Innovations

Evaluation of User's Experience and Acoustic Performance in Film-House Design: A Case Study of Samonda Ibadan, Oyo State, Nigeria

[1]J. B. Taiwo; [2]Obakin, O. A; [3]Odetola O. E
Department of Architecture, University of Ibadan, Oyo State, Nigeria

Abstract: *Reverberation and echoes has been the bane of most cinema houses designs. These undoubtedly causes uncoordinated sound and auditory problems to the movies lovers. This highlights the significance of sound quality in influencing moviegoers' psychological well-being, level of immersion, and overall satisfaction, noting that while visual aspects are often prioritized, acoustics play an equally vital, yet sometimes overlooked, role. The study addresses the problem of inadequate acoustic design in many cinemas, which can negatively impact the auditory experience despite advancements in visual technology. The research aims to optimize acoustic design in cinemas, focusing on elements such as soundproofing, speaker placement, material selection, acoustic treatments, and room configuration to enhance the overall movie going experience. This study x-ray the Film house cinema in Samonda, examining how these acoustic factors affect user experience within a specific timeframe. This research employed a quantitative approach to evaluate the acoustic performance of the study cinema house using the balloon pop technique to measure the reverberation time (RT60) conducted at six (6) different locations. The reverberation time (RT60) analysis revealed a critical average of 5.01 seconds, substantially higher than the recommended 0.3 to 0.6 seconds for cinemas. This excessive reverberation is likely contributing to reduced speech clarity, sound precision issues, echo effects, and listening fatigue, thereby detracting from the overall auditory experience. In conclusion, this research highlights the paramount importance of effective acoustic design in enhancing the overall cinema user experience.*

Keywords: *Acoustic; Performance; Reverberation; Cinema*

1. Introduction

Cinemahouses has been an avenue or medium for storytelling, where visual and auditory elements are combined to create immersive experiences that captivate audiences, (Salselas, et al., 2021, 2019 and Zhou 2022). In this wise, (Ward, 2016) agreed that auditory elements are very important in film house design. However, M. London (2023), believed that one of the major aspects of modern cinema is the sound

design, which ensure dialogue clarity, ambient sounds, music composition, foley (sound) effects and spatial sound mixing. This effective sound techniques enable three-dimensional soundscapes that immerse viewers in the narrative, Pietroni (2021). Consequently, sound factors such as reverberation, echo control, noise isolation and sound localization, could be address where adequate acoustic design is in place, (Rockfon, 2023 and Coboset al., 2017). But where poor acoustic is paramount, cinema is characterized by reverberation or muffled audio, making dialogue difficult to understand, Caniniet al., (2013). Conversely, well-designed acoustics enhance clarity and balance, ensuring that every seat in the auditorium delivers a consistent and engaging audio experience, (Big Rentz, 2023, Mahmoud & Abdelaziz, 2018).

The importance of acoustic design extends beyond technical considerations; it directly influences audience engagement and satisfaction. Immersive audio environments elevate movies from being mere visuals on a screen to transportive events that captivate viewers emotionally and mentally (Hutson, 2023). Crystal-clear sound grabs attention and keeps audiences engrossed in the narrative, while realistic soundscapes make fictional worlds more convincing, allowing viewers to suspend disbelief (Nguyen, 2021).

In commercial cinemas like Filmhouse Samonda—a leading cinema in Nigeria—acoustic design plays a pivotal role in delivering premium viewing experiences. By integrating advanced technologies such as surround sound systems and carefully engineered spaces with acoustic treatments like panels and soundproofing materials, Film house ensures that its audience enjoys high-quality audio fidelity that complements visual storytelling (Odgen, 2018). This study examines how acoustic design enhances user experience at Film house through quantitative analysis of reverberation time (RT60) and qualitative insights from industry professionals and audience feedback. The paper aim to highlight the importance of thoughtful acoustic planning in creating memorable cinematic experiences while offering practical recommendations for optimizing sound environments in commercial cinemas.

