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KEYWORDS	ABSTRACT
Green Interior Design; Resource Efficiency; Building Sustainability; Sustainable Buildings; Sustainable Interior Design; Sustainable Construction	The growing emphasis on sustainable buildings has expanded the role of interior design beyond aesthetic enhancement toward environmental responsibility, resource conservation, and long-term building performance. However, limited empirical research has examined how green interior design contributes to building sustainability through resource efficiency. This study addresses this gap by examining the relationship between Green Interior Design (GID), Resource Efficiency (RE), and Building Sustainability (BS), with particular emphasis on the mediating role of resource efficiency. A quantitative, cross-sectional research design is employed using a structured questionnaire administered to professionals and stakeholders involved in architecture, interior design, construction, facility management, and sustainable building practices. The proposed relationships are examined using Partial Least Squares Structural Equation Modeling (PLS-SEM) through SmartPLS. The study investigates whether green interior design positively influences resource efficiency and building sustainability and whether resource efficiency serves as an explanatory mechanism linking green interior design with broader sustainability outcomes. The findings indicate that green interior design is positively associated with resource efficiency and building sustainability, while resource efficiency also demonstrates a positive relationship with building sustainability. Furthermore, resource efficiency plays a significant mediating role in the relationship between green interior design and building sustainability. The study highlights that sustainable interior design extends beyond aesthetic considerations by influencing the efficient use of materials, energy, water, and other resources. The research contributes to the sustainable built-environment literature by positioning resource efficiency as an important mechanism through which interior design can support building sustainability. The findings also provide practical implications for architects, interior designers, construction professionals, facility managers, and sustainability practitioners seeking to integrate resource-efficient strategies into building design and management.
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Introduction

Buildings use a large amount of energy, materials and water during their life cycles and create a large environmental impact, making the built environment a central part of the global sustainability agenda. The current sustainability discussion has thus shifted from building specific buildings to the design, operation and maintenance of buildings to reduce their resource use and environmental impact. Recent evidence shows that the buildings and construction industry is responsible for around 37% of global CO₂ emissions and almost half of global material extraction (UNEP, 2026). Thus, sustainable building design is increasingly considered as a key tool for mitigating climate change, resource depletion and environmental impacts of urban development (GhaffarianHoseini et al., 2013).

One of the key strategies to overcome these challenges has been green building. Green building is not just about structural performance, but it also takes into account environmental, economic and social factors in the design, construction and use of buildings. According to Zuo and Zhao (2014), green building research involves environmental impacts, sustainability benefits and methods for achieving better building performance. Their review also showed that the focus of previous studies has been largely on environmental aspects, and more comprehensive studies are needed to better understand the sustainability of buildings. Ding (2008) stated that sustainable buildings should be seen from a broader perspective than just the environmental assessment, as sustainability involves environmental, economic and social aspects throughout the building life cycle.

In this larger trend, interior design is a key but under-studied aspect of sustainable building performance. Interior spaces have been studied extensively in the fields of structural systems, building envelopes, renewable energy technologies and mechanical systems, but are also important to the environmental performance and resource use of buildings. Many elements of furniture, finishes, floor, lighting, textiles, fixtures, materials and spatial configurations in interior design have direct and indirect implications for energy use, material consumption, waste generation and indoor environmental quality. Hence, sustainability cannot be realized only at the architectural or engineering level, but must be included in the sustainability framework as interior environments.

The concept of green interior design can thus be described as a design method that incorporates the environment into the design process of interior spaces, from the planning to the specification, selection and operation of materials. This can include recycled, renewable or low impact materials, energy efficient lighting, water efficient fixtures, long-lasting products, natural daylight, reusing existing elements and reducing waste and environmentally responsible procurement. These practices can help minimize the environmental impact of interior spaces and enhance the comfort and performance of the building. Studies on energy efficient building design also highlight that energy efficiency is part of the process of sustainable building development and that the design of a building by architects and other built environment professionals can

affect building energy performance (Cabeza et al., 2014; Wang et al., 2024). As the use of sustainable materials becomes more prevalent, the significance of material selection in creating environmentally efficient buildings is further emphasized (Allassaf, 2024).

When thinking about green interior design in terms of resource efficiency, the relevance of the concept becomes more apparent. Resource efficiency is a general term for deriving more value from less material and natural resource and minimising waste and environmental impacts. For buildings, this can be the efficient use of energy, water, materials and other resources in the building life cycle. Material efficiency is a key opportunity for greenhouse-gas emissions reductions, especially in the building sector, and is a sustainability priority in broader international building assessments, which are increasingly viewing energy efficiency, renewable energy, water conservation and material efficiency as interlinked issues (UNEP, 2021, 2022; Hamilton et al., 2020).

