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The Re-Evaluation of Function Hall Acoustic Phonetic Condition

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Abstract:

Phonology is an interdisciplinary science that studies all the mechanical waves in gases, liquids and solids, including vibrations, ultrasound, sound and infrasound. The study of acoustic function is essential nowadays. In conditions of artificial civilization development, complementary electronic ornaments are still very dependent on the level of success with the form of structure and composition of space itself. The problem arises when an adjustment on one side, meant for improvement, shifts the ideal coordinates on the other. For this reason, a comprehensive adjustment and correction idea had to emerge as a solution, with acoustic studies as a starting point. This study tries to describe the ideal pattern design based on investigations and observations of the actual conditions of the Function hall of Building X and tries to determine the suitable material for that space. The stages carried out in the research can be adjusted to the research needs. This step is to get the most comprehensive results with the most effective and efficient steps. Research methods also include integrated software and trial and error analysis. The new pattern design in the Function hall of Building X has good acoustic insulation with some adjustments that still make getting an ideal room evaluation possible.

Keywords:

function hall; re-evaluation; acoustic phonetic

I. Introduction

The 1st-century Roman architect Marcus Pollio had begun to carefully observe a space's echo and interference (original sound vibrations and reflected vibrations cancelling each other out). Nevertheless, it was not until 1856 that acoustics began to be developed as a science by Joseph Henry and was finally fully developed by Wallace Sabine in 1900. Both were American physicists. However, unfortunately, our country's trend is generally to ignore acoustic pattern design except in unique spaces such as concert halls, recording studios, or theatre stages. Whereas in any space, for people whose hearing senses are sensitive, being in a space with bad acoustics is torture.

Phonetic is an interdisciplinary science that studies all mechanical waves in gases, liquids, and solids, including vibration, ultrasound, sound, and infrasound. Experts define acoustics as the theory of sound waves and their propagation in a space. A scientist who works in acoustics is an acoustician, while someone who works in acoustic technology can be called an acoustical engineer. We can see the application of acoustics in almost all aspects of modern society, the most obvious being the audio industry.

The study of acoustic function is growing to be important today. In the conditions of the development of an all-artificial civilization, complementary electronic ornaments are still very dependent on the level of success with the form of the structure and composition of the space itself. The problem arises when an adjustment on one side, intended for improvement, shifts the ideal coordinates on the other. For this reason, a comprehensive adjustment and

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correction idea should emerge as a solution, with acoustic studies as a starting point. In linguistics, space acoustic conditions significantly affect the outcome of a message delivery process.—this theory was developed in acoustic phonetics.

The pattern design of the space is not special to fulfil specific functions. The space hall can be used for speech activities, watching movies, listening to music performances, or other crowd activities. This condition causes differences in sound reflection levels for each space function to calculate the required reverberation time (RT) value. According to the need for a space with a conversation function, it takes RT, which is in the range of 0.85-1.3 seconds, while for the music function, it takes RT calculation whose value lies in the field of 1.3-1.83 seconds (Ribeiro, 2002). The difference is needed. Therefore, the RT value that appears for the space's function has an effect that functions well. An RT that is too short will cause the space to feel dead. On the other hand, a long RT gives a lively atmosphere to the space, but for a space with a conversation function, it will cause a decrease in speech integrity. (Satwiko, 2004, p. 91). The space interior covering material as an absorber or reflector significantly affects the RT value achieved. (Doelle, 1972. p. 63).

The acoustic aspect of the space that determines its suitability with its function in its pattern design should be included. There needs to be more than just consideration of the aesthetics of space for its pattern design. Suitable listening conditions are something that supports space user satisfaction. However, creating a performance building or lecture often needs to consider the acoustic parameters that keep the space successful in carrying out its functions when used, as happened in the space of X Building. The results are 0.75-1.19 seconds. So, it is necessary to remake this space to meet existing standards.