2. Important of acoustic design

Chonguleet al. (2021) expressed acoustics as a scope which span from the fundamental physical acoustics to bioacoustics, psychoacoustics and music, and other technical fields. Therefore, acoustic design is a critical component of cinema architecture that significantly influences the overall movie-watching experience. It involves the careful planning and implementation of sound management strategies to ensure that audiences receive high-quality audio while enjoying films. Albanese et al., (2022), assert that one of the primary roles of acoustic design is to enhance sound quality, which is essential for delivering an engaging cinematic experience. In a cinema, sound must be clear and balanced, allowing audiences to hear dialogue,

sound effects, and music without distortion or interference. Poor acoustic conditions can lead to muddled sound, making it difficult for viewers to follow the plot or appreciate the film's emotional nuances. As rightly expressed by (Beranek and Mellow, 2012), sound propagation through air as pressure waves and can be affected by factors such as distance and medium properties. While, Cox and D' Antonio (2009), believed that sound reflected or absorbed when they come in contact with surfaces. This reflection or absorption delay or possibly take longer time before it decay after its source has been stopped, resulting into what is termed reverberation, Gardner, W. G. (2002)

However, many concepts have been adopted by numerous scholars in measuring acoustic in spaces. Patynenet al., (2011), asserted that acousticians have been used to the concept of impulse responses as measurement for the room acoustic investigations. However, due to some difficulties such as uncontrolled spectral response and poor repeatability, this concept has been jettisons. Meanwhile, Amber Naqvi and Adrian James (2001), further highlighted most common methods of measuring acoustics in rooms, such as real time analyzer (RTA), impulse response, tone burst, time delay spectrometry (TDS), and maximum length sequence (MLS). Therefore, this paper employed balloon pop method in evaluating the reverberation time in Samonda, cinema house.

3. Materials and Method

3.1. Materials: To ensure accuracy, this research employed the use of balloon as source of the sound, needle object for the deflating the balloon, recording device which help in recording the audio interface, and stop watch were used to carry out this experiment based on ISO 3382 and ASTM E2235 Standard.

3.2. Method: For the experimental data, reverberation time (RT60) measurements were collected and analyzed using statistical and computational methods. To ensure accuracy, the data was gathered from six (6) different locations within the cinema room using a balloon pop technique. This method involved producing a sharp, impulsive sound and recording the decay of sound energy over time. The recorded sound data was processed to determine the time it took for the sound level to decay by 60 dB (RT60), providing insights into the acoustic characteristics of the cinema environment.

4. Results and discussion

The reverberation time (RT60) values for each of the six locations in Film house Cinema, Samonda, were analyzed to assess the acoustic conditions of the space. RT60 represents the time it takes for a sound to decay by 60 decibels (dB) from its peak level. In an optimized cinema environment, an RT60 value typically falls within the

range of 0.3 to 0.6 seconds, although depending on the size of the cinema, ensuring clear speech intelligibility and immersive sound without excessive echoes. Below is an in-depth interpretation of each recording, followed by an overall assessment of the cinema's acoustic performance.

Spot 1- Reverberation Time – First Recording (5.75s)

The first measurement recorded an RT60 of 5.75 seconds as shown in figure 1, significantly exceeding the recommended range. This suggests that the space exhibits a prolonged decay of sound, meaning that reflections persist for an extended period before fading out. In a cinema setting, an RT60 this high can cause sound overlap, where dialogue and sound effects linger excessively, and reducing clarity. Moviegoers may experience difficulty distinguishing spoken words, particularly in fast-paced scenes where audio transitions are frequent. The prolonged reverberation also indicates that sound-absorbing materials such as acoustic panels, carpets, or upholstered seats may be insufficient or improperly placed, poor acoustic material were used as well.

