Spatial Design and Aural Experience in Music Schools in Lagos State

Orimoloye M.T 1, Oluwatayo A.A1.

1Department of Architecture, Covenant University Canaanland, Ota, Ogun State, Nigeria
Corresponding Author: debbyorimoloye@gmail.com.

Abstract- Sound has the ability to affect people psychologically, physiologically, behaviourally and cognitively, either negatively or positively, at all times and in all places. Architecture plays a key role in shaping sound, and in defining a certain soundscape. Architectural discourse is often dominated by visual design while the aural architecture becomes a result of the visual decisions, despite that all five senses are important to the experience of a space. Designing our soundscapes, both inside and out, is essential to creating environments which are conducive to their intended function, and do not negatively affecting inhabitants. The aim of this paper is to investigate the relationship between design strategies commonly adopted in existing music schools in Lagos State and the aural architecture it creates. In order to do this, this study has used existing literature, information from case studies and also data from the users of the existing music schools to identify the current design strategies in the music schools and how they affect the aural experience of the users. Findings show that the design strategies adopted had significant relationships with the aural architecture of the spaces, the most prominent design strategy adopted was the rectangular geometry and very little aural architecture strategies were adopted. With this understanding a tuned aural architecture design is proposed, exploring material and design manipulations, which help to create a more beneficial and enriching environment.

Keywords: Aural Architecture, Perception, Space Design, Sound.

1. Introduction

Sound plays a vital role in our lives, it is responsible for our decisions, experiences and more importantly our memories and architecture plays a major role in helping us experience sounds. However as humans we get accustomed to the sounds around our environment, barely taking notice of the psychological effect of it [1]. The world will be meaningless without sound [2]. As the world today tends to have more visual predilections, architecture has shifted from having sound as a major priority to the design of spaces [3]. Understanding the importance of the psychological impact, the concept of aural architecture, has been advocated to help achieve spaces with significant consideration of sound and its impact. We as human beings are moved more by what we are looking at and we give no thought to the various senses that have contributed to that impression. For instance, when we say of a room that it is cold and formal, we seldom mean that the temperature in it is low. Man ably arises from a natural antipathy to forms and materials found in the room in other words, something we feel.

The study of aural architecture discusses sound as a concept of design and how sound defines a space. It deals with the physical, perceptual and social aspects of sound inside a space. Unlike spatial acoustics which studies the only physical properties of sound, such as the waves (spatial acoustics) and how the sound is transmitted in the space, aural architecture is an interdisciplinary concepts that combines disciplines such as architecture, acoustics, perception and anthropology to provide a way of designing spaces that will match the needs of the inhabitants [4]. Aural architecture has a great sub-concept called auditory spatial awareness that provides a look into the various ways auditory perception can be studied and how it relates to our everyday social and cultural way of life.

There are existing literatures on the aural architecture of religious and musical spaces because sound is ubiquitously expressed in these buildings. For religious spaces there is a need for the sensation of the
'Holy Spirit' [5] and for musical spaces there is a need for the music produced and the space to be intimately fused for positive results [3]. In the study of the aural architecture of a music space, focus is on just implementing spatial acoustics to absorb external noise levels, neglecting the other aspects of aural architecture [4] such as the perceptual and cultural aspects that allows a space to be designed with the proper and preferred acoustics of the space. There are little studies on aural architecture available to researchers and designers when creating a space. It has been established that the interplay between visual and aural architecture can create powerful spatial experiences [6], but there is still no solid connection between the visual and aural realm of architecture because designers do not have substantial knowledge of aural architecture.

It is against this background that this study aimed to assess aural architecture and its relationship with space design with a view to designing a Music Academy for Lagos state. The main objectives were to identify the design strategies adopted in music schools, evaluate the perception of the music school users of the aural experience of the space and to identify the effects of the spatial design strategies on the aural perception of the space. To realize these objectives the study sought to address two research questions. These are:
1. In what ways are spatial design strategies used in music schools?
2. How do users of music schools perceive the aural experience in the space?
3. To what extent do the spatial design strategies adopted in the architecture of Music schools in Nigeria affect the aural experiences in the spaces?

This article reports findings from a research, conducted to investigate the perception of the aural experience of the users of music schools in Lagos State. Three music institutions in Lagos were analyzed based on their design strategies and their aural experience. The study shows the importance of designing with the aural experience at the forefront. Also findings from this study are expected to serve as a form of awareness to researchers and designers in the built environment and general public alike.

