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Acoustic Relationship in Outdoor Performance Spaces

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Abstract

This study investigates the acoustic challenges in outdoor performance spaces, focusing on traditional Theyyam performances in Kerala, India. These performances occur in open temple courtyards and sacred groves where sound distribution becomes uneven, resulting in poor audibility and audience discomfort. Unlike enclosed auditoriums, outdoor amphitheatres are influenced by environmental factors such as wind, vegetation, landform, and background noise, which affect acoustic performance.

The research adopts a comparative case study approach analysing four outdoor performance venues including Natarani Theatre, Cloud Tower Austria, Odeon of Pompeii, and Bamboo Amphitheatre Brazil. Parameters such as form, material, spatial arrangement, and landscape integration were evaluated.

Findings indicate that topography, reflective materials, semi-circular geometry, and stage canopies significantly improve sound clarity and projection. The study proposes context-sensitive acoustic design guidelines for culturally rooted outdoor performance spaces.

This research contributes to Acoustic Performance-Based Design (APBD) by integrating environmental and cultural factors for improving acoustic performance in traditional outdoor theatres.

Keywords; Theyyam, Acoustic performance, outdoor design, sound quality.

INTRODUCTION

The study of acoustics in open amphitheatre is been started from the Roman and Greek times from building a colosseum to deliver such intellectually sound. It is a long history of architectural experimentation.

Ancient Greek and Roman theatres severed as cultural icons and were also exceptionally advanced in terms of acoustics. The design – semicircular cavea, orchestra and skene facilitated exceptional speech clarity without amplification, even in vast auditoria accommodating thousands.

Essential elements like the incline of the seating the characteristics of the stone and the geometric arrangement enhanced sound reinforcement in via early reflections and diffraction across tiered seating. The ancient locations showcase the collaboration between acoustics and architecture which enhances the performing techniques, and still produce soundscapes that grab the attention of the spectators.

Nonetheless, applying these historical insights to modern open-air theatres presents obstacles. Semi-enclosed or shaded amphitheatres like Bikent Amphitheatre in Turkey, demonstrate that although contemporary tensile and steel designs offer shelter from the elements, they frequently produce high levels of reverberation, echoes and inconsistent sound coverage as shown in figure1.

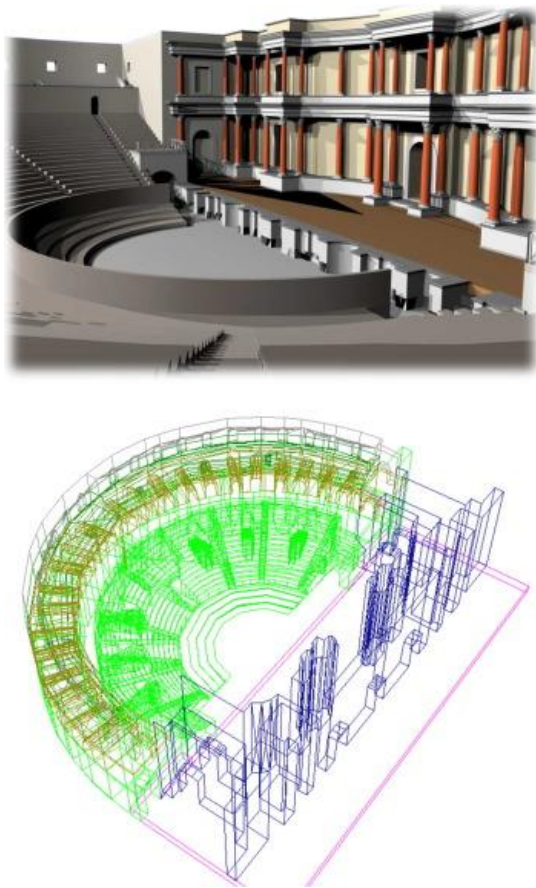


Figure 1 Virtual models created for theatre study

Source: <https://www.sciencedirect.com>

Nonetheless, applying these historical insights to modern open-air theatres presents obstacles. Semi-enclosed or shaded amphitheatres like Bikent Amphitheatre in Turkey, demonstrate that although contemporary tensile and steel designs offer shelter from the elements, they frequently produce high levels of reverberation, echoes and inconsistent sound coverage as shown in figure1.

APBD (Acoustic Performance-Based Design) suggests early addition of acoustics in the design which allows incorporation of acoustics simulation and adjustments in the shape, form, material palette, etc which satisfy the architectural and acoustic requirements.

Challenges

Indoor venues and open amphitheatres have different atmosphere in the surroundings. While the indoor theatres atmosphere can be controlled outdoor open amphitheatre have different challenges. There are factors like wind, temperature fluctuations, humidity and background noises which have to be tackled. These factors are uncontrollable and induce variation. Greek, Roman theatres are often

studied in their present damaged state. (Sara GIRÓN*, 2020) To study these ancient theatres in their original state is difficult as creating their original form is difficult due to the absence of buildings and material been degraded. The simulations done relying on the material used in the amphitheatre and crowd absorption assumptions which may not be same as the historical situations. In modern amphitheatres and odeons, the architectural focus on aesthetic design, openness, and sustainability can clash with acoustic requirements. In case when adding roof membranes or any other reflecting surfaces it creates reverberations and echoes in the space. The acoustic engineers dealing with the materials, theatre form and geometric usually work independently without any collaboration or discussion. This results in last minute haphazard fixes in the design when the expected result is not achieved. A cohesive solution is needed to achieve the aim of acoustic sound amphitheatre when that factors affecting as mentioned earlier are needed to be tackled.

