



Soul of Wood: A Systematic Review on Integrating Aesthetic Bio-Aesthetics and Engineering Functionality (2003–2025)

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ABSTRACT

The materiality of wood is often confined to a rigid dichotomy between the technical parameters of engineering and the aesthetic value of the arts. Recent scholarship has shown more interest in integrating these domains; however, considerable gaps remain, particularly in the limited exploration of emotional sustainability within contemporary sustainability discourse. In this systematic literature review (SLR), we aimed to summarize the evolving understanding of wood, from a purely structural material to a medium of cultural communication. We also investigated how blending aesthetics and engineering affects the longevity of wood. We used the SLR method in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 protocol. Data were collected exclusively from the Scopus database, covering publications from 2003 to 2025. From an initial set of 3,705 records, a rigorous screening process resulted in 20 studies that met all inclusion criteria for in-depth analysis. We found that Arts and Humanities and Social Sciences dominated the literature, each accounting for 27% of the publications. Engineering followed with 16.2%. The analysis demonstrated that integrating the visual and sensory qualities of wood with its engineering performance enhanced sustainability through emotional durability, which reduces the tendency toward premature disposal. Theoretically, the results obtained in this study contribute to the development of transdisciplinary materiality. Practically, it offers guidance for designers and the craft industry to integrate local wisdom with modern technology, fostering material innovations that embody cultural meaning and authentic “soul.”

Keywords: wood materiality, systematic literature review (SLR), Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), emotional durability, transdisciplinary

1. INTRODUCTION

Over the past decade, the debate on materiality has shifted from being restricted to only technical parameters

to a relatively more holistic perspective. Materials are no longer seen only as rigid structural elements but rather as a visual communication medium that carries messages of aesthetics and cultural identity. This pheno-

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menon is reflected in global publication data, which show a significant gap between the fields of Arts and Humanities and Engineering (Serrao *et al.*, 2024; Yuan and Sun, 2025). Although these two disciplines are traditionally considered to be on opposite spectra, where art prioritizes form and technique prioritizes function, recent research trends suggest an increasingly close integration effort (Rosado, 2022; Sharma and Kumar, 2023).

The major challenge in developing modern materials is achieving a balance between mechanical integrity and sensory value (Bibb *et al.*, 2024; Schummer *et al.*, 2009). Often, the aesthetic aspects of materials with high technical performance are ignored, whereas materials developed to emphasize visual beauty are questioned for their durability. The lack of synthesis between the “rational” value of material engineering and the “emotional” value of art aesthetics creates a gap in our understanding of how materiality should be applied in today’s era of sustainability (Strappini *et al.*, 2023).

In the past decade, our perception of materiality has undergone a total paradigm shift. Wood, which has often been historically reduced to a rigid structural element or raw commodity, is now re-emerging in global discourse as a sublime visual medium of communication (Kwak and Choi, 2025; Li *et al.*, 2021; Setiawan *et al.*, 2023). It is no longer viewed simply through technical parameters, such as compressive strength or moisture content, but is interpreted holistically as an aesthetic messenger and guardian of a living cultural identity.

This phenomenon is reflected in the dynamics of the latest scientific publications, which report a substantial wedge between the realms of Arts and Humanities and Engineering. On one hand, forests, as the origin of wood, are viewed through a technical lens, a giant laboratory that produces materials with high mechanical precision. On the other hand, naturally engraved wood fibers are a “text” that tells the story of time, climate change, and the collective memory of humans (Starzyk

et al., 2025a). The visual pattern on the surface of wood is not a meaningless ornament but a manifestation of organic life that infuses a soul into man-made objects (Alapieti *et al.*, 2020; Burnard and Kutnar, 2019).

Traditionally, the disciplines of art and engineering are often believed to stand at opposite poles, where art worships form and technique emphasizes function; however, contemporary research toward the end of the study period in 2025 shows harmonious integration of both. Wood is a meeting point where biophilic beauty meets the requirements of advanced material engineering. In this context, forests are no longer understood as objects of exploitation but rather as an ethical source of materiality (Zisi, 2021). The sustainability of forests is now transforming into a “new aesthetic,” where the honesty of the material and the origin of the wood are integral to the value and beauty of a work.

1.1. Rationale: A philosophical and transdisciplinary foundation

The primary reason for conducting this literature review is the seismic shift in the way humans interpret materiality in the 21st century. Over the years, wood has often been viewed through a lens of rigid dichotomy: either purely technically as a resource in engineering or romantically as an aesthetic object in the arts (Kwak and Choi, 2025; Starzyk *et al.*, 2025b). However, recent bibliometric data suggest inevitable convergence, with Arts and Humanities and Engineering now sharing equal importance in defining the future of materials.

Through this review, we aimed to bridge this gap by exploring how wood, as an organic material, can be employed as a communication medium that carries a message of cultural identity while meeting complex structural demands. Another reason was the need to elucidate the material’s “biography” holistically, which states that the choice of wood in modern design is not simply a mechanical decision, but an ethical statement

about man's relationship with forests and their ecosystems.

In this study, we investigate the materiality of wood through the lens of new materialism (Jane Bennett), which views wood not as a passive object but as having "agency" or life force that interacts with humans (Ferraro *et al.*, 2025). This perspective is deepened by Juhani Pallasmaa's approach to the phenomenology of architecture, which emphasizes the importance of sensory resonance and touch in understanding materials, and Tim Ingold's thinking on sustainable craft, where materiality is understood as the process of "becoming" through the craftsman's active involvement with wood fibers and textures.

This integration was then linked to the concept of emotional design (Donald Norman) to explain how the visual characteristics of wood trigger affective bonding. In the context of sustainable craft theory, this synergy between technique and aesthetics is not simply a matter of beauty but also a strategy to achieve emotional durability, where users tend to hold objects longer owing to the depth of cultural and sensory perspective.

1.2. Urgency: Future integration momentum and needs

The urgency of this review is crucial, considering the dynamics of scientific publications having reached their peak in 2025. We are at a turning point where the narrative of sustainability is no longer sufficient with carbon efficiency figures, but also has to touch on emotional and sensory aspects. Therefore, this review represents an urgent step toward charting a new direction of research before the discourse on the materiality of wood loses its philosophical depth owing to massive industrial commodification.

Furthermore, there is an urgent need to develop a paradigm of "functional aesthetics" amidst a global environmental crisis. Without an in-depth synthesis of

the current literature, we risk applying advanced material technologies that lack human value. Therefore, there is an urgency to conduct this review as a theoretical guide to ensure that future wood engineering innovations remain grounded in the nobility of forest value and the cultural heritage that comes with it, ensuring that the materiality of the future is materiality that has a "soul."