2. THEORETICAL FRAMEWORK

2.1. Aural Architecture

Aural architecture is a concept that is as old as civilisation. It adopts a wide range of diversified social and artistic examples in cultures that span a thousand years but due to our current techno-visual age, it has yet to become a major component for designing spaces. According to Blesser and Salter [4] aural architecture is the discipline that combines concepts such as architecture, acoustics, sound and perception to provide new initiatives in space design. The concept deals with the aspect of real spaces that produces emotional and behavioural response in its inhabitants [7]. It draws inspiration from the term acoustic architecture [3]. It is a concept that deals with fusing several surfaces, materials and geometries present in a space that are experienced by listening to create an aural experience [8]. As stated, it draws inspiration from acoustic architecture because of its relationship with sound. Acoustic architecture deals with the study of the physical properties of a space whereas the aural architecture concept deals with the perception of a space. According to Blesser and Salter [4], the aural architecture concept involves the creation of a space that produces strong spatial experiences. We as human beings are aural architects ourselves due to the fact that we find ourselves drawn to places that invoke certain feelings in us [7].

Blesser and Salter [4] introduced this innovative design thinking to allow designers to look beyond the orthodox approaches to designing spaces that are moved by what the eyes can see, basic sound and noise control and employ the inclusion of the auditory [9]. Aural architecture has its physical, perceptual and cultural aspect. With its connection to acoustics it becomes the interaction between physical acoustics, cultural acoustics and perceptual acoustics. The physical acoustics deals with the apparent design strategies taken to design the sound of the space, cultural acoustics encompassing the way
listeners experience the space; it has roots in cultural anthropology. Perceptual acoustics relates to the perceptive psychology of sound that deals with subjective measurements [5]. Aural architecture has the ability to be social and cultural markers, defining a space to be either public or private. Aural architecture and music are locked together in a tight embrace because one is dependent on the other.

2.2. Auditory Spatial Awareness
Spatiality is a term used in aural architecture is used to describe the different experiences of a person in a space [4]. Each sound source and spatial acoustic properties possess an aural stimulus with social, cultural and personal meaning and listeners in a space react to these stimulus [10], exploring these meanings help create the foundation of aural architecture. Auditory spatial awareness is a prism that reveals all these attributes [11]. Aural architecture is an amalgamation of spatial attributes, auditory perception and cultural values.

1. Spatial attributes: this involves the design strategies taken to design the space and how that affects the users.
2. Auditory perception: this is an involuntary human action and although neglected it has great psychological effects on humans, it is how the human mind interprets sounds produced in the space.
3. Cultural values: this is the way of life of the building users, which should be taken into consideration when designing a space.

2.3. Components of Architecture
1. Social spatiality: Social behaviour can be greatly influenced by aural architecture. Spaces have the ability to emphasize aural privacy, strengthen social cohesion or cause isolation. [12], the social context of space can be denoted by the aural enclosure. When discussing the social component of aural architecture we must refer to its basic spatial attributes such as the boundaries and size of the space. Showing how the volume of a space cannot only be perceived visually but also aurally. To fully understand spatial boundaries a space must be seen as an experiential concept that consists of virtual boundaries and these virtual boundaries leads to the birth of an abstraction known as acoustic horizon which explains the aural boundary of a space; it denotes the distance between a listener and sound source. Beyond the horizon it’s impossible to hear any sound produced. Another social component of aural architecture as shown in Fig 1 below is the acoustic arena which is the inverse of the acoustic arena where the sound source is the centre and listeners or in or out of the sonic event [10]. The acoustic arena and horizon are greatly influenced by the spatial properties and background noise.

2. Navigational spatiality: Blesser and Salter [11] noted that one has the ability to experience a space just by listening; navigating a room in the dark is possible. Every space possesses aural cues whether designed to or accidentally, these cues help to build the perception of the space. Navigational spatiality involves those aural cues that can help a listener navigate a room without vision because every surface in a room has acoustic cues.

3. Musical spatiality: This component of aural architecture is related to an integral part of music performance, exploring the acoustics of a music space and its fusion with the voices and instruments.
to make the whole space a meta-instrument. It has the ability to enhance the music and voice in a space, by carefully selecting the proper physical acoustics and merging it with sound sources [10].

