Acoustics standards comparison between performing arts centre

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Abstract. A Performing Arts Centre is a venue that needs optimum acoustic. Many art performances generate high intensity sounds that auditoriums in the building are installed with acoustic systems. Acoustic system is used to reduce the intensity of sounds, for the purpose of giving the audience and performers an ease in listening and producing sounds. Other factors that could affect the ease of audio are the design of the auditorium, the materials that are used to cover the walls and ceiling of the auditorium and the capacity of the auditorium. The research aims to analyze acoustic systems that are optimal to use in an auditorium for performing arts with qualitative methods by using secondary data from case studies and literature related to acoustic systems in performing arts centre by comparing the design of the auditorium alongside the capacity of the hall and the materials that are used to cover the surfaces of the performing arts centre according to acoustic standards referred in Acoustics of Multi-use Performing Arts Centres and Building Physics 2. It is concluded that Benjamin and Marian Schsuter Performing Arts Centre has the optimal acoustic system.

1. Introduction

A Performing Arts Centre is a facility or building that’s main function is to hold a variety of art performances. Generally art performances produce sound with high intensity. When performed indoors or outdoors, a show requires an optimal acoustic system so that the sound is comfortable to be heard by both audience and artists.

The shapes of performing halls may vary, it is very common to find a shoebox, vineyard and a fan shaped performing halls. According to the ICA Symposium in Edinburgh in 1974, Dr. Ted Schultz pointed out of 25 halls that are rated A+ and A, 16 halls are shaped as a shoebox or rectangle and 9 are shaped not a shoebox [1].

Shoebox shaped and fan or vineyard shaped halls both have advantages and disadvantages to a performing hall. A shoebox shaped halls may give a more optimum produced sound than a fan or vineyard shaped hall because of its shape, but a surrounded type hall may achieve an optimum produced sound by incorporating certain design strategies to the accentuate produced sounds.

According to Mark Holden in the book Acoustics of Multi-use Performing Art Centers, Reverberation time (RT) is a major factor that contributes to the audio comfort in the Auditorium [2]. An optimal reverberation time can be achieved through the design and form of the auditorium and its acoustic systems. The shape of the ceiling and the design of the auditorium contributes to the...
Reverberation Time (RT), as the resulting sound will be reflected through the surfaces inside the auditorium.

To identify the optimum acoustic system to use in an auditorium, comparison is done between two performing arts centre. The comparison between two performing arts centre is done by comparing the aspects that can affect the quality of the acoustic, both in terms of material, form and results of reflected sounds.

1.1. Research objectives
The purpose of this research is to identify the optimum acoustic systems to use in a Performing Hall inside a Performing Arts Centre Building that are Vineyard or Fan Shaped, based on its form of halls and surfaces inside, hall capacity and material used to produce the optimum reverberation time based on acoustic standards in Acoustics of Multi-Use Performing Art Centers and Building Physics 2.

1.2. Research benefits
The Benefits of the research is to give knowledge on optimum acoustic systems to use in a vineyard and fan shaped performing halls in a Performing Arts Centre Building.

2. Research methodology
The method used in this research is nonexperimental quantitative method. The quantitative method according to Siyoto and Sodik uses statistics [3], numbers and controlled experiments to objectify results of the research, comparison are classified as a nonexperimental quantitative method. The research began with collecting data obtained from the literature study of the Acoustics of Multi-use Performing Art Centers by Mark Holden, literature and journals regarding acoustic systems in auditorium and their case studies [2].

The analysis was conducted by comparing the use of acoustic systems between 2 art performing houses, namely Benjamin and Marian Schuster Performing Arts Centre and Michael and Susan Dell Hall in Long Center. In selecting case studies, both Performing Halls are multi use performance halls to accommodate a high number of audiences with a fan or vineyard shaped hall. Aspects of comparison are the shape and capacity of the auditorium, materials and forms of acoustic systems on the surface of the auditorium, and Reverberation Time. The conclusions were obtained from the data and analysis results on the case study of optimum acoustic standards to use in the Performing arts building.

3. Results and discussion
Comparison at Benjamin and Marian Schuster Performing Arts Centre and Michael and Susan Dell Hall are based on, aspects affecting the acoustic system, these aspects are the Auditorium form, form and acoustic Material, and technical factors such as Reverberation Time, Reflection, Clarity, and so on. Comparative aspects of the Benjamin and Marian Schuster Performing Arts Centre and Michael and Susan Dell Hall according acoustic for multi-use performing centre can be seen in Table 1.
Table 1. Comparative aspects of the Benjamin and Marian Schuster Performing Arts Centre and Michael and Susan Dell Hall according acoustic for multi-use performing centre.