Through a literature review of key documents indexed from 2003 to 2025, herein, we aimed to map how global researchers reconcile the tension between aesthetics and function. The urgency of this analysis lies in the need to formulate a new paradigm in material selection, an approach that not only attaches importance to functional efficiency but also values the material as a cultural text that has phenomenological significance for its users.

1.3. Research gap: Empty space in contemporary materiality discourse

Although bibliometric data indicate a considerable increase in interest in integrating art and engineering into wood materiality by 2025, a review of the current literature reveals at least three key research gaps that need to be filled. First, there is a methodological imbalance wherein research tends to be polarized between the dominance of quantitative data on physical performance in the engineering aspect and a qualitative-descriptive approach in the arts and humanities aspect. Thus, it remains extremely rare to find studies that offer an integrated methodology to measure the direct impacts of aesthetic values on the perception of object functionality (Stutesman *et al.*, 2025).

Second, there remains a lack of exploration of "emotional durability" in the context of sustainability. The existing literature highlights wood as a technical carbon solution but ignores how aesthetic and cultural attachments can prevent consumptive behavior and premature disposal of materials. Finally, current research is

still dominated by the global perspective of developed countries; therefore, there is a gap in the literature that specifically discusses the integration of local wisdom with modern engineering technology without eliminating its original philosophical value. In this review, we aimed to fill this gap by positioning aesthetics not simply as an additional ornament but as a core functional element in future material innovation that is more balanced and holistic than presented in previous studies (Table 1).

1.4. Research questions

Based on the Research Gap that has been mapped, namely the gap between technical data and aesthetic meaning, the following is the formulation of research questions (RQs) used to guide this literature review. To fill in the identified research gaps, in this study, we have attempted to find answers to the following questions:

RQ1: How did the meaning of wood shift from a mere structural element to a medium of cultural communication in the global literature between 2003 and 2025?

RQ2: How can the integration of aesthetic values (such as fiber patterns and textures) with engineering functionality affect the emotional durability of a material?

RQ3: To what extent has the current literature reconciled the tension between quantitative engineering methodologies and the qualitative approach of the arts and humanities in assessing the quality of a material?

1.5. Study objective: Toward aesthetic-technical synthesis

In this literature review, we aimed to systematically synthesize the evolution of the meaning of wood from a static structural element to a dynamic, cultural communication medium in global discourse over the past two decades. Furthermore, in this study, we sought to evaluate the extent to which efforts aimed at integrating aesthetic dimensions and engineering functionality can help catalyze the creation of emotional durability, thereby extending a material’s life cycle. Herein, we examined a methodological model that can reconcile the tension

Table 1. Comparative analysis of the perspectives of this study with those of previous literature

Comparison dimensions	Previous literature/previous review	This article (Setiawan <i>et al.</i> , 2026)
Key focus	Segmented: Focus on technical-mechanical parameters (<i>Engineering</i>) or decorative-symbolic aspects in isolation (<i>Arts</i>)	Transdisciplinary integration: Synergize engineering performance and sensory resonance simultaneously
Materiality paradigm	Wood is seen as a rigid structural element or a static industrial commodity	Cultural agency: Wood is interpreted as a medium of cultural communication and “text” that carries an identity message
Concept of sustainability	Oriented toward the technical carbon efficiency and biochemical parameters of the material	Emotional durability: Emphasizing emotional attachment through aesthetics as the key to material lifespan
Methodological balance	Dominated by a purely quantitative approach from the industrial perspective of developed countries	Methodological reconciliation: A synergistic balance between the <i>Arts and Humanities</i> and <i>Engineering</i> disciplines
Practical contribution	Optimization of physical strength and standardization of industrial materiality	Spirited innovation: Integration of local wisdom and philosophical values into modern engineering technology

between quantitative approaches in engineering and qualitative approaches in the humanities to acquire a more holistic and transdisciplinary perspective on materiality assessment in the future.

1.6. Study scope: Materiality and temporal limitations

To achieve a precise depth of analysis, the scope of this study was limited to specific but in-depth parameters. The focus is on wood materials and their derivatives as ideal representations of encounters between nature and technology. Temporally, the study covers global literature over the past two decades, with particular attention to the surge in recent publications toward the end of the study period in 2025, which marks a new era in bio-aesthetic innovation.

The scope of the analysis was limited to the contradiction and integration between technical dimensions, such as durability and structural integrity, and phenomenological dimensions, including textures, fiber patterns, and the symbolic meaning of wood in society. The main data sources in this review were drawn exclusively from the Scopus database, including journal articles, book chapters, and conference proceedings that explicitly addressed the wedges between the material sciences, arts, and social sciences. Despite this limitation, this study is expected to provide a clear picture of the position of wood in the discourse on future materiality without being distracted by other types of inorganic materials.

The selection of Scopus as the single database in this study was based on several strategic considerations to ensure its transdisciplinary quality and relevance. It provides access to highly reputable journals and proceedings with strict scientific curation standards. Scopus has a relatively wider scope in the fields of Social Sciences, as well as Arts and Humanities. In addition, Scopus' metadata features strongly support bibliometric analysis

and publication trend tracking through 2025, which is a key focus in mapping the global evolution of the meaning of wood materiality.

2. MATERIALS and METHODS

In this study, we used the systematic literature review method with a bibliometric approach to map the development of the discourse on wood materiality between 2003 and 2025 (Ahmadi *et al.*, 2023; Marzi *et al.*, 2025). The review procedure was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard guidelines to ensure transparency, objectivity, and reproducibility in the literature selection process (Page *et al.*, 2021). The process began with document identification through the Scopus database using specific keywords that integrate the realms of engineering and humanities, followed by screening, eligibility checking, and qualitative synthesis of 20 selected documents that represent the intersection between aesthetics and material functionality (Fig. 1).

The literature selection procedure involved a systematic reference to the PRISMA 2020 protocol, which began with the identification of 3,705 recordings through an electronic database. The initial screening stage involved eliminating irrelevant recordings, including 3,416 non-craft, 181 non-art, and 55 non-traditional-art recordings. From the screening results, 53 recordings were further examined; however, 32 recordings were excluded because they fell outside the 2003–2025 research time range. Furthermore, of the 21 reports sought to be accessed, one report could not be used, leaving 20 reports to be assessed for full feasibility. After analyzing the final assessment without any additional exclusions, we determined 20 studies that met all the inclusion criteria for in-depth analysis.