4. Aesthetic spatiality: Aural architecture can influence emotions and how a listener feels in a space and it can also change the visual perception of a space. This component describes rich acoustical qualities of a space that provide auditory texture to a space [10]. A space can have rich textures that can affect the aural perception of the space through aural embellishments.

2.4. Enhancing Aural Architecture through design

The sonic character of a space is as a result of the spatial characteristics, geometry, shape volume and materials all contribute to how a space is experienced aurally, there is great need for sound to be considered at the inception. Legen [13] states that although our perception of architecture is much richer in itself and deal very much with the aural environment; we do not use it as a method of analysing or designing. The principles of aural architecture believe that the physical articulation of space and the materiality of the form influence the aural behaviour of the space [14]. Geometry, materiality and spatial volume combine to create unique acoustic signatures that enable particular aural experiences.

2.5. Geometry

Architecture is a discipline that has strong ties to the principles of geometric organisation because of its need for efficiency and order, and the desire to create aesthetically pleasing structures, beauty in architecture is when it is aware of the value-in-use and the aesthetics inside the design is on a spiritual level. Geometry in architecture is the shape of the building, the shape of the drawings of the buildings [15]. In the design approach geometry principles include explicit compositions of forms in terms of square, rectangle, circle and triangle. Walls in design are very important elements that present the entire form of a building; they are key elements that produce reflections and illumination to a space.

2.6. Geometry and Sound

As shown in Table 1 sound has different characteristics and reactions with different shapes.

| Wall shape       | Design consideration                          | Potential problems          | Solutions                                      |
|------------------|-----------------------------------------------|------------------------------|-----------------------------------------------|
| Flat             | Reflective surfaces can cause acoustic anomalies | Echoes, uneven sound spreading | Angle walls to direct sound to audience; use absorptive or diffuse materials on walls |
| Parallel flat walls | Reflective surfaces can cause acoustic anomalies | Echoes, flutter echoes, standing waves | Avoid parallel reflective wall or treat one wall with absorptive material. |
| Concave          | Minimise reflective domes and other concave reflective Surfaces. | Hot and dead spot.          | Either eliminate dome and concave surfaces, use absorptive spray on material, or cover absorptive material with concave, acoustically transparent material. |
| Convex or uneven | Allow for even spreading of sound (diffusion) | Excessive reverberation      | Add absorption to room surfaces. |

Source: [16]

2.7. Volume

When it comes to sound design, there are two issues concerning a space. We have pressure and reflections. Treating these two variables would require treating with sound absorption and diffusion by adding more surface areas to the space which will make the room seem smaller and also if not treated, the low frequency issues from the pressure will also make the room smaller [18].
The three dimensional feeling in an aural space is related to the loudness and intensity. Volume can be manipulated in design with the sound intensity and material of the space. A physical space that has highly reflective surfaces will create a significantly large acoustic space and it still could be achieved with the height, length and width of the room. Several researches have been done on different volumes and how they affect the sound propagation in the room.

2.8. Materiality

The materials used in buildings serve as a function of the availability and always almost the suitability of materials, as well as various cultural norms and traditions. Materials make up the structure of the building. What materials are chosen by designers will affect the sound within the building. After the completion of designs, acousticians are often called in to fix the design and this may be problematic in two important ways. First is that we lose the ability to shape the dimensions of the rooms, secondly little or no consideration is given to the acoustic properties of the materials that originally make up the structure.

a) Masonry materials: these are great for sound isolation because they are quite thick in size. Its rigidity and mass are able to stop sound waves from passing through. Floors and walls are locations where masonry materials can be applied. Stone, brick and concrete are all examples of masonry materials that can be utilised. These materials are mostly used to depict formal settings as they are hard materials [19].

b) Wood and wood products: wood is less dense and provides way less sound isolation. Wood products such as MDF weigh more in mass and can be used as interior walls. Plywood is also a wood product that can be used as interior walls. The beauty of wood is its ability to reflect, absorb and resonate sound. It is also permeable, letting some of the sound energy pass on to the other side. A lot of researches show that wood gives off a warm, clean and expensive feeling [19].

c) Steel: this material engages in structure-borne sound transfer where sound is transferred through some material. Steel transmits less structure borne vibrations than wood [19]. It can be classified as a hard material, as so it will produce high frequencies [10].

