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STUDY OF ACOUSTIC SYSTEM IN THE AUDITORIUM OF THE GERMAN CULTURAL CENTER (GOETHE-INSTITUT), CENTRAL JAKARTA

Michelle Ardeli Nathania[1], Mariana[2] & Eddy Supriyatna Marizar[3]

[1]Faculty of Art and Design, University Tarumanagara Jakarta
Email: michelle.615190089@stu.untar.ac.id
[2]Faculty of Art and Design, University Tarumanagara Jakarta
Email: mariana@fsrd.untar.ac.id
[3]Faculty of Art and Design, University Tarumanagara Jakarta
Email: eddys@fsrd.untar.ac.id

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ABSTRACT

The Goethe-Institut is a cultural institution from the Federal Republic of Germany with a global reach. The Goethe-Institut promotes knowledge of the German language abroad and maintains international cultural cooperation. Through information related to the cultural, social, and political life of their country, the Goethe-Institut conveys an overview of Germany. Its cultural and educational programs encourage intercultural dialogue and enable cultural engagement. One of the main facilities needed to accommodate and distribute creations in these fields is the auditorium. The acoustic system is an important aspect of an auditorium as it greatly affects the comfort of visitors. The purpose of this research is to determine the right shape of the room so that the sound energy can be evenly distributed, to find alternative acoustic materials suitable for an auditorium, and to develop interior elements (floors, walls, and ceilings) that can be applied to the interior of Goethe-Institut's auditorium. This study uses the qualitative method. The research that has been done reveals that based on the acoustic design, the design of the Goethe-Institut auditorium is not yet optimal. The acoustic quality of the Goethe-Institut auditorium can be improved by using reflective materials on the ceiling and absorbent materials on the doors of the audience area, as well as absorbent materials on the floor, reflective materials on the ceiling, and absorbent and diffusing materials on the back wall of the stage area.

Keywords: *Acoustic, auditorium, interior, goethe-institut*

1. PREFACE

The Goethe-Institut is a cultural institution from the Federal Republic of Germany with a global reach. The Goethe-Institut promotes knowledge of the German language abroad and maintains international cultural cooperation. Through information related to the cultural, social, and political life of their country, the Goethe-Institut conveys an overview of Germany. Its cultural and educational programs encourage intercultural dialogue and enable cultural engagement.

The Goethe-Institut or German Cultural Center in Central Jakarta is a manifestation of the German government's efforts to preserve and develop its culture in Indonesia. The existence of the Goethe-Institut is expected to be able to facilitate the information needs of the Indonesian people regarding German culture in the fields of film, dance, theatre, literature, and language translation. One of the main facilities needed to accommodate and distribute creations in these fields is an auditorium.

The acoustic system is an important aspect of an auditorium as it greatly affects comfort. Room acoustics includes all the effects that users experience from the sound (Handoko, 2015). Sound management in a room begins with how the sound is produced, its propagation, and the response of a receiving room or instrument to the nature of the sound (Suptandar, 2004). Acoustic planning has several objectives, which include 1) achieving ideal hearing conditions, 2) clear,

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clear, even, not buzzing, and without-noise sound quality (Cornelia, Kusuma, & Hermono, 2021).

An inadequate acoustic system will cause acoustic defects, such as room resonance, acoustic shadows, distortion, sound concentration, reverberation, prolonged reflections, and echoes (Doelle, 1972). Acoustic defects occur because most floors, walls, and ceiling elements use hard materials (Ramadhan, Adhitama, & Nugroho, 2017).

To avoid acoustic defects, it is important to use the right acoustic material according to the function of the room. Good acoustic material is one of the most important requirements for improving the acoustic quality of a room. Absorbers, reflectors, and diffusers are characteristics of acoustic materials.

The purpose of this research is to determine the right shape of the room so that sound energy can be evenly distributed, to find alternative acoustic materials suitable for an auditorium, and to develop interior elements (floors, walls, and ceilings) that can be applied to the interior of Goethe-Institut's auditorium.