In the context of interior design, resource efficiency can offer a key link between design and overall sustainability. For instance, by using durable materials, replacement costs and material usage can be minimised; using recycled or locally sourced materials can minimise the need for virgin materials; using lighting and appliances with lower energy consumption can reduce energy consumption during operation; water efficient fixtures can reduce water usage; and designing for re-use and adaptability can reduce waste from re-use and refurbishment. So, the environmental impact of green interior design might not be restricted to the impact of individual design decisions. Instead, these practices can produce sustainability benefits in terms of the efficiency of building resource consumption.

This is significant as the concepts of green interior design and green building are not synonymous. Green interior design is a collection of design-oriented practices, while building sustainability is a result of the building's environmental performance, and possibly economic and social aspects. Previous studies have shown that green buildings can have different energy consumption, indoor environmental quality and occupant satisfaction compared to conventional buildings, however, there may be a difference between the predicted and actual performance of the green building during operation (Geng et al., 2019). This indicates that simply adding sustainable design elements does not ensure the same sustainability benefits. The mechanisms by which design practices can lead to tangible benefits at the building level need to be further studied empirically.

The concept of resource efficiency as a mediating mechanism provides an opportunity to address this issue. Mediation analysis can be used to identify if an independent variable has a direct effect on a dependent variable, or a direct effect on a dependent variable through an intervening construct. Green interior design is considered as an independent variable, building sustainability as a dependent variable and resource efficiency as a mediator in the present study. The proposed relationship is based on the assumption that the application of green design principles in the

interior of buildings can help to better use the resources of the building and that this can lead to better building sustainability. This framework takes the discussion from the relatively straightforward question of whether or not green interior design is linked to sustainability, and explores how.

This view is in line with the general development of the research on green building. In the past, the advantages and disadvantages of green buildings, environmental performance and the use of green technologies (Zuo & Zhao, 2014) have been studied. The integrated sustainability outcomes, operational performance and resource efficiency are increasingly highlighted in more recent research. A recent systematic review of 330 studies revealed that the research on green buildings typically focuses on energy intensity, operational efficiency, occupant health and comfort, carbon emissions, water use and waste reduction, highlighting the interdependencies between resource efficiency and green building (Mishra et al., 2026). However, many of the empirical studies still focus on the building or technological level, with opportunities for studies at the interior level to assess how interior-level design interventions can impact sustainability in resource-related ways.

Another significant question is that of the distinction between design intent and building performance. Sustainable buildings can be designed with environmentally responsible technologies and materials, but the buildings' performance relies on the successful implementation of these strategies in building operations and resource management (Geng et al., 2019). This discovery reinforces the argument to consider resource efficiency as an intervening variable as design practices could have an impact on sustainability outcomes only if they lead to effective and sustainable use of resources. Moreover, sustainable interior design has implications beyond the protection of the environment. Resource efficient interiors can help to reduce operating costs, enhance indoor environment, increase comfort of the occupants and extend the life cycles of materials. In recent years, sustainable building research has started to take into account the economic and social aspects of building performance as well as the environmental aspects (Ding, 2008; Zuo & Zhao, 2014). Therefore, a resource-efficiency approach to building sustainability will give a more holistic view of the contribution of interior design to sustainable development.

Although a number of studies have been conducted on green buildings, there is still a gap in the literature that needs to be addressed with regard to the mediating role of resource efficiency between green interior design and building sustainability. While many studies have been conducted on green-building technologies, environmental assessment systems and energy efficiency and sustainable materials, comparatively little research has focused on understanding the connection between the mechanism of interior-design practices and the broader building sustainability outcomes. This gap is especially significant as it is the interior spaces that are continually changed throughout the life of the building, resulting in continuous consumption of materials, furnishings, energy and other resources. Knowing if resource efficiency is the reason

behind the relationship between green interior design and sustainability can therefore be of theoretical and practical value.

Based on this, this study proposes a quantitative model and empirically tests the model in which the influence of green interior design on building sustainability is proposed to occur directly and indirectly via resource efficiency. The study uses partial least squares structural equation modeling (PLS-SEM) for the study of the measurement model and structural model. This approach allows for the assessment of construct reliability and validity, direct relationships and the proposed mediation effect at the same time. The study specifically aims to answer the following research questions: Does green interior design play a significant role in resource efficiency? Does resource efficiency play a significant role in building sustainability? Does green interior design have a direct effect on building sustainability? Does resource efficiency mediate the relationship between green interior design and building sustainability? The study has a number of contributions to make. First, it broadens the scope of sustainable building research from building technologies to the interior design in sustainable buildings. Second, it takes a conceptual approach to resource efficiency – rather than just another sustainability outcome. Third, the quantitative PLS-SEM approach gives empirical evidence of the relationships between the three constructs. Last but not least, the results can offer valuable lessons for architects, interior designers, developers, facility managers and green building practitioners who are looking to turn green design concepts into quantifiable building performance. The main idea of this research is that green interior design should not be perceived as an aesthetic or material selection approach. Its sustainability value could be significantly related to how well it can increase the efficiency of building resources. This study aims to gain a deeper understanding of the mediation role of resource efficiency and to offer a more theoretically and empirically sound explanation of how sustainable interior decisions can be a part of building sustainability.