The credibility of the synthesis was maintained by establishing strict inclusion and exclusion criteria

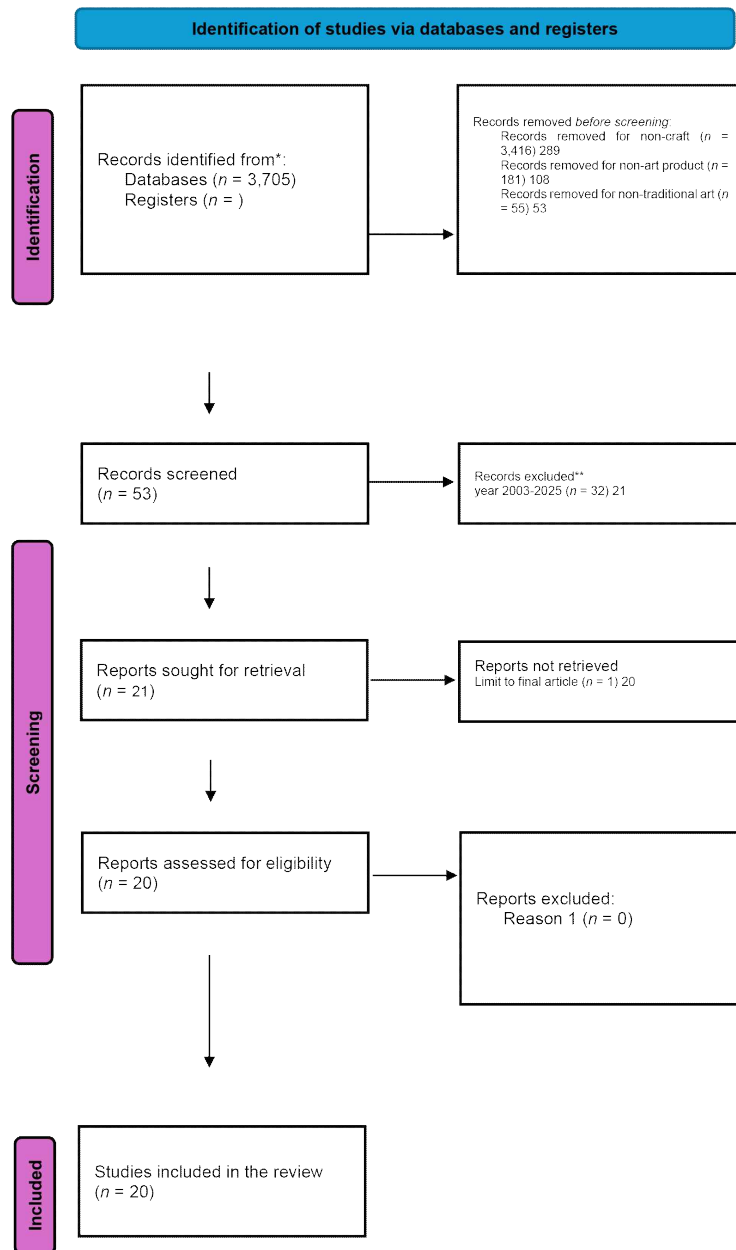


Fig. 1. Flow chart depicting the review process used in this study in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 protocol.

during the literature selection process (Ioannidis, 2016; Moosapour *et al.*, 2021). The inclusion criteria stipulated that the selected document must be an English-language

journal article, book chapter, or conference proceedings published between 2003 and 2025 and must explicitly address the intersection between the materiality of wood,

aesthetic value, and engineering functionality. On the contrary, the exclusion criterion was applied to eliminate documents that focused only on purely technical aspects without touching the humanities dimension, documents that did not provide full-text access, and editorial review articles or short opinions that were not based on strong empirical or theoretical research data. Through this systematic screening, 20 final documents were obtained that were confirmed to be highly relevant to the RQs and that could provide a comprehensive overview of future trends in art and engineering integration.

The literature search strategy was comprehensively designed to capture a transdisciplinary discourse between material technology and humanities values using Scopus' reputable database. The search was conducted using a combination of systematic keywords AND of AND Boolean operators that include the words: (TITLE-ABS-KEY (art AND of AND wood)) AND (craft) AND (art AND product) AND (traditional AND art) AND (contemporary) AND (LIMIT-TO (PUBSTAGE, "final")).

Keywords such as "art," "craft," and "traditional art" were deliberately chosen to capture the transdisciplinary wedge between material technology and humanities values. Using this strategy, we aimed to bridge the dichotomy between engineering parameters and aesthetic values, which are often studied separately. In this study, we focused on this terminology to identify literature that discussed how emotional and cultural attachments, often arising from the art aspect, can affect emotional durability, a crucial but often overlooked dimension in pure engineering studies.

This initial identification process captured 3,705 recordings that reflect the breadth of the global timber research spectrum. Search restrictions were also applied to several document types, including journal articles, book chapters, and conference proceedings, to ensure the quality of scientific data analyzed for the period 2003–2025. All search results were exported to a reference management format for further screening based on the

inclusion and exclusion criteria set in the PRISMA protocol.

A quality assessment (QA) was conducted to ensure that the selected final documents met the standards of high scientific credibility and thematic relevance before proceeding to the synthesis. The QA instrument was prepared based on criteria that included methodological clarity, analytical acuity of aesthetic and engineering slices, and contribution of the findings to the evolution of the meaning of wood materiality from 2003 to 2025. Each article was independently evaluated to minimize the risk of bias, and documents with a strong theoretical foundation and valid empirical data were the top priority in the discussion. This assessment instrument ensured that the included studies were bibliometrically relevant and provided in-depth insights that supported the transdisciplinary objectives of the research.

2.1. Study quality assessment matrix

To enhance objectivity, each of the 20 final studies was evaluated using a QA instrument that included four main criteria. Scores were rated on a scale of 0 (not fulfilling), 0.5 (partially fulfilling), and 1 (fully fulfilling; Table 2).