2. RESEARCH METHOD

The research method used is the qualitative method. The qualitative method involves collecting data in an attempt to understand a concept, opinion, and experience. Through the use of the qualitative method, descriptive data from the observed object can be obtained. In this case, the acoustic system in the interior of the Goethe-Institut's auditorium. The using of qualitative method in research describes precise facts arranged in words as a result of an analysis.

To obtain data, the following method was used.

Literature

Literature studies are conducted by exploring literature containing theories related to the research topic from various journals and books. The data obtained through literature studies will be used as a comparison with the resulting data from the actual project to test whether the actual project is proper or not.

3. RESULT AND DISCUSSION

The following things are the qualifications of good listening in an auditorium (Doelle, 1972).

1) Decent Loudness
   There should be sufficient loudness in every part of the auditorium, especially in seats that are furtherly placed. Efforts that can be made to achieve proper loudness are shortening the distance between the audience and the sound source through the use of sound-reflecting materials and applying a slope of the floor.

2) Sound Diffusion
   Sound/sound energy is evenly distributed (diffused) in the room. Audiences from all sides should be able to hear sounds clearly regardless of how close or far they are from the sound source. The selection of the right acoustic material affects sound distribution. The following are the characteristics of the right acoustic material for an auditorium.
   a) Absorbers

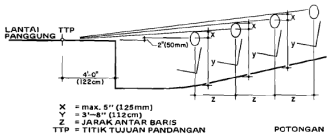
A material whose surface is made of sound-absorbing materials, such as glass wool, mineral wool, soundproof fiberglass, foam, fabric-covered absorber panels, acoustic tiles, etc (Davidson, 2022).

b) Reflectors
A material whose surface is made of a sound-reflecting material, such as marble, granite, clay brick, cement, ceramic, metal, gypsum, and concrete.

c) Diffusers
A material whose surface can diffuse sound, generally has an uneven surface, such as QRD diffuser, BAD panel, diffsorber, etc.

According to previous research, each space-forming element has different characteristics. Each interior element (floors, walls, and ceilings) requires its own treatment. The areas in an auditorium are divided into two, namely the performing area (stage as the sound source) which must be raised in height by 60-120 cm (Everest & Pohlmann, 2009) and the audience area which must be designed with a maximum height difference of 125 mm per row (Doelle, 1972). For walls, each side uses different material characteristics (absorbers, reflectors, and diffusers). For ceilings, the surface must be designed with a false ceiling to control the reflection of sound waves to achieve optimal acoustics in all areas of the room. The ceiling surface should also be made uneven instead of flat.

Figure 1
Stage and Audience Area Section



The shape of the ceiling also affects the acoustics quality. The best shape is convex because most of the sound waves are spread directly to the audience.

Figure 2
Reflection of Sound Waves on the Ceiling

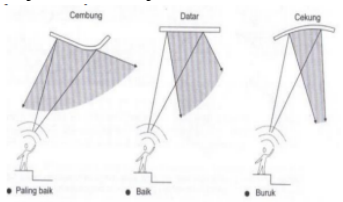


Table 1
Material Characteristics of Interior Elements

	Material Characteristics		
	Reflectors	**Absorbers**	**Diffusers**
Ceiling	✓		
Front side wall	✓		✓
Side wall	✓	✓	
Back side wall		✓	✓
Floor		✓	

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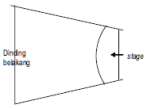
3) Control of Reverberation
Maximum reverberation characteristics should be provided in the auditorium to enable the accommodation of the audience's favorite stage programs and the performers' most efficient staging possible.

In efforts to have a control of reverberation, the shape of the auditorium has a considerable impact (Mills, 1976). Here are some shapes of auditoriums along with their advantages and disadvantages.