d) Glass: glass is massive in nature and known to be reflective in nature. Recent inventions showcase a new type of glass that will offer very good transparency while effectively absorbing sound to reduce reflectivity [19].

e) Insulating materials: materials such as fiberglass, foam, rock wool, and these materials have little mass so they have no need for isolation. Although fiberglass gains higher sound absorption property, they have the ability to absorb sound by reducing the velocity of particles that carry sound waves in the air. They are laced in the boundaries of the walls and care must be taken when placing them [19].

f) Acoustic panels: Acoustic panels are sound control panels that are hung on a wall or ceiling to control and reduce noise, eliminate slap echo, diffuse and control sound in a room. The objective is to reduce, but not entirely eliminate, resonance within the room. Acoustic panels deal more with the mid- and high-frequencies in a room. Sound absorption is different from soundproofing, which is typically used to keep sound from escaping a room [19].

The materiality of a space is a major driver in affecting the aural experience of a space. Softer, more porous and dense materials such as carpet, heavy materials have greater absorptive qualities. Hard materials such as glass, tiles and steel are known to produce high frequencies [10]. Therefore they are usually more reflective [8]. Materials are perceived also with the use of timbre, which is a psychoacoustic quality, just as we can visually tell the difference in colour we can also tell the difference in the tone colour of materials [20]. A space with wood panels will be described as warm in contrast to a space with steel columns and tile floors because wood and soft fabrics are generally associated with warmth [8].

Sound absorption has the ability to expand a space; room with complete sound absorption will simulate a virtual window creating an infinite and unbounded space, a space that will not respond to sonic illumination [10]. To achieve good listening conditions, it is appropriate to include sound diffusion and reflections, so as to create versatility [21].

2.9. Aural Connectivity
Thresholds help to define the different soundscapes of a place. They can help alter the aural experience of a space as they are the aural connection of spaces. Aural connectivity can be defined as the overall pattern in which users can hear and react to different key sounds, a threshold that occurs in two spaces that differ aurally [8]. A great example will be the Chinese garden Yi Yuan. The soundscapes differs at every level of the garden due to the style of ancient Chinese architects to avoid leading visitors to approach the most attractive space or scene directly [12]. Through soundscape mapping and analysis, the design connects and disconnects between the auditory and visual zones [9], the use of gravel paths to help the visitor more aware of his presence was utilised, and the designers also created different shapes of the paths to help slow movement so as to appreciate elements. Each element was carefully designed to create a great interplay between the aural and visual experience [9]. Thresholds also give rhythm to a design. They help to address scenarios like tall, short, cold, dead and live spaces. The transition between spaces creates a sense of rhythm to the design [22].

3. METHODOLOGY
As stated earlier, the main objectives of the study were to identify the design strategies adopted in music schools, evaluate the perception of the music school users of the aural experience of the space and to identify the effects of the spatial design strategies on the aural perception of the space. To achieve this goal, the study employed qualitative and quantitative research approaches with the use of case study and structured questionnaires. The surveys were conducted between December 2018 and February 2019. For the case study, the study population is made up of the existing music institutions in Lagos. The sample frame, however, is made up of certain music institutions in Lagos Nigeria; the purposive sampling method was adopted to select the respondents to fill the administered questionnaires.

The data described and analyzed in this study were obtained by carrying out a thorough assessment of the music institutions, using a carefully constructed observation guide. Music institutions sampled include: MUSON School of Music, Tenstrings Music Institutions and Masha Music Academy. Two instruments of data collection were employed by the researcher to help gather data. The first was the observation guide. This instrument was used to record observations made with respect to the physical characteristics of the research institutes sampled, and it was designed to examine the institutional buildings based on the subject of study and its parameters. The questionnaire was divided into 3 sections; A, B and C. Section A addressed the bio-data of the respondents, Section B addresses the aural architecture characteristics of the space while Section C focuses on the design strategies adopted in the space as seen by the users of the space.

4. RESULTS, ANALYSIS AND DISCUSSIONS
The questionnaires were administered to 3 institutions: MUSON School of Music, Tenstrings Music Academy and Masha Music Academy required the respondents to provide information of their bio-data information, the design strategies adopted and their perception based on the aural component of the space.

