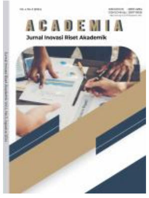

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

Jurnal P4I

SILENTERA: UTILIZING SUGAR CANE BAGASSE, COCONUT HUSK FIBER, AND EGG CARTONS AS AN INNOVATIVE ENVIRONMENTALLY FRIENDLY SOUND-ABSORBING MATERIAL USING WOOD GLUE AND LIQUID RUBBER.

Muhammad Nabighan Aquila[1], Hayyin Zuyyina Rizka Al Firdausi[2], Zulfaa Alfiyyah Widad[3]
MAN Insan Cendekia OKI, Ogan Komering Ilir, Indonesia[1,2,3]
e-mail: muhmmdnabighna@gmail.com

Diterima: *14/05/2026*; Direvisi: *25/ 5/2026*; Diterbitkan: *31/05/2026*

ABSTRAK

Kebisingan merupakan masalah lingkungan yang dapat mengganggu kenyamanan, konsentrasi, dan kesehatan manusia. Di sisi lain, penggunaan material peredam suara sintetis dapat menimbulkan persoalan lingkungan karena sebagian material tersebut sulit terurai. Limbah organik dan limbah berbasis serat, seperti ampas tebu, serat sabut kelapa, dan karton telur, memiliki struktur berpori dan berserat yang berpotensi digunakan sebagai material alternatif untuk mereduksi tingkat bunyi secara sederhana. Penelitian ini bertujuan mengevaluasi secara pendahuluan indikasi awal reduksi bunyi pada material SILENTERA yang dibuat dari ampas tebu, serat sabut kelapa, dan karton telur dengan perekat lem kayu/PVAC dan lateks cair alami. Penelitian menggunakan pendekatan kuantitatif melalui pembuatan panel dan pengujian menggunakan acoustic box sederhana yang belum setara dengan metode pengujian akustik standar pada frekuensi 500 Hz hingga 2500 Hz. Hasil pengujian menunjukkan bahwa SILENTERA menurunkan pembacaan tingkat bunyi pada seluruh frekuensi yang diuji. Penurunan terbesar terjadi pada frekuensi 2500 Hz sebesar 2,6 dB, dengan rata-rata reduksi relatif pembacaan dB sebesar 1,69%. Temuan ini menunjukkan bahwa SILENTERA memiliki indikasi awal sebagai material sederhana untuk mereduksi tingkat bunyi, tetapi belum dapat diklaim sebagai material peredam suara yang efektif secara praktis karena pengujian masih menggunakan alat sederhana, belum menggunakan instrumen terkalibrasi, dan belum mengikuti metode akustik standar. Penelitian lanjutan dengan jumlah ulangan yang memadai, variasi ketebalan dan densitas panel, alat ukur terkalibrasi, serta metode pengujian standar diperlukan untuk memvalidasi kinerja material ini.

Kata* Kunci*: *Karton Telur, Limbah Organik, Peredam Suara, Serat Kelapa, Serat Tebu*

ABSTRACT

Noise is an environmental problem that can disturb human comfort, concentration, and health. In addition, the use of synthetic sound-absorbing materials may cause environmental concerns because some of these materials are difficult to decompose. Organic and fiber-based wastes, such as sugarcane bagasse, coconut husk fiber, and egg cartons, have porous and fibrous structures that may serve as simple alternative materials for reducing sound levels**.** This study aims to preliminarily evaluate the initial indication of sound reduction in SILENTERA, a material made from sugarcane bagasse, coconut husk fiber, and egg cartons using wood glue/PVAC and natural liquid latex as binders. The study used a quantitative approach through panel fabrication and testing with a simple acoustic box that was not equivalent to a standard acoustic testing method at frequencies from 500 Hz to 2500 Hz. The results showed that SILENTERA reduced the measured sound level at all tested frequencies. The highest reduction occurred at 2500 Hz, with a decrease of 2.6 dB and an average relative dB-reading reduction of

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

1.69%. These findings indicate that SILENTERA shows an initial indication as a simple material for reducing sound levels. However, it cannot yet be claimed as a practically effective sound-absorbing material because the test used a simple apparatus, uncalibrated measurement conditions, and did not apply a standard acoustic measurement method. Further studies using adequate replications, variations in panel thickness and density, calibrated instruments, and standard acoustic testing methods are needed to validate the performance of this material.
Keyword : *coconut fiber; egg cartons; sound absorber; sugarcane fiber.*

INTRODUCTION

The increasing volume of agricultural, household, and other organic waste remains an environmental problem that requires sustainable management. Conventional waste handling, such as burning or direct disposal, can increase pollution and reduce the potential value of reusable materials. Therefore, waste management should not only focus on disposal but also on converting waste into functional products with environmental and social benefits (Pujiastuti & Aziz, 2025). At the same time, noise pollution has become an important public health concern because continuous exposure to environmental noise can disturb comfort, concentration, sleep quality, and well-being (World Health Organization Regional Office for Europe, 2019). These two issues indicate the need for alternative materials that can both utilize organic waste and help reduce sound levels in simple indoor environments.