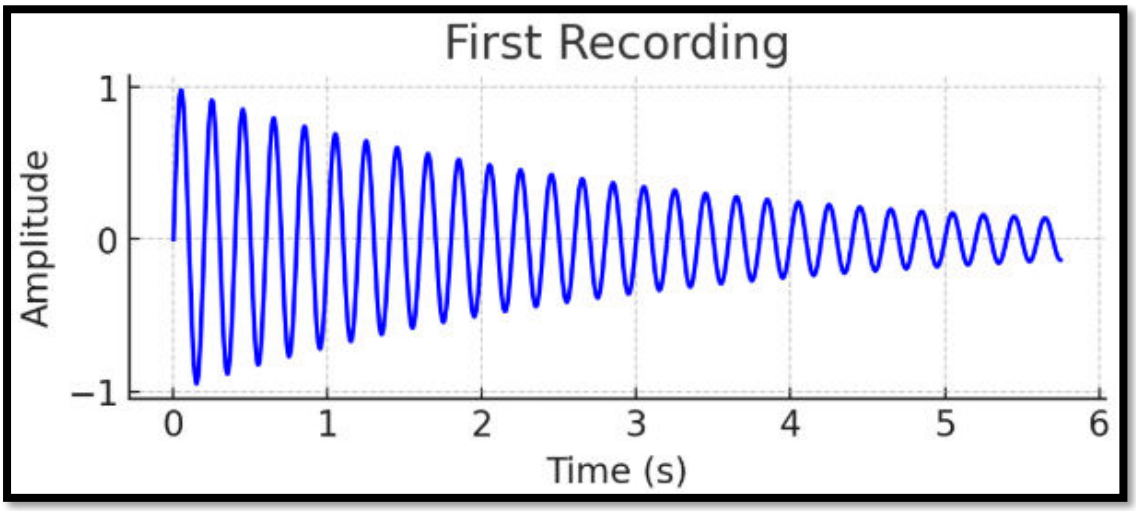

Figure1: Reverberation Time – First Recording (5.75s)

Spot 2- Reverberation Time – Second Recording (3.90s)

The second recording produced a lower RT60 value of 3.90 seconds as shown in figure 2, still significantly higher than the optimal range. While this location demonstrates a slightly better absorption of sound, the reverberation remains problematic. A value near 4 seconds suggests that sound waves are still bouncing off reflective surfaces, such as walls, ceilings, or even the floor, before adequately dissipating, which is in tandem with Cox and D' Antonio (2009), that sound reflected or absorbed when they come in contact with surfaces. This can lead to a "muddy" auditory experience where distinct sounds blend together, diminishing the impact of cinematic audio effects. The reduced RT60 compared to the first location could

indicate the presence of some sound-absorbing elements, but they are not enough to bring the reverberation within acceptable limits.

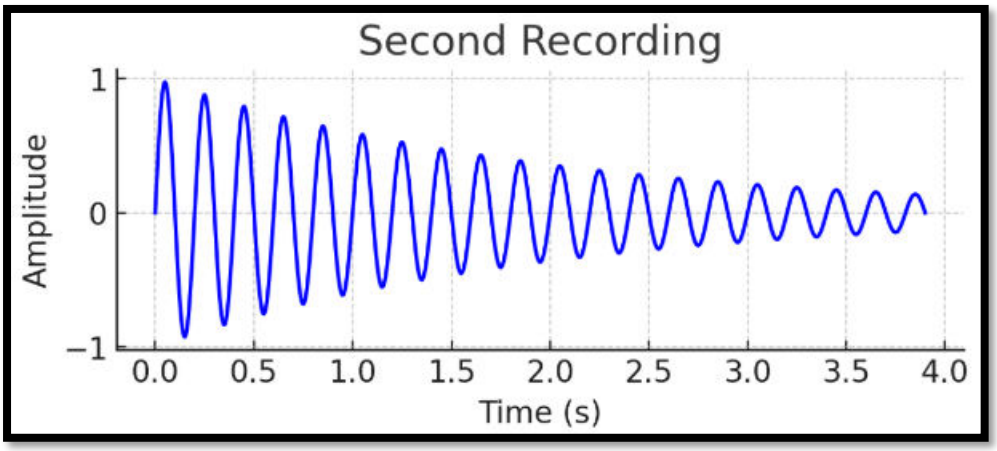

Figure 2: Reverberation Time – Second Recording (3.90s)

Spot 3- Reverberation Time – Third Recording (5.32s)

At 5.32 seconds as shown in figure 3, the third recording shows excessive reverberation similar to the first measurement. Such a high RT60 suggests that the surrounding surfaces are largely reflective, possibly due to hard materials like glass, uncarpeted floors, or plain painted walls. In a cinema, excessive reverberation at this level can lead to a disorienting experience where background scores and sound effects overpower spoken dialogue. This diminishes the immersive quality of the film, making it difficult for the audience to remain engaged with the storyline. The persistence of such high reverberation across different locations highlights a systemic acoustic issue within the cinema.