Gap for the research to be addressed:

Lack of acoustic design guidelines tailored to traditional, ritual-based open performance spaces like Theyyam. There is a lack of research on acoustic performance in customary outdoor ceremonial settings like Theyyam, despite a wealth of studies on acoustics in both ancient and contemporary amphitheatres. While Theyyam performances take place in naturally evolved locations affected by cultural practices and natural landscape components, existing literature mostly concentrates on geometrically defined and regulated environments. Performances take place in naturally developed environments like holy groves and temple courtyards, which are formed by ritual activities rather than design principles and lack formal spatial order. Additionally, environmental factors including flora, landform, wind, and humidity—which are frequently considered disruptions in traditional studies—play a crucial part in these environments but have not received enough attention as possible acoustic modifiers. Additionally, there is a dearth of user-centric evaluation because the majority of research focuses on quantitative acoustic characteristics while ignoring the experiential elements of both audiences and performers, such as projection, comfort, and sound clarity. Additionally, in such situations, integrating acoustic performance-based design strategies with environmental elements like flora, landform, and audience dispersal has received little consideration. This emphasizes the necessity of a context-sensitive strategy that improves acoustic quality while maintaining the performance space's cultural and physical authenticity.

Aim: To evaluate and enhance acoustic performance in outdoor amphitheatres for traditional performances like Theyyam.

Objective:

- Analyse sound propagation in open-air theatres
- Study impact of form, material, and landscape
- Develop design guidelines for acoustic optimization

Application:

The study's findings have implications for the domains of cultural preservation, architecture and performance design. First and foremost, by providing ways to improve audience experience, sound clarity, and dispersion without the need for electronic amplification, it may guide the design of outdoor performances spaces. These concepts can be used by architects and designers to build context-sensitive amphitheatres that respond to vegetations climate and natural landforms especially in rural or culturally significant areas. This study can be useful for landscape architecture and site planning. It promotes the idea of integrating acoustics into early design stages.

The findings can also be used to upgrade and adapt existing outdoor theaters that have problems like low audibility, excessive loudness, or uneven sound distribution. In these areas, the study's low-cost, locally adaptive solutions can be put into practice.

REVIEW OF LITERATURE

An approach to the acoustic design of outdoor space

Brown, AL, Muhar, A (2004)

This study focuses on soundscape design also called as acoustic design which is done in the outdoor spaces rather it be in urban or rural spaces. It states that instead of just design the space which is only altered to lessen the noise it should also be intentionally designed along with visual elements which focus on enhancing the audience experience. The author states that there is difference between the traditional noise control and soundscape or acoustic design. The old method focuses on reducing the unwanted sounds in the indoor spaces while the new method of design aims to create acoustically appealing setting in outdoor setting that creates an experience rememberable and enjoyable to the people. The new way has been proposed which promotes the objective of highlighting the richness of sound rather than just the loudness or clarity of the sound. The new way or method is called as "Proposed Acoustic Environment".

The article mentions 5 steps for achieving acoustic design. These 5 steps are the process of how efficiently the space can be acoustically designed. This process includes identifying the activities that take place in spaces and with respect to those activities establishing the acoustic need of each area. This identification helps in segregation the desired and undesired sounds and at what intensity these sounds are affecting the design. After understanding the desired and undesired sounds creating design options that minimize the undesired sounds and enhance the desired sounds into the space.

The paper also mentions the challenges that have to be tackled in distinguishing the different sound sources and identifying the masking effects which result when one sound blocks the other. The author suggests that referring the standards which consider particular acoustic features which are relevant to the space dedicated to a specific use is always preferred rather than relying on broad sound level measurements. The paper discusses about the potential applications of soundscape designing which can be implemented into new spaces to be built or in existing spaces. It also suggests the integration of acoustic design in urban and landscape design processes. The states that by intentionally planning sound as much as the visuals, the outdoor noise should be managed and turned into active soundscape production. The ultimate goal is to transform soundscape planning from a theoretical ideal into a useful design field that managers, planners and architects can use to enhance outdoor spaces with purposeful acoustic design. The transition made from reactive noise suppression to proactive soundscape composition can improve human experience in open areas. By understanding the acoustic design objectives, distinguishing between wanted and unwanted sounds and using appropriate tools a planner can design outdoor space that incorporates nature and cultural context together into that space.

Exploring the acoustics of Ancient Open-Air Theatres

Sara Giron, Angel Alvarez-Corbacho, Teotilo Zamarreno (2020)

This paper highlights the cultural, architectural, and scientific relevance of acoustic properties of ancient Greek and Roman outdoor theatres. These theatres are important aspect of western cultural heritage. The show relationship of structure, performance and sound. As these spaces are excellent examples of acoustic design they are still used no matter even if they are centuries old.

This study has many factors through which the acoustic design of the space can be understood. Research from field measurements, simulations and historical analysis are the factors which help understand the influence it has on the designing of the space. The paper focuses on research projects like ERATO (Identification, Evaluation, And Revival of The Acoustical Theatres and Odea) and ATLAS (Ancient Theatre Lighting and Acoustics Support) which were used to reconstruct and recreate original acoustics of that theatre. Open gathering places on hillside slopes gave way to Greek theatres, which first appeared in the sixth century BC. Their skené, orchestra and semi-circular “koilon” provided even sound dispersal without amplification and outstanding intelligibility.

Studies state that the Epidauraus theatre has tiered seating which works like a natural diffuser and enhances the voice clarity by diffraction and rebounding at frequencies of 500 Hz. This theatre is one of the best examples of acoustic designing in the ancient times. Along with adoption of Greek design concepts, roman theatres developed their own architectural features like velaria also called as awnings, 180-degree seating area, and scaenae frons also called as ornate stage walls. When these concepts were implemented it altered the acoustic behavior by increasing the intensity of the sound and improving the reflections off the stage wall but it sometimes also reduced the clarity of the sound.

Studies carried out on the site like Aspendus, Ostia, Benevento and Pompeii through the use of ODEON and CATT-Acoustic Softwares showed the balanced speech intelligibility and amplification of sound is present in the Roman theatres. Also, the small venues where concert is taken place also called as Odea where very well acoustically sound. The roofs of the theatres helped in enhancing the musical performances by prolonging the reverberation time of 2 seconds which focused on performances over the people’s discussion. Thus, the clarity of sound, projection, and design aesthetics show that the ancient architects applied acoustic design which can still be used in the modern times to study and design the amphitheatres and theatres.

