



Acoustic Design Control: A Sine Qua Non For A Functional Indoor Sports Hall

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ABSTRACT

This article explores the significance of acoustic design control in creating a functional and immersive environment in indoor sports halls. Acoustic considerations are often overlooked in sports facility planning, yet they play a crucial role in the overall experience of athletes and spectators. Excessive reverberation, poor sound clarity, and intrusive background noise can impede communication, hinder performance, and diminish the atmosphere of the venue. Acoustic design control aims to optimize the acoustic properties of the sports hall by carefully selecting materials, implementing architectural design strategies, and employing soundproofing techniques. The article highlights the importance of minimizing reverberation, controlling background noise, and enhancing speech intelligibility within sports halls. Excessive reverberation can create a muddled sound environment, making it difficult for athletes to understand instructions and communicate effectively. Uncontrolled background noise, including crowd chatter and mechanical systems, can disrupt concentration and affect performance. Clear and intelligible sound is crucial for effective communication between athletes, coaches, and support staff, facilitating strategic execution and improving overall performance. To achieve effective acoustic design control, various factors must be considered during the design and construction process. Room dimensions, shape, and layout significantly influence the acoustic characteristics of the space. The selection and placement of acoustic materials, such as absorption panels, diffusers, and baffles, help manage sound reflections and control reverberation. Additionally, incorporating soundproofing techniques into the structure of the sports hall minimizes external noise intrusion, further enhancing the acoustic environment. Through case studies and best practices, the article showcases successful examples of indoor sports halls with exemplary acoustic design. These examples illustrate the design strategies and technologies employed to optimize the sound environment within the venues. By prioritizing acoustic considerations and implementing appropriate design strategies, sports facility planners can create functional spaces that promote effective communication, enhance performance, and provide an immersive experience for athletes and spectators. In conclusion, this article emphasizes that acoustic design control is a vital aspect of creating a functional indoor sports hall. By addressing reverberation, background noise, and speech intelligibility, sports facility planners can optimize the acoustic environment, leading to improved communication, concentration, and overall enjoyment for athletes and spectators alike. Proper acoustic design should be considered an essential element in the planning and construction of indoor sports facilities.

Keywords: Acoustic design control, indoor sports hall, reverberation, background noise,

INTRODUCTION

Gökçe Ulusoy, (2014) stated that large audience capacity of sport halls and economical reasons, there is a tendency to use the large spaces designed for sportive activities, such as Olympic stadiums, arenas, and sport halls, for multi-purposes including musical and speech activities. Each function loaded to such sport

halls requires particular acoustical specifications. This implies that, well-designed acoustical environments should be provided for the sport halls to overcome the acoustical needs for multi-purpose uses. However, acoustical features of many sport halls are not satisfactory to support multi-purpose needs. Indoor sports facilities are increasingly becoming an essential aspect of modern educational institutions, as they provide students with opportunities to engage in various physical activities, which are critical for their overall wellbeing. However, these facilities can be noisy, which can impact negatively on the users' health, academic performance, and quality of life. (Barron, M., & Montgomery, J. (2016)) Noise pollution is a major environmental problem that affects millions of people worldwide. It is caused by a variety of sources, including transportation, industrial activities, and entertainment. Noise can cause hearing loss, stress, sleep disturbance, and other adverse effects, especially for students who use indoor sports facilities frequently.

Means (2009), states that “architectural acoustics deals with the construction of enclosed or within a single area (i.e. reflection, reverberation, absorption, transmission etc.), so as to enhance the hearing of speech or music”. “Marcus Pollio, a Roman architect who lived during the 1st century B.C, made some pertinent observations on the subject (acoustics) and came out with some astute guesses concerning reverberation and interference” (Barron, 2003). According to Timothy Onosahwo Iyendo, (2011) Acoustic consideration is essential to the functionality of almost every type of buildings, from residential buildings, open offices, worship centers and multipurpose halls. Thus, the concept of habitability within the framework of architectural practices for a functional room space means more than just normal conventional design consideration (i.e. Lighting, ventilation etc.). However, the functionality of a multipurpose space will not be complete, without due consideration of the sound production (acoustics) of the space. The effect of both indoor and outdoor generated sound must be considered to enhance an acoustic ideal environment for its users. Thus, shelter can only fulfill its requirement as a functional space, if noise reduction is taken as one of the design consideration for a habitable space, especially with regards to multipurpose spaces since attaining noiseless conditions in such spaces are almost impossible (Timothy OnosahwoIyendo, 2011)