Natural fiber-based materials have attracted attention as eco-friendly acoustic materials because they are lightweight, renewable, and generally have porous structures. Porous and fibrous structures can dissipate part of the sound energy through friction between air particles and fiber surfaces, which may reduce sound reflection and sound transmission under certain conditions (Yang et al., 2020). Compared with synthetic acoustic materials such as fiberglass and mineral wool, natural fiber materials are often easier to obtain, less expensive, and more environmentally acceptable. However, their acoustic performance is strongly influenced by material density, thickness, porosity, binder type, and testing method. For this reason, such materials should be reported carefully as preliminary sound-reducing materials unless they have been tested using standardized acoustic procedures.

Several previous studies have examined waste-based materials for acoustic applications. Sugarcane-based materials have been reported as promising components for acoustic panels because their fiber voids can support sound energy dissipation (Kaamin et al., 2019). Egg trays have also been studied as low-cost acoustic materials because their concave and corrugated surfaces can scatter sound waves and reduce reverberation under certain test conditions (Kaamin et al., 2018). Coconut fiber is another relevant material because its coarse, porous, and elastic fiber structure can help trap and reduce sound waves. Studies on coconut-fiber-based composites, including those combined with natural rubber, indicate that coconut fiber can be used as an alternative component for sound-reducing materials (Susilawati et al., 2021). A recent study on coconut husk panels also reported indoor noise reduction using a mobile sound meter, but such findings should be interpreted cautiously because the testing method was simple and not equivalent to standardized acoustic testing (Sestoso et al., 2026).

The research gap in the present study is that previous works have generally examined sugarcane bagasse, coconut fiber, and egg-carton structures separately or in limited pairwise combinations. For example, previous studies have discussed egg tray with coir fiber, egg tray with sugarcane or corn husk, and coconut fiber with natural rubber (Kaamin et al., 2018; Kaamin et al., 2019; Susilawati et al., 2021). Limited studies have evaluated the preliminary sound-level reduction of a single composite panel that integrates sugarcane bagasse, coconut

https://doi.org/10.51878/academia.v6i2

husk fiber, and egg cartons with combined PVAC and natural latex binders under a controlled simple-box condition. The novelty of the present study is not merely the use of waste materials, but the preliminary integration of sugarcane bagasse, coconut husk fiber, and egg cartons into a single SILENTERA panel using wood glue (PVAC) and natural liquid latex as binders. This combination is designed to combine three complementary structures: the fibrous voids of sugarcane bagasse, the coarse and elastic texture of coconut husk fiber, and the concave surface geometry of egg cartons. This material design distinguishes SILENTERA from earlier studies that focused on single materials or different material pairings.

The binder selection is also important because it affects fiber bonding, material stability, flexibility, and potential acoustic behavior. Wood glue or PVAC can help bind fibers and improve panel integrity, while natural liquid latex can provide elasticity to the composite. Merli et al. (2020) showed that adhesive-based waste panels can support the development of eco-sustainable insulating materials with thermal and acoustic relevance. In addition, natural rubber has been used as a binder in coconut-fiber-based sound-reducing composites (Susilawati et al., 2021). In this study, PVAC and natural liquid latex were used as combined binders in one SILENTERA formulation, not as two separate comparison groups. This clarification is important because the available results report one composite-panel condition rather than a comparison between two adhesive groups.

Based on this background, this study aims to preliminarily evaluate the ability of SILENTERA, a panel made from sugarcane bagasse, coconut husk fiber, and egg cartons with wood glue and natural liquid latex binders, to reduce measured sound levels at frequencies of 500–2500 Hz using a simple acoustic box. Because the testing apparatus is simple and does not use a standardized acoustic measurement method, this study does not claim practical acoustic effectiveness; instead, it provides initial evidence of sound-level reduction and identifies the need for further validation using calibrated instruments, repeated measurements, and standardized acoustic tests.

