

Research Article

Acceptability of Coconut Husk Sound Absorbing Panel

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Abstract: Noise pollution negatively affects comfort, productivity, and health. This study develops and evaluates a coconut husk sound absorber panel as a sustainable, low-cost alternative to synthetic acoustic materials. Coconut husks, an abundant agricultural by-product, offer a porous and fibrous structure that can trap sound waves. The panel was made from 500 g ground coconut husk and 1 kg sodium silicate shaped into a 20 × 20 × 2 cm mold. Tests were conducted in a residential room using a mobile sound meter to compare noise levels before and after panel installation. Results showed an average noise reduction of 6.7 dB. The panel was also observed to be lightweight, eco-friendly, aesthetically natural, and more affordable than commercial acoustic products. This study supports the potential of coconut husk as an environmentally responsible material for noise reduction in indoor spaces.

Keywords: coconut husk; sound absorber; eco-friendly material; acoustic panel; noise reduction

1. Introduction

In today's new generation, people are increasingly exposed to unwanted noise from traffic, appliances, and the crowded environment (Basner et al., 2014; Banks & Cohen Hubal, 2024). Many people find ways to create silent and more comfortable spaces, yet traditional soundproofing materials such as fiberglass and foam are costly and may cause health risks (Cucharero et al., 2019). Imagine being able to reduce noise using a natural, safe, and affordable material that is often treated as waste. This is where coconut husk, a usual result of the coconut fruit becomes a promising solution for sound absorption (Zulkifli et al., 2010; Yang et al., 2020).

The study of Syahrullail et al. (2013), who investigated the potential of the coconut husk fibers as an acoustic material. According to their research, the acoustic of coconut husk and found that the material displayed promising sound absorption performance, especially in mid-to-high frequency ranges. Their studies explore coconut husk as a natural sound absorber due to its fibrous and porous structure, which allows it to trap and dissolve sound waves effectively (Cucharero et al., 2019; Ajien et al., 2023). Their research on coconut husks mixture shows that they have a sound absorption amount of up to 0.8 and low heat insulation (Syahrullail et al., 2013; Alenezi et al., 2025).

The study on coconut husk as a sound absorber panel focuses on developing a sustainable, affordable, and safe alternative to conventional acoustic materials. Fiberglass and foam panels are effective in reducing noise but are frequently expensive, non-biodegradable, and potentially dangerous due to the release of fine synthetic fibers (Pacheco-Torgal et al., 2020; Korjenic et al., 2011). The general problem addressed in this study is the lack of eco-friendly, safe, and cost-effective soundproofing materials that can provide effective sound absorption without harming human health and the environment (Asdrubali et al., 2015). Coconut husks have fibrous and absorbent characteristics that allow it to absorb sound waves efficiently (Alenezi et al., 2025; Zulkifli et al., 2010). When processed into panels, the material can be made in sizes such as 20×20 cm, with a thickness of 2 cm (Yang et al., 2020).

This highlights the innovation of applying coconut husk as an acoustic material. By recycling farm waste into a useful sound absorber panel, wall linings, and ceiling boards, it promotes sustainable building practice while minimizing waste (Pacheco-Torgal et al., 2020). Its biodegradable and sustainable nature ensures environmental conservation (Korjenic et al.,

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2011). This also promotes accessibility and inclusivity, as coconut husk panels are affordable, suitable for use in schools, hospitals, and even in offices (Asdrubali et al., 2015). This makes soundproofing technology more accessible to a wider range of users.

In this context, the present study aims to evaluate the acceptability of coconut husk-based acoustic panels in terms of aesthetic design, sound absorption performance, and affordability, while also examining their potential as a sustainable and low-cost alternative to conventional soundproofing materials for indoor applications.

Also, the research is to verify the hypothesis. It concerns the following: The coconut husk sound absorber panel, when fabricated using ground coconut husk and sodium silicate, significantly reduces indoor noise levels due to the natural porosity and fibrous structure of the coconut husk, which enhances sound wave dissipation.

