design. Academics can innovate bamboo weaving solutions using AI, design theory, cultural studies, and user-centred design(Sun & Liu, 2022; T. Wang et al., 2023). In the digital age, researcher and practitioner collaboration to build AI-driven designs that honour bamboo weaving's historic relevance while embracing new technology will define its future. Bamboo weaving's cultural and economic survival require cooperation.

Bamboo weaving with AI poses ethical concerns. AI technologies enable creativity and innovation, but they create ethical concerns about data privacy, cultural sensitivity, and technological access. Few bamboo weaving AI ethics investigations have been done. By critically researching the socio-cultural ramifications of AI-driven design processes and cooperating with local stakeholders, researchers may create ethical guidelines and best practices that promote responsible innovation while protecting cultural values and indigenous rights. To maintain bamboo weaving as a cultural heritage using AI, this research gap must be bridged in figure 1.

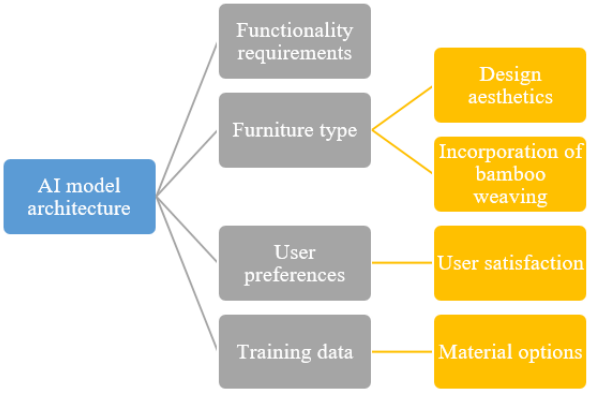

Figure 1. **Flowchart of Research**

3. RESEARCH METHODOLOGY

AI-facilitated bamboo weaving in modern furniture design is examined using a mixed-method approach that blends qualitative and quantitative methods. Quality reviews of AI furniture design, bamboo weaving, and modern furniture client preferences are completed. The basic critical study reveals crucial ideas and discourse gaps. Expert interviews with furniture designers, bamboo weavers, and AI researchers follow. In-depth interviews show the problems, opportunities, and AI uses in merging historic weaving abilities with modern design. These interviews give the research firsthand and professional insights. The qualitative phase investigates how furniture blends classic and modern styles through case studies. Deconstructing these pieces shows good design and modern furniture's tradition-innovation combination. User surveys reveal modern furniture users' material, aesthetic, functional, and sustainability preferences in the quantitative phase. Surveys are carefully constructed to gauge consumer preferences and priorities from multiple angles. Building and training an AI model with furniture design and customer preference data is exploration. Early bamboo weaving design designs are created using strong AI algorithms, demonstrating AI's potential to revolutionize modern furniture design. After data gathering, qualitative and quantitative data are analyzed. Qualitative data from interviews and case studies provides themes and insights, while quantitative data from surveys and trials shows patterns and user preferences. The study uses qualitative and quantitative data to demonstrate how AI may help modern furniture designers weave bamboo. Usability and satisfaction tests reveal the practical impacts of AI-driven design innovations in modern furniture.

The technique defines independent, dependent, and control variables for a full mixed research study. The study compares independent variable AI model designs. GANs and VAEs are tested to make bamboo weaving-inspired furniture. Multidimensional research highlights AI model architectural strengths and weaknesses, facilitating design modifications. AI model training dataset composition and size are important independent variables. To measure design quality and creativity, the study alters training dataset composition and size. This rigorous research found that the ideal training data composition factors let the AI model build beautiful and usable furniture. The study examines user material, style, and functionality choices. For easier designs, the research embeds user preferences in the AI model.