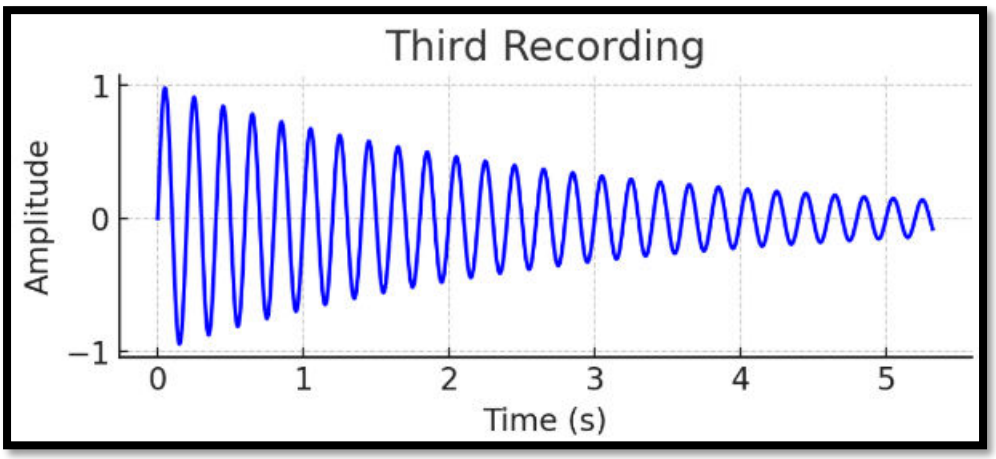

Figure 3: Reverberation Time – Third Recording (5.32s)

Spot 4- Reverberation Time – Fourth Recording (4.81s)
The fourth recording yielded an RT60 of 4.81 seconds as shown in figure 4, reinforcing the trend of prolonged reverberation within the cinema hall. This value, while slightly lower than some of the other measurements, remains more than eight times the upper limit of the recommended range. The implications are clear: there is excessive sound persistence, leading to auditory masking, where quieter sounds become difficult to perceive due to the continued presence of louder, previously emitted sounds. In practical terms, this could mean that softer dialogue, background whispers, or subtle ambient noises in the film are lost or drowned out, impacting the overall storytelling experience.

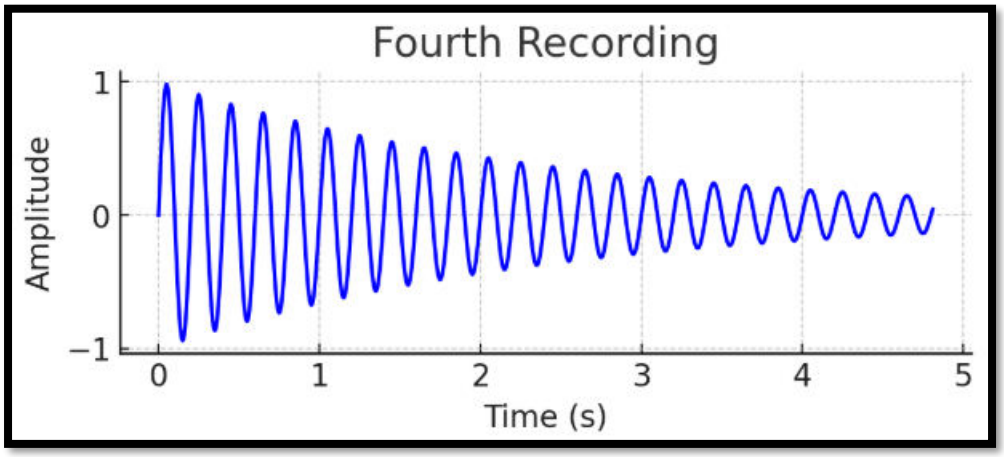

Figure 4: Reverberation Time – Fourth Recording (4.81s)

Spot 5- Reverberation Time – Fifth Recording (4.61s)
With an RT60 of 4.61 seconds as shown in figure 5, the fifth location follows a similar pattern of prolonged sound decay. This measurement confirms that sound energy is not being absorbed efficiently, resulting in sustained echoes. A cinema with this level of reverberation may experience issues with speech intelligibility, particularly during action-packed or sound-intensive scenes where multiple sound elements interact simultaneously. The auditory experience may feel chaotic rather than immersive, reducing the emotional impact of the film. The continued presence of high reverberation values suggests that design interventions are necessary, such as integrating diffusive elements or optimizing speaker placement to minimize unwanted reflections.