In this study, the research location is the space which acts as a meeting space at the X Building. This study describes the ideal pattern design based on investigations and observations of the actual condition of the Function hall of the X Building. This research also tries to determine the suitable material for the space. After the material pattern design meets the standard criteria, the audio system's pattern design develops according to the composition and existing standards. The document in question is about providing insulation treatment against clatter around the space.

New research is worth doing if it touches at least one of these traits: urgent and interesting (Siregar et al., 2021, p. 51). This research aims to create a space pattern design with a maximum quality standard. This standardization can be seen from an acoustic perspective related to clatter criteria, acoustic insulation, reverberation time, and other objective parameters so that the pattern designs are under the standards.

II. Review of Literature

The space is a place to watch a speech or a particular performance, such as theatre and music. Acoustic pattern design for theatre performances must satisfy every audience in various locations to hear speech articulation. The audience can capture and digest the nuances and dramatic effects displayed. In musical performances, the presentation of music and the expression of actors is not the main thing. However, the most important thing is that audiences from various locations must hear and enjoy the music.

Most spaces have problems with the background clatter level exceeding the required clatter criteria, thus affecting the acoustic performance of the space hall (Legoh, 1993). The criteria commonly used to measure the acoustic quality of the hall aisle are subjective and objective parameters. Secret parameters are more determined by individual perceptions in a speaker assessment by listeners with an index value between 0 to 10. Secret parameters include intimacy, spaciousness or envelopment, fullness, and overall impressions, usually used for theatre and concert hall acoustics (Legoh, 1993).

However, recently there has been a change toward using personality measures and observation. McCall (1993) claimed that the result of the assessment showed readiness among educational psychologists to get referred child institutionalised and expelled from the setting where the problem happened, but it was not always necessary for the child to be in a special school. (Gadour, A. 2009). Explaining this problem, personal conversation with primary school teachers in England suggest that they are often finding it difficult to respond to the linguisticneeds of newcomers because they lack knowledge and training in second language acquisition. As a result second language learners are very often failed to engage in meaningful social interaction within classrooms (see for example, Hatch, 1983; Krashen, 1982; Long, 1983). (Gadour, A. and Amniana, S. 2009). In line with this, parents made reference to teachers' scribbled writing on children's exercise books, which they found neither clear nor encouraging to address children's learning mistakes at home (Gadour, 2011).

Ideally, space acoustics conditioning and pattern design must be handled from a macroscope (from environmental arrangement) to finally pole to a microscope, namely conditioning training, interior pattern design, and acoustic activity spaces (Sutanto, 2015). The failure of this conditioning and plan is the most frequent factor in achieving the ideal orientation of a space.

The stages of conditioning the acoustic environment are as follows. Macro environment, namely the environment around the site in the form of a land or water environment and a noisy environment or a quiet environment. Space-macro environment, namely the environment inside the site but outside the building, is conditioned to support acoustic activity. Space-macro-microenvironment, namely inside the building but outside the acoustic space.

The microenvironment, namely the environment in the acoustic space.Conditioning the acoustic environment on the microscope uses the reverberation time calculation using the Sabine formula as a parameter for measuring the acoustic quality of the space (Doelle, 1986). Sabine's formula is the result of dividing the space volume by the total area of the absorption coefficient plus the sound absorption coefficient if the calculation is carried out in the frequency range of 1,000 Hz. The space, which is already ideal for multipurpose activities, has a reverberation time of 1.2 seconds for a frequency range of 125 – 4,000 Hz (Satwiko, 2004).

As mentioned earlier, the function of an space determines the acoustic pattern design applied to the space area. This variable is to achieve acoustic conditions sufficient for activities in the space. This difference in acoustic pattern design also causes acoustic criteria and tests depending on the space type. However, several criteria measures are used to pattern design space acoustics: clatter level and reverberation time.

