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Time-based soundscape evaluation of third-class hospital ward

Anugrah Sabdono SUDARSONO[1]; Sugeng Joko SARWONO[1]; Aisyah SHABRINA[1], Laudita Natasha TAMRIN[1]

[1] Institut Teknologi Bandung, INDONESIA

ABSTRACT

In Indonesia, the hospital ward is classified according to the number of beds inside the ward. Third class ward is the lowest class, which consist of six or eight beds inside the ward. In this study, the soundscape of a third-class hospital ward is analysed on different time of the day. The analysis is conducted based on noise level measurement, sound source identification, annoying sound source identification, and semantic scales. The noise level in the ward fluctuates between 51.5– 62.1 dBA with the highest noise level measured during the afternoon. The dominant sound sources in the third-class ward, which are similar in the morning and the afternoon, are the sound of fan and visitor of the patients. The three most annoying sound sources in the morning are the sound of patients, visitors, and doors. This result is slightly different from the afternoon survey, which shows that the three most annoying sound sources are the sound of the door, food cart, and visitors. The semantic scales show different score in the morning and the afternoon. This study shows that the soundscape in the third-class ward is changing from time to time, and the soundscape intervention must consider the difference.

Keywords: third-class hospital ward, soundscape, perception

1. INTRODUCTION

Hospital, as a health service institution needs a conducive environment in order to give optimal service. A conducive environment could be achieved by constructing a comfortable environment. One of the crucial aspects is the sonic environment. The previous study indicates that the sound environment can significantly affect both patient (1) and medical staff (2) in the hospital. The sonic environment of the hospital focused on the interaction between various sound sources and activities in the hospital.

Several institutions have made a noise standard that needs to be fulfilled by the hospital. According to the Ministry of Environment of Indonesia, the suitable sound pressure level (SPL) for hospital environment noise is 55 dBA(3) whereas for the *World Health Organization* (WHO) is 35 dBA (4), while according to National Standardization Agency of Indonesia (SNI) the suitable sound pressure level (SPL) for patient's room with more than 2 beds, are 35 dBA and 40 dBA for maximum level (5). However, the previous study indicates that the noise condition is exceeding the standard. The measurement of noise in ICU indicates that the noise is exceeding the standard (6,7). The similar condition also happened in the operating room (8) and hospital ward (9)

Most of the previous study regarding the sonic environment of the hospital focused more on the overall sound level without further analysis of the perception in the hospital ward. The study conducted by Mackrill et al. has analysed the soundscape of the hospital, although without considering the temporal aspect (10). The temporal aspect is one of the critical aspects of hospital soundscape (apart from human perception, sound source, and emotional response) and must be considered (11). The different activity on different time might give different perception, and the improvement of the sonic environment might be different. Therefore, this study tries to analyse the noise condition dominant sound sources and perception in a hospital ward in a different time.

[1] anugrah@tf.itb.ac.id

2. METHODOLOGY

The surveys for this study were conducted in five third-class hospital wards. Third-class ward is a lowest class of hospital ward in Indonesia, which consists of more than six beds [8]. This type of room is usually crowded due to the cheap rate. The beds in this type of ward, usually next to each other and separated by a thin curtain. The room usually used by patients who do not have to pay for the cure (paid by the government). Most of the patients in this room are in the recovery stage of their illness.

In this study, five wards (room 308, 309, 310, 311, and 517) are measured in the morning (09.00-11.00) and the afternoon (13.00-15.00). The measurements were conducted on two different days. The layout of the rooms are shown in Figure 1 and Figure 2. The noise measurement was conducted in ten minutes using the BSWA MPA 416 class one measurement microphone. The noise was analysed based on the parameter of L_{eq}, L_{10}, L_{50}, and L_{90}.