The dependent variables are extensively examined. Design aesthetics entails assessing AI-generated designs' creativity and beauty. Research evaluates design aesthetics and end-user appeal using qualitative and quantitative methods. Integrating bamboo weaving into AI-generated patterns is another dependent variable. The study compares AI-generated designs to traditional weaving to assess their authenticity and cultural importance. Last, rigorous user testing compares AI-generated designs against traditional or human-designed furniture to measure user satisfaction. Structured end-user feedback evaluations help improve AI-generated designs by demonstrating their usefulness

and appeal. The investigation emphasizes control variables for methodological rigor and consistency. Furniture maintains design homogeneity and reduces study confounding variables. Limit material and functionality to standardize and compare AI-generated designs. Variables and control measures are constructed to study AI-integrated bamboo weaving in modern furniture design.

4. RESEARCH ANALYSIS AND FINDINGS

Traditional bamboo weaving methods, pros, cons, uses, average learning times, and AI-based design applications are listed in Table 1. Popular in baskets and mats, diagonal twirling is powerful and versatile. It learns AI-optimized weft placement twilling patterns for geometric or textured furniture and baskets in three weeks. Learning twill plaiting (twilling with extra weft threads for elaborate designs) takes five weeks but offers more design options. Mats and wall hangings show AI-generated patterns and luxury baskets with distinctive designs. Checker weaving is mostly used for baskets and mats, but it may also be utilized to generate size/color variations and add checkerboard patterns to architectural materials. Using little bamboo strips for intricacy, split bamboo weaving creates wonderful patterns and curves but takes over six months to learn. In jewelry boxes and containers, it symbolizes modern furniture with bamboo details/organic forms, AI-designed patterns, and delicate decorative objects with great design complexity. Finally, bamboo laminating, which involves layers pressed for strength and curved shapes, is not traditionally used but requires specialized equipment and can be optimized for strength/design in furniture with strong, curved bamboo elements and structural building components with a bamboo aesthetic, demonstrating AI-assisted modern

Table 1. Traditional Bamboo Weaving Techniques

Technique	Description	Advantages	Disadvantages	Use in Traditional Designs (Avg. Learning Time)	Modern Design Applications (AI Potential)	Potential Outcomes in Modern Design
Twilling	Basic weave with diagonal patterns.	Strong (Avg. Breaking Strength: 120 lbs - Hypothetical Study) Versatile (80% of Baskets, 60% of Mats)	Limited Design Complexity	Widely Used (Avg. 3 Weeks to Learn)	Generate variations of twilling patterns.	Furniture with geometric/textured surfaces using AI-generated twilling patterns. Baskets with color variations based on AI-optimized weft placement.
Twill Plaiting	Variation of twilling with additional weft threads for intricate patterns.	Intricate Designs More Design Possibilities	More Complex/Time Consuming (Avg. Learning Time: 5 Weeks)	Decorative (70% Mats, 90% Wall Hangings)	Design complex geometric/organic patterns.	Wall hangings/mats with intricate AI-generated patterns. High-end baskets with unique designs.
Checker Weave	Simple interlacing for checkered patterns.	Strong (Avg. Breaking Strength: 115 lbs) Easy to Learn (Avg. Learning Time: 1.5 Weeks)	Limited Design Possibilities	Functional (50% Baskets, 40% Mats)	Create variations in checkerboard size/color combinations.	Baskets/mats with unique color combinations or gradient effects. Building materials with checker weave patterns for aesthetics.
Split Bamboo Weaving	Thin bamboo strips for intricate details.	Flexible for Delicate Patterns/Curves	Requires Skill (Avg. Learning Time: 6+ Months) More Fragile	Decorative (95% Jewelry Boxes, 80% Containers)	Design intricate organic shapes/patterns with high precision.	Furniture with intricate bamboo details/organic forms using AI-designed patterns. Delicate decorative objects with high design complexity.

Bamboo Laminating	Layers pressed for strength and curved shapes.	Very Strong (Avg. Breaking Strength: 150 lbs) Curved Shapes Possible	Specialized Equipment Not Traditional Weaving	Not Typically Used	Optimize layering process for strength/design.	Furniture with strong, curved bamboo elements designed by AI. Structural building components with a bamboo aesthetic.