Table 2
Shapes of Auditoriums Along with Their Advantages and Disadvantages

Room Shapes	Advantages	Disadvantages
Rectangular 	High probability of sound uniformity Good balance of initial and final sound energy	Further distance between the audience and the sound source
Fan 	Able to accommodate a large audience Maximum viewing angle for the audience	Produces reverberation and sound concentration which results in non-uniformity of sound
Hexagonal 	Very close distance between the audience and the sound source There is sound uniformity	
Horseshoe 	Efficient in absorbing sound Short reverberation time Closer distance between the audience and the viewer	Very high sound absorption at the rear

4) Elimination of Room Acoustic Defects
The room needs to be free of the following acoustical defects.
   a) Room resonance
   Occurs when a sound in a tight frequency band tends to produce a louder sound than other frequencies.
   b) Acoustic shadows
   Occurs when there is space with a depth that exceeds twice the height.
   c) Distortion
   Unintentional change in the sound quality of music caused by imbalance/excessive sound absorption by surrounding surfaces at different frequencies.
   d) Reverberation
   The sound that persists in an enclosed space after the sound source has ceased.
   e) Prolonged reflections
   f) Echoes
   Reflected sound from a surface that arrives at the listener after the direct sound.

These defects can be avoided through good design and the use of materials that match the characteristics of each interior element (floors, walls, and ceilings).

Preliminary Design

The Goethe-Institut is located on Jl. Sam Ratulangi No. 9-15, Gondangdia, Menteng, Central Jakarta, Special Capital Region of Jakarta 10350. The Goethe-Institut is a cultural institution from the Federal Republic of Germany.

Figure 3

Goethe-Institut Jakarta

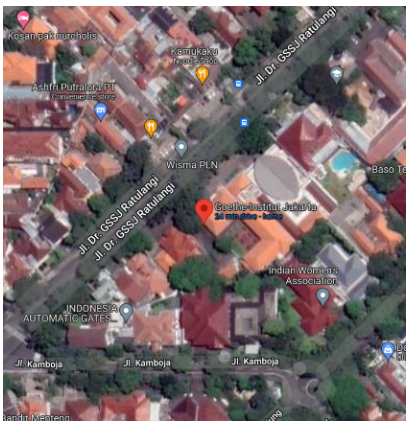
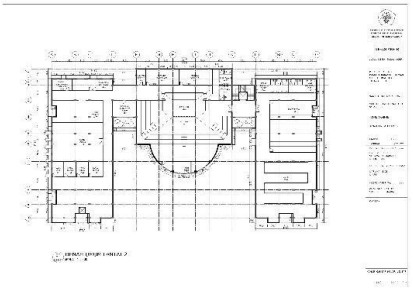


Figure 4

Goethe-Institut Jakarta Plan



The auditorium is rectangular in shape with the addition of a semicircle resembling horseshoes on the side facing the stage. This means a high probability of sound uniformity and a good balance of initial and final sound energy over most areas. However, it is worried that there will be excessive sound absorption in the semi-circle area.

This research focuses on the areas where the acoustic system will be applied, namely the audience and the stage areas.

The audience area has an area of 439.16 m². The floor used in the audience area is carpet. The walls are made of concrete covered with layers of rock wool and wood panels. The ceiling is made of gypsum, wood panels, and polyurethane as faux beams. The door is made of wood.

The stage area has an area of 81.52 m². The floor used in the stage area is hardwood and is made with a height of 76.2 cm. The walls are made of concrete covered with wood panels and paint. The ceiling is made of rock wool covered with gypsum and paint.

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Figure 5
Preliminary Design of Goethe-Institut's Auditorium