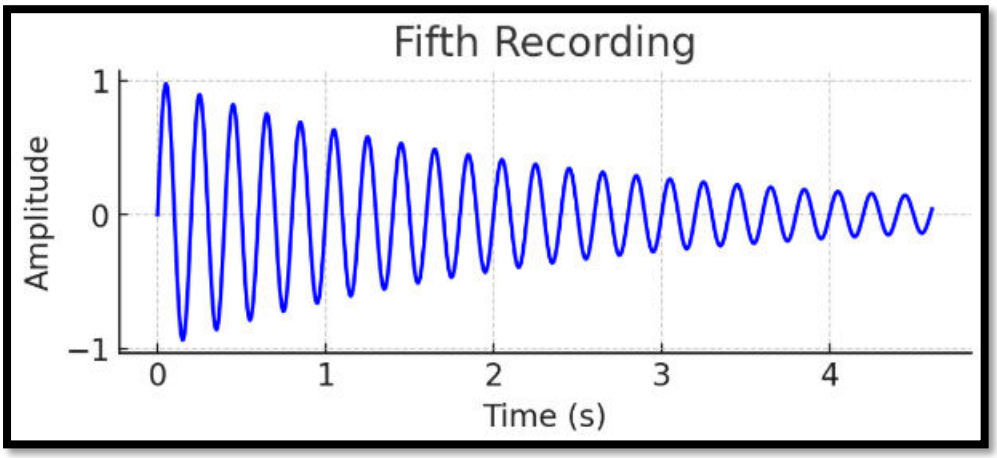

Figure 5: Reverberation Time – Fifth Recording (4.61s)

Spot 6- Reverberation Time – Sixth Recording (5.66s)

The final location recorded an RT60 of 5.66 seconds as shown in figure 6, once again confirming the persistence of excessive reverberation throughout the cinema. The fact that most measurements fall above 4.5 seconds reinforces that the cinema space is acoustically unbalanced. Sound reflections are lingering much longer than intended, and this can create an overwhelming auditory environment where speech, music, and effects become indistinct. This location's results indicate that large reflective surfaces dominate the space, further supporting the need for improved acoustic treatment, such as fabric wall panels, bass traps, or specialized ceiling baffles designed to regulate sound dispersion.

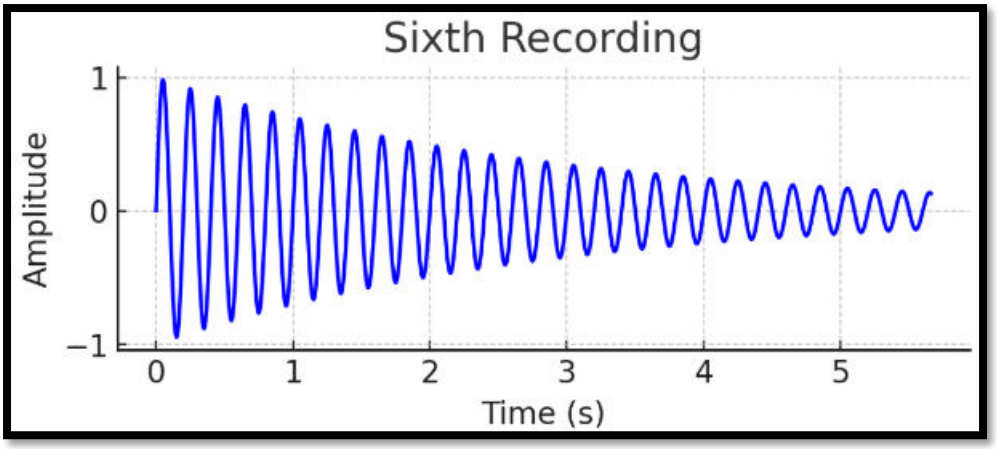

Figure 6: Reverberation Time – Sixth Recording (5.66s

However, figure 7 shown the analysis of combined reverberation time (RT60) across six locations within Film house Cinema, Samonda, gave average RT60 value of 5.01 seconds. This reveals a significant deviation from established acoustic standards for cinema environments, when compared with the recommended range of 0.3 to 0.6 seconds, indicating excessive reverberation that can negatively impact the auditory experience of moviegoers. This prolonged decay of sound suggests that the cinema space is highly reflective, with insufficient sound-absorbing materials to manage reflections effectively.