Past challenges in the study of ancient open-air theatre acoustics

Mehmet Çalışkan, Demet İrklı Eryıldız, Zühre Sü Gül

The study of acoustics in open-air performance spaces has its roots in ancient Greek and Roman theatres, which

demonstrate a sophisticated understanding of sound propagation through architectural form and material. Classical amphitheatres, characterized by their semicircular geometry, tiered seating, and reflective stage elements, achieved remarkable speech clarity without electronic amplification. These techniques allow for the evaluation of parameters like sound pressure levels, reverberation, and distribution patterns, although they often face limitations due to environmental variability in outdoor settings.

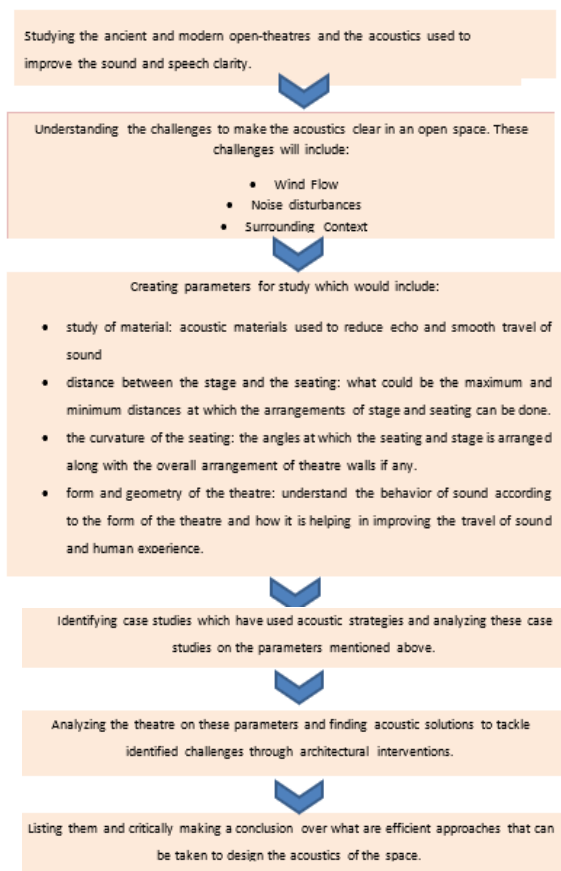
Contemporary amphitheatres attempt to integrate traditional forms with modern materials and structural systems; however, this often leads to acoustic challenges. For instance, studies on semi-enclosed theatres such as the Bilkent Odeon reveal that the introduction of tensile roofs and reflective surfaces can result in excessive reverberation, echoes, and uneven sound distribution.

Unlike enclosed auditoriums, where acoustic conditions can be controlled, open-air theatres are influenced by external factors such as wind, temperature, humidity, and ambient noise, all of which affect sound propagation and clarity. While existing literature provides valuable insights into the acoustic principles governing formal theatre design, it largely focuses on geometrically defined and purpose-built environments. There is limited attention given to informal, culturally embedded performance settings, where spatial organization is not dictated by acoustic considerations.

In this context, traditional performance forms such as Theyyam, conducted in open temple courtyards and sacred groves, remain underexplored in acoustic research. These spaces are shaped by ritual, landscape, and cultural practices rather than formal design principles, resulting in unique acoustic challenges such as uneven sound distribution and varying audience experience. Furthermore, existing studies tend to prioritize quantitative acoustic parameters while overlooking qualitative aspects such as performer-audience interaction and perceptual sound comfort.

The role of natural elements like vegetation and landform is also insufficiently examined, often being treated as external variables rather than integral components of acoustic design. Therefore, while the literature establishes a strong foundation in understanding acoustics in conventional open-air theatres, it reveals a significant gap in addressing context-specific, culturally sensitive, and environmentally integrated acoustic strategies for traditional performance settings like Theyyam.

Method of Analysis:



Sub Titles

Key Recommendations

It is ideal to use APBD focused designs which allow to design theatres according to the surrounding environment rather than retrofitting the theatre after the construction. (Badino, 2020) Merge the approaches while designing, like combining methods like wave-based techniques for in-depth diffraction and scattering analysis and geometrical acoustic frameworks which helps in broad-scale sound diffusion as earlier mentions the challenges like wind, temperature and background noises can be an obstacle, assuming them and including it into the acoustic models can improve the design. Not only design for present situations but also design for unpredictable circumstances and make the theatre adaptable to those circumstances like extreme weather conditions, noises louder than expected, etc. To achieve acoustically sound amphitheatres it is necessary to focus on speech clarity along with the music-oriented performance to engage the audience the make the experience hindrance free. By taking in note all of these considerations a multipurpose amphitheatre can be achieved. Use of reflective surfaces, creating stage canopies which help in directing sound

avoiding echoes can be implemented. The amphitheatre behaves differently when completely empty and when fully occupied. Considering the occupancy of the theatre while designing helps use accurate absorption co-efficient.



Figure 2 Solutions that can be implemented for open amphitheatre

Source: <https://www.slideshare.net/slideshow/open-air-theater/42825964>

Case Study 01: Natarani Theatre, Ahmedabad, Gujarat.

Introduction: An open Amphitheatre rebuild after the Sabarmati riverfront project took over the major chunk of the theatre. The stage is performing space for creative people. The project is revitalization of this space, architecture allowing to restore and function as a theatre.



Figure 3 Natarani Theatre, Ahmedabad, Gujarat.

Source: www.thepierro.com/

Architect: Indigo Architects

Location: Ahmedabad, Gujarat

Area: 2100 Sq.m

Design Philosophy: As the theatre has to be redesigned due a major factor which is the Sabarmati riverfront development project took over the space of Natarani theatre. The design philosophy had an aim to incorporate user comfort by using material palette towards earthy tones, and using passive cooling technology.

Spatial Planning: Since the theatre had to be completely redesign and rebuilt, the planning was to create an envelope which blocks all the noises from the outside of the theatre and improve the experience of the audience. Adding of new facilities, bringing modern technology of lights, sound, projections to improve the experiential quality of the theatre. Along with this to improve the seating area and introducing circular seating making it an efficient seating in the theatre.