The data extraction procedure was conducted systematically on the 20 final studies, which were selected to ensure the consistency and accuracy of the analyzed information. Data were extracted using standardized forms that include bibliographic identities, such as the author's name and year of publication, to map the growth trend of the document, especially at the peak of research in 2025. In addition to descriptive data, the extraction focused on substantive content, including key findings related to the intersection between aesthetics and material functionality, subject categories such as Arts and Humanities or Engineering, and the methodology used in each study. All extracted data were then classified into key themes to facilitate a comprehensive

Table 2. Quality assessment (QA) instrument matrix (total maximum score: 4)

Criteria codes	Assessment indicators	Relevance in this study
QA1	Methodological clarity	Compatibility between the data presented and conclusion regarding the meaning of wood as a cultural medium
QA2	Transdisciplinary depth	Do studies address the wedge between aesthetic value (fiber/ texture) and engineering functionality?
QA3	Theoretical contributions	Extent to which the study discusses the concept of emotional durability or material sustainability
QA4	Validity of findings	Compatibility between the data presented and the conclusion about the meaning of wood as a cultural medium

qualitative synthesis of the evolution of the meaning of wood as a cultural and technical material.

The data synthesis technique used in this study was based on a qualitative thematic synthesis approach (Starzyk *et al.*, 2025c; Thomas and Harden, 2008) aimed at integrating findings from the 20 selected studies on the evolution of the meaning of wood materiality (Table 3). The extracted data were classified into dominant subject categories, such as the Arts and Humanities and Engineering, to identify patterns of relationship between aesthetic value and technical functionality. Descriptive statistical analysis was also applied to map bibliometric trends, highlighting the significant growth in the number of documents, with a peak in publications in 2025. All the results of this synthesis are then combined narratively to answer the formulation of the RQs.

3. RESULTS and DISCUSSION

The characteristics of the 20 final studies analyzed in this review show the diversity of research designs that represent transdisciplinarity between the fields of art and engineering. Many of these studies employed a descriptive qualitative design and phenomenological analysis to explore the symbolic meaning of wood, whereas a significant number of studies adopted an experimental engineering approach to test the material's functionality.

The thematic distribution of documents was dominated

by Arts and Humanities and Social Sciences subjects, each accounting for 27% of the total data, followed by that of the engineering field at 16.2%. The document type consisted of scientific articles (35%), book chapters (30%), and books (25%), providing a comprehensive theoretical foundation for the evolution of materiality from 2003 to its peak in 2025.

Although the search strategy uses art-oriented terminology, the distribution of subject fields shows a significant representation of the technical literature. The field of "Engineering" accounted for 16.2% of the total documents, followed by those of "Agricultural and Biological Sciences" and "Environmental Science" at 8.1% each, which confirmed that the selected keywords did not conclude performance-based research but rather successfully captured studies that integrate the technical performance of wood with high-value design applications.

In terms of geographical distribution and data scale, these studies covered a global perspective, with the main contributions coming from the United States of America (USA; three documents), followed by those from Australia, Canada, and Germany (Fig. 2). Sample sizes in technical studies are generally focused on testing specific material specimens at the laboratory scale, whereas studies in the humanities often involve the analysis of traditional craft artifacts or art products as the primary unit of analysis. This research focus has consistently led to the integration of the physical

Table 3. Summary of the 20 literature studies (2003–2025) analyzed in the present study

No	Year	Authors/studies (ID)	Main subject areas	Document type	Country	QA score
1	2025	Study S1	Arts & humanities	Article	USA	4.0
2	2025	Study S2	Social sciences	Book chapter	Australia	4.0
3	2025	Study S3	Engineering	Article	Germany	3.5
4	2025	Study S4	Arts & humanities	Book	Canada	4.0
5	2024	Study S5	Social sciences	Book chapter	USA	3.5
6	2024	Study S6	Engineering	Article	Belgium	4.0
7	2023	Study S7	Environmental science	Book	Germany	3.5
8	2022	Study S8	Arts & humanities	Book chapter	Canada	4.0
9	2022	Study S9	Social sciences	Article	Italy	3.5
10	2022	Study S10	Engineering	Article	Australia	4.0
11	2021	Study S11	Agricultural & biological sciences	Book	India	3.5
12	2020	Study S12	Arts & humanities	Book chapter	Cameroon	3.5
13	2019	Study S13	Social sciences	Article	Ireland	4.0
14	2019	Study S14	Engineering	Conference paper	USA	3.5
15	2016	Study S15	Arts & humanities	Book	Undefined	3.5
16	2015	Study S16	Social sciences	Book chapter	Undefined	3.5
17	2012	Study S17	Agricultural & biological sciences	Article	Germany	4.0
18	2010	Study S18	Environmental science	Book	Canada	3.5
19	2010	Study S19	Engineering	Book chapter	Australia	4.0
20	2003	Study S20	Arts & humanities	Review	USA	3.5

QA, quality assessment.

characteristics of materials, such as cellular structure and wood growth patterns, with the resulting aesthetic value for addressing the challenges of modernity in creating materiality that is both functional and culturally meaningful.

The results of the QA of the final 20 studies revealed a high level of scientific credibility, with an extremely strong thematic relevance to the wedge between aesthetics and engineering. Based on assessment instruments that include methodological clarity and phenomenological analysis, the majority of the selected literature,

consisting primarily of journal articles and book chapters, demonstrated a high degree of scholarly rigor and were able to provide valid empirical data on the transformation of wood materiality from 2003 to reach the peak of its significance in 2025. The validity of this study was further supported by the balanced representation of the Arts, Humanities, and Engineering. Such a distribution ensures a synthesis that harmonizes theoretical richness with technical precision.

Overall, the reviewed studies were categorized as having superior quality, owing to their ability to recon-



Fig. 2. Documents based on country or territory. Data retrieved from Scopus (Elsevier) and processed by the authors.

cile the tension between material functionality and cultural identity. This focus on quality is evident from the rigorous selection process based on PRISMA guidelines, wherein only documents that explicitly integrate traditional craft values with modern engineering were included in the final analysis. Thus, the results of this QA ensure that the resulting research findings have validity that can be accounted for in mapping a new, holistic, and transdisciplinary direction for future material innovation.

The synthesis of the findings of the 20 final documents reveals a fundamental transformation in the discourse on wood materiality, which is based on the three RQs listed in Section 1.4 and is described in the following sections:

3.1. Evolution of the meanings of wood (2003–2025)

Global literature has shown a significant shift from viewing wood as a rigid structural element toward a

dynamic medium of cultural communication. The trend of publications reaching their peak in 2025 reflects that wood is now holistically interpreted as an aesthetic messenger and guardian of cultural identity, beyond mere traditional technical parameters.

Based on a detailed study of the available documents and bibliometric data, the findings that deepen our understanding of the shift in the meaning of wood (Fig. 3) are summarized below.

