Study of stage acoustic parameters of Cak Durasim concert hall Surabaya for javanese traditional dance performance

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Abstract. One of the important things in stage acoustic is how a performer can hear their own and their comrades' musical instrument. Stage acoustics condition for Indonesian traditional music will affect the quality and harmonization of the performance. Music on traditional dance performance has an important role in determining the dance movement. This paper discusses the stage acoustic parameters for a Javanese traditional dance performance on Cak Durasim Concert Hall Surabaya based on the optimum acoustics parameters of the Javanese gamelan as an accompanying music for Javanese traditional dance. Those parameters are loudness level, RT, BR, TR, C80, D50 and Support. Measurements were made with two variations of sound source position, which are on the corner in front of the stage and on the center in front of the stage. According to the measurement result and analysis, the optimum position for gamelan’s player is on the corner in front of the stage, but with the loudness level distribution having a 4dB difference between the nearest and farthest positions from the source. This result is also supported on the aesthetic side of the layout of the show because its location does not affect the visual side that became the main focus of dance performances.

1. Introduction
Indonesia is a country that has a lot of ethnic and culture. Every place has its own culture. That is why in every city or district there would find a place called cultural center in order to continue the cultures’ existence. One of many interesting thing about Indonesian culture is a traditional dance performance. A performance is a kind of communication process through artwork performed by an artist to the community or by a dancer to the audiences. In traditional dance performance, the most important thing which also determined the success of a show is the harmony between the dance and its music. As the name implies, Javanese traditional dance, the music that accompanies the dancer are produced by Javanese traditional musical instrument, better known by name ‘gamelan’. As explained by [1], the gamelans’ music on traditional dance performance plays a role in enlivens the performance, not only accompanying the dance but also gives a ‘soul’ in the dance or its story. In traditional dance performance, even if the main focus is on the dancer, the audio side should not be ignored. Without the harmony between dance and music, the story or messages in traditional dance performance would not clearly deliver to audiences.

Until nowadays, the Javanese gamelan performances’ quality judged mostly based on subjective aspect. While in reality, the sound that heard by musician, dancer, and audiences have their own perception. It could cause a difference assessment between one and another listener. There are several parameters that have been introduce to describe about acoustics condition, and all of those parameters can be found in Room Impulse Response (RIR)[2]. According to [2], there are three different aspects
describe the acoustics condition on stage; the direct sound, the early reflections sound, and the late reflections sound.

In a traditional dance performance, pengrawit usually is not on the same stage with the dancer. Therefore, this study has done to know the optimum position of pengrawit on Javanese traditional dance performances in ‘Cak Durasim’ concert hall. This study based on the previous research done by Suyatno[3], which is obtained the optimum value in several parameters for pengrawit. So in order to reach the harmony of dance and its music, dancers would feel the same impression as pengrawit.

The object of the study is ‘Cak Durasim’ concert hall belongs to Dinas Kebudayaan dan Pariwisata Jawa Timur. This hall is one of the concert halls in Surabaya which is mostly used to perform Indonesian traditional arts performances include the traditional dance performances. This hall has a volume of 4500m³ with 536m² for listener area and 412 chairs. While the width of the stage is 10m and its length is 14m.

Figure 1. Cak Durasim Concert Hall (a) view from stage (b) view from audiences

2. Experimental Method

To obtain the stage acoustic parameters, the measurement was performed by using Impulse Response (IR) method[2]. From the IR method can be obtained the distribution of acoustics parameters such as Loudness Level (LL), Reverberation Time (RT), Bass ratio (BR), STearly, STlate, Clarity of music (C₈₀) and Definition of speech (D₅₀). The determination of measurement point is based on one of the positions of Tari Bedhaya (Bedhaya dance)[4]. The measurement point represents the dancer on stage. The sound source is placed based on the position of musician, where musician here refers to ‘pengrawit’. Pengrawit is person who plays Javanese gamelan instrument. In this paper, the measurement done by used two variations of sound source position, which are the A position, in the corner in front of the stage, and B position, in the center in front of the stage. While the receiver (microphone) place on stage in accordance with the dancers’ position. Fig. 2 shows the measurement points and the sound source position.