4.1. Design strategies adopted
The questionnaires required the respondents to indicate the design strategy that has been adopted in their institution. They were given a total of 12 design strategies, the design strategies have been summarised in the Table 2 below also showing the most adopted strategy in the music institutions.

| Design strategy                                | N   | Mean  | Std. Deviation | Rank |
|-----------------------------------------------|-----|-------|----------------|------|
| Rectangular Shape                             | 103 | 4.0874| .44517         | 1    |
| Large Rooms                                   | 103 | 3.6408| .85008         | 2    |
| Narrow Rooms                                  | 103 | 3.4563| 1.03637        | 3    |
| Angled Walls                                  | 103 | 2.2427| 1.24826        | 4    |
| Connected Rooms With Large Openings           | 103 | 1.8738| 1.23415        | 5    |
Inclined Ceilings 103 1.3495 .83676 6
Convex Ceilings 103 1.2039 .63182 7
Shoebox Shape 103 1.1942 .52503 8
Round Shape 103 1.1748 .56754 9
Horseshoe Shape 103 1.1553 .53792 10
Rooms with Mezzanine Floors 103 1.1165 .47073 11
Fan Shape 103 1.0583 .33797 12

### 4.2. Perception of aural experience in the space

As part of the objectives of this study, the perception of the aural experience by the users should be evaluated to help a relationship with the adopted design strategies. The section B of the questionnaires included questions on the perception of the space based on the components of aural architecture which are: social spatiality, navigational spatiality, musical spatiality and aesthetic spatiality, Table 3 shows the summarised results.

| Aural Characteristics | N  | Mean Score | Rank |
|-----------------------|----|------------|------|
| there is proper interaction between the lecturer and students | 103 | 4.16 | 1 |
| the distance between the lecturer and the student is adequate | 103 | 4.03 | 2 |
| the room helps me to recreate the sound i visualize | 103 | 3.81 | 3 |
| one cannot but have an encounter with others within this space | 103 | 3.70 | 4 |
| i am very influenced by the acoustics of the room when i sing/play my instruments | 103 | 3.58 | 5 |
| the room enhances my instrument's timbre/voice | 103 | 3.56 | 6 |
| when i sing or play the instrument my view of the space changes in a positive way | 103 | 3.40 | 7 |
| i can move from space to space by listening | 103 | 3.24 | 8 |
| the acoustics of the space has a rich texture | 103 | 3.24 | 9 |
| it is possible for me to navigate through spaces in the dark | 103 | 3.15 | 10 |
| the space feels very private | 103 | 3.11 | 11 |
| the room changes my instrument/voice negatively | 103 | 2.26 | 12 |

### 4.3. Dimensions of Perception of the Aural characteristics

The study also investigated the dimensions of the users’ perception of the aural characteristics of the space in the music schools using exploratory factor analysis. Table 4. below shows the result of the exploratory factor analysis performed on the 12 aural attributes of the music space used to investigate the perception of the students in the music schools sampled. It can be seen that the result in Table 5 that the attributes used to investigate the respondents’ perception were viewed from five main dimensions (factors) and that the total variance explained across all 12 attributes is around 72.406%.

The exploratory factor analysis results have broken down the 12 variables into five components. The first components are the perceived materiality of the space which is accounting for around 23% of the variance across the 12 variables. The second component is the perceived aural illusion of the space which is accounting for about 15% of the variance across the 12 variables loaded. The third dimension is the perceived sound intimacy of the space which is accounting for about 14% of the variance across the 12 variables loaded. The remaining two components are the perceived ease of navigation and the perceived auditory quality of the space which are accounting for 12% and 9% of the variance across the 12 variables investigated respectively.
### Table 4: The factor analysis results showing the aural characteristics of the space

| Factor                        | Variables                                                                 | Factor loadings | Percentage of variance | Percentage cumulative |
|-------------------------------|---------------------------------------------------------------------------|-----------------|------------------------|-----------------------|
| Factor 1: Materiality of the space | It is possible for me to navigate through spaces in the dark the room enhances my instrument's timbre/voice | .911            | 22.839                 | 22.839                |
|                               |                                                                            |                 |                        |                       |
| Factor 2: Aural Illusion of the space | When i sing or play the instrument my view of the space changes in a positive way the acoustics of the space has a rich texture | .907            | 15.052                 | 37.891                |
|                               |                                                                            |                 |                        |                       |
| Factor 3: Sound Intimacy of Space | The distance between the lecturer and the student is adequate The room helps me to recreate the sound i visualize The space feels very private | .753            | 14.028                 | 51.919                |
|                               |                                                                            |                 |                        |                       |
| Factor 4: Ease of Navigation | I can move from space to space by listening One cannot but have an encounter with others within this space | .814            | 11.801                 | 63.720                |
|                               |                                                                            |                 |                        |                       |
| Factor 5: Auditory quality of the space | There is proper interaction between the lecturer and students The room changes my instrument/voice negatively I am very influenced by the acoustics of the room when i sing/play my instruments | .695            | 8.686                  | 72.406                |