- **Dominance of multidisciplinary collaboration:** The data demonstrate a balanced distribution of research contributions between the Social Sciences and the Arts and Humanities, which collectively outweigh the singular focus on engineering. This finding suggests that recent research has tended to integrate materials science from a sociological perspective to elucidate the interactions between human communities and forests, as well as their timber.

- **Shifting publication medium:** Study characteristics showed that Book Chapters (30%) and books (25%) had almost equal portions of articles (35%). These results

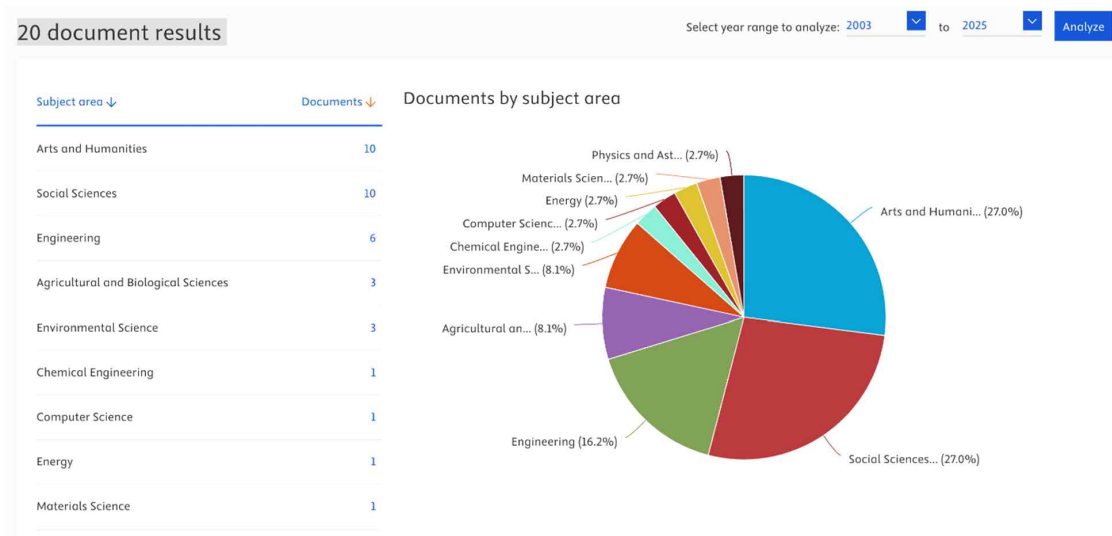


Fig. 3. Documents based on subject area. Data retrieved from Scopus (Elsevier) and processed by the authors.

suggest that discussing wood as an aesthetic message requires a longer and more in-depth narrative space than that provided by a concise technical laboratory report.

- Integration of the field of life sciences: The emergence of contributions from Agricultural and Biological Sciences (8.1%) and Environmental Science (8.1%) provides another finding that wood is now viewed as a bridge between the preservation of forest ecosystems and human handicrafts.

- Peak of significance in 2025: The trend of document growth reaches its highest point with four documents in 2025, confirming that it is currently a crucial phase in which traditional technical parameters begin to be fully integrated with humanities values in scientific literature (Fig. 4).

3.2. Aesthetics, engineering, and emotional durability

The integration of the natural visual characteristics of wood, such as fiber patterns and textures, with modern engineering functionality has been proven to improve

longevity through the concept of emotional durability. The biophilic beauty of wood not only enhances its aesthetic attractiveness but also creates an emotional attachment in the user, which can prevent consumptive behavior and premature disposal of materials.

Some of the findings reinforce the narrative on the integration of aesthetics and functionality of wood.

- Unification of arts and engineering perspectives: The data reveal a balanced contribution from Arts and Humanities and Social Sciences, which synergize with the field of Engineering to redefine material quality. This integration moves beyond mere mechanical strength to incorporate sensory resonance as a key metric.

- Sustainability through traditional crafts: Most documents filtered through the PRISMA protocol focus on the areas of crafts and traditional arts, which indicates that past values are key to creating future products that have high emotional resilience.

- Roles of environmental and life sciences: The emergence of research contributions from Environmental Science and Agricultural and Biological Sciences demonstrates that the aesthetics of wood texture are now

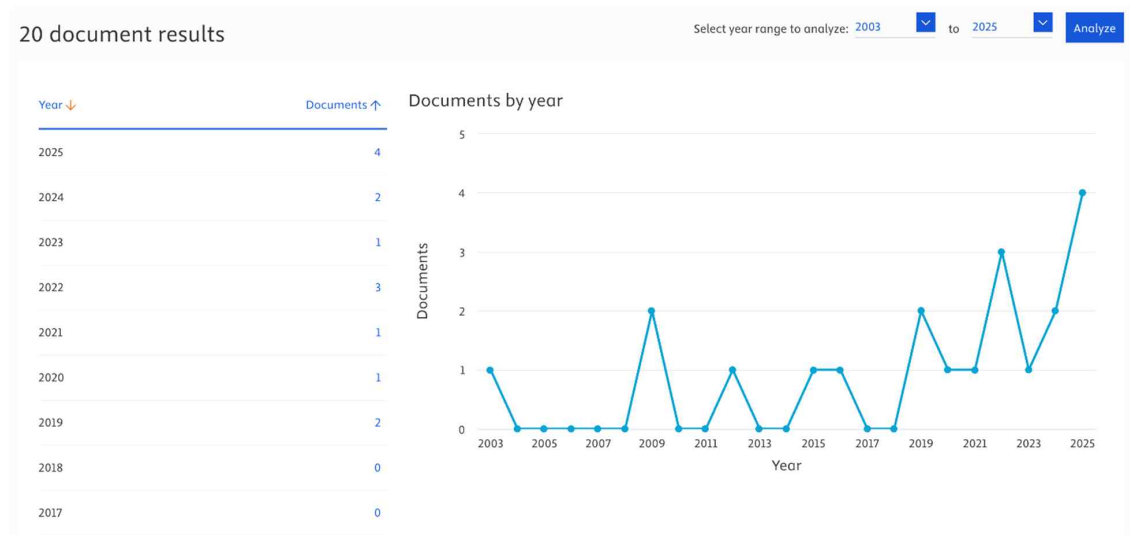


Fig. 4. Documents based on year. Data retrieved from Scopus (Elsevier) and processed by the authors.

technically associated with forest ecosystem preservation and material efficiency.

- **Global materiality transformation:** The geographical distribution patterns of research from the USA, Australia, Germany, and Canada prove that the use of wood aesthetics as a functional solution to suppress consumptive behavior is a global scientific trend.