The sound source used is the impulse sound of the balloon, which is then record by using a microphone. The resulting sound signal is then analyzed using YMEC’s sound analyzer and Matlab to obtain acoustic parameters of LL, RT, BR, TR, C₈₀, D₅₀, and Support time.
3. Result and Discussions

3.1. Loudness Level (LL)

The measurements of Loudness Level (LL) were performed to determine the distribution pattern of sound evenness on the stage. On source A, the LL measured 1m in front of the source is 87.8dB, while on source B, the LL measured on 1m in front of the source is 87.4dB. According to [5], a music plays on stage called ‘gambyong pareanom’, which is also one of the accompanying music in Javanese traditional dance, gamelan as a sound source produce LL value around 75dB to 97dB. Figure 3 shows the distribution pattern of LL on stage at a frequency of 1000Hz.

![Figure 3. Distribution pattern of loudness level at frequency of 1000Hz](image)

According to Fig. 3, the distribution pattern of LL whether by using source A or source B have the same evenness value. The value of LL for each source has the same range. When using source A, the LL size ranges from 80.5dB to 85.7dB. While by using source B, the LL size ranged from 75.2dB to 81dB. According to previous research, the LL value ranges from 67dB to 82dB [6]. Thus, in this case, the position of source B meets the criterion rather than the position of source A. However, when viewed from the evenness of LL, the two sound source positions give the same result.

3.2. Reverberation Time (RT)

The reverberation time (RT) is the most commonly used parameter in measurement. The value of the reverberation time indicates the ability of a space to respond to a sound. Fig. 4 shows the distribution pattern of RT value on stage.

Based on Fig. 4, using source A we get a RT between 0.8s to 1.21s, whereas when using source B we get RT between 0.84s to 1.11s. Using source A, the RT value is greater than source B because the position of the source A is closer to the wall which make the sound heard louder. According to a previous study [4] the optimum RT value is 1.2 second. So based on the two variations of the location of the sound source the criteria is not yet achieved. When viewed in terms of its evenness the source B has a more equitable results than source A. Both the location of source A and source B needs further treatment to increase the value of the RT on the stage.
3.3. **Bass Ratio (BR) and Treble Ratio (TR)**

Other parameters that related to RT are Bass Ratio (BR) and Treble Ratio (TR). Bass Ratio (BR) is a ratio between the reverberation time in low-range frequency (bass) with the reverberation time in mid-range frequency. BR parameters are related to *warmth*. If the value of BR is more than 1 then the room called *warmth*. *Warmth* gives the impression of spaciousness in the room and gives solemn effect or better appreciation. While the Treble Ratio (TR) is a ratio between the reverberation time in high-range frequency and the reverberation time in mid-range frequency. TR parameters related to *brilliance*. If the value of TR is more than 1, it means that the sound in high frequency (treble) heard clearly. The distribution of BR values as shown in Fig. 5a while for TR as shown in Fig. 5b.

![Figure 5](image)

**Figure 5.** Distribution pattern of (a)bass ratio and (b)treble ratio

According to Fig. 5a, the value of BR obtained by using source A is between 0.74-1.09, while the source B is 0.68-0.91. Based on previous research, the optimum BR value obtained is 0.92[4]. Therefore, the location of source B has not met the criteria, while source A at some point just exceeds the criteria. Therefore, the positions’ area of source A is better than source B. Although the value of BR when using source A there is a larger value, it does not affecting anything because the value of BR of more than 1 will give a solemn effect that can support the role of dances’ music in the dances’ spirit on the dance moves shown.

Based on the sound evenness obtained as show in Fig. 4b, it shows that by using source A the distribution pattern of TR value on most of the stage ranged from 0.77 to 0.94. While by using the source B, the value of TR on stage ranged from 0.84 to 1.15. On the previous research, the optimum value of TR is 0.99[3]. In accordance with various studies that have been done by [5, 6], the sound produced by Javanese gamelan is at low-range frequency and mid-range frequency. Therefore, the location of source A is more suitable for Javanese gamelan music performances than source B.
3.4. Clarity of Music (C80) and Definition of Speech (D50)
Other parameters that still related to RT are C80 and D50. In a dance performance, there is generally a 'sinden' or a singer who also accompany the music accompaniment that will tell a supporting narration on certain parts of the accompaniment. Definition of speech (D50) has more influence on the audience as the recipient of the message performances, while for the dancers on the stage the music is much more important. The distribution pattern of C80 and D50 as shown in Fig. 6 below.