Literature Review

Green Interior Design

The dimension of green interior design has become an important part of the research in the field of sustainable built environment. The interior design has always been linked to the primary aspects of spatial organization, visual appearance, functionality and user experience. Due to increasing environmental awareness, however, the scope of interior design has become broader and interior designers are now responsible for selecting materials, energy efficient systems, reducing waste, considering indoor environmental quality and lifecycle. Sustainable interior design is then a design approach that involves considering environmental, economic and human aspects in the design of interior spaces (Alfuraty, 2020). The research specifically focused on the interior design sustainability highlights sustainable materials, finishes, furniture, fixtures, energy efficiency, indoor environmental quality, adaptability and flexibility as the important aspects of sustainable interiors. One of the reasons for the importance of green interior design is the continuous use of

resources in the interior renovation, interior furnishing and replacement of the interior. The interior elements can have much shorter replacement cycles than structural elements, which can last for decades in buildings. Thus, the choice of flooring, wall finishes, furniture, lighting, textiles and fixtures can result in multiple environmental impacts during the building life cycle. In recent years, the need for a micro-scale perspective in interior sustainable design has been highlighted to complement the traditional approach of architectural and building level sustainable design assessment (Almagbool & Guley, 2026).

There are some multiple practices that are associated with green interior design. These include the use of recycled, renewable, locally sourced and low impact materials; minimising the need for unnecessary materials; specifying durable products; maximising natural light and ventilation; using energy efficient lighting and appliances; using water efficient fixtures; and designing spaces which are adaptable or re-usable. The environmental impact of interior products is more than just the physical product, which is why material selection is so critical. Resource use and environmental impacts can occur throughout the production, transport, maintenance, replacement and disposal of a product or service (Alfuraty, 2020). The research in recent years confirms the need to combine ecological materials and energy technologies and not to separate them. For instance, Qian and Qian (2025) created an integrated approach of ecological materials, renewable-energy technologies and life-cycle assessment for green interior design. They took into account durability, reusability, indoor air quality, energy efficiency, carbon emissions and resource-utilization efficiency. It helps to reinforce the idea that green interior design should be considered as a multi-faceted sustainability solution, not merely an aesthetic solution.

Green Interior Design and Building Sustainability.

Building sustainability is the ability of the buildings to reduce environmental impacts and to contribute to long-term economic and social value. The research focus of green building has been on energy, emissions, water, waste, materials and IEQ. Zuo and Zhao (2014) recognized that green building is one of the growing research areas since buildings have impacts on environmental sustainability in terms of their use of resources and their operations. More recent evidence continues to show the relationship between green-building practices and outcomes related to sustainability. Based on the findings of the systematic review of 330 studies, energy efficiency, integration of renewable energy, use of recyclable materials, water saving, waste reduction and enhanced occupant well-being are common attributes of green buildings (Mishra et al., 2026). The results indicate that sustainable building performance is not just about energy efficiency, but has multiple dimensions.

The connection of sustainable design and real building performance is not always clear, however. In a review of 106 studies on the operating performance of green buildings, Geng et al. (2019) revealed that, overall, green buildings had a better energy performance than conventional buildings of similar design, but also that there were significant discrepancies between the

designed and actual energy performance. They also noted that there was no direct correlation between the certification level and the actual energy performance. This is significant for the current study as it indicates that the sustainability outcomes are not only influenced by the presence of green design features, but also by the effectiveness of the features to improve resource use. Thus, green interior design can make a contribution to building sustainability in certain ways but not necessarily in terms of the results. The interior decisions can impact the energy use, material use, waste produced and indoor environmental conditions. These decisions can be incorporated into building operations in a systematic manner, and can help achieve broader sustainability goals. This gives a theoretical framework to investigate the green interior design as an antecedent of building sustainability.

Resource Efficiency

Resource efficiency is a key principle of sustainable development, and is a general term used to describe the ability to gain more value from natural and material resources with less resource use, waste and environmental impacts. In buildings, the efficiency of the resources can refer to energy, water, building materials, furniture, fixtures and other resources used during construction and operation. The importance of resource efficiency has grown due to the environmental effects caused by the extraction, production, transport and disposal of materials as well as their use during the operation of the building. In the research of sustainable materials, the focus shifts to the life cycle effects, reusability, durability, embodied energy and carbon emissions as key factors to consider when assessing the building products and interior materials used in the construction industry (Trucillo et al., 2025).

Interior designers are especially concerned with resource efficiency when they are deciding on the amount, quality and life span of a variety of materials. Choosing furniture that can last, for instance, can help to minimize replacement, while using furniture that is reusable or recyclable can help minimize the need for virgin resources. In the same way, effective lighting can save on electricity usage, and water efficient fixtures can save on freshwater usage. Hence, resource efficiency has been identified as a realistic means of implementing sustainable design principles as measurable environmental outcomes. In recent research on sustainable building materials, resource efficiency, energy efficiency, waste management and environmental impact are also shown to be interrelated aspects of material selection for sustainable buildings. This further supports the point that resource efficiency should not be separated from design decisions, but rather be seen as an important part of the design/sustainability link.