The clatter in a space can be compared to a closed space with any function. This condition is due to the source of clatter levels that can come from within the space itself (internal clatter) or from outside the space (external clatter) (Acoustical Society of America, 2000). Sources of clatter from within the space can come from equipment that functions, such as air conditioning and lighting systems. Sources of clatter originating from outside the space are very dependent on the position of the space, where this source can come from operating transportation equipment or other areas where activities are taking place. Although the clatter that area can experience regardless of its function is roughly the same, a suggested minimum clatter level depends on the site's activity. 25 dB is the list of minimum clatter levels presented by Leslie Doelle (1993), where the recommended clatter criteria for a space in a school environment.

Reverberation time is the most commonly used parameter in space acoustic pattern design. Wallace C. Sabine created this parameter in the 19th century. Factors that affect reverberation time at an average temperature of 22°C are space volume (V), listener capacity, and absorptive or reflective scope (A). The space reverberation time (RT) parameter varies depending on its use. The interior surface covering material, related to the absorption and reflection coefficients, is very influential in determining the RT of an space (Doelle, 1972). An anechoic chamber is a space with an inner surface absorbing sound energy (very short RT).

In contrast, a space with a sound-reflective inner surface (a very long RT) is called a reverberation chamber. The reverberation time of a space used as a speech space in a school environment is recommended to be between 1 and 1.5 seconds. The Acoustical Society of America suggests this like. For a music space, the reverberation time is recommended to be between 1.5 to 2 seconds, while for multifunction, it is 0.3 seconds (Mediastika, 2005).

In every space, felt or not, there will always be sound. This variable is the basis for understanding the existence of background clatter. Background clatter can be defined as sound originating from other than the primary sound source or unwanted sound. In a closed space such as an space, background clatter is generated by mechanical or electrical equipment. They are such as air conditioning, fans, Etc. Likewise, clatter that comes from outside the space, such as traffic clatter on the highway, vehicle parking area, Etc.

Background clatter cannot be eliminated but reduced or reduced through a series of acoustic treatments against the space. The amount of space background clatter can be known through the measurement of the Sound Pressure Level (TTB) in the space in the middle-frequency range of the octave band between 63 Hz to 8 kHz, where the measurement results are used to determine space clatter criteria by mapping them on the clatter criteria curve (Clatter). Criteria– NC).

III. Research Method

This research took place in several stages. The stages carried out in the study can be adapted to research needs. This step is to get the most comprehensive results with the most effective and efficient measures.

The first stage measures the background clatter and NC on the research object. After that, it is continued by measuring the space's characteristics, namely the volume of the space and the materials that make up the space, to be simulated using Google Sketchup. RT calculation and select the material determined according to the standard in the next step. The next step is to find the appropriate Transmission Loss (TL) to get LP2 due to external clatter. Which then looks for the proper TL value to get LP2 due to clatter from within. In this step and before, if it is not following the standard, it is necessary to repeat the steps in material selection. Next is an audio system simulation using Ease 4.3, which looks for acoustic parameters through the system, namely C-50, and C-80. If these steps are not standard, the following activities must repeat the simulation to find a suitable sound. If appropriate, proceed with data analysis and end with preparing a recurring report.

This reverberation time data collecting procedure was carried out in the space before being pattern designed using a Sound Level Meter (SLM) connected to a laptop with FFT Analyzer software installed. This measurement is carried out three times at 1 point. This measurement is carried out when the space is empty. Firecrackers are used to generate impulse signals. This firecracker is used because the impulse generated is large and capable of producing sound intensity up to 110 dB.

In the end, all the data obtained will be analyzed according to the needs of the research orientation. It also uses the consideration of the principle of benefit, which means that data that does not support the research orientation will not be used as a reference in making research conclusions.

IV. Discussion

The stages carried out in research can be adapted to research needs. This condition is done to get the most comprehensive results with the most effective and efficient steps. Background Clatter measurement is carried out at 1 point and is taken for 1 minute when all activities are in the space space. The background clatter measured in this case is the sound pressure level generated by the clatter from the equipment in the space. Measurements are made by operating all the lights and air conditioners to get conditions close to the space's daily operation.