![Figure 6](image_url)

(a) Distribution pattern of clarity of music (b) definition of speech, at frequency of 1000Hz

Based on Fig. 6, both C80 and D50 have nearly identical distribution pattern. Based on a previous study the optimal value of C80 was 4 - 6.7dB[3]. In Fig. 6a by using source B we get the distribution of the value of C80 nearing the value in the previous study. However, the value of C80 obtained from the source area B still does not meet the range of the previous value, which also true for the location of source A. So whether when using source A and source B improvement is needed to increase the value. For the value of D50 as seen in Fig. 6b, using source A obtained value of D50 between 34-61% whereas by using source B obtained value of D50 between 12-51%. According to previous research, the value of D50 should be in the range of 66% - 75.4% [3]. Based on voice clarity classification, source A has better value than source B. The value of D50 in source area A is 66% while in source area B is 59%. Based on these two values then the location of source A fulfill more criteria than source B, so location of source A is more suitable for pengrawit.

3.5. Support Time (ST)
Three important aspects on stage acoustics which explained by [2] as well as included in the annex of ISO 3382-1[8] where the direct sound, early reflections, and late reflection are covered by support time parameters; STearly and STlate. STearly is the ratio between early reflections, which is the sound at 20ms to 100ms, with the direct sound, which is the sound at 0ms to 10ms. While the STlate is the ratio between the late reflections, which is the sound at 100ms to 1000ms, with the direct sound. The distribution pattern of STearly and STlate on stage as well as shown in Fig. 7.

![Figure 7](image_url)

Based on Fig. 7, both STearly and STlate values are in the positive range. In STearly, if the value is more than 1 then it means the first reflection is greater than the direct sound. Similarly with STlate, if the value of STlate more than 1 then the last reflection is greater than the direct sound. If the STearly value is 4, it indicates that the first reflection is 4 times greater than the direct sound. The same is true with STlate. Values that are too great are feared can lead to overlapping sounds that can affect dancers’ ability to listen to the music. It can also affect the overall quality of the show because it could disrupt the function of a performance as a communication media, such as the message is not deliver to the audience. Therefore, smaller values are better. When using source A the STearly value is 8.3-12.1 and STlate is 4-9, while by using source B the STearly value is 4-17.8 and STlate is 1.2-10.8. Based
on these results, source B gives a value with a large enough range so that the pattern of distribution is uneven. While the source A STearly value obtained has a smaller range. Thus, source A gives better results than source B.

![Figure 7](image)

**Figure 7.** Distribution pattern of (a)STearly (b)STlate, at frequency of 1000Hz

4. **Conclusions**

According to the measurement result and analysis, values of acoustics parameters by using source A is 80dB to 85.7dB for LL, 0.8s to 1.2s for reverberation time, -0.1 to +4.8dB for C80, 34% to 57.8% for D50, 0.7-1 for bass ratio, 0.77 to 0.96 for treble ratio, while the STearly value ranged from 8.3 to 12.1 and STlate ranged from 1.2 to 10.8. Whereas values by using source B is 75dB to 81dB for LL, 0.84s to 1.15s for reverberation time, +1.3 to +4.9dB for C80, 12% to 51% for D50, 0.68 to 0.91 for bass ratio, 0.77 to 0.96 for treble ratio, while the STearly value ranged from 4.1 to 17.8 and STlate ranged from 1.2 to 10.8. Therefore, the optimum position for the crew is at the source A position, but with the LL distribution having a 4dB difference between the nearest and farthest positions from the source. This result is also supported on the aesthetic side of the layout of the show because its location does not affect the visual side that became the main focus of dance performances.

5. **References**

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