Material and technique: Use of earthy materials like bricks, mosaic-china, concrete and timber to improve the quality of theatre.

Acoustic Measures done:

- The plan shows angled and curved walls rather than straight parallel lines. This reduces flutter echoes and standing waves.
- The stage is at the centre of the amphitheatre dividing it into 2 equal halves.
- The metal truss structure above, typically used to support reflectors to send sound back to audience and light fixture which act as minor diffuser.
- Red highlighted wall segments around the perimeter likely represent hard plastered concrete surface which are good in reflecting the sound back to audience.
- The black dots shown in the plan specify lighting and sound placements allow distributed speaker placements, reducing over-amplification and uneven loudness.

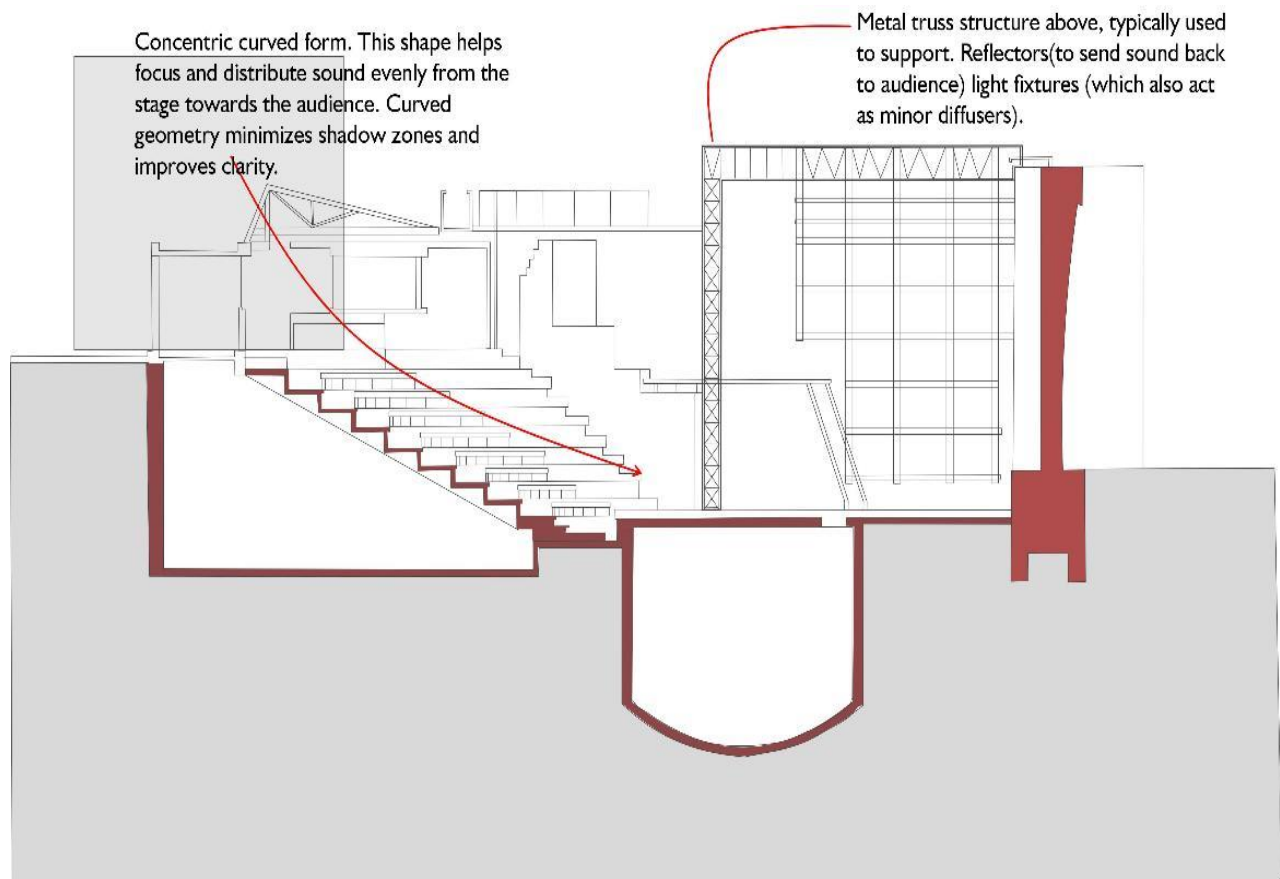


Figure 4 Section of Natarani Theatre, Ahmedabad, Gujarat showing sound travelling in the amphitheatre
Source: Author

