SCIENTIFIC CULTURE

www.sci-cult.com

SCIENTIFIC CULTURE, Vol. 11, No. 3.1, (2025), pp. 539-554
Open Access. Online & Print

DOI: 10.5281/zenodo.11032542

THE USE OF BIO-BASED AND RECYCLED MATERIALS IN INTERIOR DESIGN: ENVIRONMENTAL PERSPECTIVES AND AESTHETIC QUALITY

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Received: 29/07/2025
Accepted: 01/08/2025

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ABSTRACT

The increasing demand for sustainability in design and construction has resulted in a transition towards the utilisation of bio-based and recycled materials in interior design. These accessories, derived from renewable resources or recycled materials, have considerable environmental benefits, including diminished carbon footprints, energy conservation, and waste minimisation. The aesthetic quality of these accessories is a vital factor in their disposal, as interior design emphasises sustainability, visual attractiveness, and practicality. This study examines the environmental viewpoints and aesthetic value of bio-based and recycled materials in interior design, seeking to evaluate their potential to harmonise ecological advantages with aesthetic superiority. The study evaluates the environmental consequences, aesthetic qualities, and disposal issues of these materials through a mixed-methods approach, which includes interviews with industry specialists, case studies, assessments, life cycle analysis (LCA), and sensitivity testing. The findings underscore the ecological advantages of bio-based and recycled materials, such as less carbon emissions and waste, while also examining their texture, colour, durability, and general aesthetic appeal in interior design. The investigation further delineates essential barriers to their extensive adoption, such as cost, availability, and consumer perceptions, and provides pragmatic suggestions for incorporating these materials into conventional design techniques. This study enhances the comprehension of how sustainable elements can transform interior design by providing both environmentally beneficial and visually appealing outcomes.

KEYWORDS: Bio-Based Materials, Recycled Materials, Interior Design, Environmental Sustainability.

1. INTRODUCTION

Recently, sustainability has emerged as a pivotal factor in design and building practices, with an increased focus on minimising environmental effect while upholding high standards of design. In response to escalating environmental concerns including climate change, resource depletion, and waste accumulation, the interior design industry has started to investigate essential material selections that conform to sustainable principles. Bio-based and recycled materials are increasingly recognised for their ability to provide ecological advantages and aesthetic value in interior design. Bio-based materials are derived from renewable resources, such as plant fibres, wood, bamboo, and cork, which not only diminish dependence on finite resources but also contribute to reduced carbon footprints and decreased environmental degradation. Additionally, recycled materials, such as plastics, metals, glass, and paper, are products of waste diversion, which aids in mitigating landfill pressure and diminishes the necessity for raw material extraction. [2]. The incorporation of these accessories in interior design has been a central topic of conversation among designers, environmentalists, and consumers, since they signify a viable solution for mitigating the environmental effect of interior environments. Although the environmental benefits of bio-based and recycled materials are widely recognised, their aesthetic quality in interior design continues to be a topic of ongoing discussion. Interior design encompasses not only sustainability but also the creation of aesthetically pleasing, practical, and comfortable environments for occupants. Consequently, the challenge is to ascertain whether bio-based and recycled materials can provide comparable aesthetic qualities, such as texture, colour, durability, and overall visual appeal, to conventional, non-sustainable materials like hardwood, marble, and synthetic fabrics. This investigation aims to connect sustainability with aesthetic superiority by analysing the performance of these elements from both environmental and aesthetic viewpoints in interior design contexts [5]. The interior design industry is increasingly adopting sustainable practices to minimise its environmental footprint, addressing global concerns such as resource depletion, climate change, and waste management. A burgeoning area of interest is the utilisation of bio-based and recycled materials as alternatives to conventional, resource-intensive materials in interior design schemes [6]. These accessories, derived from renewable sources or recovered waste materials, have the potential to substantially diminish the carbon footprint and overall environmental impact of interior spaces. Nonetheless, despite the esteemed environmental advantages, visual quality continues to be a significant consideration. Many designers and consumers are confused whether bio-based and recycled materials can fulfil the aesthetic, functional, and environmental standards required in interior design, sometimes linking sustainability with diminished design quality. The issue resides in the insufficient comprehension of how bio-based and recycled materials may harmonise environmental sustainability with aesthetic attractiveness in interior design. Although the environmental advantages of utilising these accessories are well-established, there remains a deficiency in research about their aesthetic attributes, including aspects such as texture, colour, durability, and overall visual cohesion within interior environments. Similarly, the abandonment of these accessories is impeded by concerns regarding their emptiness, expense, and efficacy, along with opposition from both designers and consumers who may choose aesthetics above sustainability. This study seeks to investigate the integration of bio-based and recycled materials into interior design while maintaining aesthetic integrity and evaluating their environmental advantages. The exploration will also examine the barriers to their abandonment, providing advice for design professionals and industry stakeholders on promoting a transition to more sustainable design methods [8]. The study seeks to examine the role of bio-based and recycled materials in interior design, focussing on their environmental impact and aesthetic value. As the globe progresses towards sustainability, design approaches are increasingly using ecologically friendly methods. Bio-based materials (such as bamboo, hemp, and cork) and reclaimed materials (such as recycled plastics, glass, and metals) are at the forefront of this movement. This study will analyse both the environmental advantages and the aesthetic concerns of utilising these items in interior settings. This investigation is crucial as it will quantify the environmental advantages of bio-based and recycled materials relative to conventional alternatives, providing empirical data to guide decisions made by designers, engineers, and manufacturers. This will facilitate the transition towards enhanced sustainable design practices, bolstering overarching aspirations of sustainability among the design and construction sectors.

1. How do bio-based and recycled accoutrements compare to traditional accoutrements in terms

of environmental sustainability (carbon footmark, energy consumption, waste reduction)?
2. What are the aesthetic parcels (texture, color, continuity) of bio-based and recycled accoutrements used in interior design?
3. What are the challenges and limitations in using these accoutrements in interior design, particularly with respect to cost, vacuity, and public perception?
4. How do bio-based and recycled accoutrements impact the perceived quality of interior spaces by druggies (i.e., comfort, attractiveness, and functionality)?

