Research Article

A Model Proposal for the Selection of Interior Covering and Insulation Products Produced from Waste Materials


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Abstract: The increasing amount of waste associated with industrialization and rising consumption contributes to air, water, and soil pollution, biodiversity loss, climate change, and serious human health problems, ultimately leading to a decline in quality of life. Furthermore, the inadequacy of landfill capacity and the presence of toxic waste disrupt ecosystem balance and accelerate the depletion of natural resources. In this context, recycling waste materials and incorporating them into building materials used in the construction industry is of critical importance for achieving sustainability goals. However, a review of the existing literature reveals that studies addressing interior finishing products produced from waste materials and their application remain limited. In response to increasingly pressing environmental challenges worldwide, this study proposes a systems-based model for selecting interior covering and insulation products produced from waste materials. The model developed within this framework is based on the use of agricultural and construction waste, which constitute a significant share in terms of both quantity and type, as covering and insulation materials among interior finishing products used in interior applications. The model is structured through a holistic approach that includes the analysis of the most suitable waste materials, their integration into the design stage based on analytical findings, and the implementation processes of the resulting materials. In particular, the evaluation of agricultural and construction waste as covering and insulation materials offers solutions aligned with green design principles by combining functionality and aesthetics. Based on data obtained from the literature, strategies that guide and facilitate the selection process have been identified, and economic advantages have been evaluated alongside environmental benefits. This study aims to promote the use of waste materials in the selection of interior covering and insulation products, raise awareness regarding their adoption within relevant industries, and provide a resource to guide designers in decision-making processes. Furthermore, it is expected to contribute to policies and regulations that encourage the use of waste materials in the construction industry. With the proposed model, it is anticipated that both environmental and economic benefits can be considered, that designers can be better informed during the interior design stage regarding the selection of interior covering and insulation products produced from waste materials based on appropriate criteria, and that environmental impacts can be reduced while improving resource management.

Keywords: Waste materials, İnterior covering products, interior insulation products, agricultural wastes, construction wastes, material selection model.

Atık Malzemelerden Üretilen İç Mekan Kaplama ve Yalıtım Ürünlerinin Seçimi İçin Bir Model Önerisi

Özet: Sanayileşme ve tüketim artışıyla birlikte artan atık miktarı, doğal kaynakların tükenmesine ve yaşam kalitesinin düşmesine neden olmaktadır. Bu bağlamda, atık malzemelerin geri dönüştürülerek yapı sektörüne entegre edilmesi, sürdürülebilirlik hedefleri açısından kritik bir öneme sahiptir. Ancak mevcut literatür incelendiğinde, iç mekân bitiş ürünleri kapsamında atık malzeme kullanımının oldukça sınırlı olduğu görülmektedir. Çalışmanın amacı, küresel bağlamda artan çevresel sorunların etkisi doğrultusunda, binalarda atık malzemelerden üretilebilecek iç mekân kaplama ve yalıtım ürünlerinin seçimine yönelik sistem yaklaşımıyla tasarlanmış bir model önerisi sunmaktadır. Bu kapsamda geliştirilen model önerisi, atık miktarı ve türleri incelendiğinde, yoğunluk arz eden tarımsal ve inşaat atıklarının iç mekân uygulamalarında, iç mekân bitiş ürünlerinden; kaplama ve yalıtım malzemesi olarak kullanımını esas almaktadır. Model, atık malzemelerin seçimi için analiz, tasarım aşamasına entegrasyonu ve uygulama aşamalarını içeren bütüncül bir yaklaşımla yapılandırılmıştır. Özellikle tarımsal ve inşaat atıkların kaplama ve yalıtım malzemesi olarak değerlendirilmesi, işlevsellik ve estetiği birleştirerek yeşil tasarım ilkeleriyle uyumlu çözümler sunmaktadır. Literatür taraması yoluyla elde edilen veriler doğrultusunda, seçimi yönlendirmeye ve kolaylaştırmaya yönelik stratejiler belirlenmiş; çevresel faydaların yanı sıra ekonomik avantajlar da değerlendirilmiştir. Çalışma ile iç mekân kaplama ve yalıtım ürünlerinin seçiminde atık malzemelerin kullanımının yaygınlaştırılması, ilgili sektörlerde atık malzeme kullanımının benimsenmesine yönelik farkındalık yaratacak ve karar aşamasında tasarımcılara yol gösterecek bir kaynak oluşturulması amaçlanmaktadır. Ayrıca, atık malzemelerin yapı sektöründe kullanımını teşvik eden politika ve düzenlemelerine katkı sağlayacağı düşünülmektedir. Bu doğrultuda geliştirilen model önerisiyle hem çevresel hem ekonomik faydaların gözetilebileceği, iç mekân tasarımı aşamasında tasarımcıların, uygun ölçütlere göre atık malzemeden dönüştürülmüş iç mekân kaplama ve yalıtım ürünlerinin seçimi konusunda bilinçlendirileceği ve çevresel etkilerin azaltılarak kaynak yönetiminin iyileştirilebileceği düşünülmektedir.

Anahtar kelimeler: Atık malzemeler, iç mekân kaplama ürünleri, iç mekân yalıtım ürünleri, tarımsal atıklar, inşaat atıkları, malzeme seçim modeli.

1.INTRODUCTION

Rapid population growth and the increase in construction activities driven by rising demand are among the primary causes of the depletion of natural resources. As of 2025, the world population stands at 8,218,187,542, while Türkiye’s population is reported to be 87,643,318 [1]. The growing population and increasing demand for resources disrupt ecosystem balance by causing environmental problems such as water and air pollution. The escalation of these environmental issues has made the importance of sustainable architectural practices more evident. In this context, the use of building materials derived from waste in interior design contributes significantly to resource efficiency and environmental sustainability [2]. Worldwide, approximately 2.1 billion tons of municipal solid waste are generated each year, and in low-income countries only about 40% of this waste is properly disposed of. Waste management is directly related to sustainable development goals, and the global amount of waste is projected to reach 3.782 billion tons by 2050 [3]. These data highlight the importance of reducing resource consumption and developing robust waste management strategies, along with their consistent and effective implementation.