From the existing background clatter measurement results, the Clatter criterion is 36 dB. This condition shows that the existing space needs to follow current standards, where the space space must have an NC of 25 dB. So, we need an excellent acoustic insulation pattern design, so the background clatter as per the standard, which has NC 25.

The space reverberation time (RT) measurement is determined at 1 point right in the middle, representing the points in the audience area and expressed in RT60. The reverberation time is obtained by measuring the impulse response using an impulse signal in the form of a firecracker eruption. By standard, the allowed reverberation time for an space is 0.3 seconds. In this study, the current reverberation time was 0.79 seconds.

Based on the clatter criteria table, for speech purposes, the ideal is NC 25. However, this value can be reduced to NC 35 if the clatter is only heard occasionally. However, if clatter occurs constantly, NC 25 should be applied.

As seen in the Function hall of the X Building, by activating the lighting and air conditioning, the clatter criteria are NC 36. This condition shows that the X Building's hall does not meet the requirements as a discussion place. This condition is the initial determinant of how successful the pattern design of a pattern-designed space is. To install the optimal acoustic insulation, reduce the clatter criteria from 36 dB to 25 dB. By knowing the value of the absorption coefficient on each material, the performance of the pattern designed insulation can be measured by calculating the TL.

First, the average reverberation time is calculated for three measurements to analyze and get the space's reverberation time. Based on the research results, the space of the X Building has a reverberation time of about 0.79 seconds. It is assumed that the acoustic conditions of the X Building's Function hall space are not good enough because, ideally, an space has a reverberation time of 0.3-0.6 seconds. The long reverberation time at the space of X Building is possible because the reflected field from the space's surface is not enough to absorb the sound. The entire surface of the space does not have a sound suppression system. This condition causes the sound to be not absorbed correctly. As a result, the bouncing sound takes a long time to get the same value as the background clatter.

The level of speech intelligibility (Speech Intelligibility, SI) in the space states how the listener can capture the information the speaker conveys. The measure of the clarity of speech here is an objective measure, which means the level of clarity transparency of the address can be measured in physical parameters and expressed quantitatively—the value of the clarity of speech described in Clarity (C-50 and 80).

Based on the results of data analysis, based on the C-50 data, the average value of C-50 is -1.39 or negative. At the same time, the minimum limit for C-50 that can still be tolerated is -2dB, while for C-80, it has an average of 0.21. The two parameters of speech clarity at the Function hall of X Building are suitable. This condition is due to the relatively large amount of sound energy utilized compared to the total and residual sound energy. According to the standard, one of the contributing factors is the space's reverberation time.

In this study, the distribution pattern of speech intelligibility for C-50 is almost evenly distributed throughout the space. As for the C-80, it is also almost evenly distributed throughout the space. Referring to the standard can be good because the value of C-80 and 50 X Building's Function hall spaces is -2 to 2, so it is pretty good.

The average is obtained by 0.32. The average value of 0.32 for the Function hall of the X Building is sufficient to reduce the long reverberation time. The reverberation time of the measurement is quite long, which is 0.79 seconds. To minimize the long reverberation time, what can be done is to use acoustic dampers on the walls and roof of the space. Using the Sabine equation can obtain the average coefficient of the space for the desired reverberation time. So by entering the desired reverberation time value of 0.3 seconds and in the equation, the average coefficient (α) is 0.3016.