2. METHODOLOGY

This study seeks to evaluate the application of bio-based and recycled materials in interior design, emphasising indicators of environmental, social, and economic sustainability. This assessment evaluates the community's comprehension of the advantages, methodologies, and prospects associated with sustainable practices in interior design. The assessment addressed the knowledge level regarding bio-based and recycled materials. The sources of knowledge and optimal learning channels for the current and updated options of potential sustainable materials have been assessed. The significance of sustainability in interior design and the challenges communities encounter regarding the utilisation of bio-based and recycled materials have been incorporated into the evaluation. The expectations of future adaptability and trends of using sustainable materials have been studied. The role of different stockholders involved in practices, law, and awareness has been analysed in terms of promoting and fostering the sustainability of future interior design practices. Data describing the attitudes, problems, and behaviours of a small community sample have been acquired through a pre-designed questionnaire. The questionnaire aims to develop a general perception of respondents regarding their grasp of sustainability factors in interior design. The respondents were requested to answer and convey qualitatively their ideas in an accurate manner. The survey comprised of four primary components that explored specific sustainability dimensions and features of interior design. The first component develops a database of demographic and basic information of the respondents. This includes gender, age, level of education, perceptions and previous experiences of interior design techniques or concepts, and if respondents emphasise sustainability in interior design. 67% of responders were male and 68% are within the age of 25 and 44. The bulk of the respondents has Bachelor's degree or above and about half of the sample do not own house. Most of the respondents 93% feel use of bio-based and recycled materials in interior design is beneficial and essential for beter sustainability. However, the responders exhibit verity in their experiences in interior design methods. The second section of the survey analysed qualitatively the level of awareness and expertise of employing bio-based products and recycled materials in interior design. The questions have been developed to measure the extent to which respondents are grasping the concept of sustainability in interior design and knowing learning channels in this fields. This section boost understanding the level of interest of respondents in sustainability in interior design available ways used for find and explore the available bio-based and recycled materials used in interior design. This section examined prior experiences with bio-based and recycled materials in interior design. The subsequent inquiry sought to determine whether the respondents have participated in any training or educational program focused on sustainability in interior design. Respondents' opinions and impressions of their preferred methodologies and learning channels for sustainable practices in interior design. This section of the questionnaire enquired about the importance of incorporating sustainability concepts into interior design curricula across all academic levels. Experiences pertaining to sustainability in interior design are encapsulated in Figure 1. This figure depicts the distribution by gender, age, academic affiliation, educational background, home ownership, personal valuation of sustainability, and prior experience with bio-based and recycled products.

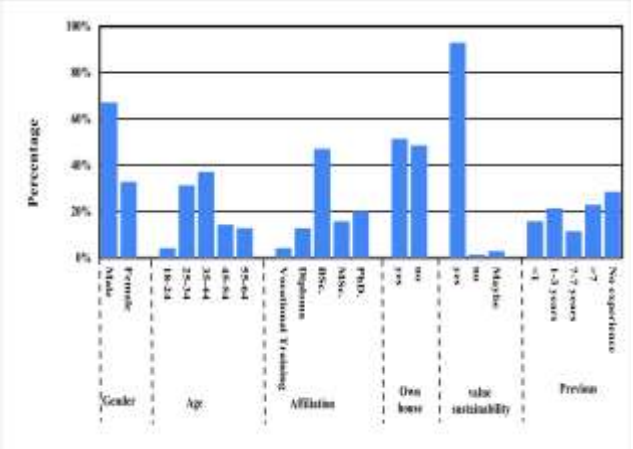

Figure 1: Respondents' Distribution by Demographics and Sustainability Experience in Interior Design.

The respondents' environmental thoughts and attitudes have been evaluated in the third section. Enquiries concerning environmental considerations and obligations related to sustainable practices in interior design are examined. Environmental problems and advantages of implementing sustainability in interior design through the utilisation of recycled and bio-based materials have been recognised. The responders were requested to specify the primary environmental advantages of utilising recycled and bio-based materials in interior design. The respondents were given the option to identify potential natural resources available for sustainable practices in interior design. The lists comprised five essential items for prospective sustainable practices in interior design. The materials comprise recycled glass, metals, wood, plastic, and textiles. Participants have been requested to enumerate recyclable materials that are accessible and may be utilised in interior design. Enquiries concerning the aesthetic appeal of utilising recycled and bio-based materials in interior design have been posed to the study sample to assess the degree of attraction. Respondents must evaluate the visual quality of bio-based and recycled materials relative to traditional products utilised in current operations. The respondents were asked to evaluate the future significance of aesthetic aspects (texture, colour, durability, variety, visual appeal) in the use of sustainable materials for interior design. The final segment examines whether the communities respond positively to the use of sustainable materials in their interior design decisions. This cultural inquiry identifies necessary procedures and policies for incorporating sustainable materials in future interior design projects and building educational channels and exchange platforms centred on sustainability in interior design. Obstacles and obstacles encountered by interior design techniques in incorporating bio-based and recycled materials. Respondents were requested to share their perspectives on the obstacles faced when utilising bio-based and recycled products. This will encompass problems related to availability, cost, quality index, restricted aesthetic possibilities, and expertise and experience. Anticipations concerning the future accessibility of recycled and bio-based materials, as well as their affordability relative to existing commodities utilised in interior design. The questionnaire included a component that examines future trends and adoption practices. The part comprised measurements of the significance of utilising sustainable materials in interior design and the motivating elements for their future application. These issues encompass availability, cost, experiences, alternatives, and environmental considerations. The section assessed the extent to which interior designers may implement sustainable techniques in their work and elevate awareness of sustainability in interior design.