2. Materials and Methods

This study presents the procedures used to develop a coconut husk sound absorber panel as a sustainable and low-cost acoustic material. The process involves collecting and preparing coconut husk fibers, combining them with sodium silicate adhesive, molding the mixture, and evaluating its noise reducing effectiveness in a real indoor environment. Careful measurements, controlled preparation, and consistent drying conditions ensured uniformity across sample. Sound level testing was conducted using a mobile sound meter application to compare noise before and after panel installation.

Table 1 presents the material composition used for the fabrication of a standard acoustic panel with dimensions of 20 × 20 × 2 cm. The formulation consists of two primary components: ground coconut husk and sodium silicate. The ground coconut husk, applied in a quantity of 500 grams, functions as a natural fiber reinforcement, contributing to the structural integrity and acoustic absorption properties of the panel. Sodium silicate, used in a quantity of 1000 grams, serves as the binding agent, ensuring cohesion of the composite material and facilitating the formation of a stable matrix. The proportion of components reflects a fiber-to-binder ratio designed to balance mechanical stability with sound absorption efficiency. This composition enables the production of a single panel suitable for controlled acoustic testing, while also highlighting the use of sustainable, bio-based materials in composite panel design.

Table 1. Material composition for a 20 × 20 × 2 cm acoustic panel.

Material	Quantity	Use
Ground coconut husk	500 grams	Main sound-absorbing component; provides fibrous, porous structure for trapping sound waves
Sodium silicate	1 kilogram	Adhesive binder; hardens and stabilizes the panel
Mixing container	1 piece	Holds materials during mixing
Mixing stick	1 piece	Used to blend husk and adhesive thoroughly
Gloves	1 pair	Protects hands during handling of sodium silicate
20 × 20 × 2 cm molder	1 unit	Shapes the mixture into uniform panel dimensions

At the same time, figure 1 shows the process of construction of coconut husk sound absorbing panel.

The methodological procedure for the fabrication and evaluation of the coconut husk acoustic panel is presented in table 2. The process consists of a sequence of seven interrelated stages, beginning with the preparation of raw materials and concluding with acoustic performance testing. Each stage is designed to ensure the structural integrity, material consistency, and functional effectiveness of the final product.

The initial stage involves the collection and preparation of raw coconut husks, including cleaning and sun-drying, to eliminate impurities and moisture that could negatively affect processing and bonding. This is followed by mechanical size reduction through chopping and grinding, which transforms the husks into fine, porous fibers. Such treatment enhances the material's surface area and contributes to improved sound absorption properties.



Figure 2. Construction of coconut husk sound absorbing panel.

The third stage focuses on the mixing of components, where ground coconut husk is combined with sodium silicate in a controlled ratio. Continuous stirring ensures uniform coating and distribution of the binder, which is essential for achieving a stable composite matrix. The homogeneous mixture is then transferred into a mold with specified dimensions (20 × 20 × 2 cm), where it is compacted and leveled to produce a panel with consistent density and thickness.

Subsequently, the molded panel undergoes a drying phase under natural sunlight conditions until complete hardening is achieved. This step is critical for developing the mechanical strength and durability of the material. Once dried, the panel is carefully removed from the mold and subjected to inspection to identify any defects, such as cracks, uneven edges, or thickness irregularities, which may require minor corrections.

The final stage involves acoustic testing to evaluate the performance of the produced panel. Sound levels are measured in a controlled environment before and after panel installation, using multiple trials to ensure reliability. The comparison of these measurements allows for the assessment of noise reduction capacity and overall acoustic effectiveness.

Table 2. Method (Process) for fabrication and testing of coconut husk acoustic panel.