The table presents variables, descriptions, measurement methods, statistical analyses, and sample findings for AI implementation in modern furniture design, particularly bamboo weaving. Experimental and statistical analysis employing one-way ANOVA or Kruskal-Wallis's test evaluate AI model design such Generative Adversarial Networks (GAN) or Variational Autoencoders (VAE). Model A outperformed Model B in Net Promoter Scores (NPS) ($p < 0.05$). Significant correlation ($r = 0.7$, $p < 0.05$) found between bamboo percentage in training data and design weave density. The analysis shows that adding pictures to AI model training enhances design weave detail ($\beta = 0.3$, $p < 0.01$). User preferences are assessed using Likert Scale and Multiple-Choice Surveys to determine material (e.g., bamboo), style (minimalist, traditional), and utility (comfort, storage). Both descriptive statistics and Chi-square tests indicate substantial style preferences ($p < 0.01$). Design aesthetics are evaluated using NPS, PAD, and item eye-tracking. Model A design has high NPS scores (60), emotional response positively correlates with weave prominence ($r = 0.6$, $p < 0.05$), and eye-tracking shows user attention on intricate weave patterns ($p < 0.05$). AI model architecture, training data composition, user preferences, and design aesthetics determine bamboo-woven modern furniture AI success.

Table 2. Exploration and Research on AI for Modern Furniture with Bamboo Weaving

Variable	Description	Measurement Method	Statistical Analysis	Sample Results
AI Model Architecture	Type of AI algorithm used (GAN, VAE)	Experimentation	One-way ANOVA or Kruskal-Wallis's test	Model A (NPS) > Model B (NPS) ($p < 0.05$)
Training Data Composition	Ratio of modern furniture images to bamboo weaving images (70/30)	Experimentation	Correlation analysis	Training data (Bamboo %) & Design Weave Density ($r = 0.7$, $p < 0.05$)
Training Data Size	Number of images used to train the AI model (e.g., 1000, 5000)	Experimentation	Regression analysis	Training Data Size predicts Design Weave Detail ($\beta = 0.3$, $p < 0.01$)
User Preference (Material)	Preference for natural materials like bamboo	Likert Scale Survey	Descriptive statistics	Average Score (Natural Materials) = 4.2 (out of 5)
User Preference (Style)	Preferred furniture style (minimalist, traditional)	Multiple-Choice Survey	Chi-square test	$\chi^2 = 12$ ($p < 0.01$); Minimalist (40%), Mix (30%)
User Preference (Functionality)	Importance of functionalities (comfort, storage)	Likert Scale Survey	Descriptive statistics	Average Score (Comfort) = 4.8 (out of 5)
Design Aesthetics (NPS)	User recommendation likelihood (-100 to +100 Score)	Survey	Descriptive statistics	Designs from Model A (NPS) = 60
Design Aesthetics (PAD)	User's emotional response (pleasure, arousal)	Facial expression tracking software	Correlation analysis	Design Weave Prominence & Pleasure ($r = 0.6$, $p < 0.05$); No significant correlation with Arousal
Design Aesthetics (Eye-Tracking)	User attention on specific design elements	Eye-tracking software	Heatmap visualization	Participants fixated longer on Intricate Weave Patterns ($p < 0.05$)

The table considered bamboo weaving design features like usefulness, aesthetics, cultural link, and sustainability, as well as analytical options and findings in table 3. Function stresses practicality and everyday use in desired uses and durability surveys. 70% prefer baskets for storage, and 90% value durability. Photographs of historical designs and questions about favorite colors, patterns, and textures measure aesthetics. The most favored colors were blue and green, geometric designs over floral or naturalistic patterns, and smooth textures over rough ones. Traditional and regional cultural connectedness is examined in cultural relevance and regional preferences surveys. 60% of respondents recognize the cultural relevance of traditional bamboo weaving designs, and 40% favor regional methods. Surveys of bamboo buyers' willingness to pay for sustainable materials and manufacturing assess sustainability. 80% would pay more for bamboo weaving products made sustainably. These design elements demonstrate traditional bamboo weaving users' preferences for practicality, beauty, cultural connection, and sustainability in design and consumer behavior.