With an average of 0.3016, the X Building's Function hall reverberation time can function as a discussion space. Cover the walls and roof with acoustic dampers to get a standard (α) of 0.3016. The background clatter of the X Building's Function hall space looks quite large. We can determine this by plotting to the Clatter Criteria Curve, which is 40 when all equipment is activated. This clatter can be overcome by using a material with a certain thickness. Thus, clatter from outside will not enter inside. Background clatter is always present in every space. Background clatter can be caused by equipment in the space or sounds from outside. If it is too large, the background clatter generated by the equipment in the space will decrease the quality of the clarity of speech. In a space with high background clatter, the conversation will be at a sound pressure level more remarkable than the background clatter itself so that the listener can well capture the information conveyed. Talks or discussions can occur well if the space has a clatter criterion (NC) between 25-35.

The data analysis results showed that the Function hall of the X Building had a clatter criterion of NC 36. So, the Function hall space of the X Building needed to meet the requirements for space with NC 25-35. The high NC value is caused by the following:

1. Poor dampening system in the building.
2. There is clatter due to the structure.

Once rebuilt, the acoustical dampers on the walls will be optimized, thereby increasing the sound absorption performance of the space. One of the good behaviours in an enclosed space is the phenomenon of hum. Reverberation is a reflected sound that appears after the direct or original sound. In this case, the space volume factor, the reflected field, and the absorption coefficient from the space's surface significantly affect the sound reflection.

The space used for talks requires optimal time so that the conversation can occur correctly. Reverberation time that is too long will result in more transparent conversations because the sound produced by the speaker will be distorted by the sound that was previously issued because of the sound that had not once lost its energy. On the other hand, if the reverberation time is too short, the space feels "dry" because the sound resonance disappears so quickly.

A reverberation time of 0.79 seconds was also found. This condition is quite long, considering its function as a space for conversation and listening. Meanwhile, the recommended reverberation time for the talk space is 0.3-0.6 seconds. This long reverberation time is caused by the need for sound-absorbing materials with a significant absorption coefficient so that they are insufficient to absorb the existing sound.

The clarity of speech in the space shows how the listener can catch the information the speaker conveys well. The measure of the clarity of speech discourses is in Clarity (C-50 and 80). In this study, the C-50 value was -1.39 or negative. At the same time, the minimum limit for C-50 that can still be tolerated is -2dB, while for C-80, it has an average of 0.24. when compared with existing standards, the current pattern design results are pretty good.

Covering the reflecting surface of the space with acoustical control material with a high absorption coefficient can be an effective and efficient measure to overcome the shortcomings in this segment. This step is a strategy to reduce reflections and increase sound absorption so that the reverberation time of the space can be reduced significantly, which will indirectly cause the residual and total sound energy to be smaller and increase the ratio of energy fuel utilized and in the end, will be able to increase the level of speech intelligibility.

V. Conclusion

The new pattern design of the Function hall of X Building has good acoustic insulation, as seen from the average LP2 obtained due to external clatter of 28 dBA or has an NC clatter criterion of 36. The high NC value is caused by the structure's poor soundproofing system and clatter. Simulation results using walls in brick, plywood, and fibre configurations with thicknesses of 11 cm, 1 cm, and 0.7 cm, respectively, provide good acoustic insulation. It can be seen from the Lp2 value, which is reduced by 15 dB from Lp1.

The reverberation time value generated before the repattern designed space averaged 0.79 seconds. According to the material used, the value weight changed to 0.39 seconds after the repattern design. These materials are fibre on the walls, Alice on the chairs, gypsum on the ceiling, carpet on the floor, and wood on the doors. After being repattern designed, the STI value is 0.61%, and the %Alcons is 4.31 % for clarity of conversation in the space. Clarity C-80 and C-50 are 0.24 and -1.39, respectively, with the configuration of the speakers according to the standard. Acoustic conditioning in the space-macro-microenvironment is carried out by providing transitional spaces in the form of circulation spaces between the space and other spaces.

Based on the study's conclusions, it is recommended that the composition and layout of the construction and equipment of the space be adjusted to the recommended standards. This step is very influential in achieving the expectations of the role and function of the space. It is highly recommended to conduct a more in-depth study to formulate the most effective and efficient strategy and execution for the adjustment.

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