Population growth, rapid urbanization, and industrial development in Türkiye increase the amount of waste generated, thereby underscoring the need for appropriate disposal methods, production and consumption practices that generate less waste, and the implementation of effective environmental policies [4]. Waste refers to materials that have become unusable due to environmental, economic, or functional reasons but still possess the potential to be recycled or reused. Waste management is of critical importance in reducing environmental pollution and ensuring environmental sustainability. In the literature, waste types are classified in various ways and include categories such as glass, electronic, paper, radioactive, industrial, medical, construction, organic, inorganic, plastic, metal, chemical, healthcare, nuclear, composite, and oil waste [2, 5, 6].

When studies on waste generation and management are examined, waste quantities are observed to vary across categories, with construction waste and agricultural (organic) waste accounting for relatively higher proportions. According to 2020 data from the European Statistical Office, 37.1% of the total waste generated in European Union countries originates from construction activities, making the construction industry the largest waste-producing industry. Construction waste, composed of materials such as concrete, iron, glass, plastic, and domestic appliances, represents a major environmental concern due to both the intensive consumption of natural resources in their production and the large volumes of waste generated. On the other hand, according to the Municipal Waste Statistics Survey conducted by the Turkish Statistical Institute (TÜİK) in 2016, nationwide municipal waste data indicate that biological waste accounts for the largest share at 55.54% compared with other waste types. This situation highlights the importance of the sustainable management of agricultural waste with high recycling potential and emphasizes that the use of biological waste in next-generation material production and agricultural waste management processes can provide both environmental and economic benefits [7, 8, 9, 10, 11].

Çüçen and Altuncı (2022) state that recycled materials such as concrete, metal, and glass are primarily used in foundations, fillings, and structural systems, whereas their integration into interior design remains limited due to aesthetic criteria and health-related constraints. Similarly, in the study conducted by Akyıldız (2020), the contribution of recycled materials to architectural design was examined through ten building examples; the acquisition methods of these materials, their locations of use, and their roles in design were analyzed through diagrams. Although Akyıldız argues that waste-based materials can provide originality and environmental benefits in interior spaces, the study also emphasizes that their practical applications remain limited. The article in Yapı İnşaat Dergisi (2025) and Akyıldız (2020) further underline that recycling rates in interior design remain below 10%, mainly due to criteria such as aesthetics, health considerations, and user perception. These findings clearly demonstrate that the evaluation of waste-based materials as interior finishing products in interior design has not yet become widespread [7, 12, 10, 13, 14, 34].

Literature reviews indicate that waste materials are predominantly used in rough construction processes; however, despite the high volume of waste generated in the construction industry, their utilization as finishing products in interior design remains limited. The substantial quantities of construction- and agriculture-derived waste suggest that converting these materials into interior finishing elements—such as insulation and covering used in interior applications—can play an important role in reducing resource consumption and strengthening sustainable design principles. In this context, the study aims to encourage the integration of waste-based interior building materials into interior architectural design and to provide designers and practitioners with a systematic evaluation tool through a product selection model developed in line with material properties and functional advantages.

2.METHOD

The proposed model presents a systematic decision-making process for the selection of interior finishing products produced from waste materials and aims to contribute to the construction industry in line with sustainable design principles. In developing the model, covering and insulation products derived from various waste materials were first examined through a literature review, from which environmental, economic, and functional impact assessment criteria were identified. At this stage, a comprehensive literature review approach is adopted to map existing research on the use of waste materials and material selection in design studies. The aim is to identify the main research themes, methodological approaches, and gaps in the existing literature. Based on these criteria determined through a literature review, three main processes—analysis, design, and application—were defined. Each process is supported by stages of information collection, analysis, and evaluation, ensuring the applicability of the model from the early design phase to the post-implementation stage.

Developed using a systems approach, each stage is addressed in terms of systems, subsystems, and processes. Within the overall structure, inputs, processes, and outputs are defined, and the output of one subsystem is configured to serve as the input for the subsequent subsystem. In cases where problems arise at any step, the model allows a return to previous stages, thereby enhancing process flexibility. In this way, a feedback-based structure is established that supports designers' decision-making and guides material selection in accordance with spatial requirements and sustainability criteria. The framework is structured to ensure applicability across various stages of the interior design process. Accordingly, this study proposes a sustainability-oriented, feedback-based, and applicable product selection model that promotes the use of waste materials in the selection of interior covering and insulation products.

3.INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS

By revising recent studies found in the literature, a comprehensive review was conducted on the integration of waste materials into interior building materials. In this study, a literature review was conducted using the Scopus, Web of Science, and Dergipark databases and conference papers. Initially, a broad search was conducted using the keywords 'interior coating products', interior cladding products', 'interior covering products', 'waste material', and 'recycled material'. Then, to clarify and narrow the focus of the study, the types of waste used in the waste conversion process were identified as "construction waste" and "agricultural waste"; in this context, the research was limited to studies classifying these materials. Subsequently, a second phase of the search was structured using the keywords 'interior coating products', 'insulation products', 'covering materials', finishing products', and 'interior building materials' to narrow down the types of materials produced from waste materials.

The studies selected during this review process were chosen from sources that provided the most detailed data on waste materials and the properties of materials produced from these waste materials, to be used in the evaluation processes of the model steps. At this stage, studies providing comprehensive answers to the following questions raised during the screening were prioritized: where is the waste material sourced from, what is the waste material transformed into, in which sector is this newly produced material used, and what are the advantages and disadvantages identified in the use and subsequent stages of the material? This systematic approach contributed to the creation of a transparent and understandable dataset supporting the study's findings; it also ensured that the literature was used as a strategic source of information in developing the research model.