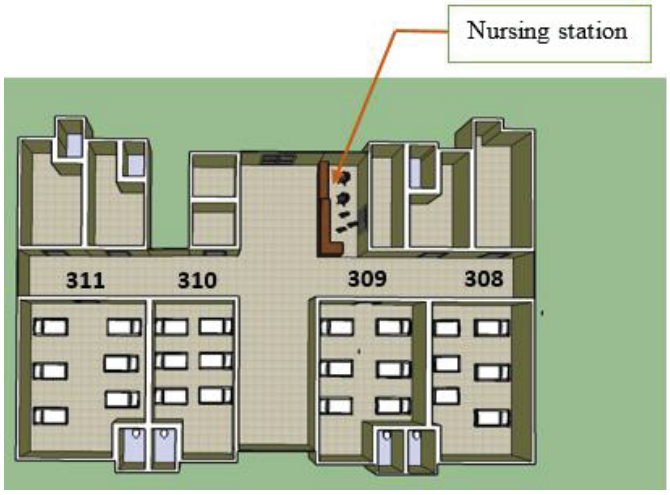

Figure 1 – Layout for room 308-311

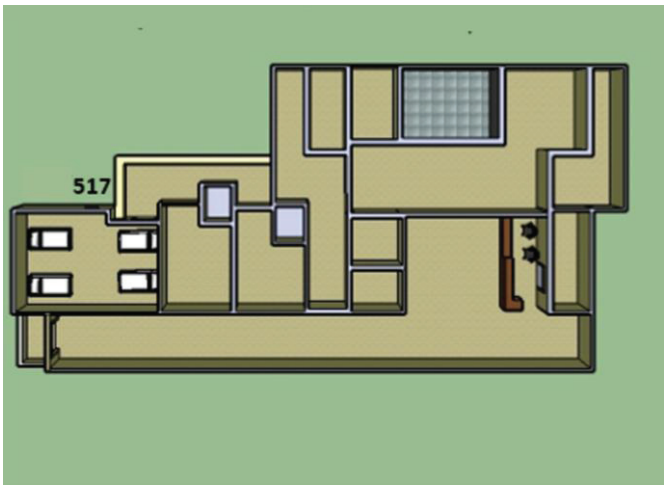

Figure 2 – Layout of room 517

After the measurement, a questionnaire was distributed to the patients asking the perception of the space, dominant sound source, and annoyance rating of the different sound source. Fifty-nine respondents (28 males and 31 females) voluntarily join the experiment. Thirty-six patients joint the experiment and 23 patient's guard, who also stayed in the ward. The average age of the patients was 42.5, with a standard deviation of 15.4.

The questionnaire consists of three part. The first part is that semantic scales consist of 13 scales. The scales were developed through a focus group with the patients. The scales are shown in Table 1

Table 1 – Semantic scale used in the experiment

Indonesian	English Translation
Mengganggu - Tidak Menganggu	Disturbing-not disturbing
Membosankan – Menarik	Boring-interesting
Menakutkan-Tidak menakutkan	Scary-reassuring
Tertekan – Menenangkan	Depressing-calming
Puas-Tidak Puas	Satisfied-unsatisfied
Ribut-hening	Noisy-silence
Tidak privat-privat	Not private-private
Tidak nyaman-nyaman	Uncomfortable-comfortable
Dinamis-monoton	Dynamic-monotonous
Sempit-luas	Cramped-spacious
Lambat-Cepat	Slow-fast
Penuh-kosong	Full-empty
Kesal-Senang	Annoyed-pleased

The second part of the questionnaire asked about the dominance of different sound source and how annoying is the sound source. There are eight sound sources which need to be rated: fan, door, visitor, food cart, mobile phone, eating utensil, curtain, and patients. These sound sources were selected according to the focus group, which asked what kind of sound source which make the patients feel annoyed.

3. Result and Discussions

3.1 Equivalent Sound Pressure Level and Percentile Level

The sound level profile is identified by measuring L_{eq}, L_{10}, L_{50}, and L_{90} in the morning and the afternoon in a different room. The overall result during the morning and afternoon measurement is shown in Table 2. In general, the measurement shows that the noise the hospital wards varied between 51.5-62.1 dBA. The values are exceeding the noise standard in Indonesia, and also WHO.

Table 2 – Noise measurement result

	L_{eq}	L_{10}	L_{50}	L_{90}
Min (dBA)	51.5	53.0	48.9	46.6
Max (dBA)	62.1	64.7	59.6	55.3

Further analysis is done using Analysis of Variance (ANOVA) to understand the level difference between different room. ANOVA shows that variation of noise in a different room the room is not significant $F(5,9) = 1.35$, $p = 0.33$. Analysis using T-test indicates that the variation of noise (L_{eq}, L_{10}, L_{50}, and L_{90}) are significantly (sig=0.000) affected by the time of measurement. The result is consistent among the other noise parameters (L10, L50, L90). Generally, equivalent sound pressure level during the afternoon tends to be higher than the morning as shown in Figure 3. This factor caused by the activity inside the ward. The activities tend to be more crowded during the day compared to the condition the morning.