RESEARCH METHOD

This study employs a quantitative method. The data obtained are quantitative, derived from the average values of simple sound insulation tests. In this study, the problem was addressed by designing a simple sound insulation test experiment. The test specimens were designed in the form of rectangles measuring 23 cm x 18 cm x 2 cm. Six samples were made in the form of blocks. A quantitative approach was chosen because it allows for objective measurement of sound absorption levels at various frequencies, enabling statistical analysis of the results. (Gboe et al., 2024; Bakri et al., 2025)

The equipment used in this study included a blender, a rectangular mold, an acoustic box, two smartphones, a sound decibel meter application, an electronic scale, a mixing bowl, and a spoon. The blender was used to grind sugarcane bagasse, coconut fiber, and egg trays into smaller particles to obtain a more uniform mixture. The rectangular mold, measuring 23 cm × 18 cm × 2 cm, was used to shape the SILENTERA panel. The acoustic box was used as a simple testing chamber to evaluate the preliminary sound-reduction performance of the material. Two smartphones were used during the test: one smartphone functioned as the audio source, while the other was used as the measuring device with a sound decibel meter application installed. An electronic scale was used to measure the composition of the mixture, while the mixing bowl and spoon were used to combine the raw materials and binders. Direct sunlight was used as the drying method to reduce moisture and harden the formed panel before testing.

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

The materials used in this study consisted of sugarcane bagasse, coconut fiber, egg trays, wood glue, and liquid rubber. Wood glue was treated as a PVAC-based adhesive, while liquid rubber was treated as natural liquid latex. Both binders were used together in a single composite formulation. Sugarcane bagasse was obtained as residue from the sugarcane milling process, while coconut fiber was obtained from coconut husks. Egg trays made from paper or pressed fiber were used as an additional porous material in the composite. Wood glue, which is a polyvinyl acetate (PVA)-based adhesive, and liquid rubber, in the form of natural liquid latex, were used as binders to improve the bonding and stability of the SILENTERA panel. These materials were selected because they are low-cost, easily available, and have fibrous or porous structures that may support preliminary sound-level reduction.

The production process of the sound-reduction samples was carried out separately according to the type of adhesive used. In this study, two adhesive formulations were prepared: one using wood glue and the other using liquid rubber. Although the adhesive types differed, the initial preparation of the fibers was conducted using the same procedure for both groups to ensure that the basic raw materials had similar physical conditions before mixing. Pre-selected sugarcane bagasse, coconut fiber, and egg cartons were first processed using a blender until the materials became smaller and more uniform while still maintaining their fibrous structure. The processed fibers were then dried under direct sunlight for 3–5 days to reduce their moisture content. This drying stage was important because excessive moisture may interfere with adhesive bonding, prolong the drying process, and increase the risk of adhesion failure. Adequate drying also helps improve the stability of the composite sample before molding and acoustic testing (Araújo et al., 2025).

For the wood-glue formulation, the dried sugarcane bagasse, coconut fiber, and egg carton fibers were mixed in a 1:1:1 mass ratio until the materials were evenly distributed. Wood glue was then added at 20% of the total weight of the fiber mixture. The adhesive was poured slowly while the mixture was stirred manually to ensure that the fibers were evenly coated. After the mixture became homogeneous, it was placed into a rectangular mold and shaped into a panel. The molded sample was left at room temperature for 48 hours to allow the wood glue to dry and harden completely. After drying, the sample was carefully removed from the mold. A total of six samples were prepared for the wood-glue adhesive group. For the liquid-rubber formulation, the dried sugarcane bagasse, coconut fiber, and egg carton fibers were also mixed in a 1:1:1 mass ratio until a uniform fiber mixture was obtained. Liquid rubber was added at 25% of the total weight of the fiber mixture. This proportion was higher than the wood-glue formulation because liquid rubber has different viscosity and coating characteristics, requiring a larger amount to cover the fibers more evenly and support effective bonding. The liquid rubber was added gradually while the mixture was stirred manually until all fibers were coated. The mixture was then placed into a rectangular mold and gently pressed to obtain a flat and compact surface. The molded sample was left at room temperature for 72 hours until the liquid rubber dried and hardened. After complete drying, the sample was removed from the mold. A total of six samples were prepared for the liquid-rubber adhesive group.