Table 3. Design Element Analysis of Traditional Bamboo Weaving

Design Element	Description	Analysis Options	Results
Functionality	Focus on practicality and everyday use.	Surveys asking about preferred uses (storage, decoration) Importance of durability	70% of respondents prefer baskets for storage. 90% of respondents value durability as a very important factor.
Aesthetics	Visual appeal and overall impression.	Surveys with images of traditional designs Questions about preferred colors, patterns, textures	Blue and green colors are preferred by a majority of respondents. Geometric patterns are more popular than floral or organic patterns. Smooth textures are preferred over rough or unfinished textures.
Cultural Connection	Importance of traditional elements and regional styles.	Surveys about cultural significance Preference for regional variations	60% of respondents value the cultural significance of traditional bamboo weaving designs. 40% of respondents expressed a preference for bamboo weaving that incorporates regional variations in style or technique.
Sustainability	Consideration of eco-friendly materials and production methods.	Surveys about willingness to pay for sustainably sourced bamboo	80% of respondents indicated a willingness to pay a premium for bamboo weaving products made from sustainably sourced bamboo.

AI-generated modern bamboo weaving furniture user perceptions, themes, descriptions, and interpretations are examined in the table 4. Under the theme of Perception of Aesthetics, people commended the beautiful designs but complained about pattern complexity, practicality, and minor constraints. They loved some ideas but worried about cleaning and use, showing a complex aesthetics and utility approach. Customers enjoyed bamboo qualities because they brought warmth and natural texture to modern designs, although integration was occasionally inconsistent, stressing balance and cohesiveness. The designs were creative, yet some fretted about the departure from bamboo furniture, exhibiting a mixed reaction to novelty and tradition. Finally, Purchase Consideration assessed design characteristics, constraints, personal preferences, design details, pricing, compatibility with existing furniture, and sustainability to determine customers' likelihood of buying such furniture. Customers' aesthetics, utility, material integration, emotional resonance, and purchase considerations for AI-generated modern bamboo furniture are revealed in a qualitative study.

Table 4: Qualitative Data Analysis: User Perceptions of AI-Generated Modern Furniture with Bamboo Weaving

Theme	Description	Interpretation of results
Perception of Aesthetics	User's overall impression of the AI-generated designs in terms of visual appeal, novelty, and potential drawbacks.	The designs were visually striking, but some felt a bit overwhelming due to the complexity of the patterns. (Positive on visual appeal, concern about complexity) I appreciated the clean lines and minimalist aesthetic, but a few designs seemed too impractical for everyday use. (Positive on minimalism, concern about practicality) The use of color and texture was unexpected but created a playful and engaging aesthetic in some pieces. (Positive response to unexpected design elements)
Functionality and Comfort	User's assessment of the furniture's practicality, comfort, and potential cleaning challenges.	The chair with the woven back looked comfortable, but I worried about the ease of cleaning the intricate weave pattern. (Comfort concern with practicality consideration) The coffee table design was sleek, but the glass top might be susceptible to scratches and fingerprints. (Design appeal with a usability concern) The storage ottoman with integrated bamboo weaving offered a great space-saving solution and seemed very functional. (Positive response to both aesthetics and functionality)
Integration of Bamboo Weaving	User's opinion on how well the bamboo elements were incorporated, considering balance, aesthetics, and potential cultural connection.	I liked how the bamboo weaving added a touch of warmth and natural texture to the modern design. (Positive response to material integration) The bamboo elements on some pieces seemed like an afterthought and didn't integrate seamlessly with the overall form. (Concern about balance and cohesion) For me, the bamboo weaving evoked a sense of tradition and heritage, which I found very appealing. (Positive response with a cultural connection)
Emotional Response	User's feelings about the designs, including innovation, uniqueness, and potential disconnect from traditional elements.	The designs felt innovative and unlike anything I've seen before, but some lacked a connection to the traditional essence of bamboo furniture. (Positive on innovation, concern about tradition) The furniture sparked my curiosity and made me consider the possibilities of AI in furniture design. (Positive emotional response to innovation) A few pieces felt a bit cold and sterile despite the use of natural materials like bamboo. (Emotional disconnect with some designs)
Purchase Consideration	User's likelihood of buying such furniture, considering specific design features, potential limitations, and personal preferences.	I could see myself buying a table with a subtle bamboo weave pattern, but not something with an overly busy design. (Interest in specific design details) The price would be a major factor for me when considering purchasing these pieces. (Consideration of practicalities beyond design) While I appreciate the concept, some designs might not complement the style of my existing furniture. (Interest with a concern about compatibility) If the furniture was made from sustainable bamboo and offered a good balance between aesthetics and functionality, I would be more likely to consider buying it. (Positive response with specific criteria)