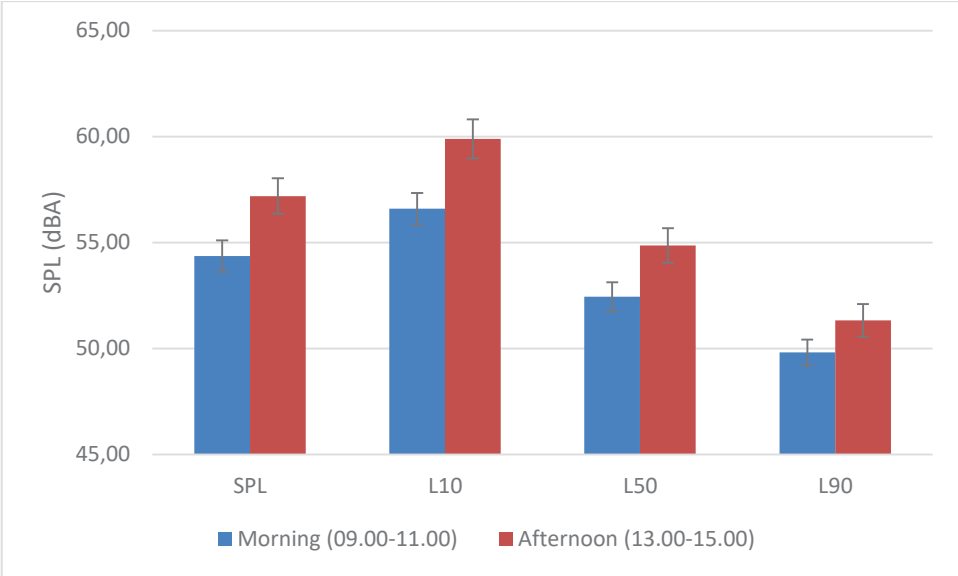

Figure 3 – Noise measurement in the morning and afternoon

3.2 Perception difference between morning and afternoon time

In this study, the perception of the sonic environment is analysed in two different times. Analysis of semantic scores indicates that the patients perceived the environment differently, as shown in Figure 4. In the morning, the patients feel less boring, more satisfied, more private, more dynamic, faster, less full, and less annoying in the morning compared to in the afternoon. The patients of both two different time (morning and afternoon) feels that the soundscape is not disturbing, not scary, and comfortable. This result indicates that the perception of the soundscape changes at different time. Further analysis is conducted by understanding the acoustic environment and the annoyance of different sound source according to the patients' impression.