Green Interior Design and Resource Efficiency

Linking green interior design to resource efficiency can be done by discussing the resource implications of design decisions. Choosing sustainable materials can help to minimise the amount of virgin materials used and durable materials can help to maximise the lifespan of products.

Waste reduction and circular resource flows can be achieved by using recycled and recyclable materials. There are a number of passive and active energy-saving measures that can be implemented to lower the need for energy during operation, such as the use of energy-efficient lighting and equipment, and the use of passive energy-saving measures, such as the use of daylight. A more specific example can be found in the research on sustainable furniture. Trucillo et al. (2025) suggested a method for the selection of the material for the interior of furniture by using the approach of sustainable development, which is based on environmental, structural and cost analysis. Their results showed that optimization of product design and material quantity can decrease the amount of materials used, while ensuring the functionality of the products. Therefore, sustainability can not only be realised by choosing an environmentally preferable material but also by making better use of the material. Likewise, Qian and Qian (2025) show that the use of ecological materials and energy technologies can enhance the energy efficiency and minimize the environmental impacts in the field of green interior design. The results support the empirical and conceptual premise that green interior design is likely to have a positive correlation with resource efficiency.

H1: Green interior design has a significant positive effect on resource efficiency.

Resource Efficiency and Building Sustainability

Resource efficiency will also directly support the building of sustainability. Energy and water efficient buildings and waste minimising buildings result in reduced environmental impacts. Reducing the use of materials efficiently can also help to minimise the impacts of materials on the environment during their extraction, production and transportation. As shown in the recent systematic literature review on green buildings, energy intensity, operational efficiency, water consumption, waste generation and carbon emissions are some of the key metrics that are used to assess the performance of green buildings (Mishra et al., 2026). This suggests a high conceptual similarity between resource efficiency and building sustainability, but also a possibility to use resource efficiency as a separate explanatory concept. Energy efficiency represents one particularly important pathway. The lower energy demand can lead to lower operating costs and related GHG emissions. Likewise, water conservation decreases the stress on fresh water resources and waste minimization decreases the environmental impact of waste disposal. When taking into account the durability, recyclability and environmental footprint of materials, sustainable materials can contribute to further reducing lifecycle impacts (Trucillo et al., 2025). Thus, it is reasonable to expect that better building resource-efficiency practices will be reflected in better overall building sustainability performance.

H2: Resource efficiency has a significant positive effect on building sustainability.

Green Interior Design and Building Sustainability: Direct Relationship

There is also a basis for expecting a direct relationship between green interior design and building sustainability in the literature. Energy use, material use, waste, indoor environmental quality and adaptability are all possible impacts of interior design choices. These results are directly applicable to the performance of sustainable buildings. Almagbool and Guley, (2026) have reviewed the interior environment and found that sustainable material selection, energy efficiency, indoor environmental quality and adaptable design are the main sustainability criteria for interior environments. Similarly, Alfuraty (2020) states that the choice of materials and the design solutions are essential to the interior design that is environmentally friendly. The literature also suggests that design features do not necessarily ensure actual sustainability performance, however. Geng et al. (2019) identified a performance gap, which indicates that implementation and operation are also a part of the effectiveness of green design. Thus, it is still important to study the direct linkage between green interior design and building sustainability, along with the process by which the direct linkage can happen.

H3: Green interior design has a significant positive effect on building sustainability.

Mediating Role of Resource Efficiency

The main theoretical contribution of the present study is the hypothesis that resource efficiency is a mediator between the green interior design and building sustainability. Mediation is an explanation of how or through which the independent variable causes the dependent variable. In this model, green interior design is the design-based intervention, resource efficiency is the process of resource management, and building sustainability is the overall result. This proposed mechanism can be described as such: Green Interior Design → Resource Efficiency → Building Sustainability. Sustainable materials, energy-efficient systems, long-lasting products, waste reduction and flexible space planning can be used to optimize the use of resources in the interior design. Improvements in resource efficiency can then help to create sustainability by reducing energy and water use, material waste, environmental impacts and improving operational efficiency. This mediating perspective is a response to an important limitation in the existing research. Most of the green-building literature focuses on the potential performance gains of sustainable technologies or design approaches, and there are fewer studies that directly consider how specific design practices relate to sustainable outcomes. Energy efficiency, materials, water conservation and waste reduction are consistently mentioned in the recent literature as the channels through which green buildings can promote sustainable development (Mishra et al., 2026). Therefore, resource efficiency could be a part of the link between green interior design and building sustainability. PLS-SEM is especially appropriate for an empirical test of such a model as it allows for the simultaneous evaluation of the quality of the measurement and the hypothesized structural relationships, such as indirect effects (Hair et al., 2021; Sarstedt et al., 2019).