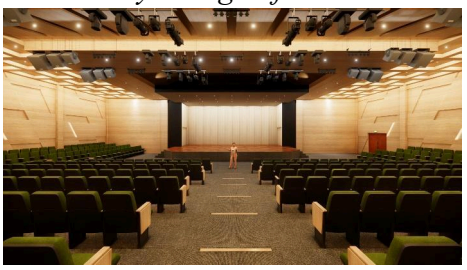


Figure 6
Preliminary Design of Goethe-Institut's Auditorium

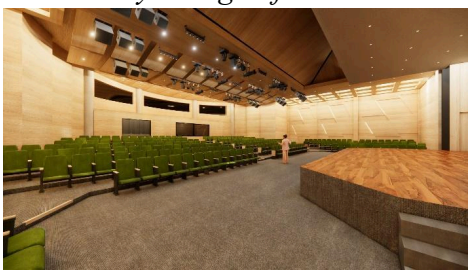


Figure 7
Preliminary Design of Goethe-Institut's Auditorium

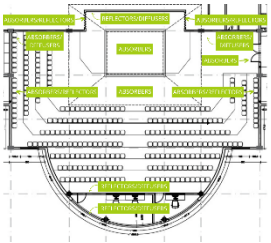
Table 3
Analysis of Room Shape and Interior Eelements

Aspects	Literature Data	Factual Data	Conformity
Room shape	Good auditorium shapes are rectangular, fan, hexagonal, and horseshoes.	The auditorium is rectangular in shape with the addition of a semicircle resembling horseshoes.	Conformed
Treatment of interior elements	A good ceiling for an auditorium is flat, but convex is best.	Auditorium ceilings are a combination of flat and convex.	Conformed
	The back wall must use reflective material.	The back wall uses concrete, brick, glass, and wood panels.	Conformed
	The side walls must use absorbent and reflective materials.	The side walls use concrete, brick, rock wool, and wood panels.	Conformed
	The stage area is raised in height by 60-120 cm.	The stage area is raised 76.2 cm in height.	Conformed
	Audience areas must be designed with a maximum height difference of 125 mm per row.	Audience areas are designed with a height difference of 125 mm per row.	Conformed

Table 4
Material Characteristics

Material Characteristics			
Audience Area			
Total Area: 439.16 m²			
Materials for	**Literature**	**Factual**	**Conformity**
Floor	Absorbers	Carpet (absorbers)	Conformed
Ceiling	Reflectors	Wood panels (reflectors)	Conformed
		Gypsum (reflectors)	Conformed
		Polyurethane (absorbers)	Not conformed
Side wall	Absorbers and reflectors	Concrete (reflectors)	Conformed
		Brick (reflectors)	Conformed
		Rock wool (absorbers)	Conformed
		Wood panels (reflectors)	Conformed
Back side wall	Reflectors and diffusers	Concrete (reflectors)	Conformed
		Brick (reflectors)	Conformed
		Glass (reflectors)	Conformed
		Wood panels (reflectors)	Conformed
Door	Absorbers	Wood (reflectors)	Not conformed
Stage Area			
Total Area: 81,52 m²			
Materials for	**Literature**	**Factual**	**Conformity**
Floor	Absorbers	Hardwood (reflectors)	Not conformed
Ceiling	Reflectors	Rock wool (absorbers)	Not conformed
		Gypsum (reflectors)	Conformed
Front side wall	Reflectors and diffusers	Brick (reflectors)	Conformed
		Wood panels (reflectors)	Conformed
Side wall	Absorbers and reflectors	Concrete (reflectors)	Conformed
		Brick (reflectors)	Conformed
		Wood panels (reflectors)	Conformed

Figure 8
Recommended Material Characteristics



4. CONCLUSIONS AND RECOMMENDATIONS

Good acoustic design can prevent acoustic defects. It is important to choose the right material characteristics for each part of the room and give appropriate treatment to each interior element that makes up the room.

It can be concluded that based on the acoustic design, the design of the Goethe-Institut auditorium is not yet optimal. The material characteristics applied to floors, walls and ceilings have not been fully proper. The acoustic quality of the Goethe-Institut auditorium can be improved by using reflective materials on the ceiling and absorbent materials on the doors of the

audience area, as well as absorbent materials on the floor, reflective materials on the ceiling, and absorbent and diffusing materials on the back wall of the stage area.

If the acoustic design is proper, it will result in a room that can evenly distribute sound to all parts without any acoustic defects so the quality of the performance will be optimal and the audience are able to comfortably enjoy the show.

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