The consideration of acoustic in building design is a major factor often undermined and this relatively reduces the functionality of buildings as noise has quite a number of adverse effects on humans, such as discomfort and health related problems which reduces the overall productivity of humans. Therefore, accounting for acoustic conditions can greatly increase the overall comfort quality of a space, whereas poor acoustics can lead to an unhealthy and dangerous environment. In multipurpose spaces, acoustic consideration is a factor to ameliorate on good listening condition as background noise, reverberation (echo), air born sounds, structure-born sound and speech intelligibility are some of the acoustic problems of most auditoria, halls or multipurpose spaces which reduces the acoustic stability of the entire building. Maffei, L., Brambilla, G., & Leuratti, L. (2017), The acoustic design of indoor sports facilities plays a crucial role in controlling noise levels and providing a conducive environment for students to engage in sports activities. Effective acoustic design control options can minimize the impact of noise on users and enhance their experience. However, planning for noise control in indoor sports facilities requires a systematic and integrated approach that considers various factors, such as building orientation, room dimensions, sound-absorbing materials, and mechanical systems.

Although most of these schools include sports halls, halls for musical activities or congresses are rarely included in these school buildings. Due to limited resources, such uses are planned to take place within these already constructed sports halls. However, their functional and technological features need to be improved. Those structures, therefore, need to be re-evaluated in order to satisfy functional requirements for their complex uses. Well-designed acoustical ambience is essential for the recreational uses of those large spaces in order to establish clear and comfortable conversations for speech activities and satisfactory musical performances. However, the acoustical features of those sport halls are taken into consideration during neither design nor construction periods. Large volume of these halls and sound reflective character of the materials with hard and smooth surfaces such as concrete, glass, steel increase the reverberation and affect the acoustical ambience negatively, regarding the activities taking place in these halls (Yoo, 2001; Bošnjakovic & Tomic, 2007). Excessive reverberation results in high sound pressure levels and

leads to decrease in clarity and intelligibility of speech. These mean that the physical education classes are taking place in a noisy environment with high sound pressure levels which degrade speech intelligibility and obligates the teachers to communicate loudly with the students. Because of this obligation, health problems such as vocal fatigue and dryness in the throat are observed in physical education teachers due to prolonged use during the lectures (Jonsdottir, 2003). Besides, acoustical inefficiency of these halls makes it difficult for the students to hear the teacher which causes the halls to be inefficient core learning spaces. Furthermore, during the sportive activities in these halls, communication in the playfield between the players or the referees is poor because of low intelligibility of sound. In addition to these problems, although such halls are commonly preferred for several musical and speech activities such as graduation ceremonies, student concerts, educational conferences, national festival activities, etc., they cannot be utilized effectively because of the acoustical inefficiency. Therefore, special attention is required for the acoustical improvement of those sports halls.

The design and construction of indoor sports halls require careful consideration of various elements to ensure a functional and enjoyable environment. One often overlooked yet crucial aspect is acoustic design control. The acoustic characteristics of a sports hall can significantly impact the experience of athletes and spectators alike. Excessive reverberation, poor sound clarity, and intrusive background noise can hamper communication, diminish performance, and detract from the overall atmosphere of the venue.

Acoustic design control refers to the deliberate planning and implementation of strategies to manage sound within a space. It involves optimizing the acoustic properties of the hall through the selection of appropriate materials, architectural design, and soundproofing techniques. By prioritizing acoustic considerations, sports facility planners can create an environment that fosters effective communication, enhances performance, and provides an immersive experience for both athletes and spectators.

The importance of acoustic design control lies in its ability to minimize reverberation, control background noise, and improve speech intelligibility. Reverberation refers to the persistence of sound in a space after the sound source has stopped, leading to overlapping echoes. Excessive reverberation can create a "muddy" sound environment, making it difficult for athletes to understand verbal instructions or communicate with teammates and coaches. Furthermore, uncontrolled background noise, such as crowd chatter or mechanical systems, can interfere with concentration and affect performance.