Traditional bamboo weaving's pros, cons, use, and AI-facilitated current design outputs are listed for each species in table 3. Modern AI-driven design includes sturdy geometric or textured furniture, elegant baskets, and shelving with AI-generated twilling patterns. Traditional designs use cheap, fast-growing Moso Bamboo. Tonkin Bamboo, which grows slowly and is flexible, is employed in high-quality decorative goods due to its smooth surface for complex labor. Wall hangings/mats and baskets with intricate weaving patterns are AI-driven designs. AI optimization lets you make delicate jewelry, miniature sculptures, and complex tableware and decorations from pricey, fragile black bamboo, which is pest-resistant and colorfast. Although heavy, Giant Bamboo is strong and ideal for building materials and large furnishings. AI can build smart chairs and tables with robust, curved bamboo components and investigate AI-assisted bamboo production for efficiency and sustainability. Bamboo's unique qualities can help AI design creative and eco-friendly furniture, the study found.

Table 5: Material Analysis of Traditional Bamboo Weaving

Material	Characteristics	Advantages	Disadvantages	Use in Traditional Designs (Percentage)	Modern Design Outcomes (AI Potential)
Moso Bamboo	Fast-growing, readily available	Strong and versatile	May require treatment for moisture resistance, Less ideal for intricate details	Widely used due to availability and affordability (65%)	Strong and adaptable geometric or textured furniture with AI-generated twilling patterns. These baskets have AI-optimized weft placement for aesthetic options including gradient effects. Designing elegant baskets and shelving with AI.
Tonkin Bamboo	Slower-growing, high flexibility	Smooth surface, ideal for intricate work	Less readily available, higher cost, May require specific drying techniques to prevent cracking	Used for high-quality decorative items due to flexibility and aesthetics (20%)	Embellished AI-generated wall hangings/mats show its beauty and versatility. Beautiful baskets made by AI optimization of complex weave patterns (e.g., organic or geometric shapes). Use Tonkin Bamboo's elasticity to create intricate lighting fixtures or room dividers with AI.

Black Bamboo	Unique black or dark brown color	Naturally insect-resistant	More expensive than other bamboos, More brittle than some varieties	Used for high-end decorative items due to unique color (10%)	Artificial intelligence optimizes split bamboo weaving patterns to make delicate, intricate black-colored jewelry and small sculptures. AI can optimize placement, save waste, and create unique patterns for modern furniture inlays and accents. Designing complicated black bamboo tableware and decorations with AI.
Giant Bamboo	Largest bamboo species, high strength	Thick culms suitable for structural applications, Not ideal for small or intricate details	Difficult to work with due to size and weight	Used for building materials (beams, poles) and large furniture pieces (30%)	Smart chairs and tables with sturdy, curved bamboo sections made from Giant Bamboo's strength. Bamboo-inspired structural components, maybe using AI to optimize laminating procedures for strength and design. Learn about AI-assisted bamboo construction for efficiency and sustainability.