Sound resistance testing was conducted in a similar manner for both sample groups. Testing was performed sequentially to prevent variations in room conditions. Acoustic box preparation: Sound absorption testing was conducted using a closed acoustic box as the testing apparatus. Each interior side of the acoustic box was lined with a test sample. The samples were attached using a thin layer of the same adhesive used on the original samples (wood glue or liquid rubber) to ensure the acoustic properties of the material remained unchanged. Test

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

equipment: Two mobile phones were provided as the primary tools. One phone is placed inside the acoustic box to measure noise levels (using a sound decibel meter app). The other phone is placed outside the box and used to play sounds. The positions of both phones are kept stable throughout the entire test. Measurement procedure: The "sound decibel meter" app is operated on the measuring phone. The test is conducted at various sound frequencies, namely 500 Hz, 1000 Hz, 1500 Hz, 2000 Hz, and 2500 Hz. Each frequency was tested three times for each sample, yielding an average value. Sound attenuation observation: The sound attenuation level was measured by comparing the decibel (dB) values recorded under two conditions: the initial condition (an empty acoustic box without material) and the material-lined condition (the acoustic box lined with material). The difference between these two values indicates the sound absorption level produced by each composite material. (Gboe et al., 2024; Bakri et al., 2025)

The data obtained includes average decibel values for each frequency, both under baseline conditions and under conditions using wood glue samples and liquid rubber samples. Sound attenuation is calculated as the difference between the baseline value and the value with the sample. Next, the attenuation values from both groups were compared descriptively to determine which adhesive produced better sound attenuation across each frequency range. The final results are presented in the form of simple tables and bar charts. Interpretation was conducted using a quantitative descriptive approach without further statistical analysis. (Araújo et al., 2025; Gboe et al., 2024)

RESULTS AND DISCUSSION

Results

Analysis Phase

Noise is a common problem encountered in daily life, particularly in urban environments, schools, and homes located near highways. High noise levels can disrupt concentration, communication, and a person's comfort while carrying out activities. Therefore, a material is needed that can help reduce noise levels at an affordable cost and is easily available in the local environment. This aligns with the research by Gboe et al. (2024), which states that noise pollution can impact human health, emotions, and behavior; thus, environmentally friendly and effective sound-absorbing materials are needed to help reduce noise levels. During this analysis phase, observations were also conducted on the characteristics of each material before using them as sound-absorbing samples. Based on the observations, coconut fiber has a denser fiber structure compared to sugarcane bagasse, while egg cartons have concave cavities that can help reduce sound reflections. The combination of these three materials is expected to enhance sound-absorption capabilities compared to using a single material alone.

In addition to analyzing the materials, an analysis of the testing medium used was also conducted. An acoustic box made of cardboard was chosen because it is easy to shape and can simulate a simple enclosed space. Thin concrete was used to simulate room walls so that the testing would more closely resemble real-world conditions. Noise level measurements were taken using a sound decibel meter app on an Android device, with the sound source coming from YouTube at frequencies ranging from 500 Hz to 2500 Hz. Based on the initial analysis conducted, organic waste materials such as sugarcane bagasse and coconut fiber have the potential to be utilized as simple sound-absorbing materials. In addition to being more environmentally friendly, the use of recycled materials such as egg cartons can also serve as an innovative alternative for acoustic materials, offering relatively low costs and ease of application in daily life.

https://doi.org/10.51878/academia.v6i2

Development Phase

In this phase, the acoustic box used as the primary medium in the sound absorption testing process was designed. The acoustic box was made of cardboard because it is readily available, lightweight, and easily shaped to meet research needs. Additionally, thin concrete was added to certain parts of the box as a simple simulation of room walls to make the testing conditions more closely resemble a real-world environment. The use of this simple acoustic test setup is supported by research by Buluklu et al. (2023), who developed a low-cost Alpha Cabin model system for testing acoustic materials. This study demonstrated that simple acoustic boxes remain capable of measuring a material's sound absorption performance with results approaching those of standard laboratory testing, particularly at mid-to-high frequencies. Furthermore, Purwanto et al. (2020) also developed a portable sound reduction box as an alternative to conventional acoustic test chambers and obtained sound reduction index measurements that were not significantly different from those of standard sound insulation chambers. Both studies demonstrate that the use of simple acoustic boxes can serve as a more practical and economical alternative for testing sound-absorbing materials, while still yielding measurements sufficiently representative for laboratory-scale research.

The acoustic box is designed as a simple enclosed chamber to control the direction of sound wave propagation during the testing process. The use of enclosed spaces in acoustic research aims to create more controlled measurement conditions so that the influence of noise interference from the surrounding environment can be minimized. Inside the box, an Android device is placed as a sound intensity measuring instrument, along with sound-absorbing materials to be tested for their ability to absorb and reduce sound reflections. Meanwhile, outside the acoustic box, a smartphone is used as a sound source during the testing process. The concept of controlling the sound source and a controlled listening environment was also employed in research by Ermert et al. (2026) in virtual reality-based acoustic testing to analyze the impact of sound interference on listeners' comprehension and memory.