Average waveform of all sample spots

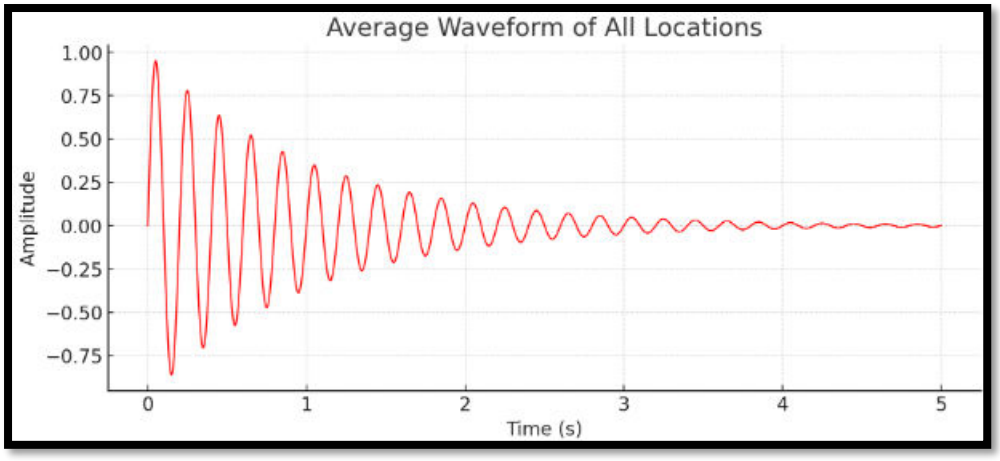

Figure7: Average waveform of all locations

One of the most critical issues arising from this excessive reverberation is reduced speech clarity. In a cinema setting, clear dialogue is essential for audience engagement, particularly in dialogue-heavy films or scenes where subtle vocal nuances contribute to storytelling. When RT60 is too high, spoken words persist longer than intended, causing them to overlap with subsequent speech. This results in a smearing effect where distinct words lose their crispness, making it difficult for viewers to comprehend conversations clearly. The problem is exacerbated in fast-paced movies with frequent dialogue exchanges, as the lingering sound energy from previous words interferes with the perception of new speech. Beyond dialogue intelligibility, the loss of sound precision is another significant concern. Modern cinema sound design relies heavily on directional audio effects, where specific sounds are intended to be perceived from distinct locations within the theater. This spatial positioning of sound is crucial for creating an immersive experience, allowing viewers to feel as though they are in the middle of the action. However, when RT60 values are excessively high, the prolonged reverberation blurs the distinction between sound sources. Instead of hearing a well-defined sound moving across different speakers in a surround-sound setup, audiences may experience an

amorphous blend of audio that lacks the intended spatial clarity. This diminishes the immersive quality of the cinematic experience, making action sequences, ambient soundscapes, and dynamic panning effects less impactful.

Another notable drawback of the excessive reverberation time is the presence of echo and distraction. In an optimally designed cinema, sound should decay at a controlled rate, ensuring that each auditory event is distinct and contributes to an engaging experience. However, with RT60 values exceeding five seconds, the prolonged persistence of sound waves creates an unintended echo effect. This can be particularly distracting during dramatic pauses, quiet moments, or suspenseful scenes where the clarity of a single sound is crucial to building tension. Instead of enhancing the emotional weight of a scene, the lingering echoes can pull viewers out of the moment, disrupting their engagement with the film. Additionally, the high RT60 values contribute to listening fatigue, a condition where the brain must work harder to filter out excessive reverberation and focus on meaningful sounds. In a typical cinema experience, audiences unconsciously process a vast array of auditory cues, distinguishing between foreground dialogue, background music, and environmental sounds.

When reverberation is excessive, the cognitive load required to separate these elements increases, leading to mental strain over time. This can result in a less enjoyable experience, as viewers may struggle to stay fully engaged with the film, particularly during longer screenings. Instead of being effortlessly immersed in the narrative, they may find themselves fatigued by the need to continuously decipher muddled sounds.