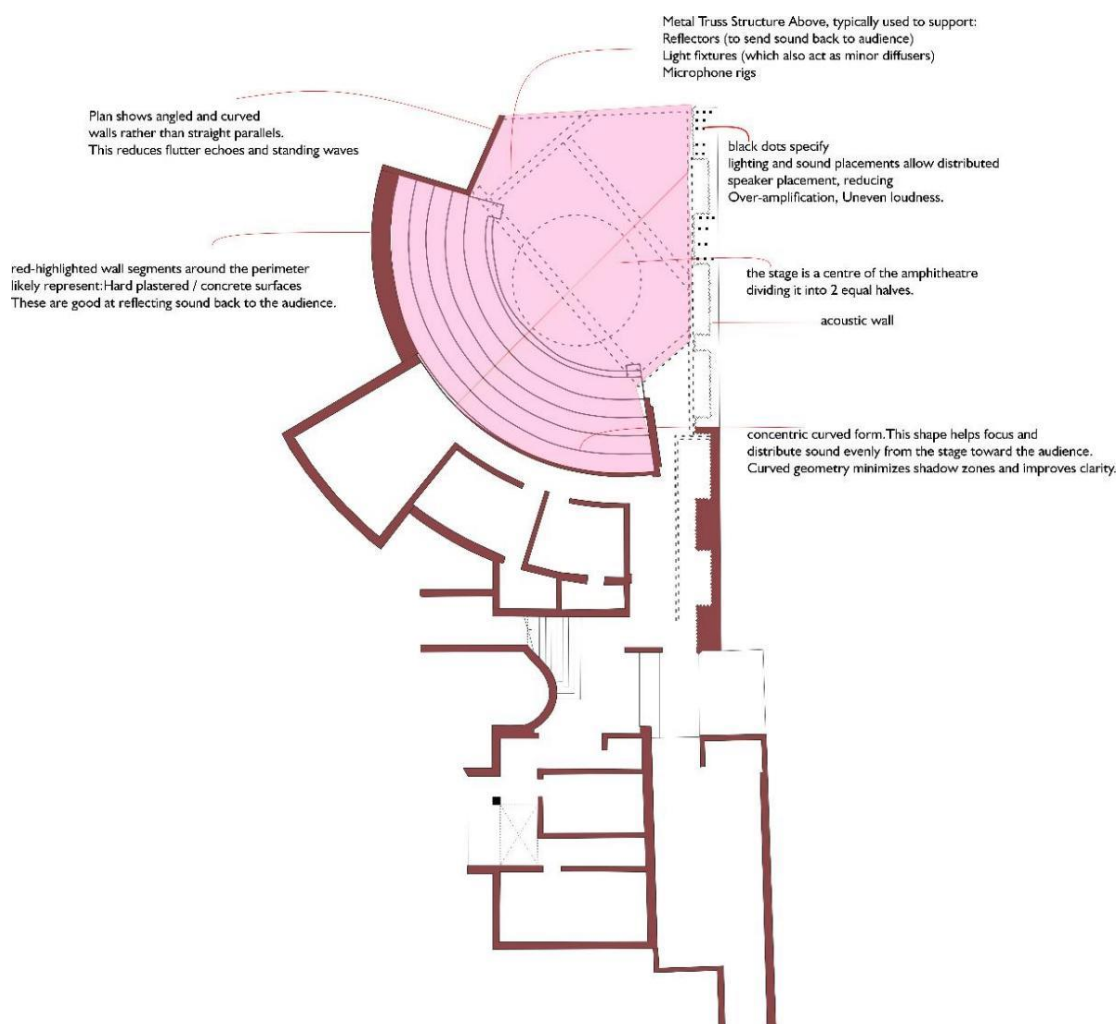


Figure 5 Ground floor Plan showing the acoustics strategies applied

Source: Author

Learning and Inference: The aim of the project was to create an acoustically sound and improve the human comfort of the space. Use of passive strategies like cooling of the space through material use worked out.

Case Study 02: Cloud Tower, Grafenegg, Austria



Figure 6 Ground floor Plan showing the acoustics strategies applied

Source: Author

Introduction: The cloud tower Amphitheatre is an open-air theatre made to conduct concerts and act as a pavilion in the park of Grafenegg.

Architect: The next Enterprise Architects

Location: Grafenegg, Austria **Area:** 651 Sq.m

Design Philosophy: The idea was to create a space in the centre of the park which while just be used as a theatre but a multipurpose space. The aim was to blend landscape and architecture in to the space. The design has integrated a roof form that merges into the space become like a part of the nature depicting like the clouds over the theatre.

Spatial Planning: The space is designed to enhance the volume of the theatre. When the arrives in to the entry, the entrance is a narrow path creating a feeling of being compressed and as they pass through the entry they entry a

huge open space of the theatre. The theatre has used element of the landscape like depression, slope and the hill rock.

Material and technique: In order to make a theatre a part of the landscape the materials used were that complement with the landscape. The monolithic concrete stage creates an emphasis on the openness of the theatre. Steel and glass used make the landscape reflect and create transparency.

Acoustic Measures done:

- The topography plays a major role in the acoustics of the theatre's sound. The topography of the site has been changed such that depressions are created in places and the excavated soil is used in the perimeter of theatre creating a terrain on which the seating tiers are designed.
- This artificially created terrain helps in reflecting the sound in the direction of the audience seating without letting it loose into the space or outside the space.
- The seating is placed in the decibel range as to the sound reaches the audience and it is not out of range.
- The roof design is helping in improving the mutual sound clarity on stage among the artists by creating a convex shaped roof with metal panel suspended.
- The use of materials like metal and concrete help in reflecting the sound as they have the property to acoustically reflect the sound and project it towards the audience.
- The distance between the stage and seating is between 30-40 meters. This is because keeping the seating close to the stage can reduce the loss of sound and can improve the clarity at the same time.

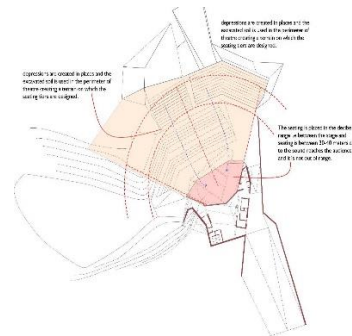


Figure 7 Ground floor Plan showing the acoustics strategies applied

Source: Author

Learning and Inference: Play of topography plays an important role in acoustics improving the sound quality. The material selection and the form of the material contributes to the sound quality and the travel of the sound. As the theatre is in the open space blending of the landscape and the built form through its surrounding context and landscape features makes the built as a part of landscape.

- Marble is used for flooring of the odea's Orchestra as the material has the property to reflect the sound, and improve the projections of sound from the stage.

Learning and Inference:

- The ancient theatre like Odea of Pompeii relied on the covered/ roofed space for better acoustics of sound. Creating an enclosure in the space helps in improving the sound quality within the space.
- The materials selection creates a major impact over the reflections and absorptions of the sound, creating a reasonable reverberation time. It also helps in improving the clarity of sound and speech.
- The form of the theatre played a major role in acoustics rather than just for aesthetic purposes.