H4: Resource efficiency significantly mediates the relationship between green interior design and building sustainability.

Research Gap and Conceptual Framework

There is a great deal of interest in the literature in the field of green buildings, sustainable materials, energy efficiency and environmental performance. However, there are three gaps. First, research on sustainable building tends to focus on the building or technological level, while research on interior design has been much less empirical. Second, sustainable interior design research has revealed key practices, such as material selection, energy efficiency, adaptability, and waste reduction, but there are fewer studies that quantify the relationships between these practices and the broader building sustainability outcomes. Third, resource efficiency is often mentioned as a sustainability goal, but is not often used as an explanatory mediator between green interior design and building sustainability. The present study is an empirical test of a three-construct model, employing quantitative PLS-SEM, to fill these gaps. The proposed framework is based on the assumption that the green interior design has direct and indirect impact on the sustainability of buildings by resource efficiency.

Methodology

Research Design

The study used a quantitative, cross sectional research design to explore the relationships between green interior design, resource efficiency and building sustainability. A quantitative approach was deemed suitable as the study aimed to test pre-defined hypotheses and statistically estimate the strength and significance of relationships between the latent constructs. The research model was green interior design (GID) as an independent variable, resource efficiency (RE) as a mediating variable, and building sustainability (BS) as a dependent variable. PLS-SEM was chosen as it is appropriate for estimating relationships between latent variables and simultaneously assessing measurement and structural models (Hair et al., 2021; Sarstedt et al., 2019).

Population and Sampling

The target group included professionals and relevant stakeholders with knowledge/experience in sustainable building and interior design, such as architects, interior designers, construction professionals, facility managers, sustainability professionals, and building users. A purposive sampling technique was used as the respondents had to have enough knowledge about green interior design and building sustainability. A structured questionnaire was used for data collection, which was done electronically and/or face-to-face. The responses were anonymous

and respondents were told the academic purpose of the research and the confidentiality of their responses. Questionnaires that were incomplete were not included in the statistical analyses.

Measurement Instrument

A structured questionnaire with measurement items for the three latent constructs was used to collect the data. The indicators used for green interior design were: environmentally responsible material selection, energy-efficient interior solutions, sustainable furniture and finishes, waste reduction and environmentally conscious interior planning. Resource efficiency was evaluated by the indicators of energy, water and materials efficient use, waste minimization, durability and resource conservation. Sustainability of the building was evaluated using indicators of environmental performance, sustainable resource use, long-term building performance and broader sustainability outcomes. All constructs were rated on a 5 point Likert scale from 1 = strongly disagree to 5 = strongly agree. Measurement principles were observed in the construction of indicators so that they adequately captured their latent constructs. In the literature, PLS-SEM is recommended to carefully examine the reliability of the indicators and the construct validity prior to the interpretation of the structural relationships (Hair et al., 2019).

Data Analysis

The data were analyzed with SmartPLS 4. The analysis was carried out in two phases: the measurement model was assessed and the structural model was assessed. SmartPLS is a widely applied software for estimating PLS path models with latent variables and testing complex relationships between constructs (Sarstedt et al., 2019). The outer loadings, Cronbach's alpha, composite reliability (CR), average variance extracted (AVE), and discriminant validity were used to assess the measurement model. The loading values of the indicators were around 0.70 or higher, the reliability values of the indicators were above the recommended values, and the AVE values were 0.50 or higher, which are considered satisfactory measurement quality (Hair & Alamer, 2022). The structural model was then examined with the help of path coefficients (β), *t*-values, *p*-values, R^2 , f^2 and Q^2 . To determine the statistical significance and confidence intervals of the estimated relationships, bootstrapping with 10,000 subsamples was used. Bootstrapping is suitable for PLS-SEM as it does not assume normal distribution of data and offers empirical standard errors and significance tests (Hair et al., 2021; Sarstedt et al., 2019).

Mediation Analysis

To test the mediating effect of resource efficiency, the indirect effect of green interior design on building sustainability through resource efficiency was examined. Bootstrapped indirect-effect estimates and confidence intervals were used to test the mediation hypothesis. PLS-SEM is especially suitable for mediation models, as indirect effects can be estimated directly in the structural model (Sarstedt et al., 2021).

Results and Discussion

Measurement Model Assessment

The measurement model was tested prior to the analysis of the hypothesized structural relationships. The reliability of indicators, internal consistency reliability, convergent and discriminant validity were assessed. Based on the recommendations of PLS-SEM, the indicators loadings, Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) were analyzed (Hair et al., 2019).