3. RESULTS AND DISCUSSION

3.1. Awareness and Knowledge of Bio-based and Recycled Materials

3.1.1. Recycled Materials

The items include their reclaimed materials, such as paper, glass, plastic, metal fragments, and discarded tires. The most recyclable materials are those left in a relatively pristine state, allowing them to be melted and used into new valuable products. Among the least recyclable materials are combined polymers or components that cannot be separated.The chemistry of certain polymers is such that those previously created from monomers cannot be dissolved and reconstituted into another functional form. We categorise these items into three classifications [9]. The initial category of recycled materials consists of non-retail rudiments employed in diverse manners to obstruct recycling. Wood serves as a prevalent illustration. It is both feasible and advantageous to salvage the wood fragments employed in similarly compromised structures. The letter exemplifies this class effectively.Paper fibres possess characteristics that facilitate recycling and can be processed up to five times. More than one-third of global paper goods are recycled, and this figure is projected to exceed fifty percent in the coming decades. Paper recycling is primarily motivated by the growing necessity for waste paper storage rather than the demand for wood to produce virgin paper. Factors complicating paper recycling include adhesives, coatings, caps, grease, and various pollutants, along with tendons containing recycled paper fibres that are more elongated, less robust, and drier than new fibres. - derived from trees [10].

The basic elements composed of material and possessing limited global reserves constitute the secondary tier of recyclable materials. Examples of these elements are platinum, chromium, and the complete category of precious materials. Offering numerous recycling chances, especially through costly methods, appears to mitigate the depletion of these compounds' natural resources in the foreseeable future. Appliances and corridors akin to the aforementioned ministry's corridor constitute the third category of items to consider in recycling (the category of material). These passages are often repaired and repurposed; indeed, if this is not

possible, the deposits for these artefacts serve as a stimulus for recycling.

3.1.2. Plastics Recycling

Plastics have emerged as a substantial problem in municipal waste management since World War II.Significant plastics have poor biodegradability and serve as a substantial contribution to solid waste in areas where debris is collected post-biodegradation of other contaminants.Extracting plastics from municipal solid waste is a feasible undertaking because to the diverse composition, pollutants, constituent colours, and other attributes. In comparison to recovery technologies for other accessories from the past fifty years, post-consumer recycling technology has advanced more rapidly. High-viscosity polyethylene (HDPE) and polyethylene terephthalate (PET) post-consumer products have been considered recyclable only in the past five years. The need for these two products, specifically clean PET and HDPE milk bottles, has become substantial. The plastic request is underdeveloped between recycling requests due to delayed recycling capabilities. Nonetheless, numerous plastics are processed through rolling, carpeting, chopping, or whisking before to being sold to transformers. The two types of plastics substantially influence recycling. Upon heating, thermoplastics transition to a fluid state, and upon cooling, they revert to a solid form. Thermoplastics are predominantly recyclable, as they can be repeatedly heated, melted, and reshaped. Polyvinyl chlorides (PVC) and polyblends (polyethylene and low and high viscosity polypropylenes) exemplify recycled thermoplastics utilised extensively in the production of plastic tubes, household items, and other durable accessories. Terephthalate, polystyrene, and polyethylene. The predominant material in plastic packaging is thermoplastic, which is potentially recyclable. Thermoplastics constitute the largest proportion of commonly recycled plastics. Plastics that form bonds between polymeric units upon heating are referred to as thermo-resistant plastics. These bonds confer rigidity to polymers, which do not plasticise upon heating. Thermoresistant polymers can be incinerated to generate heat, despite their inability to be recycled. Epoxy resins, a notable category of thermosetting plastics, are characterised by an oxygen atom positioned between two neighbouring carbon atoms (1,2-epoxide or oxirane). Epoxides are commonly employed in composite materials alongside graphite or glass fibre [13]. Additional thermosensitive plastic components encompass silicones, some polyesters, and phenolic crosslinked polymers. Considering plastic pollutants is essential. For instance, paint applied to plastic objects is a prevalent contamination, and numerous dressings may include adulterants. Heating plastics for recycling may compromise the integrity of the reclaimed materials or generate gas.

SKIN

Furthermore, the skin is recyclable. Significant quantities of leather and rubber are manufactured from previously synthesised polymers and stored in multiple places. A hydrocarbon polymer, synthetic leather, and rubber may also have supplementary components that mimic black padding carbon. Specific skins can be obtained and interred [15]. The iron rings present in numerous radial tires provide a considerable obstacle in the incineration and reclamation of leather and tires. Conveyor systems and shredding machinery are impeded by iron in recycling and combustion operations.

CARDS

A network of original processors and officials engages in the buying and selling of corrected letters and generated documents, then placing these things on the market and importing them to paper enterprises. Furthermore, factories acquire accessories directly from collectors. Classified review papers, corrugated cardboard, mixed papers (journals, jars, and boxes of cards), high-grade decolorised paper (white service paper), and dough cover (often thick cardboard) are all classified as regenerated paper. The advancement of improved paper manufacturers involves utilising raw resources to produce recycled paper and paper goods, including newsprint, cardboard scraps, standard paperboard, and financial letterheads. The subsequently manufactured dough paste, hydro-products, animal layers, and cellulose insulators or protectors can all be derived from shredded paper [16].

GLASS

Demands for recycled glass yield negligible pollution. The primary objective of the recycling program organisers should be the superior quality of recycled glass. Glass is required for window panes, protective coatings, artistic glasswork, beach applications, post-industrial melting, and asphalt production. Requests for advanced glass pertain to transparent packaging and brown glass.

METALS

Laminating, bundling, and shredding are processes employed to prepare ferrous and non-ferrous materials for commercial purposes. In the last century, recycled essence has been exported and utilised for domestic uses via a well organised and

anticipated network of treatment and recycling. Buses, home appliances, vibrant apparel, islands, and many iron and sword artefacts exemplify relics of iron. Aluminium, bobby pins, lead, barrels, and precious materials are examples of non-ferrous waste. By integrating the processes of rolling, bending, and shearing, iron and non-ferrous metals can be prepared for commerce upon demand. Prior to fulfilling the final request, instructors periodically melt iron in moulds or moulds [17].