From each study, the advantages and disadvantages of the waste types used and the covering and insulation products produced from these wastes were evaluated in terms of parameters such as technical performance, environmental impact, and production process, thereby data regarding the material transformation processes were collected in a multidimensional manner.

In their study, Ata-Ali et al. (2021) compared recycled and non-recycled insulation materials under different climatic conditions in Spain using the life cycle assessment (LCA) method. Among the "recycled" materials analyzed are wastes obtained from the cork industry. These wastes refer to the recycled form of natural cork derived from the bark of the cork oak tree (Quercus suber), which, after processing, has been used for the first time as an insulation material. The study reports relatively low environmental impact and energy efficiency as advantages. Whereas lower performance in certain climatic regions compared to conventional materials is identified as a disadvantage [15].

In the study conducted by Güller (2001), forestry industry wastes such as fibers, sawdust, and woody particles were combined with various binders and converted into composite wood building materials. These composites were used in the production of building materials such as plywood, fiberboard, and Oriented Strand Board (OSB). The study reports reduced natural resource consumption and lower production costs as advantages. Whereas low resistance to moisture is identified as a disadvantage [16].

In the study conducted by Alici and Dalkılıç (2022), bio-based materials obtained from agricultural and marine-based wastes were converted into furniture, flooring, and surface covering building materials to be used in interior spaces. The study reports renewability, low environmental impact, and aesthetic diversity as advantages. Whereas limited durability and longevity compared to conventional products are identified as disadvantages [17].

In Li's (2016) study, which focuses on the use of renewable materials derived from textile and agricultural wastes to produce wall covering and decorative interior elements, the study reports aesthetic diversity, low environmental impact, and cultural compatibility as advantages. Whereas low fire resistance and moisture resistance are identified as disadvantages [18].

In their research, Guirguis et al. (2023) examined the use of sugarcane bagasse, a locally available agricultural waste in Egypt, in the production of fiberboard intended for covering applications. The resulting board was proposed as an interior covering material and was reported to provide thermal insulation properties as well as aesthetic contributions to interior spaces. The study indicates that the use of the developed material reduces energy consumption and carbon emissions. The study reports thermal insulation properties, aesthetic contribution, reduced energy consumption, and lower carbon emissions as advantages. Whereas no explicit disadvantages are reported [19].

In their study, Devi et al. (2023) presents a general evaluation of sustainable building materials. The study examines the use of waste such as recycled plastic, waste steel dust (ferrock), cork, bamboo, straw bales, and mycelium in the construction industry. They considered these materials as alternatives that can be used for covering, filling, or insulation purposes in walls, floors, and structural elements. The study reports low environmental impact, renewability, and energy efficiency as advantages. Whereas limitations in technical durability and fire safety are identified as disadvantages [20].

In the study conducted by Chen et al. (2024), the technological development of biomaterials used in the construction industry and their implications at the policy level were comprehensively examined. Materials such as mycelium, bio-concrete, natural fibers, and recycled composites were evaluated as options for façade covering, insulation, and interior furnishing elements. The study reports reduced CO_2 emissions, lower water absorption, and improved energy efficiency as advantages. Whereas lack of policy awareness and dependence on conventional materials are identified as disadvantages [21].

In their study, Bourbia, Kazeoui, and Belarbi (2023) compiled an overview of recent studies conducted on bio-based building materials. The study suggests that agricultural wastes such as alfa grass, straw, date palm, and cork can be used in the production of insulation and covering covering materials. The study reports low embodied energy these materials possess, their CO_2-neutral or negative characteristics, and high moisture buffering capacity as advantages. Whereas lack of data on long-term durability particularly of alfa grass, straw, and date palm and compliance with standards are identified as disadvantages [22].

In their study, La Gennusa et al. (2021) evaluated the thermal performance of nine different insulation materials produced from agricultural and industrial wastes. The study reports low environmental impact and high energy efficiency of these materials as advantages. Whereas the need for additional structural strength testing, particularly on wheat straw, rice husk, and corn cob is identified as a disadvantage [23].

The study conducted by Aydın İpekçi et al. (2017), discussed the recovery of building and demolition waste generated by the construction industry for use in the production of interior building materials and assessed its sustainability implications. The study investigated the use of recovered materials in production of building materials such as covering, partition elements, and insulation products, and evaluated their contributions to resource conservation, the reduction of environmental burden, and the improvement of economic efficiency. An exemplary case study conducted specifically examined the use of surface building materials produced from recycled concrete and wood wastes in interior spaces. The findings indicate that although the technical performance of these materials was found to be adequate, users who prioritize aesthetic criteria—such as aesthetic variety, visual diversity, discernible material texture, and overall design coherence—tend to approach these materials with reservation. This situation was associated particularly with the expectations for visual quality in interior design to be high. The study reports resource conservation reduced environmental burden, and economic efficiency as advantages. Whereas lack of certification and limited aesthetic acceptance are identified as disadvantages [24].

In the study conducted by Yalçınkaya, Ş. and Karadeniz, İ. (2022), the reuse of waste materials in architectural design was evaluated through ten building examples. The acquisition methods of the materials, their application areas, and their roles in the design process were analyzed through diagrams. The study reports the potential for creative design and a wide range of applications as advantages. Whereas insufficient compliance with technical standards is identified as a disadvantage [25].

In their study, Lisowski and Glinicki (2023) examined the usage potential of insulation materials produced from biomass wastes in the construction industry. In the study, materials with low thermal conductivity (<0.100 W/m·K) were comparatively evaluated in terms of their environmental impact, production costs, and technical performance. The study notes low carbon footprint of bio-based materials and their contribution to energy savings as advantage. Whereas, low resistance to moisture of some biomass-derived materials, particularly wood shavings and wood residues, straw and wheat stalks, cotton and textile wastes, and rice husk, and their fast biological degradation are identified as their disadvantages [26].