| Aspects                        | Benjamin and Marian Schuster Performing Arts Centre | Michael and Susan Dell Hall |
|--------------------------------|---------------------------------------------------|------------------------------|
| Auditorium Capacity           | 2325                                              | 2442                         |
| Stage Lifts                   | 3 stage lifts                                     | 2 stage lifts                |
| Auditorium Form               | Resembles a Fan                                   | Vineyard                     |
| Source: Acoustics of Multi-use Performing Arts Centre [2] | Source: Acoustics of Multi-use Performing Arts Centre [2] |
| Ceiling form                  | Flat and convex                                   | Flat                         |
| Source: Acoustics of Multi-use Performing Arts Centre [2] | Source: Acoustics of Multi-use Performing Arts Centre [2] |
| Reverberation Time            | 2 seconds                                         | 1.8 – 2.2 seconds            |
| Acoustic systems in ceiling   | Usage of mesh made by steel that is connected to the frame steel, resulting in 0 sound degradation. | Usage of acoustic curtains that are made of velvet that are put above the resonant ceiling. |
| Acoustic systems in auditorium walls | 25mm thick acoustic panel are installed on the sides of the room, this will assist the sounds that are resonated by the Throat Wall to not reduce the produced sound. | The velvet acoustic curtain are found on the sides, ceilings and walls of the upper balcony. |
| Velvet curtains are seen on the walls on the back sides of the room to reduce some over sound reverberation | There are hollow panels found on the Auditorium’s Throat Wall that are made of woods. There is also seen the usage of Acoustic Shell to amplify the Reverberation Time |
| Acoustic Materials            | Fiber Glass for the sides of the room, Velvet are used for the curtain | Velvet Woods                 |
Sound transparent structure and wall grilles in Michael and Susan Dell Hall can be seen in Figure 1 and 2. The shape of the auditorium is based on the capacity the auditorium holds, a more larger amount of audience results in a larger area of balconies [4]. For performance Halls, that are fan shaped it is more optimum to have a capacity of 2500 audience max [4], and for Vineyard Performance Halls it optimum to hold a capacity of more than 1800 audience [5]. A large stage area requires acoustic shells. Acoustic shells are recommended to be parabolic surfaces, in aims to disperse sound evenly throughout the Auditorium [6]. The use of the Acoustic Shell on the wall and acoustic curtains of Michael and Susan Dell Hall made the Reverberation Time of the Auditorium 1.8 to 2.2 seconds [2]. Performing Halls with Stage Lifts helps to maximize the variety of performances and communication between artists and audiences. Stage lifts serve as an extended area that can expand the performing area to the outer stage line, making it closer to the audience area [2].

The convex ceiling shapes as seen in table 1, can spread sound waves and create a clear sound to be heard by the audience, but excessive convex surfaces can produce a large amount of sound reflections. Meanwhile, concave surfaces produce “Whispering Gallery” [7], which is a sound convergence, that means the sound is stronger in one point. This applies to the shape of the rear wall of the Auditorium [2]. A combination between flat and concave or convex surfaces could achieve a more optimal acoustic form. Concave surfaces can be formed by arranging multiple flat surfaces, this will result in a more optimal acoustics system to spread reflected sounds evenly throughout the entire auditorium [2]. Flat or mildly inclined surfaces in floors can give the reverberation a good envelope, resulting in an even sound to all directions in the auditorium [8]. The use of a grilles acoustic panel aims to allow the sound to move unhindered towards the sound absorbent surface.

The Material used for acoustic, plays an important role in sound received by the user of the auditorium. The use of material varies but is based on the surface location to reflect the sound (Reflector), the surface location for absorbing sound (Absorber), the surface location to diffuse the sound (diffuser) and place for sound insulation (Insulator). Location of the wall function is explained in the Table 2 and wall specification locations based on acoustic functions can be seen in Figure 3.
Table 2. Wall location based on sound propagity.

| Wall Types | Location |
|------------|----------|
| Reflector  | • Walls that are facing the audience  
|            | • Ceiling |
| Absorber   | • Parallel Stage Walls  
|            | • Parallel Auditorium Walls  
|            | • Walls on the backside of the room  
|            | • Auditorium Floors |
| Diffuser   | • Parallel Stage Walls  
|            | • Parallel Auditorium Walls  
|            | • Walls on the backside of the room |
| Insulator  | • Auditorium’s side walls  
|            | • Back walls |

Figure 3. Wall specification locations based on acoustic functions.

The use of excessive wood as the main material of the wall is less optimal because it can produce a decrease in the value of Reverberation Time and Bass Ratio (BR).

4. Conclusion

Based on the analysis, the shape of the auditorium, acoustic form and acoustic material that are used are factors that can affect the quality of acoustics. The Optimal reverberation time in a multifunctional Auditorium has an average of 1 and 2 seconds, so the Benjamin and Marian Schuster Performing Arts Centre, which has a Reverberation Time of 2 seconds, is more Optimal than Michael and Susan Dell Hall, aspects that contribute to achieving the optimum reverberation time are flat and convex surfaces that is located in the ceiling and walls to reflect the sound and spread the sound evenly throughout the auditorium. The use of 3 stage lifts at Benjamin and Marian Schuster Performing Arts Centre maximizes the sound heard by users because stage lifts are an extended area that can open the artist’s movement to the outer stage line. So the stage distance to the audience is closer. The majority of the materials used in Benjamin and Marian Schuster Performing Arts Centre, did also influence the acoustic quality and produced sound in the auditorium, as a smaller amount of wood is used to coat the surfaces. This affects the Bass Ratio and Reverberation time. Whereas the Michael and Susan Dell Hall, used a larger amount of wood.

References

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