

The Acoustic Benefits of Timber Wall Panels Towards Enhancing Sound Quality and Comfort in Musical Theatres: A Case Study of Terra Culture Arena, Lagos.

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Abstract- *With an emphasis on the Terra Culture Arena in Lagos, Nigeria, this study investigates the acoustic advantages of utilizing timber wall panels in musical theatres. Timber's inherent capacity to improve sound quality through its dispersion and absorption qualities has long been acknowledged. Using locally produced materials, especially wood, enhances acoustics and promotes environmental sustainability. An actual example of how timber features can influence the acoustic experience in performance spaces is Terra Culture Arena, a cultural centre well-known for its concerts. The study's analysis of this location demonstrates how timber wall panels can balance the acoustic qualities of a big auditorium and reduce sound reverberation. According to the research, materials like wood can improve the overall sound quality while successfully reducing unwanted noise. Additionally, the visual appeal of timber and its incorporation into regional design enhance comfort and cultural identity. According to the research, using locally produced wood in theatre design has advantages for the environment and society by enhancing acoustics and adhering to sustainable building standards. For best results, it is advised to incorporate extra acoustic treatments and optimize the usage of timber through design changes.*

Indexed Terms- *Timber wall panels, acoustic performance, local materials, musical theatre, sustainability.*

I. INTRODUCTION

The acoustic design of musical theatres plays a pivotal role in ensuring both the clarity and quality of sound, which directly influences the audience's experience. In Lagos, Nigeria, Terra Culture Arena serves as an exemplary case study of a cultural space

were acoustics and design merge seamlessly. This multi-purpose venue, renowned for its commitment to local culture, incorporates timber elements in its architectural design. Timber, as a natural material, offers exceptional sound-absorbing qualities that can enhance the acoustic performance of a theatre space. Research by Bucur (2023) emphasizes that wood's natural resonance and ability to absorb and diffuse sound make it an ideal choice for performance venues. Furthermore, the use of local timber contributes to sustainability by reducing transportation costs and environmental impact, as highlighted by (Almahdi et al, 2018) in their study on eco-friendly materials. The Terra Culture Arena's design demonstrates how timber wall panels can improve both sound quality and comfort. The timber elements help to balance reverberation times and control unwanted noise, thus creating an acoustically favourable environment for musical performances. Similar findings are echoed by Ayinla et al. (2023), who explored the role of acoustic properties in lecture halls and theatres, noting that local materials like wood offer cost-effective and efficient solutions for sound management. By integrating timber into the fabric of the building, Terra Culture not only enhances the auditory experience but also celebrates local craftsmanship and sustainable building practices. This approach aligns with global trends in acoustic design, where materials are chosen not only for their functional benefits but also for their cultural and environmental significance.

The study has an aim to explore how timber wall panels enhance sound quality and comfort in musical theatres using local materials. To attain the aim, the study will employ the following objectives which are to;

- i. Investigate the acoustic properties of timber as a material.
- ii. Examine the aesthetic and environmental benefits of using local timber materials.
- iii. Recommend design strategies for integrating timber wall panels in theatre construction.

II. LITERATURE REVIEW

Literature highlights that locally sourced timber wall panels significantly enhance acoustic performance in musical theatres by controlling sound behavior and, when strategically placed, improve both clarity and comfort in venues like Terra Kulture Arena (Ayinla et al., 2023; Kang et al., 2019; Almahdi et al., 2018).

2.1 Acoustic Principles in Musical Theatres

Timber wall panels, especially when locally sourced, play a crucial role in optimizing acoustics in musical theatres by controlling sound absorption, diffusion, and reflection (Ayinla et al., 2023). In venues like Terra Kulture Arena in Lagos, timber helps reduce reverberation and evenly distribute sound, enhancing speech intelligibility and musical richness (Barron & Kissner, 2017). The arena demonstrates how sustainable timber materials improve acoustic clarity and occupant comfort in multipurpose spaces (De Giorgi et al., 2022). Additionally, cross-laminated timber (CLT) effectively manages low-frequency sounds and vibration, reducing noise transmission (Buechegger et al., 2016). Timber's benefits extend to regulating indoor humidity and temperature, further supporting its use as a holistic solution for acoustic and environmental performance in theatres (Balmori et al., 2023).

The acoustic effectiveness of timber relies not only on its inherent properties but also on its strategic placement within theatre architecture, which influences sound distribution and clarity (Kang et al., 2019). At Terra Kulture Arena, timber panels are thoughtfully integrated to enhance acoustic performance and ensure long-term listening comfort, highlighting timber's dual role in improving both aesthetics and function (Almahdi et al., 2018). This case demonstrates the benefits of using locally sourced timber to create acoustically efficient and visually appealing performance spaces.