In the study conducted by Marín-Calvo et al. (2023), insulation panels were produced using recycled paper and rice husk, and the resulting building materials were tested according to ASTM standards. The study notes low thermal conductivity (0.04 W/m·K) of these materials and adequate mechanical durability they offer as their advantage. Whereas, difficulties in achieving homogeneity during production are identified as their disadvantages [27].

In the study conducted by Ertaş and Mıhlayanlar (2025), products such as new glass panels, glass wool, and expanded glass aggregate were produced from glass wastes. As an advantage, it was reported that adding 10% glass cullet to the glass production process reduces energy consumption by approximately 2.5–3%, and that each 1 ton of glass cullet used saves about 1.2 tons of raw materials. Whereas, lower compressive strength these newly produced expanded glass aggregates exhibited compared to the conventional aggregates, and their increased water absorption capacity due to their higher porosity were noted as their disadvantageous features that require careful consideration in terms of durability when used under external environmental conditions [28].

In the experimental study conducted by Özbek (2022), brick waste—one of the most common by-products of construction and demolition waste—was used to produce a new composite acoustic material, with clay added as a binder and rice husk waste incorporated to provide porosity. The study reports that applying this material as a finishing layer on interior wall surfaces yields favorable results in projects where increased overall sound absorption is desired. The main advantage of the material is its high sound absorption coefficient. In addition, because the material is elastic before firing, it allows reflective panels to be produced in different shapes. As a disadvantage, it is noted that the effect of different firing temperatures on the sound absorption performance of the material could not be determined with certainty. Furthermore, it was observed that increasing the thickness of the samples is more effective in improving the sound absorption coefficient, particularly at low frequencies [29].

In the study by Liuzzi et al. (2023), paper pulp was first produced by processing locally sourced office paper waste. Biomass aggregates—including sawdust powder, coffee grounds, and fava bean residues—were subsequently incorporated into the pulp mixture, from which bio-based thermal insulating building materials were produced. The study reports that these materials exhibit low thermal conductivity and can therefore be used as thermal insulation panels, while their acoustic properties also allow their application as sound insulation panels installed on interior walls and suspended ceilings. As an advantage, it is reported that all tested samples exhibited sufficiently low thermal conductivity to be classified as thermal insulators. In particular, the mixture containing sawdust powder demonstrated the best insulation performance as per the study. As a disadvantage, differences in acoustic behavior were observed between the upper and lower surfaces of the samples due to shrinkage occurring during the production and drying processes. The fibrous structure of the mixture containing sawdust powder contributed to superior insulation performance by enabling the material to develop a more porous final matrix [30].

In the study conducted by Sezgin and Aytar Sever (2022), new materials produced using recycled wood and paper wastes were examined. The study reports acoustic insulation, energy efficiency, humidity regulation, and antibacterial properties as advantages. Whereas the need for further research on durability is identified as a disadvantage [31].

In the study conducted by Sair et al. (2019), an environmentally friendly composite material was produced from a mixture of gypsum, cork fibers, and waste cardboard. The aim of the study was to develop ecological thermal insulation materials capable of meeting economic, ecological, and mechanical requirements by limiting heat losses in buildings. The primary advantage of the newly produced material is the significant improvement in thermal insulation capacity—up to 300%—compared to pure gypsum. With the addition of waste cardboard to the mixture, the mechanical properties of the material were observed to improve, as the cardboard waste helps fill the voids between cork particles. As a disadvantage, it was noted that due to the hydrophilic nature and high porosity of plant fibers, the material exhibited greater water absorption than pure gypsum, indicating that this property must be carefully controlled. The study concludes that the developed material is suitable for building thermal insulation applications. [32].

In the study conducted by Barreca and Fichera (2013), the use of olive pits as an additive in lime–cement mortar was examined. The aim of the study was to determine whether the incorporation of olive pits could contribute positively to improving the thermal insulation properties of the mortar and enhancing its thermos-physical characteristics. The results showed that the addition of olive pits reduced the thermal conductivity of the mortar. The study also reports that as the density of the material increases, its thermal conductivity increases, whereas the specific heat capacity exhibits an inverse relationship with density. [33].

Based on the data obtained from the reviewed studies, Table 1 systematically presents the potential of different types of waste materials to be transformed into interior building products. It is observed that agricultural and construction wastes can be used particularly as insulation, covering, covering and partition elements on interior surfaces such as walls, ceilings, and floors.

Table 1. Interior Covering and Insulation Products Produced Form Waste Materials [*15-33*]