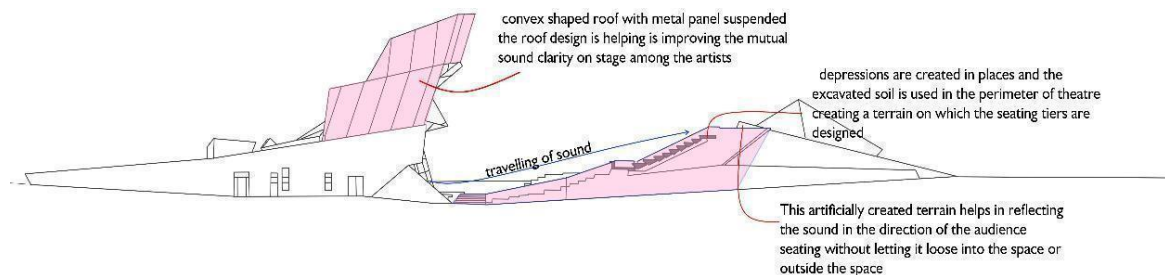


Figure 8 Section showing the acoustics strategies applied

Source: Author



Figure 9 roof of the theatre

Source: divisare.com

Case Study 03: The Odea of Pompeii, Campania, Italy

with the capacity of 1500 occupants which is the best example of use of acoustics.

Introduction: Odea of Pompeii is an ancient theatre built to conduct musical performances and council meetings



Figure 10: The Odea of Pompeii

Source: <https://ancienttheatrearchive.com/>

Case Study 03: The Odea of Pompeii, Campania, Italy

Introduction: Odea of Pompeii is an ancient theatre built to conduct musical performances and council meetings with the capacity of 1500 occupants which is the best example of use of acoustics.

Architect: Caius Quinctius Valgus and Marcus Porcius

Location: Campania, Italy

Area: 1200 Sq.m

Design Philosophy: The idea of designing the odea of Pompeii was to create a small theatre which is acoustically sound and optimized, and can be used to musical performances and meetings. This odea was built besides the large Pompeii Great theatre.

Spatial Planning: Spatially the odea was placed besides the actual large open amphitheatre. It is radially arranged with a focal point at the centre. The seating tiers of the theatre were placed such that each tier represented the social hierarchy of the people present. To ease of the circulation in and around the odea there are exterior staircases and corridors provided to reduce crowding. The symmetrical form of the odea helps in centering the stage creating equal distribution of sound throughout the audience helping to

create undisturbed sound flow. **Material and technique:** Stone masonry which includes limestone for building seating tiers. Wood for structural system of the odea and metal cramps to keep stone blocks in place. Tuff stone for seating area and marble flooring is also used improving the acoustics of the space.

Acoustic Measures done:

- The reverberation time of the Odea is 2.2 seconds which is only achievable if there is a roof intact to the space. This roof is made of wood which allows the sound to reflect into the cavea.
- As the roof is made of wood it also helps in balancing the harsh and excess reflections from the marble flooring and reduce unnecessary reverberations.
- The scenic walls also called as Scaenae Frons is a reflective surface which helps in reflecting the sound to the audience whilst improving the clarity of speech and sound.
- The geometry of Cavea with the semi-circular seating of 21 tiers in a truncated form helps in scattering the sound in the space, minimizing dead zones and allow audience to listen to musical performances without disturbances.
- Tuff stone is used to make the seating which has cavities made behind the seating tiers. This cavity helps in reducing seat-to-seat noise disturbances. As the stone has the roughness which act as natural diffusers of sound.