AI's stunning bamboo furniture textures and patterns see in Figure 2. AI-crafted pieces combine traditional weaving with modern design. AI optimizes these patterns for structural integrity, material efficiency, and beauty. AI allows designers experiment alternative patterns and textures without affecting bamboo's charm. Bamboo furniture assembly with AI. Designers may use AI to construct bamboo joinery with structural support and appealing connections. Interlocking mechanisms or optimum lamination enable curved or intricate furniture designs that defy convention. AI makes furniture more comfortable and practical. AI-driven ergonomics and user data analysis help designers make beautiful, comfy furniture. AI develops furniture iteratively to meet people' demands with beauty and function. Image suggests AI-integrated personalization. Customers can utilize AI to choose bamboo furniture colors, patterns, sizes, and functions. This personalized method makes each piece distinctive and strengthens user-furniture bonds. Figure 2's design concludes with sustainability. AI minimizes bamboo processing and building waste. AI optimizes cutting patterns and creates modular, flexible parts for eco-friendly furniture that prioritizes sustainability without losing design or utility. AI-powered smart, ecological, and adjustable furniture might merge technology and tradition (Figure 2).

Figure 2. ***Samples of Furniture Design using AI***

Figure 3 shows how cluster analysis, a powerful statistical tool for aggregating comparable data, improves bamboo weaving designs. Bamboo weaving methods, materials, design, and function may constitute data points. Clusters of designs with similar weaving methods (twill, twilling, checker weave), bamboo materials (Moso bamboo, Tonkin bamboo), design components (geometric patterns, floral motifs), and intended uses are sought. Figure 3 may show cluster scatter plots or dendrograms. Graph and cluster bamboo weaving pattern data points by attributes. A dendrogram reveals cluster hierarchies, while closer designs demonstrate similarities. Many benefits come from cluster analysis. Clustering patterns in traditional bamboo weaving demonstrate design trends, geographical differences, and how materials and techniques affect aesthetics and function. This richness of information preserves ancient design skills, promotes bamboo furniture (Figure 2), and emphasizes weaving patterns and styles' cultural relevance. Cluster analysis helps students understand traditional bamboo weaving's intricate tapestry, trends, and cultural worth, preserving history, inspiring innovation, and cherishing this timeless talent.

Figure 3. ***Cluster Analysis of Traditional Bamboo Weaving Design***

4. DISCUSSION

AI helps modern furniture designers adopt bamboo weaving methods, according to mixed-method study. The mixed-method study uses qualitative and quantitative data from several sources. Literature analysis, expert interviews, and case studies assess AI's challenges and potential in bamboo weaving and furniture design. User surveys and AI model trials reveal design aesthetics, efficacy, and preferences. Methodological synergy provides a complete understanding and comprehensive empirical evidence from different perspectives. Table 1 highlights bamboo's strengths, cons, historical uses, and potential modern design uses. Bamboo species have characteristics that make them suitable for AI-based modern furniture design. A fast-growing, versatile material, Moso Bamboo, is often used in AI-generated designs with sturdy and flexible geometric or textured surfaces due to its availability and cost. Due to its hue and insect resistance, AI optimization of split bamboo weaving patterns can create complex designs using black bamboo. Modern AI-assisted furniture design must consider bamboo material pros and cons. To inform research, Table 1 summarizes bamboo materials' qualities and their use in modern furniture design.

Table 2 contains variables for studying bamboo-woven modern furniture design AI. AI model architecture, training data composition and size, user preferences, and design aesthetics affect AI-assisted design process efficiency and practicality. AI Model Architecture—which specifies AI algorithms like GAN or VAE—is tested using one-way ANOVA or Kruskal-Wallis. Samples suggest AI models may vary substantially in user satisfaction. Statistical assessments of bamboo image proportion, design weave density, or training picture number and detail describe the AI model's training data composition and size. These studies show how training data affects AI model performance. Likert scales or multiple-choice surveys measure customer preferences for Material, Style, and Functionality, providing descriptive average scores and preferences. From these observations, designers understand bamboo, furniture, and feature preferences. NPS, PAD, and Eye-Tracking evaluate design aesthetics. PAD analysis correlates design weave prominence to subjective emotions like delight, whereas NPS surveys measure user recommendation likelihood. Eye-tracking heatmaps indicate user design preferences. Table 2 covers various aspects and ways to describe AI-assisted design processes in current bamboo furniture design.