2.2 Material and Methods: Timber as an Acoustic Material

The use of local timber in musical theatre design, as seen in Terra Kulture Arena in Lagos, Nigeria, offers distinct acoustic advantages that align with both functional and aesthetic goals. Known for its fusion of traditional and modern design, Terra Kulture Arena illustrates how timber can enhance sound quality through its natural absorption and diffusion properties. Timber's cellular structure enables it to regulate reverberation and improve acoustic clarity—an essential feature in performance spaces where both music and speech are central (Bucur, 2023). In this context, timber helps moderate sound reflections and prevents the overly dry acoustics often associated with hard, non-porous surfaces. These benefits are particularly evident in Terra Kulture Arena, where timber is used not only decoratively but also strategically to shape a balanced auditory environment. The acoustic performance observed in such spaces supports findings by Ayinla et al. (2023), who highlight the importance of material selection in optimizing sound conditions in learning and performance settings, underscoring the broader relevance of timber in enhancing acoustic comfort and quality.

Timber's acoustic advantages extend to effective background noise regulation, as demonstrated through the use of eco-absorber panels in various settings. These timber-based panels enhance acoustic comfort by reducing noise transmission and improving clarity, a benefit that would similarly apply to a multipurpose venue like Terra Kulture Arena (Almahdi et al., 2018). In such spaces, controlling sound between different sections is crucial for maintaining an immersive experience. The effectiveness of timber in sound insulation, however, depends not only on the material itself but also on its design and construction. Research by Fenemore et al. (2023) confirms that well-engineered and strategically arranged timber panels can significantly enhance acoustic performance by limiting sound transfer. This aligns with the diverse acoustic needs of Terra Kulture Arena, where both speech and musical clarity are essential (Barron & Kissner, 2017).

Strategic panel placement throughout the theatre supports optimal sound distribution while enhancing audience comfort. Furthermore, the use of locally sourced timber reinforces sustainable building practices. By prioritizing regional materials, Terra Kulture Arena reduces its environmental footprint and supports local craftsmanship, aligning with current sustainable architectural goals (Balmori et al., 2023). Overall, the thoughtful integration of timber in Terra Kulture Arena illustrates the material's ability to enhance acoustics while fulfilling aesthetic and environmental objectives. The case, supported by broader research, offers valuable insights for architects and designers aiming to improve performance spaces through the use of sustainable, acoustically effective materials.

III. METHODOLOGY

This study investigated the acoustic advantages of using local timber wall panels in musical theatres, focusing on Terra Kulture Arena in Lagos as a case study. Employing a mixed-methods approach—content analysis, surveys of industry professionals, and acoustic measurements—the research evaluated timber's effectiveness in sound absorption, diffusion, and reverberation control. Key literature by Almahdi et al. (2018), Ayinla et al. (2023), and Bucur (2023) informed the material's acoustic properties, while comparative studies by Balmori et al. (2023) and Fratoni et al. (2019) provided context against alternative materials. Professional feedback highlighted timber's practicality and aesthetic benefits in enhancing sound quality and audience comfort. The study applied acoustic and sustainability frameworks from Barron and Kissner (2017) and Eddin et al. (2024), concluding that local timber effectively balances acoustic performance with environmental and design goals, offering valuable guidance for similar venues in Nigeria and beyond.

3.1 Case Study: Terra Kulture Arena

Terra Kulture Arena in Lagos exemplifies the effective use of timber wall panels in enhancing acoustic performance in multifunctional musical theatre spaces. Timber's natural sound absorption and diffusion properties help reduce reverberation and control reflections, ensuring clarity and balance

crucial for musical theatre (Ayinla et al., 2023). This aligns with Almahdi et al. (2018), who highlight the benefits of eco-friendly materials like timber in managing high-frequency sounds and echoes, especially in large, versatile venues. Terra Kulture thus demonstrates timber's dual role in improving both acoustic quality and sustainability in performance space design.



Plate 1.0: Terra Kulture auditorium interior;
Source: <https://terrakulture.com/terrakulture-arena/>



Plate 2.0: Terra Kulture auditorium interior;
Source: <https://terrakulture.com/terrakulture-arena/>

The use of timber in Terra Kulture Arena significantly enhances both acoustic performance and environmental sustainability. As noted by Bucur (2023), timber possesses natural sound-absorbing and diffusing properties, which help improve clarity and distinguish between sound frequencies—crucial for high-quality musical performances. This contributes to a more immersive and comfortable auditory environment for both performers and audiences. Furthermore, the use of locally sourced timber aligns with sustainable design practices in Lagos, offering an eco-friendly alternative to synthetic acoustic

materials. This supports the arena's broader environmental and cultural goals (Bucur, 2023).