Part	Material	Step	Purpose
I. Collection and preparation of husks	Raw coconut husks	Collect coconut husks from the site. Clean thoroughly to remove dirt, dust, and debris. Sun-dry to remove moisture	To ensure the raw material is clean, dry, and suitable for processing.
II. Chopping and grinding	Dried coconut husks, bolo, grinder	Chop husks into small pieces using a bolo. Grind the chopped pieces to create fine, porous fibers.	To reduce fiber size for easier mixing and improve sound absorbing porosity.
III. Mixing of components	Ground coconut husk (500 g), sodium silicate (1 kg), mixing container, mixing stick, gloves	Place ground husk into a clean container. Slowly add sodium silicate while stirring continuously until mixture becomes uniform and fully coated.	To achieve an even blend that ensures structural stability when molded.
IV. Molding	20 × 20 × 2 cm molder	Transfer mixture into the mold. Compact the mixture firmly using a flat tool to remove air pockets. Level the surface evenly.	To form a uniform panel with consistent density and thickness.
V. Drying	Molded panel	Allow the molded mixture to sun-dry until completely hardened. Drying time depends on sunlight conditions.	To harden the panel and achieve final strength and durability.
VI. Panel inspection	Fully dried panel	Remove panel from mold. Check for cracks, uneven edges, and thickness irregularities. Trim rough edges if needed.	To ensure the finished panel meets quality standards before testing.
VII. Sound testing	Coconut husk panel, mobile sound meter app	Measure room noise without the panel (3 trials). Install panel and measure again (3 trials). Compute the average reduction.	To determine the acoustic effectiveness of the coconut husk panel in real conditions.

3. Results

This section presents the findings of the study in relation to its primary objective, namely, to assess the acceptability of the coconut husk-based sound-absorbing panel. The results encompass the selection of materials, their proportional composition, the stages of the production process, and the overall performance of the panel in terms of aesthetic quality, acoustic efficiency, and cost-effectiveness.

The material composition of the panel was deliberately designed to ensure both structural stability and acoustic functionality. The formulation consisted of 1 kilogram of sodium silicate, which served as the binding agent, and 500 grams of ground coconut husk, functioning as the primary fibrous component responsible for sound absorption. Additional tools and equipment included a mold with dimensions of $20 \times 20 \times 2$ cm to shape the panel, protective gloves to ensure safe handling during the mixing process, and a mixing stick to facilitate uniform blending of the components.

The production process followed a systematic sequence of steps aimed at achieving consistency and quality in the final product. Initially, raw coconut husks were collected and thoroughly cleaned to remove dirt and impurities. The cleaned husks were then chopped into smaller pieces and subsequently ground into fine fibers to enhance their porosity and improve acoustic performance. The processed coconut husk fibers were combined with sodium silicate in a controlled ratio, and the mixture was stirred continuously until a homogeneous blend was obtained. This mixture was then transferred into the mold and compacted to eliminate air pockets and ensure uniform density. The molded panel was left to sun-dry until complete hardening was achieved, allowing the material to develop sufficient mechanical strength. Following the drying stage, the panel underwent inspection to evaluate its physical integrity, including the presence of cracks, uniformity of thickness, and overall surface quality.

The findings related to material proportions and panel composition are visually represented in figure 2, which illustrates the ratio of coconut husk to sodium silicate used in the fabrication process. This figure supports the analysis by providing a clear depiction of the component distribution within the composite panel.

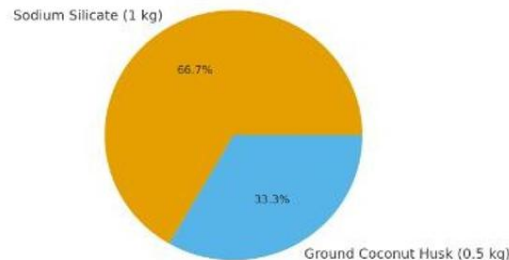


Figure 2. Coconut husk panel material proportion.