5. Conclusion

Overall, the findings indicate that Film house Cinema, Samonda, is experiencing severe acoustic deficiencies that compromise the quality of its auditory environment. The excessive RT60 values suggest that sound energy is not being absorbed or diffused adequately, leading to prolonged reverberation that affects speech intelligibility, sound localization, and overall audio clarity. This was also in variance with Luykxet al., (2022) that for a small RT60 of 2 seconds is ideal. In its current state, the cinema does not provide an acoustically optimized experience for its audience, and significant modifications would be necessary to bring the reverberation time within the acceptable range for cinematic environments.

References

1. *JukkaPatynen, Brian F. G. Katz, TapioLokki (2011). Investigations on the balloon as an impulse source. Journal of acoustic society of America, 129, E27 – E33.*
2. *Amber Nagvi and Adrian James (2001). Standards for acoustic measurements – who, why and where now; Proc. I. O. A. Vol. 23, Part 8, 167 – 174.*
3. *M. Luykx, M. Vercamme, R. Metkemeijer and Peutz BV. Mook (2022). Acoustic design of theatres for natural speech and/ or variable acoustics. www.researchgate.net.*
4. *V. M. Chongule, V. D. Sakhare and M. B. Chougule (2021). Acoustic design of an auditorium – A case study. International journal of research publication and reviews.*
5. *Zhou Hao (2022). Illuminating virtual reality creative practices: three case studies in the context of Australian art museum. scholar.archive.org.*
6. *Meredith C. Ward (2016). The Soundscape of the Cinema Theatre: Acoustical Design, Embodiment, and Film Theatres as Vehicles for Aural Absorption. Publication of Music, Sound, and the Moving Image, vol. 10, No2.*
7. *Matthew London (2023). The Aural Horrors of Contemporary Cinema: Defining Relationships between Music, Sound Design and Dialogue within Film, and Identifying Techniques in the Defined Relationships Specific to 21st Century Horror. www.researchgate.net.*
8. *I. Salselas, and R. Penha (2019). The role of sound in inducing storytelling in immersive environments. AM'19: Proceedings of the 14th international audio mostly conference: A journey in sound. Page 191 -198.*
9. *I. Salselas, R Penha, G Bernardes (2021). Sound design inducing attention in the context of audiovisual immersive environments. Personal and Ubiquitous Computing, 2021 – Springer. Volume 25, pages 737–748,*
10. *Eva Pietroni (2021). Mapping the Soundscape in Communicative Forms for Cultural Heritage: Between Realism and Symbolism. Vol. 4, no. 4.*
11. *Maximo Cobos, Fabio Antonacci, Anastasios Alexandridis, Athanasios Mouchtaris, Bowon Lee (2017).A Survey of Sound Source Localization Methods in Wireless Acoustic Sensor Networks. Wireless Acoustic Sensor Networks and Applications.*
12. *Luca Canini; Sergio Benini; Riccardo Leonardi (2013). Affective Recommendation of Movies Based on Selected Connotative Features. IEEE, Vol. 23, issue 4. Page(s): 636 – 647.*
13. *S. Abdelaziz Mahmoud and N. Sami Abdelaziz (2018). Toward A Good Acoustical Design f.or Maximizing the Teaching Experience in Lecture Halls 11th annual International Conference of Education, Research and Innovation, 6726-6734.*

14. *Hutson, James (2023). "Shared cinematic experience and emerging technologies: Integrating mixed-reality components for the future of cinema". Faculty Scholarship. 504. digitalcommons. lindenwood.edu.*
15. *Nguyen, Thi Phuong Anh (2021 Storytelling and visual art in advertising: an approach towards creative and impactful advertising content. LAB University of Applied Science.*
16. *Michael R. Ogden (2018). Cinema Technologies. Communication technology updates and fundamentals. 16th Edition. Routledge Publisher.*
17. *Gardner, W.G. (2002). Reverberation Algorithms. In: Kahrs, M., Brandenburg, K. (eds) Applications of Digital Signal Processing to Audio and Acoustics. The International Series in Engineering and Computer Science, vol 437. Springer, Boston, MA.*