In addition to serving as a testing medium, the acoustic box also functions to minimize the influence of external environmental sounds that could affect measurement results. With the acoustic box, the testing process is expected to demonstrate the sound-insulating capabilities of materials more clearly compared to measurements in open spaces. The use of enclosed spaces in acoustic testing aligns with research conducted by Neri et al. (2021), who employed the impedance tube method to control sound wave propagation during acoustic material testing. In that study, testing was conducted using a closed tube equipped with a sound source, a measuring microphone, and material samples so that sound waves could be measured in a more directed manner and produce more accurate measurement data.

Figure 1. Simple acoustic box used for preliminary sound-level reduction testing.

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia
Jurnal P4I

Based on Figure 1, the acoustic box was used as a simple non-standard testing chamber to compare sound-level readings before and after the installation of SILENTERA panels. This setup was designed only for preliminary observation and was not equivalent to standardized acoustic testing. The SILENTERA material was developed by combining egg cartons, coconut fiber, and sugarcane bagasse because these materials are easily available, relatively inexpensive, and have potential as environmentally friendly sound-level reducing materials derived from organic and recycled waste.

Figure 2. Raw materials used in the SILENTERA composite panel.

Based on Figure 2, the main materials used to produce the SILENTERA panel consisted of sugarcane bagasse, coconut husk fiber, and egg cartons. These materials were selected because they are organic and recycled wastes that are easy to obtain, low in cost, and have physical structures that may support preliminary sound-level reduction. Sugarcane bagasse and coconut husk fiber provide fibrous and porous structures that can interact with sound waves, while egg cartons contribute paper-based porous characteristics and surface geometry that may help reduce sound reflection. Therefore, the combination of these three materials was expected to form an environmentally oriented composite panel for initial sound-level reduction testing.

Before the mixing process, all materials were first prepared and cleaned to ensure no impurities that could affect sample quality remained. The sugarcane bagasse was dried to reduce moisture content, the coconut fiber was tidied to ensure more uniform fiber sizes, and the egg cartons were cut into small pieces to facilitate mixing. This preparation stage was carried out to produce a more homogeneous material mixture. Next, all materials are mixed in a 1:1:1 ratio to achieve a more even combination. The mixing process is done manually until all materials are thoroughly blended. Afterward, Fox glue is added as the primary binder to ensure the materials bond together and are easier to shape during the molding process. The glue is added gradually while the mixture is stirred to ensure the binder is evenly distributed throughout the material.

Once the mixture begins to bind, the material is placed into a rectangular mold and compacted slowly. During this molding stage, liquid rubber latex is added as an additional binder while the material is compacted. The addition of rubber latex aims to impart elastic properties to the sample after the drying process. In addition to enhancing elasticity, the rubber latex also helps strengthen the material's structure so the sample does not become brittle when used in testing.

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

Figure 3. SILENTERA panels after molding and drying

Based on Figure 3, the SILENTERA panel was formed after the mixture of sugarcane bagasse, coconut husk fiber, and egg-carton fibers was combined with PVAC and natural liquid latex binders, molded, and dried until the structure became more stable. The molding process helped shape the mixed organic and recycled materials into a compact rectangular panel, while the binders supported the adhesion between fibers and improved the physical integrity of the sample. This formed panel was then prepared for installation in the simple acoustic box to observe its preliminary ability to reduce measured sound-level readings at the selected frequencies.

After the molding process is complete, the sample is then dried for some time until the rubber latex dries and the material becomes denser and more stable. Next, the prototype sample is tightly wrapped in plastic to help reduce the characteristic odor produced by the rubber latex. Additionally, the plastic layer helps maintain the sample's shape, keeping it stable and preventing damage during the installation and testing processes.

Testing Procedure

Testing was conducted to determine the sound-absorbing capabilities of the material in reducing sound intensity across various frequency ranges. The test was performed using an acoustic chamber previously provided, with the sound-absorbing material placed inside the chamber alongside an Android device serving as a sound level meter to measure incoming sound. The use of this material aimed to assess the influence of fibrous structure, porous surface, and elastic properties on sound damping performance.

The sound source used came from YouTube videos played via a laptop. The frequency variations used in the testing process were 500 Hz, 1000 Hz, 1500 Hz, 2000 Hz, and 2500 Hz. This frequency range was selected to determine the material's ability to dampen sound at mid-to-high frequencies. During the testing process, the laptop's volume was kept constant to ensure more stable and easily comparable measurement results.Noise level measurements were taken using a sound decibel meter app on an Android device. Before installing the sound-absorbing samples, an initial sound intensity measurement (I0) was first taken inside the acoustic box without using any sound-absorbing material. This initial measurement served as a baseline to determine the noise level from the sound source before any treatment was applied to the acoustic box.