4.4. Relationship between the Perception of the Aural Experience and the Design Strategies

This section of the results studied the relationship between the perception of the aural characteristics and the design strategies adopted which is related to Objective 3: To what extent do the spatial design strategies adopted in the architecture of music schools in Nigeria affect the aural experiences in the space. Five regression analyses were carried out. The dependent variables were the factors identified from the exploratory factor analysis and the independent variables were the spatial design strategies. There were significant relationships in all the five regression analyses. The first regression analysis investigated the influence of the spatial design strategies on the first factor which is the materiality of
the space. The regression analysis was significant ($F=9.976, P=0.000, R^2=0.632$), this implies that the significant variables accounted for 63.2% of the variance in materiality of the space. The specific variables that were significant as shown in Table 5 are rectangular shaped space ($\beta=0.547, p (0.000)$), narrow rooms ($\beta=-0.278, p=0.019$), large rooms ($\beta=-0.330, p=0.003$), connected rooms with large openings ($\beta=-0.519, p=0.000$) and the convex ceilings ($\beta=0.333, p=0.014$). The result presented in Figures 2 shows that the use of rectangular shapes used in all of the spaces positively influenced the materiality of the space. Figure 3 shows that the materiality of the space was also positively influenced by the use of narrow rooms in just one space. Figure 4 shows the use of large rooms in all of the spaces positively influenced the materiality of the space and Figure 5 shows the use of convex ceiling design in some of the spaces positively influenced the materiality of the space.

Figure 2: Relationship with rectangular shape  
Figure 3: Relationship with narrow rooms

Figure 4: Relationship with large rooms  
Figure 5: Relationship with convex ceiling

The second regression analysis was in relationship with the second component which is the aural illusion of the space; ($F=4.079, P=0.000, R^2=0.449$), this implies that the significant variables accounted for 44.9% of the variance in the aural illusion of the space. The specific variables that were significant as shown in Table 5 are round shaped space ($\beta=0.407, p (0.000)$), the inclined ceilings ($\beta=0.411, p=0.043$). Aural illusion of a space is in close relationship with the aesthetic spatiality component in aural architecture, this component shows how design strategies can affect the aural perspective of a space. The results shown in Figure 6 reveals respondents recorded higher level or aural illusion when they could not tell if round shape was used. It is however noteworthy that the aural illusion where round shape was categorically not used was low and Figure 7 shows that the inclined ceiling used in some of the spaces positively influenced the aural illusion of the space.
The third regression analysis was in relationship with the third component which was the sound intimacy; \( F=6.287, P=.000, R^2=0.590 \), this implies that the significant variables accounted for 59% of the variance in of the space. The specific variables that were significant as shown in Table 5 are rectangular shaped space (Beta=0.627, p =0.000), narrow rooms (Beta= -0.439, p=0.001), large rooms (Beta=-0.545, p=0.000), the Horseshoe plan (Beta= -1.094, p= 0.04) and rooms with mezzanine floors (Beta = 1.443, p= 0.033). Sound intimacy of a space is connected to the musical spatiality of aural architecture and it is very imperative to a music practice room. The results in Figure 8 showed that the use of rectangular shape in some spaces positively influenced the sound intimacy of the space. Figure 9 showed that shows that spaces with no horseshoe shape had higher sound intimacy. Figure 10 showed that the use of narrow rooms in some spaces positively influenced the sound intimacy of the space and Figure 11 showed that the use of large rooms in some spaces positively influenced the sound intimacy of the space and Figure 12 shows that spaces with no room with mezzanine floors had higher sound intimacy.