- **Evolution of literary formats:** The dominance of publications in the form of books (25%), book chapters (30%), and journal articles suggests that discussions on the integration of functionality and biophilic beauty require more in-depth narrative analysis than does standard laboratory testing.

3.3. Reconciliation of the methodologies of engineering and humanities

Current literature is beginning to reconcile the tensions between the quantitative methodology of Engineering and the qualitative approach of Arts and Humanities through a balanced distribution of subjects across both the social-artistic and engineering fields. This transdis-

ciplinary synthesis enables a relatively clearer assessment of material quality, wherein mechanical strength is evaluated simultaneously with sensory resonance and the symbolic meaning of the material to humans.

Findings that deepen our understanding of methodological reconciliation between engineering and the humanities are as follows:

- **Broadening the spectrum of disciplines:** Data revealed contributions from the fields of Agricultural and Biological Sciences, as well as Environmental Science, indicating that material QA now incorporates ecological and biological sustainability parameters.

- **Geographic focus gap:** Despite the integration of methodologies, research remained dominated by perspectives from developed countries, such as the USA, Australia, and Canada, highlighting the need to incorporate methodologies based on local wisdom from other regions.

- **Traditional craft-based methodology:** A selection process that was used to specifically screen documents related to crafts and traditional arts revealed that modern materiality assessment methods borrowed heavily from

past craft practices to elucidate the integrity of materials in their entirety.

· Peak trends for collaboration in 2025: The surge in the number of publications that peaked in 2025 reflected that this transdisciplinary methodology is no longer only an experiment; rather, it has become a new standard in contemporary wood materiality discourse.

The heterogeneity analysis targeted diverse cross-disciplinary perspectives represented within the final selection of studies, wherein the distinct methodologies of Engineering and Arts and Humanities were integrated to provide a holistic exploration of emotional durability, while ensuring a multifaceted exploration of the subject. This heterogeneity is not seen as an obstacle, but rather as a force that provides depth to thematic synthesis, as it enables the materiality of wood to be evaluated simultaneously in terms of its technical performance and symbolic resonance.

A sensitivity analysis was conducted to ensure the robustness of the findings by verifying the consistency of narratives across various document types ranging from journal articles to books and book chapters (Fig. 5). The results of the analysis revealed that the central theme of

the evolution of wood as a medium of cultural communication remained stable and significant across all categories without being biased by the format of a particular publication. This proves that the conclusions regarding the shift in the meaning of wood toward the end of the study period in 2025 have strong validity and high reliability in representing global trends in the scientific literature.

3.4. Discussion

The paradigm shift in timber materiality observed from 2003 to 2025 marks the end of an era when timber was only considered a static structural commodity. In this study, we explored how cross-disciplinary integration redefines the future of wood materiality.

3.4.1. Evolution of meaning: From structural to cultural (RQ1)

Our findings confirm that over the past two decades, global literature has successfully deconstructed technocentric views on wood. Research has shown a growing interest in the heritage and cultural materiality of wood,

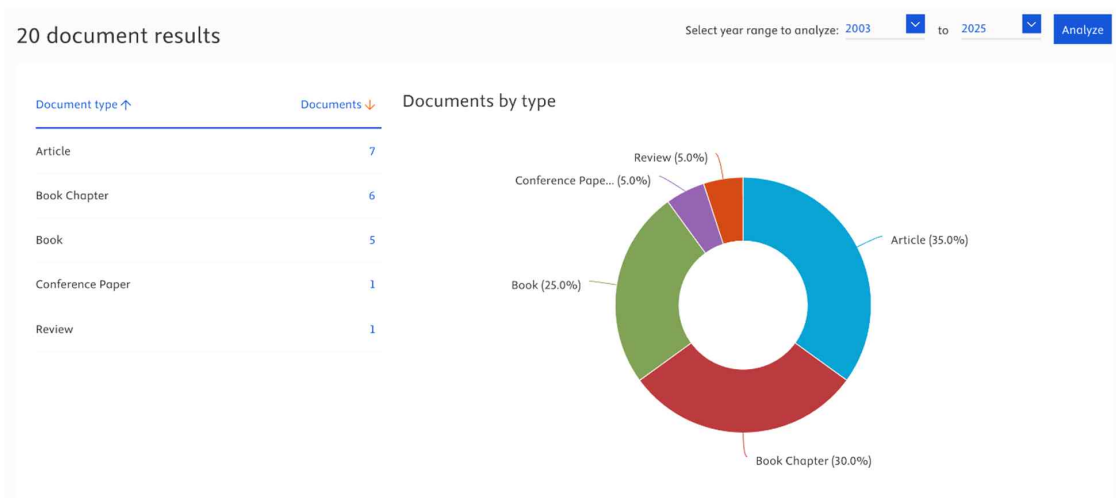


Fig. 5. Documents based on type. Data retrieved from Scopus (Elsevier) and processed by the authors.

particularly since 2010, reflecting the expansion of the discourse from technocentric to cultural and historical implications of these materials (Beech *et al.*, 2017; de Melo Júnior *et al.*, 2025). At the beginning of the review period (2003), the research focus was dominated by mechanical power and industrial efficiency, whereas the trend toward the end of the study period in 2025 exhibited a surge in narratives that position wood as a dynamic medium for cultural communication. This shift shows that wood is now recognized as having “agency” in conveying identity and aesthetic messages. Wood is no longer only used to build the physical structure of a building but also to create value and memory for its occupants, moving beyond traditional technical parameters to a relatively more holistic implication (Bo and Abdul Rani, 2025; Leworthy, 2024; Starzyk *et al.*, 2025c).

3.4.2. Aesthetic-engineering and emotional sustainability synergy (RQ2)

Discussions of the integration of natural visual characteristics with engineering functionality revealed a strong positive correlation with emotional durability. The biophilic beauty of wood, which radiates through the uniqueness of fiber patterns and textures, proves not only to be a decorative visual appeal but also a core functional element that creates an emotional attachment between humans and objects (Aduwo *et al.*, 2021; Karci Demirkol and Kalayci Önaç, 2024). This synergy is a crucial sustainability strategy: materials that “speak” aesthetically tend to be maintained for longer periods by their users. Thus, modern engineering, capable of maintaining or even strengthening the natural visual character of wood, directly contributes to reducing consumptive behavior and preventing the premature disposal of materials.