LITERATURE REVIEW CONDUCTED WITHIN THE SCOPE OF THE STUDY						
AUTHORS	**YEAR**	**WASTE TYPE**	**NEW MATERIAL PRODUCED**	**INTERIOR APPLICATION AREA**	**ADVANTAGES**	**DISADVANTAGES**
Ata-Ali, N., Penadés-Plà, V., Martínez-Muñoz, D., & Yepes, V.	2021	Recycled cork waste	Insulation materials	Wall and ceiling insulation	Low environmental impact, energy efficiency	Weak performance in certain climates
Güller, B.	2001	Fibers, sawdust, woody particles	Wood composites	Wall and floor covering	Reduced natural resource consumption, low production cost	Adverse environmental impact of binders, low moisture resistance
Alici, N., & Dalkılıç, B.	2022	Agricultural and marine-based wastes	Bio-based furniture, flooring, surface covering	Furniture, flooring, surface covering	Renewability, low environmental impact, aesthetic diversity	Limited durability and longevity
Li, J.	2016	Textile and agricultural wastes	Wall cladding, decorative components	Wall cladding, decorative components for the interior	Aesthetic diversity, low environmental impact, cultural compatibility	Low fire and moisture resistance
Guirguis, M. N., Farahat, Z., & Micheal, A.	2023	Sugarcane bagasse	Fiberboard	Wall covering	Reduced heat loss, aesthetic contribution, low energy consumption	Not specified
Devi, M., Saini, N., Bhardwaj, I., & Kataria, R.	2023	Plastic, steel dust, cork, bamboo, straw, mycelium	Wall systems, floor systems, insulation layers, structural components	Walls, floors, insulation, structural components for the interior	Low environmental impact, renewability, energy efficiency	Limited technical durability and fire safety
Chen, L., Zhang, Y., Chen, Z., Dong, Y., Jiang, Y., Hua, J., Liu, Y., Osman, A. I., Farghali, M., Huang, L., Rooney, D. W., & Yap, P. S.	2024	Mycelium, bioconcrete, natural fibers, composites	Facade covering, insulation, interior furnishing materials	Facade covering, insulation, interior furnishing	CO_2 emission reduction, low water absorption, energy efficiency	Lack of policy awareness, dependence on conventional materials
Bourbia, S., Kazeoui, H., & Belarbi, R.	2023	Alfa grass, straw, date palm, cork	Insulation and covering materials	Covering, wall and ceiling insulation	Low embodied energy, CO_2-neutrality, high moisture buffering capacity	Lack of data on long-term durability and compliance with standards
La Gennusa, M., Marino, C., Nucara, A., Panzera, M. F., & Pietrafesa, M.	2021	Agricultural and industrial wastes	Insulation materials	Wall and ceiling insulation	Low environmental impact, high energy efficiency	Additional tests required to determine accurate structural strength
Aydın İpekçi, C., Coşkun, N., & Tikansak Karadayı, T.	2017	Concrete and wood construction wastes	Coveringg, partition panels, and insulation materials	Covering, partition and insulation panels	Resource conservation, reduced environmental burden, economic efficiency	Lack of aesthetic acceptance, insufficient certification data
Yalçınkaya, Ş., & Karadeniz, İ.	2022	Various waste materials	Building materials (various types)	Wall panels, partitions, decorative components for the interior	Enables creative design applications; wide range of uses	Lack of compliance with technical standards
Lisowski, P., & Glinicki, M. A.	2023	Biomass wastes	Insulation materials	Wall and ceiling insulation	Low carbon footprint, energy savings	Low resistance to moisture and biological degradation
Marín-Calvo, N., González-Serrud, S., & James-Rivas, A.	2023	Recycled newspaper, rice husk	Thermal insulation panels	Suspended ceilings, partitions, doors, furniture, attics, walls and floors	Low thermal conductivity, sustainability, low carbon footprint, low embodied energy, high compressive durability, moisture control	Long drying time, risk of mold formation in highly humid environments, need for additional chemical treatment for flame resistance
Ertaş, G., & Mıhlayanlar, E.	2025	Glass wastes (construction/demolition waste)	Glass panels, glass aggregate, glass mosaic	Thermal and acoustic insulation, decorative surface cladding	Energy savings and conservation of natural resources	Insufficient collection and sorting infrastructure
Özbek, U.	2022	Rice husk	Composite acoustic materials	Finishing layer on wall surfaces	High sound absorption performance	Sporadic nonlinear influence of parameters on acoustic results
Liuzzi, S., Rubino, C., Martellotta, F., & Stefanizzi, P.	2023	Sawdust, coffee grounds, fava bean residues	Thermal and acoustic insulation materials for walls and ceilings	Walls, ceilings, acoustic panels	Efficient thermal insulation	Acoustic behavior differences between upper and lower surfaces of the material
Sezgin, S., & Aytar Sever, İ.	2022	Waste wood, timber offcuts, paper/newspaper	Recycled wood, wood terrazzo	Wall covering	High acoustic performance, moisture regulation, energy efficiency, antibacterial properties, high durability	Low mechanical durability
Sair, S., Mandili, B., Taqi, M., & El Bouari, A.	2019	Cork fiber, waste cardboard	Composite panels	Thermal and acoustic insulation	Efficient thermal insulation, high sound absorption	High water absorption, weak mechanical resistance
Barreca, F., & Fichera, C.	2013	Cork granules	Cement/lime mortar with cork granule additive	Thermal insulation	Efficient thermal insulation	Not specified

As shown in the table, the advantages of waste-based products include a low carbon footprint, energy efficiency, reduced consumption of natural resources, the use of local resources, aesthetic diversity, and cost-effectiveness. Particularly favorable performance has been observed in criteria such as sound and thermal insulation, impact absorption, lightness, and ease of installation. However, several technical and perceptual limitations are also identified, including moisture and fire resistance, long-term mechanical performance, micro-plastic emissions, aesthetic acceptance, and compliance with standards. These findings suggest that waste-based materials can be considered a sustainable alternative in interior design; however, they also demonstrate that multidimensional criteria—such as technical validation, user perception, and regulatory compliance—must be addressed in an integrated manner to enable their widespread adoption.

4. A SELECTION MODEL FOR INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS

The "Selection Model for Interior Covering and Insulation Products Produced from Waste Materials" was developed using a systems approach to evaluate waste-based building materials in interior environments from a holistic perspective, considering environmental, economic, and design dimensions. Initially, an extensive literature review was conducted to identify the criteria and evaluation approaches employed in the reviewed studies. Consequently, the data derived from the literature were assessed based on their contribution to the stages of the model, and those deemed to be limited in their application suitability were excluded.

The selected data were organized within the main structure of the model under the relationships of "Inputs," "Process," and "Outputs," thereby forming the decision-making stages of the model (Figure 1). In the "Inputs" stage, the objective is to promote efficient resource utilization, reduce raw material consumption, and increase the use of waste materials through appropriate material selection based on their reuse in interior covering and covering applications. Accordingly, the defined goals include: classifying the types of waste predominantly generated by the construction industry; determining which types of waste materials can be integrated into specific interior finishing products; transforming the identified waste materials into new interior finishing products; and encouraging the selection and adoption of these products in interior design applications. The resources required to achieve these objectives include actors such as designers, interior architects, architects, material engineers, and users; as well as legislation, standards, and certifications; new materials derived from waste materials; literature and patent data; product information available in the market; qualified workforce; technology and experience; supply and logistics resources; and financial resources.