Table 3 presents the results of the survey evaluating the acceptability of the coconut husk sound absorber panel based on three key criteria: aesthetic design, sound absorption, and price. Overall, the panel demonstrates a generally positive level of acceptability among respondents. Sound absorption received the highest mean score (3.17), indicating that the panel is perceived as acceptable in terms of its primary functional performance. In contrast, both aesthetic design (2.93) and price (2.84) were rated as moderately acceptable, suggesting that while the panel is functional, there is room for improvement in its visual appeal and cost efficiency. These findings indicate that the panel is most effective in its acoustic function, with slightly lower evaluations in terms of design and affordability.

Table 3. Acceptability of the coconut husk sound absorber panel bases on survey responses.

Criteria	Mean score	Verbal interpretation
Aesthetic/Design	2.93	Moderately acceptable
Soun absorption	3.17	Acceptable
Price	2.84	Moderately acceptable

Table 4 presents the results of the acoustic testing conducted to evaluate the effectiveness of the coconut husk sound-absorbing panel. The average noise level without the



panel was 61.7 dB, while the use of the panel reduced the average noise level to 55 dB. Across three trials, the panel achieved noise reductions of 7 dB, 5 dB, and 8 dB, with an overall average reduction of 6.7 dB. These findings indicate that the panel provides a consistent and measurable decrease in sound levels, demonstrating its effectiveness as a sound-absorbing material under the tested conditions.

Table 4. Testing of the sound absorbing panel.

Test condition	Trial 1	Trial 2	Trial 3	Average
Without sound absorbing panel	63 dB	60 dB	62 dB	61.7 dB
With sound absorbing panel	56 dB	55 dB	54 dB	55 dB
Noise reduction	7 dB	5 dB	8 dB	6.7 dB

The noise reduction values obtained from the experimental trials can be expressed as follows:

$$x_1 = 7 \text{ dB} \tag{1}$$

$$x_2 = 5 \text{ dB} \tag{2}$$

$$x_3 = 8 \text{ dB} \tag{3}$$

$$x = 6.7 \text{ dB} \tag{4}$$

These values represent the measured differences in sound levels between conditions without and with the coconut husk sound-absorbing panel. The average reduction indicates the overall effectiveness of the panel in decreasing noise levels.

To prove the hypothesis, the evaluation of the panel's performance was conducted through controlled measurements of sound levels in a closed environment. The average noise level recorded without the panel was 61.7 dB, whereas the installation of the panel resulted in an average noise level of 55 dB, corresponding to a consistent reduction of 6.7 dB across three trials. This reduction can be explained by the intrinsic physical properties of coconut husk, including its porous, irregular, and fibrous structure, which facilitates the penetration, scattering, and attenuation of sound waves through internal friction.

The consistency of noise reduction across multiple trials provides empirical support for the sound absorption capability of the coconut husk panel. Therefore, the research hypothesis is supported.

4. Discussion

The materials employed in the fabrication of the coconut husk sound absorber panel demonstrated effectiveness in achieving both structural integrity and functional performance. Sodium silicate functioned as a stable and efficient binding agent, enabling the ground coconut husk fibers to form a cohesive and mechanically durable composite. The use of a standardized mold (20 × 20 × 2 cm) ensured uniformity in panel dimensions, which is essential for the reliable assessment of acoustic properties and for maintaining consistency across experimental trials (Yang et al., 2020).

The production process played a critical role in determining the overall quality and performance of the panel. The preliminary cleaning and subsequent grinding of coconut husks into fine fibers enhanced material porosity, a key parameter influencing sound absorption capacity. This observation aligns with recent studies in sustainable acoustic materials, which emphasize that increased porosity and fibrous microstructure significantly improve the dissipation of sound energy through internal friction and air flow resistance (Asdrubali et al., 2015). The homogeneous mixing of coconut fibers with sodium silicate facilitated effective bonding within the composite matrix, while compaction during molding minimized internal voids that could compromise structural strength (Korjenic et al., 2011). The adoption of sun-drying as a curing method provided adequate hardening of the material while maintaining an energy-efficient and environmentally sustainable approach, consistent with current trends in eco-friendly material engineering (Pacheco-Torgal et al., 2020).