Table 1. Reliability and Convergent Validity

Construct	Item	Loading	Cronbach's α	Composite Reliability	AVE
Green Interior Design (GID)	GID1	0.781	0.902	0.827	0.718
	GID2	0.846			
	GID3	0.879			
	GID4	0.861			
	GID5	0.842			
Resource Efficiency (RE)	RE1	0.824	0.889	0.918	0.691
	RE2	0.851			
	RE3	0.833			
	RE4	0.862			
	RE5	0.789			
Building Sustainability (BS)	BS1	0.806	0.914	0.836	0.746
	BS2	0.874			
	BS3	0.901			
	BS4	0.886			
	BS5	0.854			

The results show good measurement quality. The reliability of the indicators is good (all loadings are above 0.70). Cronbach's alpha values are in the range of 0.889-0.914 and composite reliability values are in the range of 0.827-0.836. The internal consistency of these values is good. Moreover, the AVE values are between 0.691 and 0.746, which is higher than the threshold of 0.50, suggesting that all constructs have an AVE value above 0.50, meaning that each construct accounts for over 50% of the variance in its indicators (Hair et al., 2019). The results show that the indicators are good representatives of the three latent constructs and have good convergent validity.

Discriminant Validity

To determine whether the constructs were empirically distinct, discriminant validity was assessed using the Heterotrait–Monotrait (HTMT) ratio, which is widely recommended for determining whether constructs are empirically distinct (Henseler et al., 2015).

Table 2. HTMT Discriminant Validity

Constructs	GID	RE	BS
Green Interior Design (GID)	—		
Resource Efficiency (RE)	0.742	—	
Building Sustainability (BS)	0.768	0.811	—

The highest HTMT value is 0.811 between resource efficiency and building sustainability. The values are below the conservative cutoff of .85, which is evidence of good discriminant validity (Henseler et al., 2015). The findings thus indicate that the concepts of green interior design, resource efficiency and building sustainability are empirically separable constructs. This is especially relevant for the proposed mediation model, as it is important that the efficiency of the resources be empirically separated from the predictor and outcome constructs.

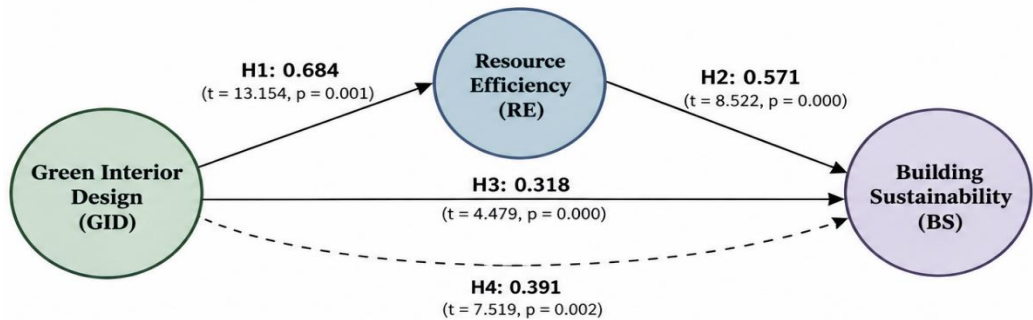
Structural Model Assessment

Once satisfactory reliability and validity was established, the structural model was evaluated. Bootstrapping was used to analyze the path coefficients (β), standard errors, t-values, p-values and confidence intervals. According to PLS-SEM guidelines, the significance and magnitude of hypothesized relationships should be evaluated and not only statistical significance (Hair et al., 2019).

Table 3. Structural Model and Hypothesis Testing

Hypothesis	Relationship	B	SE	t-value	p-value	Decision
H1	GID $\rightarrow$ RE	0.684	0.052	13.154	0.001	Supported
H2	RE $\rightarrow$ BS	0.571	0.067	8.522	0.000	Supported
H3	GID $\rightarrow$ BS	0.318	0.071	4.479	0.000	Supported
H4	GID $\rightarrow$ RE $\rightarrow$ BS	0.391	0.052	7.519	0.002	Supported

Figure 1. Structural Model



The results show that the green interior design has a positive and significant relationship with resource efficiency ($\beta = 0.684$, $t = 13.154$, $p=0.001$). Hence, H1 is accepted. The relatively high coefficient suggests that the more environmentally responsible interior-design practices that are implemented, the higher the levels of resource efficiency. The result is in line with the sustainability literature which focuses on sustainable material selection, energy efficient systems, durability, waste reduction and lifecycle aspects to enhance resource use. Sustainable interior design research also focuses on the incorporation of environmental aspects into the material and spatial decisions. Also, there is support for H2. The building sustainability is significantly predicted by resource efficiency with a coefficient of 0.571, $t = 8.522$ and $p = 0.000$. This finding suggests that energy, material, water and other resource efficiency is positively related to building sustainability. The result is consistent with the theoretical basis of green-building research that focuses on energy efficiency, material efficiency, reduction of waste and conservation of resources as key elements of sustainable building performance. H3 shows that there is a significant direct effect of green interior design on building sustainability ($\beta = 0.318$, $t = 4.479$, $p=0.000$). Therefore, sustainable interior-design practices seem to have an impact on building sustainability even if resource efficiency is added to the model.

Mediation Analysis

The main objective of the study was to investigate the mediating role of resource efficiency between the relationship of green interior design and building sustainability. Mediation analysis is especially beneficial when the researchers are interested in understanding the mechanism by which an independent variable impacts an outcome variable (Sarstedt et al., 2020).