In the "Process" stage, the designer follows the "Analysis," "Design," and "Implementation" action steps defined in the model and proceeds toward selecting interior covering and insulation products produced from waste materials in line with the established objective and goals. Within this stage, the "Analysis" process comprises user requirement analyses, functionality analyses, and application area analyses. The "Design" process includes the determination of the needs program, the configuration of spatial relationships, preliminary design activities, material selection and main decisions, and approved final design. In the "Implementation" process, the creation of the implementation project according to the approved final design, quantity take-off and cost estimation, implementation process planning, and execution are carried out. Within this process, production planning is not included; the focus is on material selection and on defining application decisions specific to the selected material.

In the "Outputs" stage, the outputs of the model are defined in terms of environmental, economic, and implementation-oriented gains. Accordingly, the expected outputs are structured as follows: under environmental benefits, reduction of environmental pollution and resource consumption; under economic efficiency, cost savings through reduced need for new product production and lower material costs; under waste valorization, reduction of waste quantity and alleviation of disposal burden; and under dissemination potential, promotion of waste material use in interior covering products, along with increased industry awareness and a broader range of application examples. These outputs contribute to demonstrating the applicability of the model and its contribution to sustainability goals.

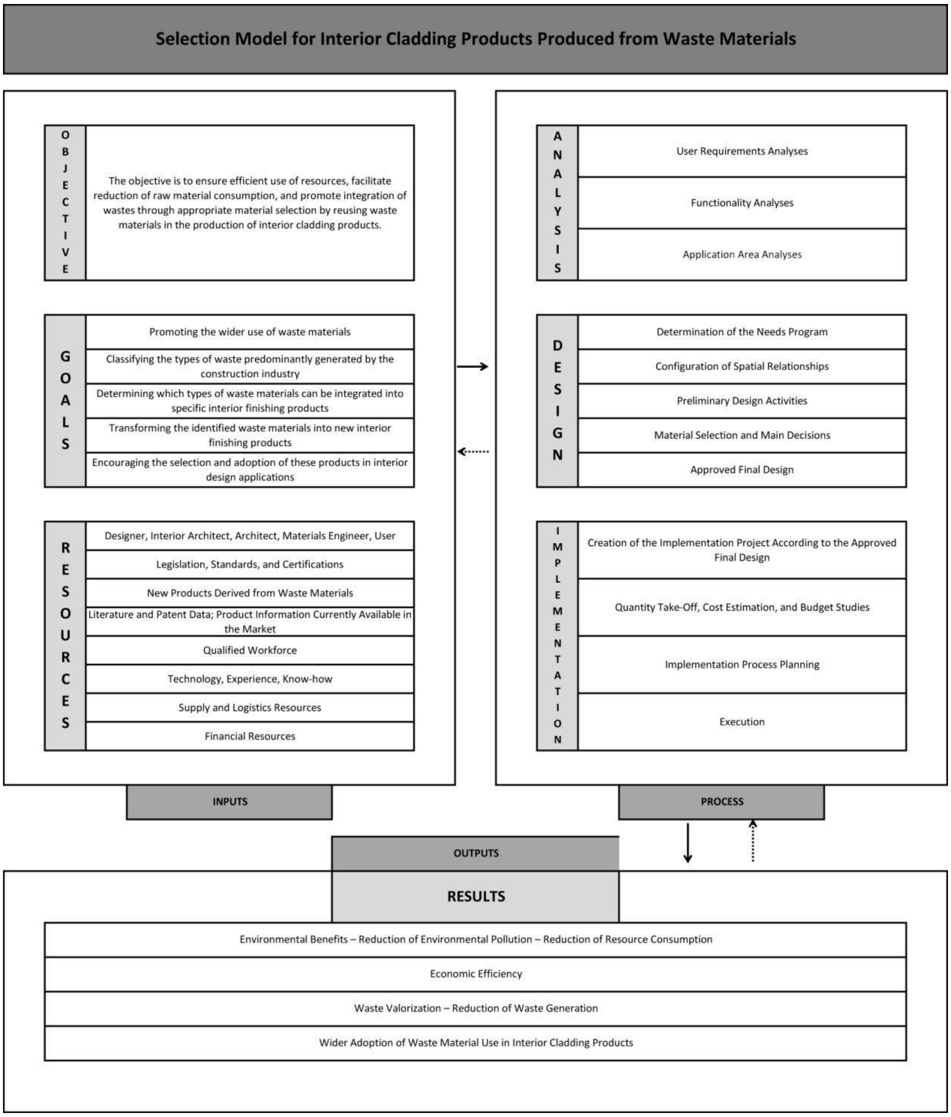

Figure 1. Selection Model for Interior Covering and Insulation Products Produced from Waste Materials (developed by the author).

This comprehensive selection model not only provides designers with a technical decision-making tool but also enables a holistic evaluation of factors such as user requirements, environmental impact, and production conditions. In this way, the model offers a guiding framework for designers and indirectly facilitates users' access to more sustainable, functional, and environmentally responsive products.

Systems and Subsystems of the Model

The "Inputs" stage of the model is structured to define the initial conditions and key decision drivers that shape its conceptual framework. At this stage, a sustainability-oriented objective is established to promote the selection and use of waste-based materials. Accordingly, the goals and resources required to achieve this objective are systematically identified. These inputs should not be treated merely as data sources; rather, they function as strategic drivers that shape the direction of the decision-making process. In this way, the operation of the model is guided, and a holistic decision-making framework is established. This stage provides the necessary data and resources to support the proper and systematic functioning of the "Analysis," "Design," and "Implementation" systems.