After the initial measurement was completed, the sound-absorbing material samples were then installed on the inside of the acoustic box on the side where the sound source would arrive. Next, the sound source was played again at the same frequency, and a final sound intensity measurement (I) was taken after using the sound-absorbing material. Testing was conducted step-by-step at each frequency variation to obtain more accurate and easily

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

analyzable data. During the testing process, the distance between the sound source and the acoustic box was set at 5 cm, with a measurement duration of 20 seconds at each frequency. The distance and testing duration were set to maintain constant experimental conditions so that the measurement results would not be significantly affected by changes in position or data collection duration. Additionally, efforts were made to keep the surrounding environmental conditions stable to minimize the impact of external noise that could affect the measurement results. The measurement data was then recorded in tabular form for further analysis. The analysis involved comparing the noise levels before using the sample (I0) and after using the sample (I). Next, the sound damping effectiveness is calculated to determine the extent to which the combination of sugarcane bagasse, coconut fiber, egg trays, Fox glue, and liquid rubber latex helps reduce sound intensity in the acoustic box.

Test Results

Based on the test process conducted, data on noise levels before and after using soundproofing materials were obtained across various frequency ranges. Testing was performed using an acoustic box made of cardboard and thin concrete as a simple simulation of a room wall. Measurements were taken using a sound decibel meter app on an Android device, with the sound source originating from a YouTube video played via a laptop. The measurement results show that the use of sound-absorbing materials made from sugarcane bagasse, coconut fiber, egg cartons, Fox glue, and liquid rubber latex was able to reduce sound intensity across all tested frequency variations. This reduction in sound intensity indicates that a combination of fibrous, porous, and elastic materials has the ability to help absorb and reduce the energy of sound waves entering the acoustic box.

The following table shows the noise level measurement results before using sound-absorbing materials (I0) and after using sound-absorbing materials (I).

Table 1. Sound reduction levels for the samples.

Frequency (Hz)	**Distance (cm)**	**Time (s)**	***I0* (dB)**	***I* (dB)**
500	5	50	78,2	77,4
1000	20	50	75,3	74,6
1500	20	50	75,6	74,8
2000	20	50	75,1	73,7
2500	20	50	72,7	70.1

Notes:
I0: Noise level before using the sample
I: Noise level after using the sample

Based on the test data obtained, all frequencies experienced a decrease in sound intensity after using the soundproofing material. The largest reduction occurred at 2500 Hz with a difference of 2.6 dB, while the smallest reduction occurred at 1000 Hz with a difference of 0.7

https://doi.org/10.51878/academia.v6i2

ACADEMIA: Jurnal Inovasi Riset Akademik
Vol. 6, No. 2, Maret-Mei 2026
e-ISSN : 2807-1808 | p-ISSN : 2807-2294
Online Journal System https://jurnalp4i.com/index.php/academia

dB. These results indicate that the material used tends to be more effective at dampening sound at high frequencies compared to low frequencies. Sound attenuation effectiveness was then calculated based on the difference between sound intensity before and after using the sound-absorbing material. Based on the calculations performed, an average sound absorption efficiency of 1.69% was obtained. Although the efficiency value obtained is still relatively low, the results of this study indicate that organic waste and recycled materials have the potential to be utilized as a simple, more environmentally friendly, and economical alternative sound-absorbing material.

Additionally, the use of liquid rubber latex as an additional binder is expected to help improve sound damping capabilities by imparting elastic properties to the material. These elastic properties help reduce some of the sound wave vibrations striking the sample surface. The material's fibrous and porous structure also helps absorb some of the sound energy, resulting in lower sound intensity inside the acoustic box compared to before using the sound-damping material.

Discussion

Based on the test results, the use of materials made from sugarcane bagasse, coconut fiber, and egg cartons demonstrated the ability to help reduce sound intensity across all tested frequency ranges. The decrease in decibel levels after using the samples indicates that materials with fibrous and porous structures are capable of absorbing some of the sound wave energy entering the acoustic box. Additionally, the use of liquid rubber latex as an additional binder imparts elastic properties to the material, thereby helping to reduce the vibrations of sound waves striking the sample surface.

Test results indicate that the sound-absorbing material tends to be more effective at high frequencies compared to low frequencies. This is evident from the greatest reduction in sound intensity occurring at 2500 Hz. At high frequencies, sound waves have shorter wavelengths, making them easier to absorb by porous and fibrous materials such as sugarcane bagasse and coconut fiber. Conversely, at low frequencies, sound waves have longer wavelengths, making it easier for them to penetrate the simple damping materials used in this study.