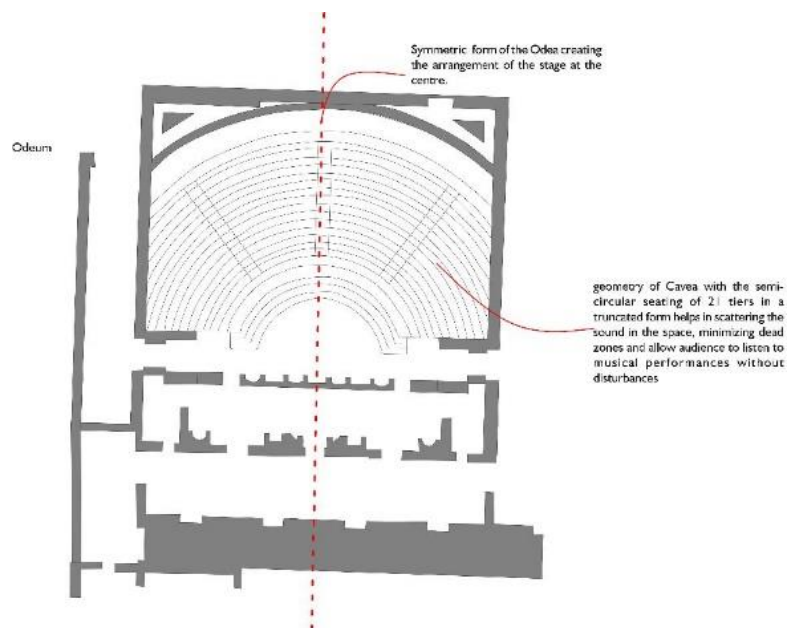


Figure 11 plan of Odea of Pompeii

Source: Author

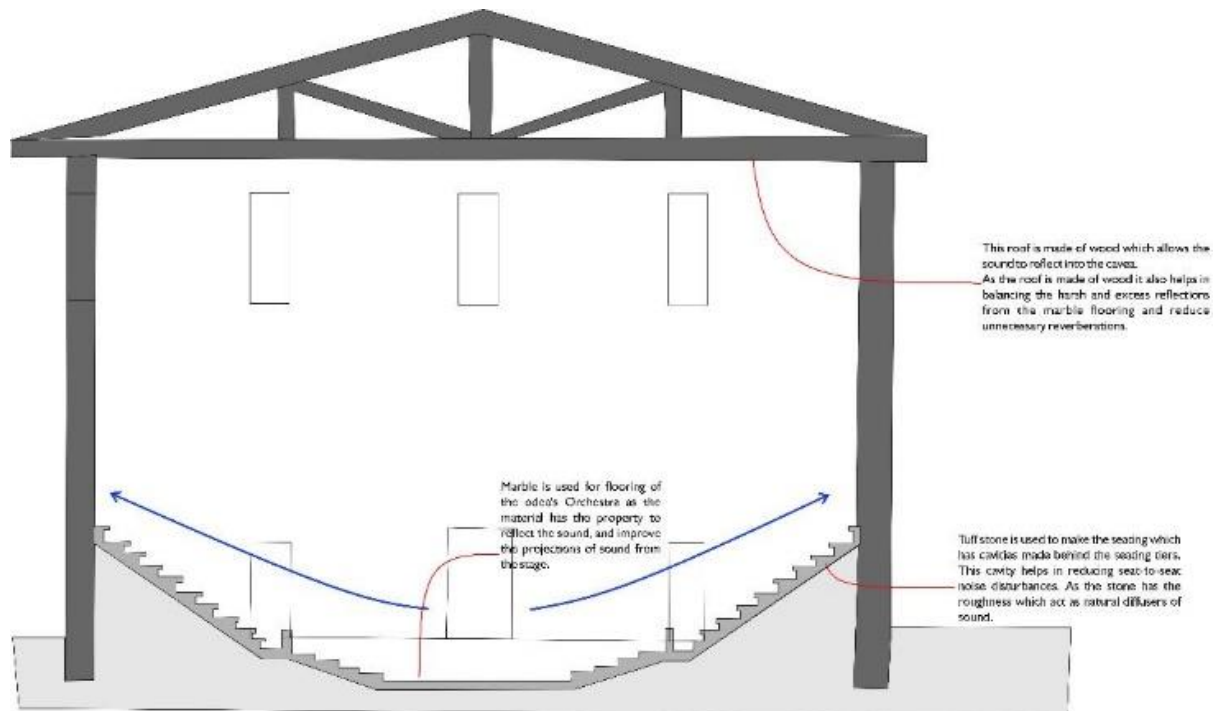


Figure 12 Section

Source: Author

Case Study 04: Bamboo Amphitheatre Space structure, Gavea, Brazil

Area: 200 Sq.m

Introduction: The Bamboo Amphitheatre is a space built for cultural performances, and gatherings. This structure is built as an open structure which is flexible, lightweight and a space which can adapt to spatial needs.



Figure 13 Bamboo Amphitheatre Space

Source: www.archdaily.com

Architect: Bambutec Design

Location: Gavea, Brazil

Design Philosophy: The major aim of the design was to experiment which bamboo as the material which could be used an element of roof in the Amphitheatre showcasing its flexibility, strength, and natural material usage. The space made by natural materials reduces carbon footprint, creates a well ventilated and shaded space.

Spatial Planning: The is planned in a semi-circular layout creating a form with a radial seating. The entry points are given at the perimeter of the theatre to easy out the entrance.

Material and technique: Bamboo is the primary material used in the project.

Acoustic Measures done:

- Bamboo has the natural texture of roughness which helps in reducing the echoes and diffusing the sound.
- As the theatre is open air is allowing the reverberation to controlled on its on by letting the unwanted reverberation to escape the space while

allowing only necessary sound to get directed towards the audience.

- The curved roof of the amphitheatre behaves like a reflector of sound and sends the sound towards the seating.
- The bamboo as a material has the property to absorb frequencies of mid – range whilst improving

the clarity of sound and speech during musical performances.

- As the seating and stage are in radial arrangement it improves the projection of sound without any need of electronic amplification.