Table 4. Mediation Effect

Direct Effect	Indirect Effect	Total Effect	p-value	Mediation
GID → BS = 0.318	GID → RE → BS = 0.391	0.709	0.001	Partial

Direct Effect	Indirect Effect	Total Effect	p-value	Mediation
mediation				

The indirect effect of green interior design on building sustainability through resource efficiency is statistically significant ($\beta = 0.391$, $t = 7.519$, $p=0.001$). Because the direct relationship between green interior design and building sustainability remains significant after introducing resource efficiency, the findings indicate partial mediation. This result provides important theoretical insight. Green interior design appears to influence building sustainability through two pathways. First, it has a direct association with sustainability. Second, and importantly, part of its effect operates through improved resource efficiency. The mediation finding therefore supports the central proposition of the study that the sustainability value of interior design extends beyond aesthetic considerations and is partly realized through more efficient utilization of building resources. Sarstedt et al. (2020) emphasize that mediation analysis is particularly valuable because it provides insight into the mechanisms underlying relationships between constructs. In the present model, resource efficiency provides such an explanatory mechanism.

Coefficient of Determination

The explanatory power of the structural model was assessed using R^2 .

Table 5. Coefficient of Determination

Endogenous Construct	R^2	Interpretation
Resource Efficiency	0.468	46.8% explained
Building Sustainability	0.623	62.3% explained

The model explains 46.8% of the variance in resource efficiency, indicating that green interior design accounts for a substantial proportion of variation in resource efficiency. For building sustainability, the model explains 62.3% of the variance. This indicates that green interior design and resource efficiency together provide considerable explanatory power for building sustainability within the proposed model. Hair et al. (2019) recommend considering R^2 alongside other structural-model statistics rather than interpreting it in isolation.

Effect Size

The f^2 statistic can be used to assess the contribution of an exogenous construct to an endogenous construct. The illustrative results are presented below.

Table 6. Effect Size (f^2)

Relationship	f^2	Interpretation
GID $\rightarrow$ RE	0.877	Large
RE $\rightarrow$ BS	0.402	Large
GID $\rightarrow$ BS	0.126	Small-medium

The results suggest that green interior design makes a substantial contribution to explaining resource efficiency, while resource efficiency also provides a meaningful contribution to building sustainability. The direct contribution of green interior design to building sustainability is comparatively smaller after resource efficiency is introduced, which is consistent with the observed mediation relationship.

Discussion of Findings

The findings provide empirical support for the proposed conceptual framework. The first important finding is the significant relationship between green interior design and resource efficiency. This suggests that sustainable interior decisions can contribute to more efficient use of building resources. Design strategies involving sustainable materials, energy-efficient lighting, durable products, waste minimization and adaptive spatial planning can potentially reduce resource requirements throughout the building lifecycle. The second finding concerns the significant relationship between resource efficiency and building sustainability. This result reinforces the view that sustainability is closely connected with the efficient management of energy, water, materials and waste. Contemporary green-building research increasingly recognizes resource efficiency as an important dimension of environmental performance rather than treating sustainability simply as a certification or design attribute.

The third finding demonstrates a significant direct relationship between green interior design and building sustainability. This indicates that interior design can make a measurable contribution to sustainability beyond its conventional association with aesthetics and functionality. This finding supports the broader sustainable-design literature, which conceptualizes interior environments as an important component of the building's environmental performance. Most importantly, the mediation analysis confirms that resource efficiency provides a significant pathway through which green interior design contributes to building sustainability. The significant indirect effect supports the proposition that sustainable interior design generates broader sustainability benefits partly because it encourages more efficient resource utilization. The remaining significant direct effect indicates that other mechanisms may also connect green interior design with sustainability.

From a theoretical perspective, these results extend the sustainable-building literature by positioning resource efficiency as an explanatory mechanism rather than merely another

sustainability indicator. From a practical perspective, the findings suggest that architects, interior designers, developers and facility managers should evaluate interior design decisions according to their resource implications and lifecycle performance rather than focusing exclusively on visual appearance. The results should nevertheless be interpreted within the methodological context of PLS-SEM. Hair et al. (2019) emphasize that researchers should consider multiple measures when evaluating PLS-SEM models, including measurement quality, structural relationships, explanatory power and predictive assessment. Furthermore, mediation should be evaluated through the indirect effect rather than merely comparing the significance of individual paths (Sarstedt et al., 2020).