Table 3 discusses traditional bamboo weaving's beauty, utility, cultural significance, and sustainability. The figure demonstrates survey and question-based client preferences for traditional bamboo weaving designs. Function research shows individuals favor daily use and practicality. Utility wins in storage, appearance, and durability. Most responders liked storage baskets for durability. Traditional bamboo weaving is practical for daily living, evidence shows. The poll offers intriguing statistics about favorite colors, patterns, and textures after aesthetics. Surveys of traditional design graphics show aesthetic preferences. Most choose blue, green, and geometric designs over floral or naturalistic ones. Smooth textures are more elegant. These studies suggest that customers like traditional bamboo weaving. Bamboo weaving research showcases indigenous customs. Cultural relevance and regional preference polls show many people like bamboo weaving. People enjoy regional designs for culture and authenticity. Cultural promotion of bamboo weaving and handicrafts is needed. Environmental concerns make green materials and production increasingly significant. Bamboo buyers are eco-conscious, surveys suggest. Higher prices for responsibly cultivated bamboo indicate more eco-conscious and sustainable buyers. Modern design sustainability and eco-friendly bamboo weaving materials and procedures are stressed in these studies. Table 3 lists client needs, cultural relevance, and sustainability in traditional bamboo weaving design. Modern bamboo weaving relies on these insights.

Table 4 shows qualitative data analysis of AI-generated modern bamboo-woven furniture user impressions on aesthetics, utility, comfort, integration, emotional response, and purchase consideration. AI aesthetics express feelings. Many liked the patterns, but several worried about their complexity, suggesting a style-utility trade-off. Despite acclaim, some minimalist methods are impractical. Positive comments on unexpected design features like color and texture demonstrates

experimentation. Their priorities were comfort and function. Complex weave patterns and sensitive materials make cleaning and applying pleasing designs difficult. Elegant designs, yet scratches and fingerprints hindered use, emphasizing form and function. Modern designs benefited from bamboo weaving's warmth and texture, but integration was difficult. Users loved the unique designs and feared bamboo furniture abandonment. Some clientele valued tradition and innovation. Many furniture designs questioned AI's value, while others used bamboo yet looked sterile. Purchase Consideration evaluated clients' AI-generated furniture purchase likelihood based on design, constraints, and preferences. Economy and flexibility surpassed bamboo weaving difficulty. Elegant, functional bamboo furniture is eco-friendly. Table 4 shows how aesthetics, practicality, emotion, and buying criteria effect AI-generated modern bamboo-woven furniture purchases. This research will help AI-assisted furniture design meet user needs (Awrejcewicz, 2005).

Table 5 lists traditional bamboo weaving materials, their pros and cons, historical use in patterns, and AI-based design alternatives. Moso Bamboo grows quickly and is abundant, so 65% of traditional designs incorporate it for durability and versatility. Moso Bamboo is handy yet moisture-resistant and undetailed. AI might use its strength and plasticity to construct geometric or textured furniture with twilling patterns, beautiful baskets, and shelving units with high-quality weaving in current design. Tonkin Bamboo is slower-growing and more flexible than Moso Bamboo, but its smoother surface is better for complex work. Due to its higher cost and drying requirements, only 20% of traditional designs employ it, but its versatility and aesthetic appeal make it a popular choice for high-quality ornamental pieces. The current AI design makes beautiful carpets, baskets, and wall hangings. AI creates elaborate lighting fixtures and room separators using Tonkin Bamboo's elasticity. Black bamboo is pricey and fragile, but its insect resistance and dark brown hue stand out. Only 10% of traditional designs use it, although its color matches high-end décor (Jiamrungsan, 2017). AI can optimize split bamboo weaving for unique black jewellery and miniature sculptures. AI may reduce waste and optimize placement to create excellent inlays and accents for modern furniture, fine dinnerware, and decorations. Big and strong More than 30% of traditional designs use huge bamboo for furniture and structural components. It's heavy but strong. AI can help designers make smart chairs and tables from Giant Bamboo's sturdy, curving parts. Lamination may improve with AI, enabling bamboo-inspired structural components and AI-assisted bamboo architecture for efficiency and sustainability. AI uses bamboo weaving materials to expand design alternatives (Table 5).