3.1.3. C. Recycling in Interior

Reclaimed accessories are repurposed as raw materials for products, with the primary objective of determining the chemical composition or constituents of the material. Consequently, a primary prerequisite for recycling is that materials be as clean, durable, and less contaminated as possible; for instance, crushed masonry free from any wood or plastic elements. Accessory recycling is not conducted at the construction site, except for the crushed aggregate utilised in concrete production. Beyond construction, wood, plastics, and essence can be recycled in industrial or synthetic companies. The initial and subsequent utilisations of recycled accessories should remain unconnected. Automobile tires can be employed for acoustic insulation, plastic bottles can be repurposed into drainage pipes, and vintage window frames can be transformed into kitchen cabinets. Recycled materials employed in construction products may have been sourced externally from the construction site, and reclaimed equipment from a deconstructed structure or construction debris may be retrieved and utilised externally as well. Various materials and products present distinct circumstances in which recycling may be a feasible alternative. Since the product's launch, numerous prominent directors have adopted the reclamation of post-industrial trash as a common practice. The created waste accessories are employed to manufacture plasterboard walls for interior use and can be recycled back to the facility. Plasterboard surplus returned from the plant structure point and reintegrated into the production process is recycled differently. The execution of this task is contingent upon the cleanliness of the material [18].

WOOD

Wood is employed in various structural components and construction materials. It is utilised in a diverse array of vibrant shapes that differ from structural wood, which may be centuries old, as well as in contemporary items such as chipboard and fibreboard, which consist of little wood fragments bonded by resin adhesive. Wood products serve multiple functions, including the construction of robust shafts and ceilings, as well as the fabrication of basic components such as rails. The facility is conducive for exercise and recovery due to the extensive use of wood in its construction and its accessibility. Like plywood, a substantial proportion of all engineered wood products utilised in construction is derived from wood, which is employed to mould concrete. The dimensions of wood holes in construction can vary considerably based on the type of wood product and its intended use. During the deconstruction or demolition process, softwood is significantly more susceptible to damage. Nevertheless, recovered wood has numerous alternatives for utilisation and restoration. Its shape determines its application as either structural or non-structural wood for exercising; it can be utilised for shutters and concrete casting; it can be repurposed for kitchenware or cabinetry; it may also be recycled akin to rustic freight and employed as an enhancer [19]. Figures 2 and 3 demonstrate that salvaged wood has been successfully repurposed in contemporary interior applications, including kitchen furniture and work desks, showcasing its versatility and aesthetic appeal.

Figure 2: Kitchen with Recycled Wood. Source: https://www.interiorrecycling.com.

Figure 3: Recycled Work Desk with Recycled. Source: https://www.interiorrecycling.com.

3.1.3. D. Repurposed Pallets and a Desk Made of Recycled Paper

Old wood, often superior in quality to contemporary wood, is typically characterised by

minimal defects and is accessible in various sizes, lengths, and compositions that are difficult to produce from sustainable sources today. Figure 4 demonstrates that used wood pallets may be creatively utilised to build elegant and sustainable bedroom furniture, showcasing the functional and aesthetic capabilities of recycled materials.

Figure 4: Bedroom with Recycled Pallets. Source: https://www.interiorrecycling.com.

The newest interior trend is now the use of recycled pallets.

To assess minerals and their products in installations, all substances must withstand significant energy. In comparison to non-metallic building accessories, this results in increased expenses. It is frequently straightforward to differentiate essence from other components and from each other. Some elements can be easily extracted from mixed trash; for instance, electromagnetic methods can isolate iron and steel, while other electromagnetic procedures can separate aluminium and other materials. Figures 5 and 6 illustrate the innovative repurposing of recycled metal components in interior furnishings and decor, including coffee tables and wall finishes, highlighting the aesthetic and functional possibilities of metal recycling in interior design.

Figure 5: Coffee Table Made from Metal Parts of an Outdated Tractor.

Figure 6: The Coffee with Metal Flooring Source: https://www.interiorrecycling.com.

A fluidised bed that segregates materials by viscosity can frequently be employed to separate substances from one another and from other materials. Ultimately, essence can be readily retrieved by melting it in essence furnaces. Consequently, only a restricted quantity of essence—albeit substantial—reaches the storage facilities; this encompasses essence primarily linked to other low-value accessories that induce non-economic segregation, such as featherlight bias and specific composite panel products [21]. Figure 7 illustrates the excellent integration of recycled steel components into contemporary bar interior designs, merging sustainability with industrial aesthetics.

Figure 7: Recycled Steel Bar. Source: https://www.interiorrecycling.com

The essence packages have been completely reinstated in their physical and chemical states during the melting process, though not always seamlessly. The finished product, and thus the essence derived, is fundamentally novel and can be perpetually retrieved. There are two categories of essence: ferrous and non-ferrous. Chromatic Ferrous Essence Ferrous essence encompasses wrought iron, cast iron, soft steel, high-carbon steel, corrosion-resistant steel, high-elasticity steel, and numerous

more iron alloys. Examples of various bonding include a composition of at least 80% iron and up to 5% carbon. Additional elements such as boron, chromium, manganese, and others constitute the remaining possibilities. [23]. Swords generally provide significant utility for recycling or physical training. The division of the structural sword into regular passageways constitutes one interpretation. This suggests that the employment of the opposite hand is likely forthcoming. Moreover, sword components can be repurposed in systems featuring dynamic interiors and exteriors, serving as structural shafts in buildings. The reutilization of sword shafts and columns offers considerable environmental advantages by conserving energy in two ways: initially, through the energy expended to remelt the sword in a roaster, and subsequently, by reducing the energy necessary for the production of new swords. [24].