3.4.3. Methodological reconciliation: Toward transdisciplinary assessment (RQ3)

The tension between quantitative engineering metho-

dologies and qualitative arts and humanities approaches is now beginning to find a harmonious common ground. The balance of the subject portions in the literature reflects the emergence of new standards for assessing material quality. This transdisciplinary synthesis enables a clearer evaluation, wherein the physical strength of a material is no longer separated from its sensory resonance. These findings suggest that, in the future, the quality of a wood product will be judged by its ability to meet technical standards while providing symbolic meaning to humans (Rilatupa, 2021; Starzyk *et al.*, 2025b). This reconciliation is a critical foundation for humane and sustainable innovation in materiality.

The results obtained in this study confirmed a paradigm shift from a technocentric view to a relatively more holistic and transdisciplinary meaning of wood materiality. The analysis of the 20 selected studies revealed that the meaning of wood has shifted from a rigid structural element to a dynamic medium of cultural communication, with a significant peak in related publications in 2025.

The significance of this finding lies in the successful integration of biophilic aesthetic values such as fiber patterns and textures with engineered functionality, which has been proven to increase emotional durability and suppress consumptive behavior toward materials. Furthermore, the methodological reconciliation between Engineering and Arts and Humanities provides a new foundation for assessing material quality, moving beyond reliance on mechanical strength to include sensory resonance and cultural identity as core functional elements.

The results of this study revealed a distinct and critical perspective, diverging from previous studies that often separate technical performance from cultural value (Laguens, 2024; Monterroza-Rios and Gutiérrez-Aguilar, 2022; Tolia-Kelly, 2009). Previous engineering research has traditionally positioned wood as a structural material judged based on its mechanical strength and biochemical

efficiency, whereas studies in the arts and humanities have often limited discussions on decorative or symbolic aspects in isolation. The results obtained in this study break down this dichotomy by offering the latest evidence from the literature toward the end of the study period in 2025, which reveals that aesthetics is not simply an additional ornament but an inherent functional element in ensuring material sustainability.

A comparison of bibliometric data also reveals a shift in geographical and methodological focus that is more inclusive than in reviews of the previous decade. In contrast to the previous literature, which was dominated by a purely quantitative approach from the industrial perspective of developed countries, the current findings reflect a more balanced integration between Social Sciences and Arts and Humanities, which indicates a global effort to incorporate material “agency” and local wisdom into modern engineering (Ijatuyi *et al.*, 2025; Kurnio *et al.*, 2021; Mercer *et al.*, 2012). Thus, this review fills the gap left by previous literature by positioning emotional durability as a crucial bridge between technical acumen and aesthetic resonance in the discourse on contemporary wood materiality.

Theoretically, the results obtained in this study con-

tribute to the development of a transdisciplinary materiality theory by positioning aesthetics not simply as a secondary element but as a decisive functional factor in extending the life cycle of materials through the concept of emotional durability. The paradigm shift from 2003 to 2025 reinforces the theoretical foundation that wood quality should be evaluated simultaneously for its mechanical strength and engineering, as well as its sensory resonance (Du *et al.*, 2024; Kuasakul *et al.*, 2025; Lin *et al.*, 2025). This integration reconciles the methodological tensions between the fields of Engineering and Arts and Humanities, thus opening opportunities for the development of new research frameworks that are more holistic in examining the relationship between people, objects, and the environment.

A transdisciplinary relationship synthesis matrix was used to map the correlations between aesthetic values, engineering functionality, and sustainability based on the findings of the 20 reviewed studies.

Based on the above matrix, the relationship between the three variables is no longer linear but circular and mutually reinforcing (Table 4). A few major inferences drawn based on the findings obtained using the above-mentioned matrix are presented below.

Table 4. Synthesis matrix: Aesthetics–function–sustainability

Synthesis dimensions	Aesthetic parameters (humanities)	Functional parameters (engineering)	Sustainability outputs	Key theoretical references
Emotional durability	Sensory resonance, unique fiber patterns, and biophilic texture	Structural integrity and mechanical resistance of materials	Extension of the product life cycle through affective bonding (preventing premature disposal)	Emotional design (Norman); Sustainable craft (Ingold)
Materiality agency	Wood as a “cultural text” and a carrier of collective memory	Structural integrity and mechanical resistance of materials	Material transformation of a commodity into a valued subject (consumption ethics)	New materialism (Bennett); Phenomenology (Pallasmaa)
Functional aesthetics	Organic beauty as a trigger for biophilic calmness	Optimization of material performance through modern engineering	Reduction of carbon footprint through the selection of ecologically durable natural materials	Functional aesthetics; Bio-aesthetics

- Aesthetics as a catalyst of function: The visual beauty of wood (fibers and textures) is not just an ornament, but rather a functional element that determines how humans interact with an object. Studies have shown that without strong aesthetics, even high-performance materials are susceptible to consumptive behavior (easy to dispose of; Ji and Lin, 2022; Madge, 1997; Strappini *et al.*, 2023).

- Function as a sustainer of meaning: Engineering functionality guarantees that the “cultural message” carried by wood can survive physically for a long time. Without adequate mechanical strength, the aesthetic and symbolic value of wood is lost as the material deteriorates (D’Itria and Colombi, 2022; Harris *et al.*, 2021; Thundathil *et al.*, 2023).

- Final synthesis (emotional durability): The meeting between the “soul” (aesthetics) and the “body” (technique) in wood results in emotional durability, which proves that future sustainability depends not only on energy efficiency but also on the ability of materials to remain relevant and loved by users across generations (Owoyemi *et al.*, 2016; Titirici *et al.*, 2022; Yu *et al.*, 2025).

Notably, the causal relationship between aesthetic integration, emotional resilience, and material longevity extension observed in the present study is a conceptual synthesis derived from the literature. Although this manuscript does not present quantitative life cycle assessment (LCA) data independently, this proposition is based on findings from the Engineering and Social Sciences literature indicating that psychological attachment to wooden objects significantly reduces the intensity of product replacement (premature disposal).

Claims regarding longer lifespans are supported by behavioral data recorded in selected case studies, where the sensory value of wood (texture, color, and warmth) has been shown to increase the user retention of objects and is in line with the theory of emotionally durable design, which states that product failures are often not

caused by technical defects (engineering) but by a loss of meaning for the user (aesthetics).

Although the integration model proposed in this study suggests a relationship between material aesthetics and extended life, the relationship is currently conceptual and is derived from the analyzed literature. This discovery is a theoretical proposition that combines user behavior data from social sciences with sustainability parameters from engineering sciences. The results obtained in this study present an initial framework that links these variables as a foundation for further testing.