Figure 6: Relationship with round shape    Figure 7: Relationship with inclined ceilings

Figure 8: Relationship with rectangular shape    Figure 9: Relationship with horseshoe shape
The fourth regression analysis was in relationship with the ease of navigation, \((F=11.191, P=.000, R^2=0.676)\), this implies that the significant variables accounted for 67.6% of the variance in of the space. The specific variables that were significant as shown in table 5 is the connected rooms with large openings \((\text{Beta}=0.635, p=0.000)\). Ease of navigation is related to the navigational spatiality of aural architecture. The result shown in Figure 13 reveals that the use of connected rooms with openings in some spaces positively influenced the ease of navigation in the building.
The final regression analysis is in relationship with the fifth component which is the auditory quality of the space; the regression analysis was significant ($F=50.116$, $P=0.000$, $R^2=0.909$), this implies that the significant variables accounted for 90.9% of the variance in auditory quality of the space. The specific variables that were significant as shown in Table 5 are the inclined ceilings ($\text{Beta}=1.831$, $P=0.024$), and rooms with mezzanine floors ($\text{Beta}=-1.443$, $P=0.033$). The results shown in Figures 14 reveal that the use of inclined ceilings in some of the spaces positively influenced the auditory quality of the space and Figure 15 reveals respondents recorded higher level or auditory quality when they could not tell if mezzanine floors were used. It is however noteworthy that the auditory quality where mezzanine floors were categorically no used was low.

### Table 5: Regression analysis for the components and the design strategies

| S/N | Design strategies | Materiality | Aural illusion | Sound Intimacy | Ease of Navigation | Auditory quality |
|-----|------------------|-------------|----------------|----------------|--------------------|------------------|
| 1.  | Rectangular shape | 0.547 (p=0.000)* | -0.255 (p=0.98) | -0.627 (p=0.000)* | -0.179 (p=0.235) | 0.44 (p=0.833) |
| 2.  | Shoebox shape    | -0.157 (p=0.224) | -0.45 (p=0.918) | 0.051 (p=0.921) | 0.345 (p=0.454) | -0.623 (p=0.375) |
| 3.  | Horseshoe shape  | 0.401 (p=0.82) | 0.045 (p=0.823) | -1.994 (p=0.177) | -0.177 (p=0.740) | -0.553 (p=0.463) |
| 4.  | Fan shape        | -0.702 (p=0.19) | -0.199 (p=0.417) | -0.041 (p=0.861) | 0.769 (p=0.011) | -0.393 (p=0.288) |
| 5.  | Narrow rooms     | -0.278 (p=0.019)* | -0.083 (p=0.417) | 0.439 (p=0.001)* | 0.183 (p=0.156) | 0.028 (p=0.722) |
| 6.  | Round shape      | 0.051 (p=0.604) | 0.407 (p=0.000)* | 0.598 (p=0.686) | 0.083 (p=0.686) | 0.308 (p=0.308) |
| 7.  | Angled walls     | -0.144 (p=0.456) | 0.201 (p=0.329) | -0.122 (p=0.660) | 0.252 (p=0.245) | -0.119 (p=0.217) |
| 8.  | Large rooms      | -0.330 (p=0.000)* | 0.142 (p=0.695) | 0.545 (p=0.000)* | 0.161 (p=0.649) | -0.18 (p=0.948) |
| 9.  | Inclined ceilings| 0.056 (p=0.729) | 0.411 (p=0.043)* | 0.725 (p=0.17) | -0.459 (p=0.303) | 1.831 (p=0.024)* |
| 10. | Connected rooms  | -0.519 (p=0.000)* | -0.241 (p=0.339) | -0.175 (p=0.291) | 0.635 (p=0.000)* | 0.161 (p=0.208) |
11. convex ceilings 0.333 (p=0.014)* 0.075 (p=0.858) 0.014 (p=0.921) -0.556 (p=0.074) -0.46 (p=0.818)
   12. rooms with mezzanine floors -0.216 (p=0.298) 0.196 (p=0.608) -0.986 (p=0.01)* 0.505 (p=0.241) -1.443 (p=0.033)*

5. CONCLUSION
The findings suggest that the design strategy most adopted was the rectangular shape, followed by narrow rooms then large rooms. These strategies have great significance to the other design strategies that have been linked to some aural architecture characteristics such as experiencing the materiality of a space and the sound intimacy of the space, there are limited design strategies adopted in the music institutions.

6. RECOMMENDATION
Music institutions require great need of auditory quality and the research shows that design strategies such as inclined ceilings are able to provide such aural characteristics to a space; design strategies that help produce great aural characteristics that will be appropriate for the space should be included in the design process.