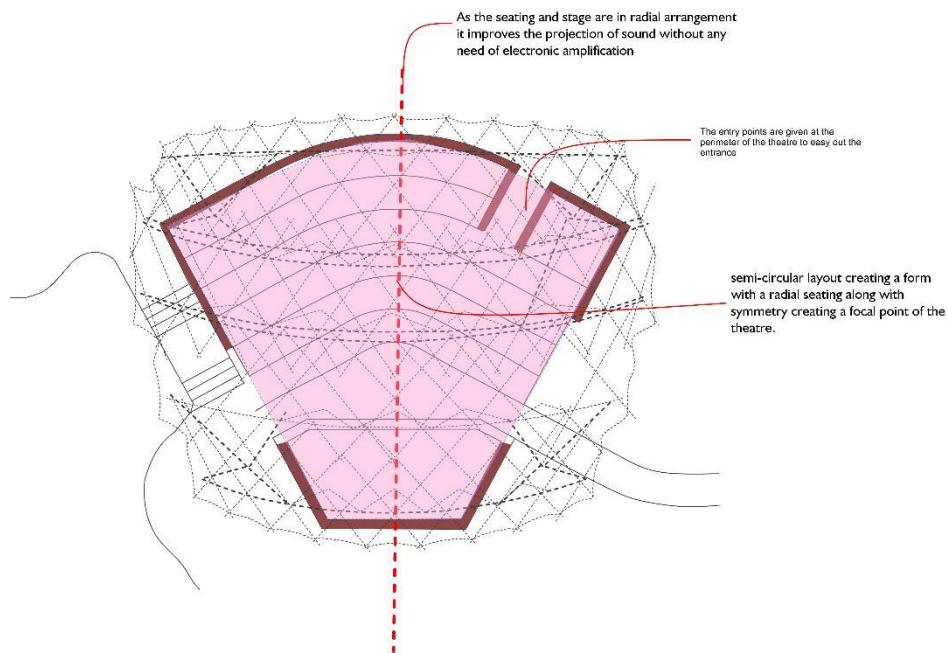


Figure 14 Amphitheatre plan

Source: Author



Figure 15 Interior View of amphitheatre

Source: archdaily.com

Comparison Case Study

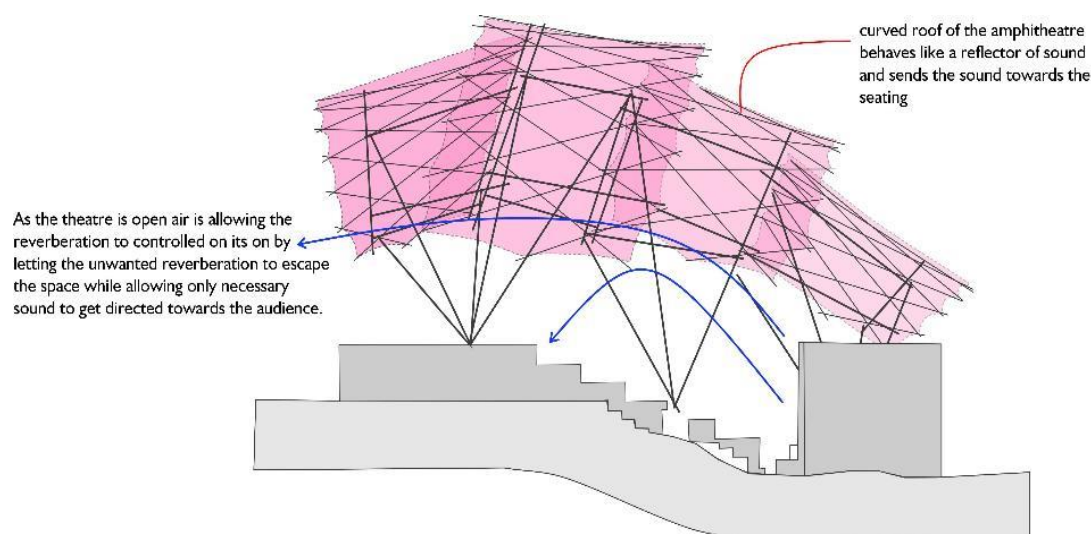


Figure 16 Amphitheatre plan

Source: Author

Table 1: The Existing of Pangium in Yogyakarta

Source: Author

Parameters	Natarani Theatre, Ahmedabad, Gujarat	Cloud Tower, Grafenegg, Austria	Odeon of Pompeii, Campania, Italy	Bamboo Amphitheatre Space Structure, Gávea, Brazil	Remarks
Material	Metal trusses support sound reflectors and lighting fixtures. Concrete surfaces reflect sound toward the audience.	Convex roof with suspended metal panels improves sound clarity among performers. Metal and concrete surfaces reflect sound toward the audience.	Wooden roof reduces excessive reverberation. Marble flooring reflects sound, while rough-textured tuff stone diffuses it.	Bamboo's rough texture helps diffuse sound and reduce echoes. It can absorb some mid-range frequencies, improving speech clarity.	A combination of reflective, absorptive, and diffusive materials improves acoustic performance.
Acoustic Considerations	The central stage divides the amphitheatre into two equal halves. Distributed lighting and sound equipment helps reduce uneven loudness.	Depressions and elevated terrain influence sound reflection and projection. The 30–40 m distance between stage and seating supports sound clarity.	The scaenae frons (scenic wall) acts as a reflective surface, improving sound clarity and projection.	The open-air arrangement allows sound to dissipate. Sloping seating and radial planning direct sound toward the audience.	Odeon of Pompeii: Scenic wall, radial layout, and enclosure support natural sound projection. Cloud Tower: Topography and stage-to-audience distance support projection.
Form and Geometry of the Theatre	Angled and curved walls reduce flutter echoes and standing waves.	The convex roof with suspended metal panels helps improve mutual sound clarity among performers.	Truncated semicircular seating helps distribute sound and limit acoustic dead zones.	The curved roof reflects sound toward the seating area.	Odeon of Pompeii: Semicircular and symmetrical geometry supports sound distribution.
Reverberation Time	N/A	N/A	Approximately 2.2 seconds, as reported	N/A	Odeon of Pompeii: Reported

			for a roofed and sufficiently enclosed space.		reverberation time $\approx$ 2.2 seconds; verification through reliable acoustic measurements is recommended.
Spatial Arrangement	Redesigned to limit external noise and improve the audience experience. Modern lighting, sound, and projection facilities enhance performance quality. Circular seating improves space utilisation.	A narrow entrance opens into a large theatre space. Landscape features, including depressions, slopes, and rocky terrain, contribute to the spatial and acoustic experience.	Located beside the larger amphitheatre, with radial seating around a central focal point. Seating tiers reflected social hierarchy, while exterior staircases and corridors improved circulation. Symmetry supports sound distribution.	Semicircular planning with radial seating and perimeter entrances facilitates audience access and circulation.	Odeon of Pompeii: Radial seating and a central focal point support sound distribution throughout the audience area.

DISCUSSION SECTION

With an emphasis on conventional performance venues like Theyyam, the goal of this study was to assess and improve acoustics performances in outdoor amphitheatres. The study was to demonstrate that an integrated link between form, material, spatial arrangement, and landscape has a significant impact on acoustic quality in outdoor locations through a comparative analysis of historical and modern case studies. The result features like reflective surfaces, controlled stage to audience distances, semicircular geometry and use of topography to enhance the distribution of sound. This study makes a significant addition by emphasizing the significance of context sensitive acoustics design. Therefore, the study promotes adaptive and minimal interventions that improve sound performance without sacrificing cultural authenticity such as making use of existing landforms, incorporating natural materials and adding lightweight reflective elements. Additionally, the study highlights the importance of Acoustic Performance-Based design approach APBD as a proactive strategy, stressing the necessity of integrating acoustic considerations from the outset of design. In conclusion, a comprehensive and multidisciplinary strategy that combines architectural design, cultural sensitivity and environmental responsiveness is needed to achieve optimal acoustics in outdoor performance spaces. By accomplishing this, performance spaces that enhance comfort and audibility while also protecting and enhancing the intangible cultural heritage connected to traditional art forms like theyyam can be created.

LIMITATIONS

The study's quantitative accuracy is diminished by its dependence on case study analysis in the absence of field measurements like wind and noise are not modeled. Additionally, it lacks user-based feedback drawn from a few worldwide instances might not be entirely applicable to Theyyam situations.

CONCLUSION

The study concludes that the combination of form, material and landscape is essential for successful outdoor acoustics. Theyyam venues need context-sensitive, minimal interventions, whereas traditional amphitheatres exhibit these tactics. Sound quality can be improved while maintaining cultural authenticity by utilizing natural features and incorporating acoustic design early on.

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