Characterization and evaluation the acoustics parameters of Graha Sepuluh Nopember ITS Surabaya

Suyatno¹, B Kurnia¹, G Prajitno¹ and S Indrawati¹
¹Department of Physics, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

E-mail: kangyatno@physics.its.ac.id

Abstract. All articles must contain an abstract. The abstract text should be formatted using 10 point Times or Times New Roman and indented 25 mm from the left margin. Leave 10 mm space after the abstract before you begin the main text of your article, starting on the same page as the abstract. The abstract should give readers concise information about the content of the article and indicate the main results obtained and conclusions drawn. The abstract is not part of the text and should be complete in itself; no table numbers, figure numbers, references or displayed mathematical expressions should be included. It should be suitable for direct inclusion in abstracting services and should not normally exceed 200 words in a single paragraph. Since contemporary information-retrieval systems rely heavily on the content of titles and abstracts to identify relevant articles in literature searches, great care should be taken in constructing both.

1. Introduction

Acoustically, a space must be able to accommodate the sound quality needs of listeners and speakers according to their needs. There are several important acoustic parameters of a space according to the function of a space. These parameters are the distribution of SPL, Reverberation Time, clarity, and definitions [1,2]. Based on Ribeiro [3], a multipurpose room has an acoustic parameter with RT is 1.2 s to 1.8 s, a clarity (C80) value of more than +3dB and definition (D50) of 50%.

This paper discusses the characterization and evaluation of the acoustic parameters of Graha 10 November (GSN), ITS Surabaya. Later, from the parameters obtained can be used to improve the acoustic parameters of GSN, so that it will be suitable for the desired room function whether as a speech room and performance room. For example, distribute of the loudspeaker system, position, and type of speaker. GSN is a room which has 45000 m³ of volume, and the area for listener is 2400 m² with capacity at 1st floor is 3000 audience. Figure 1 shows the situation of the GSN.

Currently, one of the functions this room is for graduation ceremonies and music performances, like as gamelan and traditional dance performances. As a graduation ceremony room that one of its functions is as a speech room (public lecture). Consequently, the room of GSN must be able to provide the clearly of sound (definition). Moreover, this space is also used as a concert hall, like gamelan and traditional dance also modern music. As a concert hall, this room should be able to provide clarity of sound from every played musical instrument to the audience. As a space for Javanese gamelan performances, the room must have an RT in the audience area is 1.2 s and clarity is C80 4 dB and D50 is 45% [4,5].
Part II explain the measurement procedure, and part III discusses the results of measurement and analysis, and in the last part is the conclusion.

Figure 1. Situation of graduation ceremony at GSN

2. Methodology
To obtain the acoustic parameters of the main room of the GSN, characterization is done by using two methods, IR and white noise. The IR method is used to find out the room response to the instantaneous sound from several positions in the audience area. While the white noise method used to know the distribution of SPL in the audience area. Both methods use the sound source at the front position (stage), while for the receiver microphones are installed scattered in the audience room.

From the IR method, the distribution of acoustic parameters such as RT, C80, and D50 is obtained, while by using white noise method, an acoustic parameter of SPL distribution is obtained. Measurements are made by using sound sources from a balloon burst for impulse response methods as well as synthesis sound from an audio generator. The position of the microphone is in the audience area that represents the front zone, rear, middle and side of the room. To obtain the desired acoustic parameters, the sound signal is obtained, and then analysed using a Yoshimasa electronic sound analyzer. Figure 2 shows the position of point measurement at GSN.

Figure 2. Position of measurement point.

3. Result and discussion
3.1. Distribution of SPL parameters
The GSN position, which is close to the main road, has a contribute to the high a background noise. This is supported also by the semi-open building design on the 2nd and 3rd floors. As a result, the sound can get into the room through the 2nd and 3rd floor. In this paper, the measurement was
conducted on the 1st floor that the audience exists at every event. Figure 3 shows the position and the one of geometry of the GSN.