3.1.4. Tintless Non-ferrous Essence

Bobby, brass, aluminium, zinc, drum, and lead possess significant recycling possibilities due of their superior value relative to ferrous materials. Nonetheless, the utilisation of non-ferrous recyclable materials in sword production follows a like narrative. A little quantity of essence is squandered, and the demand for fresh essence surpasses the supply of utilised essence. Despite the amalgamation of virgin essence with recycled essence, a market for it persists [25]. Figure 8 illustrates the integration of recycled materials, such as glass, with contemporary workplace designs, highlighting sustainability and aesthetic sophistication.

Figure 8: Office with Recycled Glass.
Source: https://www.interiorrecycling.com

There are three primary types of lustre that may be utilised for glass processing and recycling, ranging from windows to a singular distance of glass and glass panels made of toughened or laminated glass from facade or dressing systems. The necessity for enhanced thermal and acoustic insulation in building construction represents the most challenging hurdle to surmount, apart from the potential for damage. This indicates that the thermal performance criteria are unlikely to be satisfied just by the 4- to 6-mm glass waste. Binary-glass devices may be disassembled, emptied, and reassembled as necessary to facilitate proper sequestration [26]. Figures 9 and 10 illustrate the practical use of recycled glass and plastic materials in interior applications, including sinks and countertops, merging environmental sustainability with contemporary design.

Figure 9: Recycled Glass Sink.
Source: https://www.interiorrecycling.com

Figure 10: Furniture Made of Recycled Plastic.
Source: https://www.interiorrecycling.com

The potential for accidents during the disposal process poses a considerable challenge to the management of glass waste. Reclaiming glass waste is seldom economically viable, as the volume of glass designated for recycling or reclamation is frequently inadequate to warrant the expense of processing. This may alter if structures that have embraced the recent trend of extensive glass facades chose to rebuild or repair their compromised façades. The potential for errors throughout the disposal process poses a considerable challenge to the management of glass waste. Reclaiming glass waste is seldom economically viable, as the volume of glass

designated for recycling is frequently inadequate to warrant the expenses associated with processing a separated product. This may alter if structures that have embraced the contemporary trend of expansive glass façades chose to rebuild or repair their compromised façades [27]. Glass is among the most straightforward materials to reclaim, however its reprocessing necessitates substantial energy. Furthermore, recycled glass can be utilised in numerous applications. The majority of recycled glass is shattered and utilised in the production of fibreglass insulation or new glass containers. The construction sector utilises numerous identical goods. Figure 11 demonstrates that recycled plastic may be employed to manufacture durable and visually appealing furniture, such as chairs, showcasing the material's versatility beyond conventional applications.

Figure 11: Chairs Made Entirely of Recycled Plastic. Source: https://www.interiorrecycling.com

Polymer The construction industry significantly contributes to plastic consumption, representing over 25% of total usage, and it fluctuates mostly with the packaging sector. Although some plastics are non-recyclable due to their chemical composition, many are recyclable, and the plastics industry is actively advancing the recycling sector. Products derived from recycled plastics include geotextiles, land conservation materials, sequestration devices, window frames, roofing accessories, assorted coloured pipes and tubes, cabinetry panels, carpets, penstocks, various flooring options, road and outdoor cabinetry and accessories crafted from plastic timber, synthetic surfaces for sports fields, and walls and acoustic barriers constructed from recycled rubber tires. Albina has presented her preliminary work on the interior application of repurposed accessories as follows [29].

3.1.5. Case Study Example: The Earthship Biotecture Design (New Mexico, USA)

The Earthship Biotecture design, created by Michael Reynolds, is an innovative sustainable housing style that incorporates natural and recyclable materials in unique ways to generate self-sufficient houses. The Earthship design, situated in Taos, New Mexico, exemplifies the use of bio-based and recycled materials in interior design and construction to tackle environmental challenges while enhancing aesthetic appeal. This case study examines how Earthship homes exemplify sustainable ideals via their distinctive design, material choices, and the environmental and aesthetic advantages they provide [30].

3.1.6. Design Background

Earthships are resilient solar residences constructed with an emphasis on resource efficiency, utilising off-grid solutions for energy, water, and waste management. The design incorporates bio-based and recycled materials in both the construction and the interior to reduce environmental effect. The Earthship community in Taos, New Mexico, exemplifies the integration of sustainable architecture into practical environments, providing a functional and aesthetically pleasing living area that harmonises with nature. Figure 12 illustrates that Earthships demonstrate the integration of recycled and natural materials into off-grid living designs, demonstrating sustainable architecture that is both environmentally benign and aesthetically appealing.

Figure 12 South and East View of an Earthship Passive Solar House. Source https://en.wikipedia.org/wiki/Earthship

The Earthship Biotecture design exemplifies sustainable architecture and interior design through the use of bio-based and recycled materials. Earthships are autonomous residences constructed from natural and repurposed materials, including tires, barrels, glass bottles, and earth-derived

substances. The interior design of these residences embodies a synthesis of functionality, environmental sustainability, and artistic aesthetics. Figure 13 exemplifies the Earthship design, showcasing the integration of passive solar principles, recyclable materials, and smart zoning into a unified architectural framework.