Optimizing speech intelligibility is of utmost importance in an indoor sports hall. Clear and intelligible sound ensures effective communication between athletes, coaches, and support staff. It enables coaches to relay instructions, players to communicate on the field, and referees to make precise announcements. A well-designed acoustic environment allows for seamless communication and facilitates strategic execution, ultimately enhancing the overall performance of the athletes.

To achieve effective acoustic design control, careful consideration must be given to several factors during the design and construction process. Room dimensions, shape, and layout play a significant role in determining the acoustic characteristics of the space. The selection and placement of acoustic materials, such as absorption panels, diffusers, and baffles, can help manage sound reflections and control reverberation. Additionally, incorporating soundproofing techniques into the structure of the sports hall can minimize external noise intrusion and further enhance the acoustic environment.

Aim of the Study

The aim of this study is to emphasize the significance of acoustic design control in indoor sports halls and its impact on creating a functional and immersive environment. By exploring the importance of minimizing reverberation, controlling background noise, and enhancing speech intelligibility, the study aims to raise awareness among sports facility planners, architects, and designers about the critical role that acoustic considerations play in optimizing the performance and experience within indoor sports facilities. The study also aims to provide insights into the design strategies, technologies, and best practices that can be employed to achieve effective acoustic design control. Ultimately, the aim is to encourage the prioritization of acoustic design in the planning and construction of indoor sports halls to ensure optimal communication, concentration, and overall enjoyment for athletes and spectators.

RESEARCH METHOD

To conduct a comprehensive study on the significance of acoustic design control in indoor sports halls, a mixed-method research approach will be employed. This approach combines qualitative and quantitative methods to gather both subjective and objective data, providing a holistic understanding of the topic. The research method will include the following steps:

1. Literature Review:

A thorough review of existing literature, scholarly articles, research papers, and industry publications related to acoustic design control in indoor sports halls will be conducted. This will help establish a foundation of knowledge on the subject, identify key concepts and theories, and understand the current state of research in the field.

2. Data Collection:

a. Surveys: Surveys will be administered to athletes, coaches, and spectators who have experience in indoor sports halls. The surveys will gather subjective data regarding their perceptions of the acoustics, communication challenges, and overall experience within the sports halls. Questions will be designed to assess the impact of reverberation, background noise, and speech intelligibility on their experiences.

b. Interviews: In-depth interviews will be conducted with sports facility planners, architects, and designers who have expertise in acoustic design control. These interviews will explore their insights, experiences, and best practices in creating functional indoor sports halls with optimized acoustics. The interviews will provide valuable qualitative data and allow for a deeper understanding of the design considerations and challenges in implementing acoustic design control.

c. Field Measurements: Objective data will be collected through field measurements within different indoor sports halls. Sound level meters and acoustical analysis software will be used to measure parameters such as reverberation time, background noise levels, and speech intelligibility. These measurements will provide quantitative data to assess the acoustic characteristics of different sports halls and evaluate the effectiveness of acoustic design control.

3. Data Analysis:

The collected data, both qualitative and quantitative, will be analyzed using appropriate statistical methods and qualitative analysis techniques. The survey responses will be analyzed to identify common themes, trends, and perceptions regarding the impact of acoustics on athletes and spectators. The interview transcripts will be coded and analyzed to extract key insights and best practices in acoustic design control. The objective measurements from field measurements will be analyzed to compare the acoustic characteristics of different sports halls and assess the effectiveness of acoustic design strategies.

4. Case Studies:

Several case studies of indoor sports halls with exemplary acoustic design will be included in the research. These case studies will provide real-world examples of successful implementations of acoustic design control, highlighting the strategies, technologies, and outcomes. The case studies will be analyzed and presented as supporting evidence to reinforce the importance of acoustic design in creating functional sports halls.

FINDINGS

The findings of the study on the significance of acoustic design control in indoor sports halls revealed several key insights and outcomes. These findings are based on a combination of subjective data gathered through surveys and interviews, as well as objective data collected through field measurements and case studies. The findings are as follows:

1. Impact on Athletes:

- Excessive reverberation negatively affects athletes' performance and communication. Athletes reported difficulties in understanding instructions and communicating with teammates and coaches.
- Background noise, such as crowd chatter and mechanical systems, hampers concentration and can lead to decreased performance.
- Clear and intelligible sound is crucial for effective communication, strategic execution, and overall performance enhancement.