As the first step of the "Process" stage, the "Analysis" system provides a multidimensional evaluation framework for the selection of waste-based interior covering and insulation materials. The User Requirement Analyses subsystem enables the assessment of human-centered data such as ergonomic comfort, health impacts, user profiles, and usage feedback. Within the Functionality Analyses subsystem, physical, mechanical, and chemical properties, together with relevant sustainability and environmental factors, are examined to determine material performance and environmental impact. These analyses play a critical role, particularly in the comparison of waste-based materials with conventional products. The Application Area Analyses subsystem, in turn, enables the evaluation of factors such as supply chain feasibility, climatic compatibility, regulatory compliance, and space-specific requirements. This structure functions as a robust evaluation tool for decision-makers, supporting the assessment of technical accuracy, user satisfaction, and environmental efficiency.

The "Design" system guides material selection and spatial decision-making based on the findings obtained from the analysis stage. Within the Determination of the Needs Program subsystem, spatial requirements, material properties, and application-specific requirements are defined. Within the Configuration of Spatial Relationships subsystem, functional organization, user behavior, and comfort conditions are evaluated, and user-oriented design scenarios are developed. In the Preliminary Design Activities subsystem, design alternatives are evaluated in terms of aesthetic considerations, economic feasibility, and certification compliance. Within the Material Selection and Main Decisions subsystem, building materials produced from agricultural and construction waste are evaluated in terms of their physical, chemical, mechanical, and technical properties, insulation performance, and compatibility with spatial identity. These decisions address multiple requirements, including load-bearing capacity, resistance to wear, durability, compliance with safety standards, and sound and thermal insulation performance. Through the Approved Final Design subsystem, all these inputs are translated into final design decisions. This system offers a holistic design approach in terms of sustainability, user well-being, and technical performance

The "Implementation" system consists of processes that enable the selected material to be technically and operationally implemented within the interior environment. Within the Creation of the Implementation Project According to the Approved Final Design subsystem, aspects such as application methods, techniques, application areas, and related requirements are defined. Within the Quantity Take-Off, Cost Estimation, and Budget Studies subsystem, material quantity calculations, labor planning, unit price analyses, alternative comparisons, logistics costs, and raw material–product price comparisons are carried out, contributing to economic efficiency. Within the Implementation Process Planning subsystem, procedures such as surface preparation, equipment selection, technical specifications, scheduling, quality control, finishing processes, protective applications, and occupational health and safety measures are addressed. The Execution subsystem ensures that the material is properly applied within the space in accordance with application type (insulation, painting, cladding, covering, coating), application area (walls, ceilings, floors), and application method (on-site or prefabrication), thereby maintaining performance continuity.

The “Outputs” stage of the model defines the environmental, economic, and industry-specific gains generated through the process. Environmental benefits, economic efficiency, the reintegration of waste into reuse streams, and the broader adoption potential of waste-based materials constitute the principal outcomes of the model.

5. FINDINGS

The “Selection Model for Interior Covering and Insulation Products Produced from Waste Materials” developed in this study addresses the use of waste-based materials in interior finishing products through a multidimensional evaluation framework. The criteria and assessments derived from the literature were organized in alignment with the process–action–selection structure of the model, and the analysis was conducted based on criteria with the greatest influence on material performance and decision-making. Accordingly, the findings presented in Tables 2 and 3 constitute a structured evaluation framework that supports designers in their decision-making processes.

Table 2. Integrated Criteria for Waste-Based Product Selection (developed by the author).

VARIOUS IMPACT ASSESSMENT CRITERIA FOR INTERIOR COVERING AND INSULATION PRODUCTS PRODUCED FROM WASTE MATERIALS	
1	EFFECT OF BINDING AGENTS IN PRODUCED MATERIALS ON HUMAN HEALTH
2	EFFECT OF RAW MATERIALS ON PRODUCTION COST
3	FEASIBILITY OF MAINTAINING COLOR CONSISTENCY IN PRODUCED MATERIALS
4	IMPACT OF TIME-RELATED INDIRECT COSTS DURING THE LOGISTICS STAGE
5	IMPACT OF PRODUCED MATERIALS ON CARBON FOOTPRINT
6	BIOLOGICAL DEGRADATION RESISTANCE OF PRODUCED MATERIALS
7	WASTE GAS EMISSIONS FROM PRODUCED MATERIALS
8	CONTRIBUTION OF PRODUCED MATERIALS TO WASTE REDUCTION
9	SUPPLY CONTINUITY OF MATERIALS USED IN PRODUCTION
10	IMPACT OF ADDITIVES IN PRODUCED MATERIALS ON VOC EMISSIONS
11	TOXICITY EFFECT OF ADDITIVES IN PRODUCED MATERIALS
12	IMPACT OF ADDITIVES USED IN PRODUCED MATERIALS ON INDOOR AIR QUALITY
13	FLAME SPREAD RESISTANCE OF PRODUCED MATERIALS
14	SURFACE HARDNESS AND ABRASION RESISTANCE OF MATERIALS
15	UV RESISTANCE OF MATERIALS

Table 2 presents 15 core criteria integrated into the process–action–selection structure of the model developed for the selection of waste-based building materials. These criteria were specifically defined to reflect the characteristics of waste-based material production processes. Each criterion is associated with the content structure of the selection stage and formulated to enable its integration into the model’s decision-making system.

The criteria were developed based on the literature data presented in Table 1, with the aim of evaluating the properties of products derived from waste materials as reported in each study. Their integration into the model provides guidance for designers in achieving design objectives during the selection stage and offers systematic support for making informed product choices grounded in environmental and health considerations.

This evaluation system enables a comparative assessment of the literature data across the 15 core criteria. Each study was systematically analyzed in terms of waste type, intended use of the newly produced material, interior application area, and corresponding criteria (Table 3).

Table 3. Multi-Criteria Evaluation of Waste-Based Interior Covering and Insulation Materials Based on Literature Review (This table was created by the author based on the information in Tables 15–31).