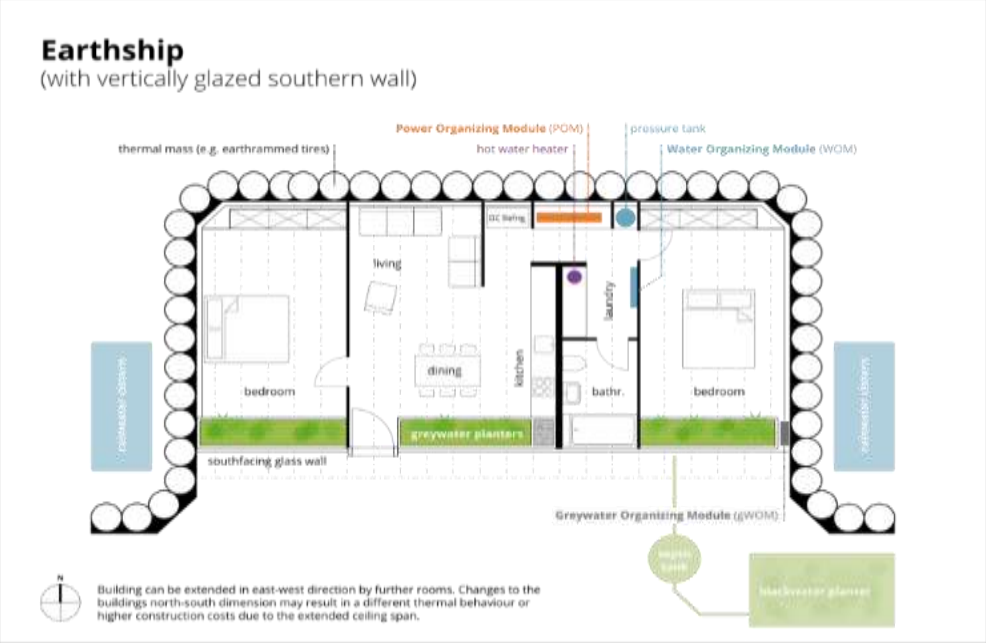

Figure 13: South and East View of an Earthship Passive Solar House. Source https://en.wikipedia.org/wiki/Earthship

3.1.7. D. Environmental Perspective

The building of Earthships fundamentally depends on recycled materials, particularly reclaimed elements like tires for structural support, aluminium barrels, and glass bottles. Tires are filled with compacted soil to create thermal mass walls that assist in the natural regulation of indoor temperatures. The utilisation of recycled materials reduces waste and repurposes goods that would otherwise be disposed away, hence endorsing the concept of indirect frugality. Figure 14 illustrates that Earthship structures are predominantly earth-sheltered edifices characterised by expansive south-facing windows and repurposed tires to enhance insulation and solar gain.

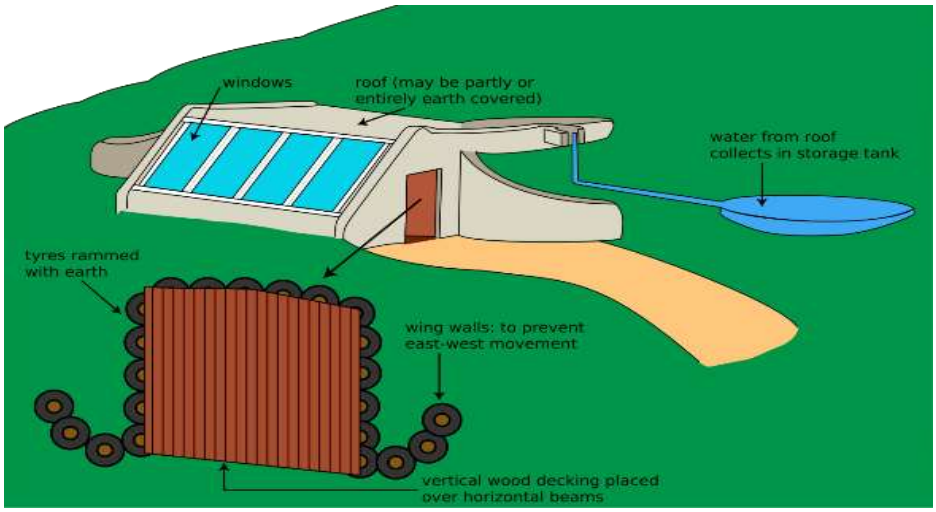

Figure 14: Most Earthship Structures are Earth-sheltered Buildings with a Large Series of Windows and Used Tires.

Source: https://en.wikipedia.org/wiki/Earthship.

1) **Energy Efficiency** The utilisation of natural materials such as adobe and soil in building, along with creative design methods, guarantees that Earthships are energy-efficient. The passive solar design reduces energy usage, with the interior temperature regulated by the thermal mass of the walls.
2) **Water Conservation** The incorporation of bio-based materials, in conjunction with rainwater harvesting systems and greywater recycling, diminishes water consumption, rendering these residences environmentally sustainable and resource-efficient.
3) **Natural Textures** The utilisation of natural materials such as adobe, stone, and wood fosters a warm, organic look. These accessories evoke a link to nature and a timeless quality, rendering the interior space tranquil and composed.
4) **Cultural Expression** The utilisation of recycled materials, such as glass bottles and aluminium cans, adds distinctive textures and vivid colours to interior design. The configuration of these accessories produces a visually impressive, yet sustainable, indoor landscape that embodies creativity and ecological responsibility.
5) **Custom Design** Due to the local sourcing and repurposing of many materials utilised in Earthship interiors, each residence possesses an own look. The creative possibilities are extensive, enabling designers and homeowners to imbue every aspect with specific cultural significance. Figure 15 illustrates that Earthships utilise natural convection cooling systems, showcasing how intentional passive design may enhance energy efficiency and indoor comfort.