3.5. Strengths and limitations of studies

The main strength of this study is the use of the PRISMA 2020 protocol, which guarantees transparency and reproducibility in mapping the evolution of wood materials over the past two decades. Another advantage is the transdisciplinary approach, which successfully reconciles quantitative engineering methodologies with qualitative arts and humanities, resulting in a comprehensive synthesis of emotional durability.

However, the limitations of this study are evident in the dominance of literature from the global perspective of developed countries, such as the USA and Australia, which has led to a lack of representation of local wisdom from Asian or Indonesian regions in modern engineering discourse. In addition, the restriction of 20 final documents in the 2003–2025 range, while ensuring high data quality, may not capture the full spectrum of non-digital publications or gray literature that develops outside the Scopus database.

The results of this review reveal a significant imbalance in geographical representation. Although the Asian region and the Global South have a rich tradition of culturally deep wood crafts, the literature indexed in the global database (Scopus) is still dominated by the perspectives of the USA and Europe.

This gap is a crucial finding, highlighting an urgent

need to document local wisdom from regions such as Indonesia in international scientific discourse. Our understanding of the evolution of wood's materiality would remain partial without engaging with the perspective of the Global South and would lose the "soul" dimension rooted in traditional craft practices that have been tested for centuries as an authentic model of sustainability (dos Santos *et al.*, 2025; Widodo, 2010).

This study has limitations because the keywords used herein are highly oriented toward aesthetic and craft aspects, which may limit the scope of purely technical wood engineering literature. However, this focus was consciously chosen to prioritize literature that offered a synthesis between traditional expertise and modern sustainability. Further research is encouraged to expand the search strategy to include broader engineering terms related to the structural performance of timber in the context of sustainability.

A major limitation of this review is the lack of direct empirical evidence quantifying the relationship between aesthetic satisfaction and the technical lifespan of wood materials. Therefore, future research should conduct longitudinal studies or consumer behavior experiments that compare the retention of use between wooden products with standard designs and products that prioritize material honesty and traditional art values.

3.6. Research implications

Practically, these findings have implications for designers and the craft industry in integrating local wisdom and natural visual characteristics of wood into modern engineering technologies to suppress highly consumptive behaviors. For policymakers, this study suggests the need for a materiality assessment standard that includes cultural and emotional sustainability indicators beyond technical carbon efficiency. Further research needs to be directed toward the exploration of more inclusive methodologies to bridge the gap in

geographical focus, especially by including perspectives from the Asian region, which is rich in woodworking traditions but has not been maximally represented in the current global literature.

The economic, policy, and real application implications are based on a synthesis of data from 20 reviewed studies.

3.6.1. Economic impact and industrial transformation

The integration between aesthetics and engineering creates significant economic added value through the "green branding" and green market strategies.

- Product differentiation: Industries that adopt the concept of bio-aesthetics can position their products in the premium segment, as consumers are willing to pay relatively more for materials that have a cultural narrative and material honesty.

- Consumer loyalty: The furniture and interior industries can reduce customer retention costs by applying the concept of emotional durability. Emotionally "loved" products reduce the replacement rate, which, in turn, strengthens the brand's reputation as an environmentally responsible entity.

- Resource efficiency: The craft industry can maximize profit margins by employing fewer volumes of wood exhibiting higher intellectual and cultural value by switching from structural commodities to high-art value products (Adkins *et al.*, 2007; Viganò *et al.*, 2023).

3.6.2. Public policy implications

The results obtained in this study confirmed the need for governments and certification bodies to redefine sustainable material standards.

- Cultural-based material standards: Public policies should start integrating the "Cultural Life Cycle Assessment" indicator, wherein the certification of green materials is measured not only by technical carbon emissions but also by their contribution to the preservation of local

craft traditions (de Silva and Henderson, 2011; Elnaggar, 2024). Therefore, transdisciplinary collaboration between material engineers and craft designers is required to accelerate the reconciliation of art engineering methodologies at an industrial scale.

- Education and curriculum: The integration of the curriculum between the faculties of engineering and design arts is urgently needed to produce experts who can design the “soulful” materiality of the future.

3.6.3. Real application examples (design sector and built environment)

These findings can be applied to various sectors to bridge theory and practice (Table 5).

Notably, the connection between aesthetic implementation and prolonged lifespan is a conceptual framework based on a synthesis of the reviewed literature and requires further empirical validation.

4. CONCLUSIONS

In this review, we argued that the materiality of wood has shifted from a structural resource to a medium of cultural communication. A synthesis of 20 studies revealed that combining biophilic aesthetics with engineer-

ing performance fosters emotional durability, a psychological attachment that slows premature replacement and extends material life cycles. It proposes a new quality benchmark that bridges engineering with the arts and humanities, treating sensory resonance and cultural identity as functional variables, along with mechanical strength. Future research should decolonize materiality discourse by foregrounding Global South knowledge, especially from Asia and Indonesia, develop quantitative measures linking aesthetics and function, and mine archival gray and traditional craft sources.

Based on the results obtained in this study, we conclude that, theoretically, the integration of the aesthetic value of wood into engineering parameters can increase emotional durability. However, this causality validation still requires the support of behavioral data or measurable LCA data to prove the extent to which visual interest can quantitatively delay the disposal of wood products.

As a follow-up to this conceptual framework, future research is needed to provide measurable empirical evidence, such as LCA data, that compares wood products with standard aesthetics versus products with “material honesty.” Large-scale consumer behavior studies are also needed to quantify the correlation between aesthetic

Table 5. Concrete implementation in several sectors

Application sectors	Real implementation examples	Contributions of emotional durability
Architecture	Use of wooden facades with exposed fibre patterns that utilize modern weather resilience engineering	Providing biophilic tranquility for residents while ensuring long-term structural integrity
Interior	Acoustic wall panels that combine the technical precision of sound cancellation with natural texture carving of wood	Creates strong sensory memories, making the space feel more personal and meaningful
Furniture	A table or chair that retains the natural “text” of wood (natural edge/live edge) with precision mechanical joints	Material honesty prevents aesthetic boredom and psychologically prolongs lifespan
Contemporary crafts	Lifestyle products (watches, wooden glasses) that combine monel/ metal techniques with selected wood grains	Communicate the cultural identity of the wearer through a unique material agency

satisfaction levels and the duration of ownership of wooden objects in real time.

CONFLICT of INTEREST

No potential conflict of interest relevant to this article was reported.

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