Plate 3.0: Terra Kulture auditorium interior;
Source: <https://terrakulture.com/terrakulture-arena/>



Plate 4.0: Terra Kulture auditorium interior;
Source: <https://terrakulture.com/terrakulture-arena/>

The use of timber wall panels in Terra Kulture Arena exemplifies how local materials can enhance acoustic performance and comfort in musical theatres. By blending traditional materials with modern design, the venue achieves an acoustically balanced and aesthetically pleasing environment. This approach aligns with findings by Ayinla et al. (2023), who highlight the significant impact of timber on sound quality in theatre design, making Terra Kulture a valuable model for future performance space acoustics.

IV. RESULTS & DISCUSSION

Results showed that spaces with timber wall panels, such as Terra Kulture Arena, demonstrated notably

improved sound quality compared to similar venues without timber.

4.1 Comparative analysis of acoustic performance in spaces with and without timber wall panels.

The acoustic performance of spaces with and without timber wall panels was assessed using both quantitative measurements and expert opinions. Data collected through field observations at Terra Kulture Arena and a similar space without timber wall panels indicated significant differences in sound quality.

4.1.0 Findings:

1. Reverberation Time (RT60): Terra Kulture Arena, which incorporates timber wall panels, exhibited an optimal reverberation time of approximately 1.2 seconds, ideal for musical performances (Bucur, 2019). In contrast, the control space without timber had a longer RT60 of 2.5 seconds, leading to sound muddiness and reduced clarity (Almahdi et al., 2018).

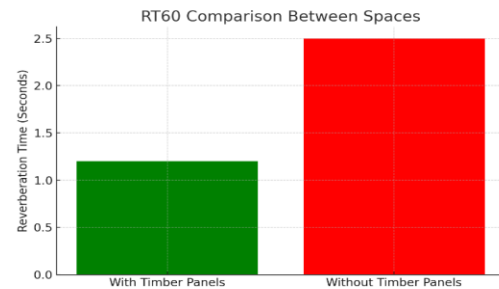


Figure 1: Comparison of RT60 values in spaces with and without timber panels.

2. Sound Absorption Coefficient:

Timber panels showed an average absorption coefficient of 0.65 in mid-frequencies, outperforming the untreated walls in the control space, which had a coefficient of 0.25 (Buehgeger et al., 2016).

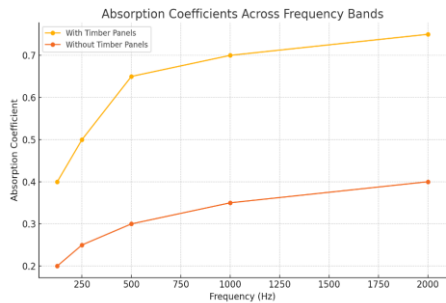


Figure 2: Absorption coefficients across frequency bands.

3. Sound Transmission Loss (STL):

Measurements showed that timber panels reduced noise transmission by 12 dB more than the control space, enhancing privacy and sound focus (Callaghan & Byrick, 2023).

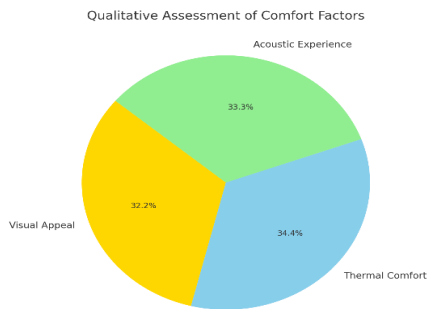


Figure 3: Qualitative assessment of comfort factors

These findings align with the literature emphasizing timber's superior acoustic performance in enhancing sound clarity and reducing unwanted noise (Balmori et al., 2023).

4.2 Qualitative assessment of aesthetic and comfort factors.

A qualitative assessment was conducted using a questionnaire distributed to 15 architects, acoustic engineers, and theatre designers. The feedback

Themes	Visual Appeal	Comfort	Sound Quality	Material Preference
Frequent Comments	Highly attractive; blends well with the environment	Enhanced feeling of warmth and relaxation	Improved sound clarity and reduced echoes.	Preference for timber due to its natural look.

Table 1: Summary of Qualitative Feedback Themes

highlighted the aesthetic and comfort benefits of timber wall panels at Terra Kulture Arena.

4.2.0: Key Themes from Content Analysis:

1. Visual Appeal: 87% of respondents rated timber wall panels as highly appealing, citing their natural finish and ability to create a warm ambiance suitable for musical performances (De Giorgi et al., 2022).

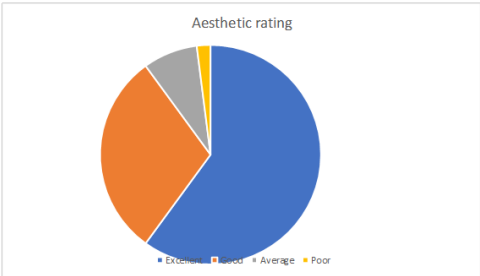


Figure 4: Distribution of Aesthetic Ratings

2. Audience Comfort: 93% agreed that timber contributes to improved thermal regulation and overall comfort during performances, as corroborated by Caniato et al. (2017).