NEW MATERIAL	INTERIOR APPLICATION AREA	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Insulation materials	Wall and ceiling insulation	✗	?	?	?	✓	?	✓	✓	✓	?	✓	✓	?	?	?
Wood composites	Wall and floor covering	?	✓	?	?	?	✓	?	✓	✓	?	?	?	✓	?	?
Bio-based furniture, flooring, surface covering	Furniture, flooring, surface covering	✓	✓	✓	✓	✓	✗	✓	✓	✓	?	✓	✓	?	?	?
Wall covering, decorative components	Wall covering, decorative components for the interior	✓	✓	✓	✓	?	?	?	?	✓	?	✓	?	✓	✓	?
Fiberboard	Wall covering	?	✓	✓	?	✓	?	✓	✓	✓	?	✓	✓	?	✓	?
Wall systems, floor systems, insulation layers, structural	Walls, floors, insulation, structural components for the interior	✗	✓	?	✗	✓	✓	✓	✓	?	✗	✗	✗	✓	✓	✓
Facade covering, insulation, interior furnishing materials	Facade covering, insulation, interior furnishing	✗	✗	?	✗	✓	✗	✓	✓	✓	✗	✗	✓	✗	?	✓
Insulation and covering materials	Covering, wall and ceiling insulation	✗	✓	?	✓	✓	✗	✓	✓	✓	?	?	✓	✗	✗	?
Insulation materials	Wall and ceiling insulation	✓	✓	?	✓	✓	?	✓	✓	✓	?	✓	✓	?	✗	?
Covering, partition panels, and insulation materials	Covering, partition and insulation panels	✗	✓	?	✗	✓	?	?	✓	✓	?	✗	?	?	✗	?
Building materials (various types)	Wall panels, partitions, decorative components for the interior	?	✓	?	✓	✓	?	?	✓	✓	?	?	✓	?	✓	✓
Insulation materials	Wall and ceiling insulation	✓	✓	?	?	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	?
Thermal insulation panels	Suspended ceilings, partitions, doors, furniture, attics, walls and	?	✓	?	✗	✓	✓	?	✓	✓	?	?	✓	?	✓	?
Glass panels, glass aggregate, glass mosaic	Thermal and acoustic insulation, decorative surface covering	?	✓	?	✗	✓	✓	✓	✓	✓	✓	✓	✓	?	?	✓
Composite acoustic materials	Finishing layer on wall surfaces	✓	✓	?	?	✓	✓	?	✓	✓	?	✓	✓	✓	?	?
Thermal and acoustic insulation materials for walls and cielings	Walls, ceilings, acoustic panels	✓	✓	?	✓	✓	?	✓	✓	✓	✓	✓	✓	✓	?	?
Recycled wood, wood terrazzo	Wall covering	✓	✓	✗	?	✓	?	?	✓	?	?	✓	✓	?	✗	?
Composite panels	Thermal and acoustic insulation	?	✓	?	?	✓	?	?	✓	?	?	?	✓	?	✗	?
Cement/lime mortar with cork granule additive	Thermal insulation	?	?	?	?	?	?	?	✓	?	?	?	?	?	?	?

✓	?	✗
POSITIVE	UNKNOWN NOT ANALYZED	NEGATIVE

The data compiled from the literature review provide detailed information on criteria such as energy use in production processes, carbon footprint, toxic content, and material integration, thereby offering technical validation and a substantive reference base for designers. For users, these data support informed decision-making by providing insight into the scientific background and environmental impacts of the products. The analyses presented in Table 3 demonstrate how the 15 core criteria integrated into the selection stage of the "Selection Model for Interior Covering and Insulation Products Produced from Waste Materials" operate at both the application and literature levels. For designers, this evaluation system enables a multidimensional assessment of technical suitability, environmental impact, sustainability, and health-related risks during the product selection process. For users, it establishes a basis for informed product choices, particularly with regard to the health impacts of the materials used.

6.CONCLUSION

Increasing industrialization and consumption patterns in our world today have led to a significant rise in waste generation, resulting in the depletion of natural resources and posing a threat to environmental sustainability. Due to its high resource consumption and adverse environmental impact, the construction industry is considered one of the priority areas for the implementation of sustainability policies. In this context, transforming waste materials into building products and integrating them into interior design processes is deemed to offer significant environmental and economic benefits. A review of the existing literature indicates that waste materials are more commonly used in their unprocessed form in building envelopes and rough construction processes. However, waste-based interior covering and insulation products—which process different types of waste materials and incorporate them into their production—are often overlooked and remain underutilized in design practice, as there is no systematic decision-making framework to guide designers in selecting appropriate products for specific applications.

To address this gap, the study proposes a model structured through a systems approach that enables the evaluation of waste materials in the selection of interior covering and insulation products. The model does not limit the use of waste materials to the selection stage alone; rather, it introduces a holistic framework encompassing design, implementation, post-application control, and documentation processes. Accordingly, the study demonstrates that agricultural and construction waste can be effectively utilized as covering, cladding and insulation materials, offering solutions capable of meeting both aesthetic and functional requirements. The model enables designers to simultaneously assess technical, environmental, economic, and user-oriented criteria, thereby supporting a more systematic and traceable selection of waste-based materials for interior surfaces. Furthermore, the model is projected to facilitate the integration of waste materials into interior building material production processes in alignment with incentive policies and to serve as a strategic tool for reducing adverse environmental impacts.

In conclusion, the proposed model is expected to contribute to the broader selection and adoption of interior finishing products produced from waste materials, while upholding environmental and economic benefits, improving resource management, and promoting the practical implementation of sustainable design. In this way, the use of new building materials derived from waste is anticipated to be encouraged through designer-driven processes that indirectly engage end users. In this respect, the model can be regarded not only as a selection tool but also as a guiding framework in terms of environmental responsibility and design ethics.

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