![Figure 3](image)

**Figure 3.** Location and architectural design of Graha Sepuluh Nopember.

Based on the measurement, the Background Noise of GSN at night when the measurement process is 60 dB and more at noon. The aim of measurement at night is to get the nature of the acoustic characteristic room with minimalizing noise. The value of this Background Noise will affect the minimum SPL value that should be generated in every activity inside the GSN building. In order to obtain the distribution of SPL parameters at the building, the sound source used must have a minimum value more 10 dB than Background Noise [1, 2]. Based on the measurement, distribution of BN and SPL as shown in Figure 4.

![Figure 4](image)

**Figure 4.** Distribution of SPL parameters.

Referring to the figure 4, the source with 100 dB of SPL on stage generates the SPL parameter of the distribution in the uneven GSN. The SPL difference between front and rear is more than 5 dB. This shows the energy that reaches the listener evenly. This is due to the dimensions of space large enough and high ceiling of about 35 m. So, the sound received by the listener is dominated by the direct sound. The geometry of room also makes the value will have an impact on the sound energy heard by the listener in the rear, especially if the resulting sound source has SPL of less than 70 dB.

3.2. Distribution of RT, C80, and D50
As mentioned in the part II, the acoustic parameter of RT, C80, and D50 of space are obtained through IR measurements method. Figure 5 shows an image of the output signal generated by one of the measuring points in GSN.
Figure 5. Impulse Signal at Graha Sepuluh Nopember.

Based on the signal IR in figure 5, parameter RT, C80, and D50 can be obtained. Figure 6 shows the distribution parameters RT, C80, and D50 at frequency 1 kHz.

Figure 6. Distribution parameter of (a) Reverberation Time; (b) C80; (c) D50.

Based on Figure 6, the distribution of the clarity of music (C80) is less (-2dB) indicates that the clarity of instrument received by the listener is lacking. Similar with C80, the value of D50 less than 40% indicated the clarity of speech is poor. It is also supported by a fairly large RT value, which is between 1.6 to 2.75 seconds.

Refers to the parameter results, the acoustic parameters of the GSN main space should be increased so that it is suitable for speech room and performance room, especially for Javanese gamelan performances. Because in every big event there are always Javanese gamelan performances and traditional dances. According to Suyatno, et al (2016), RT parameters for Javanese gamelan performances are in the range of 1.2 s to 1.6 s, D50 is 66% to 74% and C80 is +4 dB to +6.2 dB. Improvements can be made by adding a sound system with intermediate frequency characteristics as well as positioning appropriate with characteristics of space.
4. Conclusions
Based on measurement, calculation, and analysis it can be concluded that:

- The distribution of sound energy in GSN is quite evenly, that is, the difference between the SPL value between the source and the farthest position around 5 dB.
- Valued of the acoustic parameter of RT is 1.6 - 2.75 s, sound clarity is less 40% for D50 and less (-2) dB for C80.
- This condition suggests that the acoustic conditions of the GSN are poor that for speech and concert activity.
- Improved the acoustic parameters can be done by adding an electronic sound system (loudspeaker) with characteristic sound at the mid-high frequency and directivity to the back position.

5. References
[1] Beranek L 2004 Concert Hall and Opera House (Springer, Verlag)
[2] Ribeirio 2008 Room Acoustic Quality of A Multipurpose Hall: A Case Study, Acoustics 2008, Paris.
[3] Marshall L., 2006, Architectural Acoustics, Elsevier Academic Press.
[4] Suyatno, H A Tjokronegoro, I G N Merthayasa, and R Supanggah 2016 Preference of reverberation time for musicians and audience of the Javanese traditional gamelan music Journal of Physics: Conference Series 776
[5] Suyatno, H A Tjokronegoro, I G N Merthayasa and R Supanggah 2015 Acoustics Parameter Pendopo Mangkunegaran Surakarta for Javanese Gamelan Performance Procedia Social and Behavioral Science 184 322-327

Acknowledgments
The authors wish to thank to LPPM ITS Surabaya throughout BOPTN research 2017, and Graha Nopember ITS Surabaya.