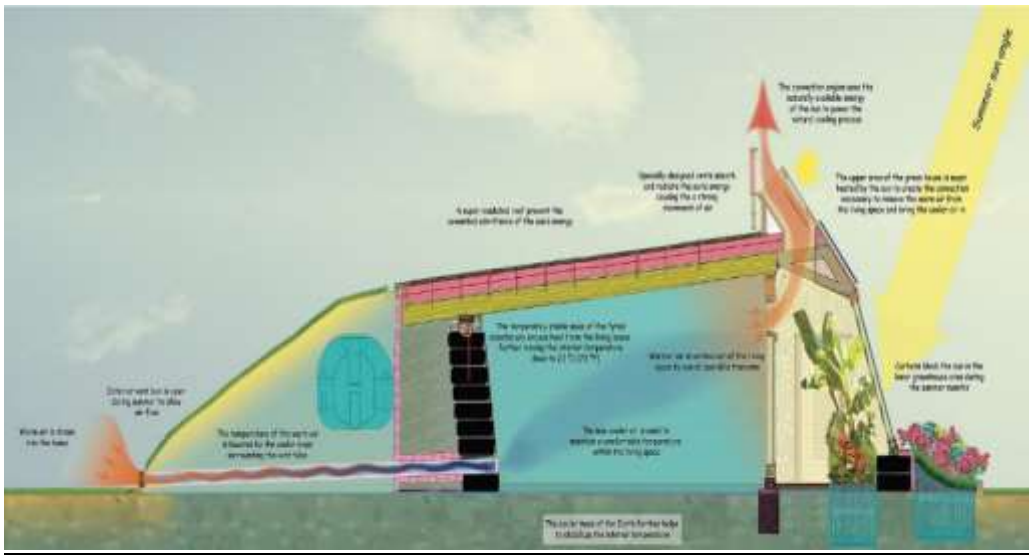

Figure 15: Natural Convection Cooling an Earthship.
Source: https://en.wikipedia.org/wiki/Earthship

3.1.8. Challenges and Results

3.1.9. Material Vacuity

The utilisation of bio-based and recycled materials may be constrained by initial availability and supply chains. To address this difficulty, Earthship designers often utilise locally sourced materials or recycle materials found on-site, ensuring sustainability and minimising transportation expenses. Continuity and Efficacy although certain bio-based accessories may be seen as less durable or wear-resistant, innovative treatments and methods have improved their longevity. Bamboo and cork, once deemed delicate, are now employed in flooring and cabinetry designs with enhanced continuity. Aesthetic Constraints Certain recycled accessories, such as those made from plastic or rubber, may possess limited aesthetic appeal. Nevertheless, intentional design integration and innovative methods can transform these accessories into visually appealing elements, as evidenced by the diverse enhancements in Earthships.

4. EMPIRICAL DATA ANALYSIS

4.1. Questionnaire

Do you have previous experience with interior design processes or mechanisms?

The responses to this question are summarized in Table 1 which show the distribution of participants based on their previous experience in interior design processes or mechanisms.

Table 1: Percentage of Responses Regarding Previous Experience with Interior Design Processes or Mechanisms.

No	More than 7 years	4-7 years	1-3 years	Less than 1 year	
28.6	22.9	11.4	21.4	15.7	% of responses

As shown in Figure 16, approximately 28.6% of respondents reported having no previous experience with interior design processes or mechanisms, highlighting the importance of educational exposure in this field.

Figure 16: Distribution of Responses Based on Experience in Interior Design; 28.6% of Respondents Reported Having no Prior Experience.

The responses to this question are presented in Table 2 and visualized in Figure 17, showing that 95.6% of respondents consider the use of sustainable materials in interior design valuable, while 3.2% do not and 1.2% remain uncertain.

Table 2: Percentage of Responses Regarding the Value of Using Sustainable Materials in Interior Design.

May be	No	Yes	
1.2%	3.2%	95.6%	% of responses

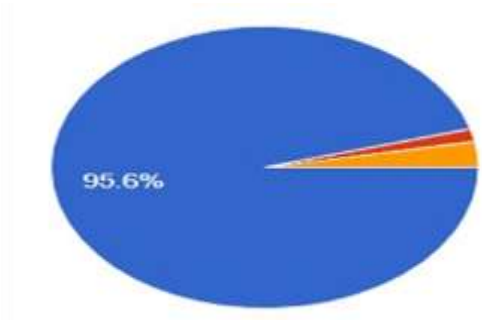

Figure 17: Distribution of Participants' Views on Using Sustainable Materials in Interior Design.

In response to the question about the most important environmental challenges facing interior designs that use recycled or naturally derived materials, the data presented in Table 3 and Figure 18 reveal that 54.3% of respondents identified Indoor Air Quality as the most critical issue. This was followed by Waste Management (50%), Energy Consumption (47.1%), and Resource Depletion (42.9%), while only 4.3% selected "Other" factors.

Table 3: Percentage of Responses Identifying Key Environmental Challenges in Interior Designs Using Recycled or Naturally Derived Materials.

Other	Resource depletion	Toxic substances	Indoor Air Quality	Energy consumption	Waste management	Carbon emissions	
4.3	42.9	41.4	54.3	47.1	50	41.4	% of responses

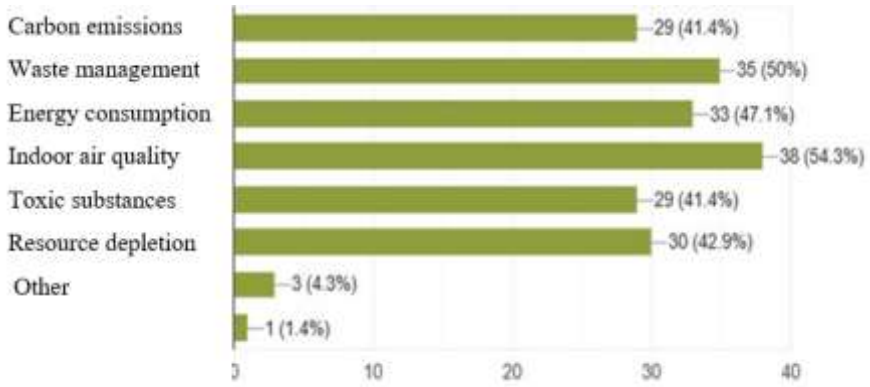

Figure 18: Distribution of Environmental Challenges Reported by Participants, with Indoor Air Quality Ranked as the Most Significant.