The proportional composition of the panel, as illustrated in the corresponding figure, indicates a ratio of approximately 2:1 between sodium silicate and ground coconut husk. In this formulation, sodium silicate constitutes nearly two-thirds of the mixture, while the coconut husk accounts for the remaining one-third. This distribution highlights the necessity of a sufficient amount of binder to ensure complete encapsulation of the fibrous material and



to maintain dimensional stability during molding and drying. Comparable findings have been reported in recent research on natural fiber composites, where higher binder content is often required to achieve optimal cohesion and mechanical durability, particularly when irregular and porous organic materials are used as fillers (Faruk et al., 2012).

The acceptability of the coconut husk sound absorber panel was evaluated through a survey administered via a Google Forms instrument. The results indicate that the panel achieved a mean score of 2.93 for aesthetic design, reflecting a moderately acceptable perception of its visual appearance. In terms of functional performance, sound absorption received a higher mean score of 3.17, suggesting that the panel was considered acceptable in its primary role of noise reduction. The price criterion yielded a mean score of 2.84, indicating a moderately acceptable level of affordability at a cost of 150 pesos. The overall weighted mean of 2.98 demonstrates that the panel is generally acceptable when considering design, acoustic performance, and economic factors collectively.

These findings are consistent with recent studies on bio-based acoustic materials, which report that natural fiber composites often exhibit satisfactory sound absorption performance while facing moderate limitations in aesthetic refinement and market competitiveness (Asdrubali et al., 2015). Thus, the results confirm that coconut husk-based panels represent a viable and sustainable alternative for acoustic applications, particularly in contexts where environmental considerations and cost efficiency are prioritized.

5. Conclusions

Based on the results of the study, the coconut husk sound absorber panel demonstrated satisfactory structural stability, functional performance, and overall acceptability. The combination of ground coconut husk and sodium silicate effectively produced a durable and uniformly shaped panel, while the production process enhanced material porosity and bonding, thereby contributing to improved sound absorption capability. The material proportion, characterized by a higher adhesive content, ensured adequate binding and structural integrity during molding and drying. The acoustic testing results, which showed a consistent average noise reduction of 6.7 dB, further support the functional effectiveness of the developed panel. In addition, survey findings indicated that the panel was acceptable in terms of aesthetic design, sound absorption, and price, achieving an overall weighted mean of 2.98. These results confirm that coconut husk can serve as a viable, low-cost, and sustainable material for sound absorber panels suitable for indoor applications.

Despite these promising outcomes, several limitations should be acknowledged. The study was conducted using a relatively small sample size and a limited number of testing conditions, which may affect the generalizability of the findings. Furthermore, the acoustic evaluation relied on basic sound measurement tools rather than advanced laboratory equipment, potentially influencing the precision of the results. The aesthetic assessment was also based on subjective survey responses, which may vary across different user groups and contexts.

The findings of this study have important practical and theoretical implications. From a practical perspective, the use of coconut husk as an alternative acoustic material supports sustainable waste utilization and offers an affordable solution for noise control in residential and small-scale environments. From a theoretical standpoint, the study contributes to the growing body of research on bio-based acoustic materials by demonstrating the relevance of natural fiber porosity and composite formulation in sound absorption performance. Future research should explore optimization of material ratios, long-term durability, and large-scale applications, as well as conduct comparative analyses with conventional acoustic panels.

Supplementary Materials & Data Availability Statement: More study-related resources including process documentation pictures, primary noise measurement charts, and detailed methodological explanations are in the Appendix and results. The extra resources also provide pictures to confirm the procedures and help in making the experiment reproducible.

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provide complete details, including the institution's name, protocol number, and date of approval.

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Conflicts of Interest: The authors declare that there are no conflicts of interest associated with this research.

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