Although the test results show a reduction in sound intensity, the average effectiveness obtained is still relatively low at 1.69%. One factor influencing this result is the simple shape of the sound-absorbing sample, which is a standard rectangle. This shape is less optimal for dispersing the direction of sound wave reflections compared to uneven surfaces like an egg tray. The concave and wavy surfaces of the egg tray help disperse sound reflections in various directions, thereby reducing the intensity of the reflected echoes. Consequently, in the flat-shaped samples, some sound waves are still reflected back into the acoustic box, reducing the damping effectiveness.

The relatively thin thickness of the damping material also affects its sound-absorbing capability. The low thickness allows some sound wave energy to still penetrate the material layer, particularly at mid-to-high frequencies. Additionally, the small cavities that function as sound absorbers are not deep enough to fully dampen sound wave vibrations. This results in a reduction in sound intensity that is not yet significant.

Another factor affecting the test results is the presence of small gaps in the acoustic box, particularly in the area where the material sample is inserted. These gaps allow sound to enter and exit without fully passing through the sound-absorbing material. Consequently, some sound leaks through the sides of the box, so the sound intensity after using the sample does not

https://doi.org/10.51878/academia.v6i2

decrease significantly. This condition indicates that the density of the test medium significantly influences sound absorption results.

In addition to material and test medium factors, the accuracy of the measuring instrument also affects the research results. The use of a sound decibel meter app on an Android device has limitations because the phone's built-in microphone is not specifically designed for scientific measurements. The microphone's sensitivity to specific frequencies may vary, so the measured decibel values may differ from those of a professional sound level meter. Additionally, the app used did not undergo a specialized calibration process, so the measurement precision remains limited.

The characteristics of the sound source from YouTube can also affect the test results. Digital audio from YouTube undergoes compression, so the stability of the sound amplitude is not entirely constant. Furthermore, the quality of the laptop speakers used to play the sound also affects the sound intensity at each frequency. At certain frequencies, laptop speakers produce sounds of varying intensity, which affects the measurement results before and after using the sound-absorbing material.

The arrangement and density of the sound-absorbing material also affect its sound absorption capability. The mixture of sugarcane bagasse, coconut fiber, and egg cartons does not yet have a completely uniform density throughout the sample. There are some parts that are more porous, allowing sound waves to pass through the material more easily. Additionally, the uneven distribution of coconut fibers causes the sound absorption capacity to vary across different parts of the material's surface.

The influence of ambient noise during the testing process also affects the stability of the data obtained. The testing was conducted in an environment that was not fully soundproof, so sounds from outside the room could still be picked up by the Android device's microphone. Conversations, surrounding activities, and wind noise can cause the measured decibel values to become less stable. Since the difference in sound attenuation obtained was relatively small, ambient noise interference had a significant impact on the final research results.

Based on the results of the study, materials made from organic waste and recycled materials still have the potential for further development as simple soundproofing alternatives. Development can be achieved by improving the surface texture of the material, increasing the sample thickness, enhancing the density of the material structure, and using more accurate testing media and measuring instruments to optimize the research results.

CONCLUSION

Based on the preliminary test using a simple acoustic box, SILENTERA showed an initial indication of its ability to reduce measured sound intensity**,** particularly at the tested frequencies of 500–2500 Hz. The material produced from sugarcane bagasse, coconut fiber, and egg cartons was able to reduce the measured sound level in all test conditions, with the highest reduction observed at 2500 Hz. However, these results should not yet be interpreted as evidence that SILENTERA is an effective practical sound-absorbing material**,** because the test was conducted using a simple apparatus and did not apply a standardized acoustic measurement method.

The findings suggest that SILENTERA has potential as a low-cost and environmentally oriented material for preliminary sound-level reduction, but further improvement and validation are required. Future studies should improve the panel design by increasing material thickness, optimizing density, and modifying the surface texture or perforation pattern to enhance sound interaction with the material. Further research should also use calibrated sound-level

https://doi.org/10.51878/academia.v6i2

instruments, controlled testing conditions, repeated measurements, and standardized acoustic testing methods such as impedance tube or reverberation room measurements. These improvements are necessary to obtain more reliable acoustic performance data and to determine whether SILENTERA can be developed into a practical sound-reducing material.