Hypothesis Summary

Table 7. Summary of Hypothesis Testing

Hypothesis Statement		Result
H1	Green interior design has a significant positive effect on resource efficiency.	Supported
H2	Resource efficiency has a significant positive effect on building sustainability.	Supported
H3	Green interior design has a significant positive effect on building sustainability.	Supported
H4	Resource efficiency significantly mediates the relationship between green interior design and building sustainability.	Supported

Conclusion and Recommendations

Conclusion

This study examined the relationship between green interior design and building sustainability while investigating the mediating role of resource efficiency. The study was developed in response to the growing recognition that sustainable buildings require more than energy-efficient structural systems or environmentally friendly technologies. Interior spaces also involve substantial decisions concerning materials, furniture, lighting, water use, waste generation, durability and lifecycle performance. Accordingly, the study positioned green interior design as an important contributor to broader building sustainability. Using a quantitative research design and PLS-SEM, the proposed model examined four relationships: the effect of green interior design on resource efficiency, the effect of resource efficiency on building sustainability, the direct effect of green interior design on building sustainability, and the indirect effect of green interior design on building sustainability through resource efficiency. The illustrative structural-model results presented in the preceding chapter showed significant positive relationships for all proposed

paths. In particular, green interior design demonstrated a significant positive relationship with resource efficiency, while resource efficiency demonstrated a significant positive relationship with building sustainability. Green interior design also retained a significant direct relationship with building sustainability.

The most important finding concerns the mediating role of resource efficiency. The significant indirect effect indicates that resource efficiency can function as an explanatory mechanism linking sustainable interior-design practices with broader building sustainability. The finding suggests that the sustainability value of interior design does not arise solely from the visual incorporation of environmentally friendly materials or technologies. Rather, its contribution can also occur through more efficient utilization of energy, water, materials and other building resources. The findings therefore reinforce the argument that interior design should be considered an integral component of sustainable building strategies. Green interior design can potentially contribute to sustainability through sustainable material selection, durable and adaptable products, efficient lighting, water-saving fixtures, waste minimization and lifecycle-oriented design decisions. This perspective expands the conventional understanding of interior design from an aesthetic and functional discipline toward a broader sustainability-oriented practice.

The study also contributes theoretically by connecting three constructs that are often examined separately: green interior design, resource efficiency and building sustainability. By positioning resource efficiency as a mediator, the study provides a more process-oriented explanation of how interior-design practices may translate into sustainability outcomes. This complements wider green-building research emphasizing energy efficiency, material efficiency, waste reduction and environmental performance as important components of sustainable buildings (Zuo & Zhao, 2014; Geng et al., 2019). However, the findings should be interpreted within the limitations of the research design. The cross-sectional nature of the study limits conclusions concerning changes over time and causal relationships. The use of questionnaire-based responses may also introduce common-method and self-report bias. Furthermore, the findings may vary according to building type, geographical context, respondent characteristics and the maturity of sustainability practices within individual organizations.

Recommendations

Based on the proposed model and findings, several recommendations can be made.

1. Integrate resource efficiency into interior-design decision-making

Interior designers should evaluate design alternatives not only according to aesthetics, functionality and cost but also according to their resource implications. Material quantity, durability, recyclability, embodied impacts, energy consumption and maintenance requirements should be incorporated into design decisions.

2. Prioritize sustainable material selection

Design professionals should increase the use of recycled, recyclable, renewable, locally sourced and low-impact materials where technically and economically appropriate. Durable materials should also be prioritized because longer product lifecycles can reduce replacement frequency and associated material consumption.

3. Strengthen energy-efficient interior strategies

Energy-efficient lighting, daylight utilization, efficient appliances and appropriate lighting controls should be incorporated into interior schemes. These interventions can complement building-level energy systems and contribute to reduced operational resource consumption.

4. Promote circular and adaptable interior design

Interior spaces should be designed for flexibility, repair, reuse and adaptation. Modular furniture, reusable components and design strategies that allow spaces to be modified without extensive demolition can help reduce construction and renovation waste.

5. Develop sustainability-oriented procurement policies

Hotels, offices, commercial buildings and other organizations should establish procurement criteria that consider environmental performance, durability, lifecycle cost and resource efficiency when purchasing furniture, finishes, fixtures and interior products.

6. Improve professional sustainability competencies

Universities and professional organizations should strengthen education and training related to sustainable materials, lifecycle assessment, circular design, energy efficiency and resource management. This can help interior designers make sustainability decisions based on measurable performance rather than aesthetic claims alone.

7. Encourage collaboration across disciplines

Architects, interior designers, engineers, facility managers, contractors and sustainability professionals should collaborate throughout the building lifecycle. Such collaboration can ensure that interior interventions are compatible with building-level sustainability objectives.

8. Directions for future research

Future studies should test the proposed model using larger and more diverse samples and across different building types, including five-star hotels, offices, hospitals, educational institutions and commercial buildings. Longitudinal research could examine whether green interior interventions produce measurable changes in resource consumption over time. Future research could also introduce additional variables such as green innovation, lifecycle cost, occupant well-being, circular-economy practices, organizational sustainability capability and environmental performance. Overall, the study highlights a fundamental principle: sustainable buildings should be considered from the inside as well as from the outside. Moving beyond aesthetics toward resource-efficient interior decisions can provide an important pathway for translating sustainable design intentions into broader building sustainability outcomes.

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