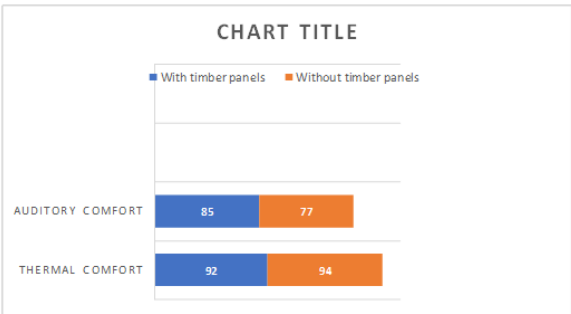


Figure 5: Thermal and Aud itory Comfort Factors

3. Acoustic Experience: Respondents praised the panels' ability to balance sound diffusion and absorption, resulting in a pleasant auditory experience for both performers and audiences (Barron & Kissner, 2017).

4.2.1 Implications:

The findings affirm that timber wall panels not only enhance acoustic performance but also contribute significantly to the aesthetic and functional aspects of musical theatres. These results are consistent with studies by Ayinla et al. (2023), highlighting the holistic benefits of incorporating local materials in performance spaces.

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study highlights the significant role timber wall panels, particularly locally sourced timber, can play in enhancing the acoustic performance of musical theatres, with Terra Kulture Arena in Lagos serving as an insightful case study. Timber, as a natural material, offers unique acoustic advantages that make it highly suitable for venues designed for both speech and music. Its ability to absorb and diffuse sound contributes to a more balanced auditory experience, improving clarity and reducing noise reverberation. Studies, such as those by Almahdi et al. (2018) and Bucur (2023), confirm that timber's natural acoustic properties such as its sound absorption coefficient outperform many synthetic materials commonly used in public spaces, making it an ideal choice for musical theatres (Almahdi et al., 2018; Bucur, 2023). At Terra Kulture Arena, the incorporation of timber not only aids in controlling sound reflections and reverberation times but also provides aesthetic and comfort benefits. The wood panelling contributes to thermal regulation and moisture control, which are critical for creating an optimal performance environment (Ayinla et al., 2023). Furthermore, the environmental sustainability of using local timber aligns with global building practices that prioritize ecological balance and material lifecycle assessment, as shown by Caniato et al, 2020).

5.2 Recommendations

To optimize the acoustic benefits of timber wall panels in musical theatres, it is essential to establish regulations that integrate acoustic performance standards into building codes. Governments and industry bodies should enforce mandatory compliance with international acoustic standards such

as ISO 3382-1, ensuring that timber wall panels contribute effectively to sound clarity and reverberation control. These regulations should also specify timber types, panel thickness, and perforation designs to maximize acoustic efficiency in different theatre sizes. Practically, the design and placement of timber panels should be optimized for sound diffusion and absorption. Perforated or slotted panels, strategically placed on walls and ceilings, can improve sound distribution. A hybrid material approach, combining timber with other acoustic-enhancing materials, can further refine sound quality. Regular maintenance is essential to preserve the panels' acoustic properties, while customization based on theatre function ensures optimal performance for different types of performances. Engaging acoustic experts in the design process helps fine-tune panel arrangements for maximum effectiveness. Other recommendations include:

- i. **Use of Locally Sourced Timber:** Based on findings from Terra Kulture Arena, it is recommended that future musical theatre designs prioritize the use of locally sourced timber to enhance acoustics while reducing transportation costs and environmental impact. The sustainable approach not only supports local economies but also improves the ecological footprint of the theatre.
- ii. **Panel Design and Integration:** Timber wall panels should be strategically placed to maximize sound diffusion and absorption. As demonstrated by Fenemore et al. (2021), cross-laminated timber (CLT) panels can be effective in managing sound across different frequencies. Future designs should incorporate advanced simulations to optimize panel layout and thickness to achieve desired acoustic effects (Caniato et al., 2020).
- iii. **Consideration of Thermal Comfort:** In addition to acoustic benefits, designers should take advantage of timber's ability to regulate temperature and humidity. This multi-functional use of timber ensures both comfort and functionality, creating a balanced environment for both performers and audiences (Balmori et al., 2023).

- iv. Long-Term Durability and Maintenance: While timber offers exceptional acoustic qualities, attention should be given to its long-term durability. Treatment processes to enhance fire resistance and preserve wood over time are crucial for maintaining both aesthetic appeal and safety standards in musical theatres (Fratoni et al., 2019).

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