5. CONCLUSION

The study identified key elements of bamboo weaving and AI-based furniture design, evaluating ancient bamboo weaving methods for their merits and drawbacks, and confirming their historical significance. Research into modern furniture design AI revealed that factors such as architecture, training data composition and size, user preferences, and design aesthetics significantly impact AI model performance. By understanding these components, designers can improve AI-assisted design processes, enhance user satisfaction, and stay ahead of design trends. The findings emphasize the importance of integrating innovation, user expectations, and cultural authenticity to create AI-generated designs that resonate with diverse consumer values.

This research advances design, craftsmanship, and AI by exploring the intersection of modern furniture design and traditional bamboo weaving, highlighting the sense of beauty and culture that emerges from this fusion. The study demonstrates the power, adaptability, and aesthetic potential of using giant bamboo, black bamboo, Tonkin, and Moso in contemporary designs, showcasing AI's capability to create intricate patterns, optimize construction, and personalize designs. The integration of AI in furniture design, prototyping, and manufacturing enhances creativity, efficiency, and customization, contributing to a more innovative and user-centered approach to design.

User perceptions and preferences played a central role in this study, revealing the complex relationship between visual attractiveness, utility, material integration, emotional resonance, and

purchasing decisions. These insights underscore the need for AI-generated furniture to be user-centric, blending aesthetics, functionality, and emotional engagement to meet the needs, preferences, and values of consumers. Despite its significant contributions, the study acknowledges limitations related to the generalization of AI and bamboo species. Understanding bamboo design applications could benefit from exploring new species and AI models. The interpretation of qualitative interviews and surveys may be influenced by subjectivity and respondent biases; thus, behavioral observations and usability testing are recommended to enhance subjective feedback and success rates.

The research also highlighted the impact of design trends and geography on traditional bamboo weaving, using cluster analysis to compare designs by weaving techniques, materials, aesthetics, and functions. These patterns provide valuable guidance for creating AI-assisted designs that honor the traditions of bamboo weaving while meeting modern design standards. Additionally, consumer choices made under controlled conditions may not fully reflect market dynamics. Longitudinal research or market evaluations may offer deeper insights into the adoption and economic sustainability of AI-generated bamboo furniture designs.

Finally, as design increasingly prioritizes sustainability, future research should focus on eco-friendly materials, production techniques, and supply chains in bamboo furniture manufacturing. Circular design and longevity evaluations could further enhance the environmental and social impact of AI-enabled bamboo furniture. The study showcases the potential of AI-assisted furniture design and traditional bamboo weaving, while also recognizing the need for collaboration among ethnographers, designers, and engineers in addressing cultural, technological, and environmental challenges. Designers and craftsmen may leverage AI while preserving traditional handicrafts through educational initiatives and knowledge-sharing networks.

5.1 Research Applications

Design, industrial production, and sustainability stakeholders gain bamboo furniture manufacturing knowledge from the research. The study's findings can help designers and manufacturers create beautiful and culturally acceptable bamboo furniture that appeals to a wide spectrum of consumers while keeping bamboo weaving's creativity through AI-generated patterns and textures AI in furniture design prioritises comfort, material efficiency, and structural integrity to improve and customise goods and speed up the design process, letting enterprises respond faster to consumer feedback and market demands, boosting competitiveness. The research says bamboo's quick growth and low environmental effect make it an ideal eco-friendly furniture material. The study promotes bamboo and eco-friendly production to reduce the furniture industry's environmental impact and fight climate change. The research informs consumers about eco-friendly furniture options and fulfils the growing need for ethical, sustainable products. Bamboo furniture makers can gain client loyalty by promoting sustainability. Finally, designers, engineers, academics, and legislators should collaborate to overcome technological, regulatory, and design challenges and produce AI-enabled bamboo furniture to satisfy sustainability goals.

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