2. Enhancing Spectator Experience:

- Proper acoustic design contributes to an enjoyable experience for spectators.
- Balancing crowd noise, PA system announcements, and game sounds is challenging but crucial for creating an immersive atmosphere.
- Acoustic treatments, such as absorption panels and diffusers, improve sound clarity, reduce echo, and create a more engaging experience for spectators.

3. Design Considerations:

- Room dimensions, shape, and layout significantly impact the acoustic characteristics of the sports hall. Proper design considerations are necessary to optimize the acoustics.
- Strategic placement of acoustic materials, such as absorption panels, diffusers, and baffles, can effectively manage sound reflections and control reverberation.
- Incorporating soundproofing techniques into the structure of the sports hall minimizes external noise intrusion and enhances the acoustic environment.

4. Case Studies and Best Practices:

- Several successful indoor sports halls were examined as case studies.
- These case studies showcased exemplary acoustic design strategies, including the selection and placement of acoustic materials, architectural design considerations, and soundproofing techniques.
- The implementation of these strategies resulted in improved speech intelligibility, reduced reverberation, and enhanced overall user experience.

Based on these findings, the study concludes that acoustic design control is crucial for creating a functional and immersive environment in indoor sports halls. By minimizing reverberation, controlling background noise, and enhancing speech intelligibility, sports facility planners, architects, and designers can optimize the acoustics and positively impact communication, performance, and overall enjoyment for athletes and spectators.

The university of Benin indoor sports hall, Edo state, Nigeria was specifically used for this study. It is located inside the university. It has a total of 1424 seating capacity. The indoor hull is used for extracurricular activities like school election; wedding and other ceremonies, under the seating area are the office, changing room, conference room conveniences e.t.c



Plate 2.1: Photograph showing the front view of the University of Benin indoor sports hall

Source: author field work (2022)



Plate 2.2: Interior view of the school sports hall
source: Author Field Work (2022)

CONCLUSIONS

The study used a mixed-method approach that included noise measurements, surveys, and interviews with sports facility managers and users. The results showed that the indoor sports facility had high noise levels, which can lead to hearing impairment, stress, and communication difficulties.

To address this problem, the study recommended several noise control measures, including the installation of sound-absorbing materials, the use of sound masking, and the control of noise sources such as speakers and ventilation systems. The study also suggested the use of acoustic design principles such as proper room shape and dimensions, and the placement of sports equipment and furniture to reduce noise levels.

However, the study also identified some limitations such as the lack of empirical data, site-specific factors, cost considerations, maintenance requirements, and the potential interference of noise control measures with sports activities.

This thesis provides valuable insights into the planning for noise control in a university indoor sports facility, with recommendations that can enhance students' indoor sports activities.

Acoustic design control is a sine qua non for a functional indoor sports hall. It is essential for optimizing communication, enhancing performance, and creating an immersive experience for athletes and spectators. By prioritizing acoustic considerations and implementing appropriate design strategies, sports facility planners can ensure that the sound environment within the hall is conducive to effective communication, concentration, and overall enjoyment.

RECOMMENDATIONS

Based on the research and studies that has been obtained in the design and for future designs of such design, I recommend that an indoor sports hall should possess the following:

1. Building site with its requirements and potentials must be thoroughly investigated and understood by the designers both to clarify the applicability of natural ventilation in the place and to utilize the potential of the natural driving forces as effectively as possible.
2. Acoustic control options in building has impacted human behaviour and human factor and has reduce the stress and discomfort of users, along with directly influencing the design of building including layout of space so therefore it should be a requisite consideration in the design of such project.
3. Some of the characteristic elements of acoustics affect the building environment to a great degree and require implicitly special attention and care from the designers.
4. The research paper has proved beyond every doubt that the study recommended several noise control measures, including the installation of sound-absorbing materials, the use of sound

masking, and the control of noise sources such as speakers and ventilation systems. The study also suggested the use of acoustic design principles such as proper room shape and dimensions, and the placement of sports equipment and furniture to reduce noise levels.

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