ACKNOWLEDGEMENTS
Research is supported by the Department of Architecture, Covenant University. The author will like to acknowledge the support and mentorship of her supervisor Dr A.A. Oluwatayo for her substantial contributions to this research work.

REFERENCES
[1] Wolfe, J. (2015). Out of the auditory: Investigating the language and practice of aural architecture. England: Griffith University.
[2] Dobos, C. (2010). Sound and Space. Acoustics Today, 394(6), 45-63.
[3] Pendley, J. (2009). Visualising sound: A musical composition of aural architecture. Florida: University of south Florida.
[4] Blesser B and Salter L. (2008). Aural Architecture: The Missing Link. Belmont: Blesser Associates, England: The MIT press.
[5] Algargoo, A. (2016). Review of aspects that shape the aural experience in. In U. o. Michigan (Ed.), Acoustics of Worship Spaces. Paper ICA2016-591 (pp. 1-10). Michigan: Buenos Aires.
[6] Kostanjšak, A. and Pap, M. (2011). Interplay or Music and Architecture: Layering of Sound and Space. University of Zagreb, 31(5), 1-8.
[7] Blesser B and Salter L. (2006). Spaces speak, are you listening: Experiencing Aural Architecture. Massachusetts, England: The MIT press.
[8] Brett, E. R. (2015). Binaural Architecture (sonic compositions of everyday spaces). Ottawa, Ontario: Carleton University.
[9] Fowler, M. (2013). Sound, Aurality and Critical Listening: Disruptions at the Boundaries of Architecture. Architecture and Culture, 1(1)159-178.
[10] Blesser, B., and Salter, L. (2007). Aural Architecture : The Invisible Experience of Space. In B. Blesser, and L.-R. Salter, Spaces Speak Are You Listening? (pp. 50-60). England: The MIT Press.
[11] Blesser B and Salter L.-R. (2007). Aural Architecture. Research Design Connections Articles, 32(1), 23-45.
[12] Mourad H.S, Shafik Z, Noaman M, Kandi A. (2009). The Lack of Interest to Enrich the Hearing Experience in Architecture. Cairo, Egypt: Cairo University.
[13] Legen, T. S. (2003). Hearing Architecture: Exploring and Designing the Aural Environment. Journal of Architectural Education, 57(2), 37-44.
[14] LaBelle, B. (2012). Acoustic Spatiality. Slovakia: Universitas Studiorum Jadektina. Journal 18:129-142 DOI 10.1007/s10984-015-9172-7.
[15] Leopold, C. (2006). Geometry Concepts in Architectural Design. 12th International Conference on Geometry and Graphics (pp. 6-10). Salvador, Brazil: University of Kaiserslautern, Germany.
[16] Ediae O.J., Enoma E.P., Igbogbo O.S., Ezema I. C. & Ekhaese E.N.(2017) A Study of the Effects of Architectural Forms on Sound Quality in Church Buildings Nigerian Journal of Environmental Sciences and Technology (NIJEST) Vol 1, No. 1 March 2017, pp 43 – 54
[17] Bakarat, M. (2016). Acoustic arenas and the spatial Formation of Aural Spaces. Retrieved February 5, 2018, from Bakarat : https://www.meratebarakat.com/research-blog/2016/4/8/acoustic-arenas-and-the-spatial-formation-of-aural-spaces.
[18] Foley, D. (2015). Room Size and Volume. Retrieved February 14, 2018, from Acoustic Fields: https://www.acousticfields.com/room-size-volume/

[19] Lachot, W. (2007). Materials and their uses in Architectural Acoustics. Retrieved March 14, 2019, from Wes Lachot Design: http://weslachot.com/new/articles_materials.html

[20] Wang K. (2003). The Aesthetic Principles of Soundscape in Architectural Design and Built Environment. Texas: Texas A and M University.

[21] Kleiner Ml, Titchy.J. (2014). Acoustics of Small Rooms. New, York: CRC Press, Taylor and Francis Group.

[22] Oluwatayo A. A., Aderonmu P. A. and Adowo E. B. (2015) Architecture Students’ Perception of their Learning Environment and their Academic Performances. Learning Environment Research Journal 18:129-142 DOI 10.1007/s10984-015-9172-7