In relation to the primary environmental advantages of recycled and naturally obtained materials in interior design, the statistics presented in Table 4 and Figure 19 indicate that 75.7% of respondents recognised the conservation of natural resources as the most substantial benefit. This was succeeded by waste reduction (68.6%), energy consumption reduction (50%), and carbon emissions reduction (45.7%), with merely 4.3% opting for "Other."

Table 4: Percentage of Responses Identifying Environmental Benefits of Recycled or Naturally Sourced Materials in Interior Sesign.

Other	Conserving natural resources	Reducing energy consumption	Reducing waste	Reducing carbon emissions	
4.3	75.7	50	68.6	45.7	% of responses

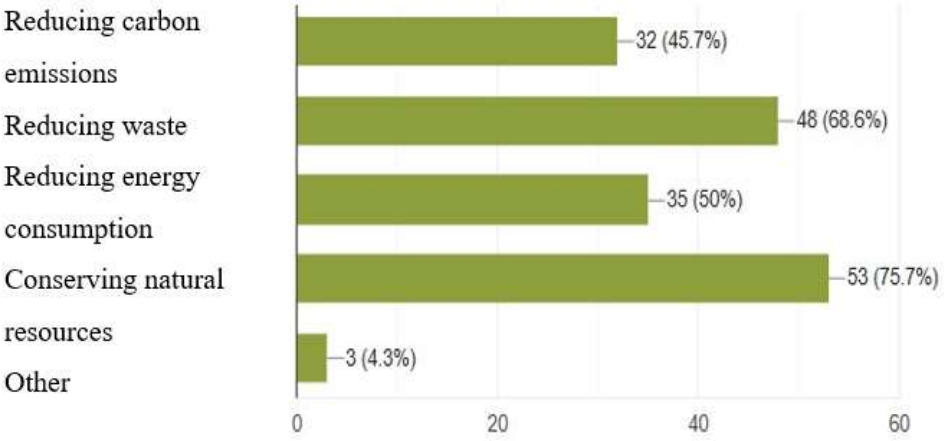

Figure 19: Distribution of Responses Regarding Environmental Benefits, with Conserving Natural Resources Ranked Highest.

In response to the question about natural materials used or recommended in interior design, Table 5 and Figure 20 show that 88.6% of participants reported using wood, making it the most commonly preferred material. This was followed by natural stone (64.4%), glass (54.4%), and clay/mixed clay (54.3%), while 10.1% indicated other materials.

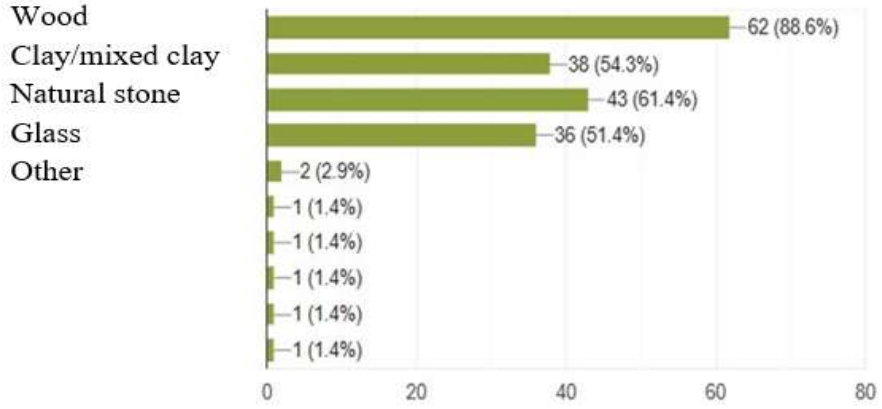

Figure 20: Distribution of Responses Indicating Preferred Natural Materials, with Wood Being the Most Common.

Table 5: Percentage of Responses Regarding Natural Materials Used or Recommended in Interior Design.

Other	Glass	Natural Stone	Clay/Mixed Clay	Wood	
10.1	54.4	64.4	54.3	88.6	% of responses

Regarding the biggest concerns when securing natural or recycled materials for a project, the results in Table 6 and Figure 21 indicate that cost was the primary concern for 27.1% of respondents. This was followed by limited availability (22.9%) and material performance (18.6%). In contrast, only 12.9% of respondents identified aesthetic limitations as a concern, making it the least cited issue.

Table 6: Percentage of Responses Regarding Concerns When Securing Natural or Recycled Materials for a Project.

Other	Aesthetic limitations	Acceptability	Material performance	Cost	Limited availability	
22.9	12.9	17.1	18.6	27.1	22.9	% of responses

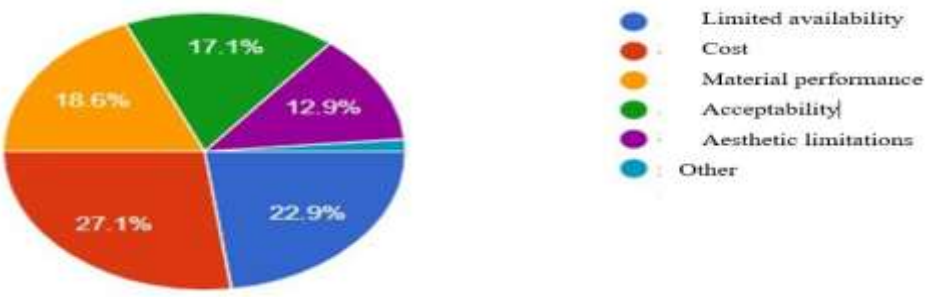

Figure 21: Distribution of Major Concerns, with Cost Identified as the Most Significant.

5. CONCLUSION

This exploration seeks to emphasise the role of bio-based and recycled materials in defining a sustainable future for interior design, highlighting their environmental and aesthetic benefits. Through this exploration, designers and engineers can adopt further sustainable design techniques that help protect the environment and meet visitors' desires for aesthetically pleasing and creative venues.

Acknowledgment: We thanks Ajloun National University for making this work possible.

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