REFERENCES

Araújo, L. B. R., Freitas, I. L. B., Souza, M. L. de, Cabral, A. E. B., & Guths, S. (2025). Thermal conductivity and sound absorption performance of panels based on coir fiber and castor oil resin. *Ambiente Construído*, *25*, 1–12. https://doi.org/10.1590/s1678-86212025000100846

Bakri, I., Musafir, F. S., Amar, K., Kusno, A., & Fadhilah, R. N. (2025). Innovative approaches to sound absorption in agricultural waste-based composites: The role of perforation geometry. *Engineering, Technology & Applied Science Research, 15*(6), 30624–30632. https://doi.org/10.48084/etasr.14540

Bimara, B. C., Azizah, A. R., Wulansari, T. A., Nurbaiti, U., & Fianti, F. (2021). Analisis Material Serat Alam Tebu Sebagai Bahan Peredam Suara. *Jurnal Fisika : Fisika Sains Dan Aplikasinya*, *6*(2), 97–100. https://doi.org/10.35508/fisa.v6i2.6839

Buluklu, H. M., Bal Kocyigit, F., & Kose, E. (2023). Low-Cost Alpha Cabin Like Test Box Proposal for the Development of New Acoustic Sound Insulation Materials. *Gazi University Journal of Science*, *36*(1), 1–18. https://doi.org/10.35378/gujs.1010472

Ermert, C. A., Schlittmeier, S. J., Bönsch, A., Kuhlen, T. W., & Fels, J. (2026). Heard-text recall and listening effort under irrelevant speech and pseudo-speech in virtual reality. *Acta Acustica*. https://doi.org/10.1051/aacus/2026003

Gboe, N. A., Ružickij, R., & Grubliauskas, R. (2024). Exploring the sound absorption characteristics of biodegradable agricultural wastes, coconut fiber, groundnut shell, and sugarcane fiber. *Environmental and Climate Technologies, 28*(1), 940–951. https://doi.org/10.2478/rtuect-2024-0071

Kaamin, M., Ahmad, N. F. A., Ngadiman, N., Kadir, A. A., Razali, S. N. M., Mokhtar, M., & Sahat, S. (2018). Study on the effectiveness of egg tray and coir fibre as a sound absorber. *E3S Web of Conferences, 34*, Article 02005. https://doi.org/10.1051/e3sconf/20183402005

Kaamin, M., Zaid, N. F. M., Daud, M. E., Rahman, R. A., Hassim, H. M., Hamid, N. B., & Mokhtar, M. (2019). Analysis on absorption sound acoustic panels from egg tray with corn husk and sugar cane. *International Journal of Innovative Technology and Exploring Engineering, 8*(9S3), 1426–1431. https://www.ijitee.org/portfolio-item/i33040789s319/

Merli, F., Belloni, E., & Buratti, C. (2020). Production of eco-sustainable insulating panels by recovering wood waste: Fabrication and preliminary experimental characterization of thermal and acoustic properties. *E3S Web of Conferences*, *197*, 1–10. https://doi.org/10.1051/e3sconf/202019708021

Neri, M., Levi, E., Cuerva, E., Pardo-Bosch, F., Zabaleta, A. G., & Pujadas, P. (2021). Sound absorbing and insulating low-cost panels from end-of-life household materials for the development of vulnerable contexts in circular economy perspective. *Applied Sciences (Switzerland)*, *11*(12), 1–19. https://doi.org/10.3390/app11125372

Pujiastuti, H., & Aziz, S. R. (2025). Utilization of agricultural and organic waste as eco-friendly biomass-based adsorbents. *World Chemical Engineering Journal, 9*(1), 30–35. http://dx.doi.org/10.62870/wcej.v9i1.33760

Purwanto, B., Aryantie, M. H., Zulfachmi, Z., & Aprishanty, R. (2020). Low-cost and portable sound reduction box: Innovation for acoustic material performance measurement. *Journal of Engineering and Technological Sciences, 52*(5), 732–744. https://doi.org/10.5614/j.eng.technol.sci.2020.52.5.9

Sestoso, A., Lausa, M., Cabanero, M. H., Cabilan, R. B., & Belano, M. (2026). Acceptability of coconut husk sound absorbing panel. *Journal of Economics, Innovative Management and Entrepreneurship, 4*(1). https://doi.org/10.59652/a9wk1a50

Susilawati, N., Nurhayati, C., & Susanto, T. (2021). Komposit limbah serabut kelapa dan karet alam sebagai alternatif bahan peredam suara. *Jurnal Dinamika Penelitian Industri, 32*(2), 102–109. https://doi.org/10.28959/jdpi.v32i2.7189

World Health Organization Regional Office for Europe. (2019). *Environmental noise guidelines for the European Region*. World Health Organization Regional Office for Europe. https://www.who.int/europe/publications/i/item/9789289053563

Yang, T., Hu, L., Xiong, X., Petrů, M., Noman, M. T., Mishra, R., & Militký, J. (2020). Sound absorption properties of natural fibers: A review. *Sustainability (Switzerland)*, *12*(20), 1–25. https://doi.org/10.3390/su12208477

https://doi.org/10.51878/academia.v6i2