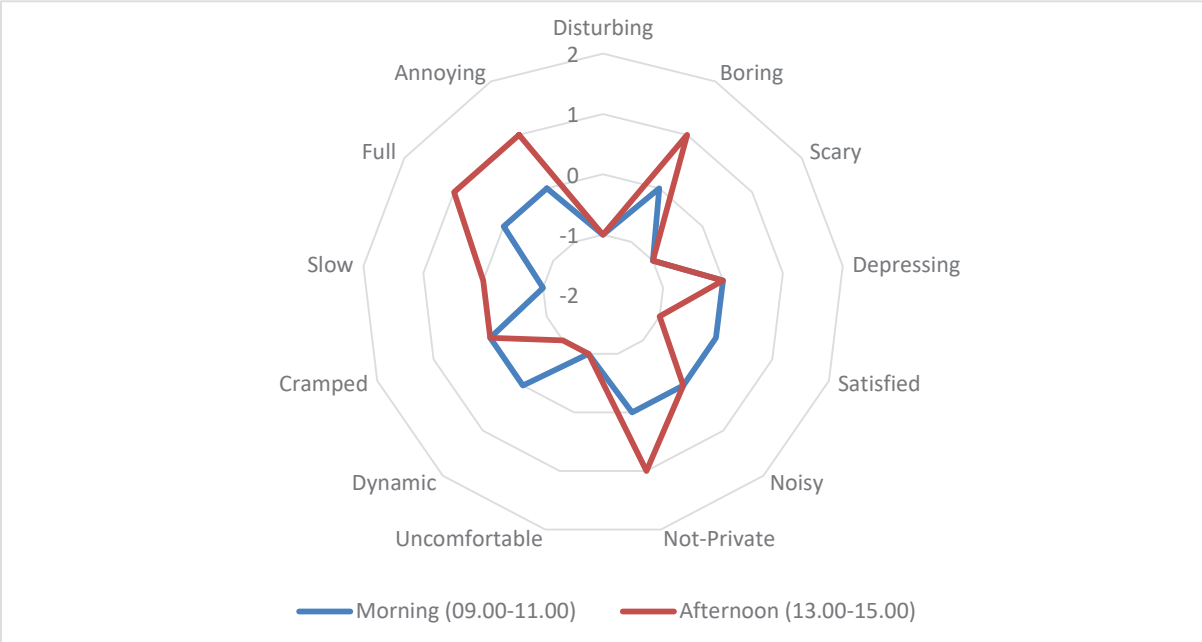

Figure 4 – Median score of semantic scale rating in the morning and afternoon

Analysis of dominant sound source indicates that the morning and afternoon shows similar dominant sound source. The most dominant sound source is the visitor and the sound of the fan. In this

hospital, the patients are allowed to be accompanied their family. The visitor explained in this study represent the people who accompany the patients. In the afternoon, the sound of visitor become more dominant since usually, they do more activity with the patients. This phenomenon also happens to patients. They do more activity in the afternoon, which make the sound of them become more dominant, compared to the morning time. The dominance of the other sound sources seems to be consistent between two different measurement time, as shown in Figure 5.

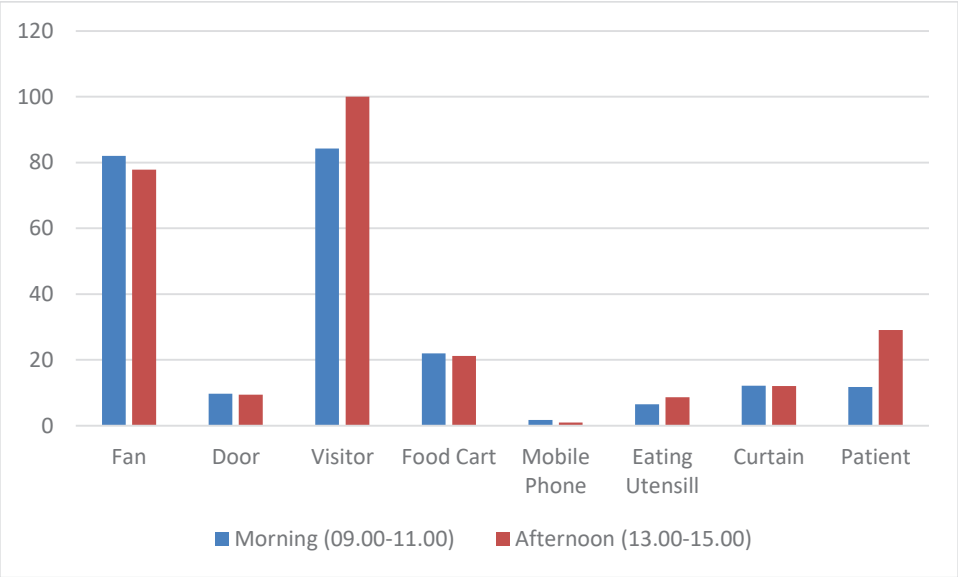

Figure 5 – Dominant sound source at different times

Interesting result is shown from the annoyance rating of the sound sources. The result is shown in Figure 6. Generally, the sound sources annoyance is different between the morning and afternoon condition. The phenomena are shown primarily on the sound of the door, mobile phone and patient. The sound of the door is more annoyed in the afternoon, although the sound is as dominant as in the morning condition.

The most interesting result shown by the sound of the mobile phone. The sound of the mobile phone is more annoying in the morning although the sound is not dominant. According to the rating of the dominant sound, the sound of a mobile phone is not dominant both in the morning and in the afternoon.

The sound of patients is more dominant in the afternoon, but it is less annoying. It might be possible that the patients expect the activity of patients become higher in the afternoon, so they are more tolerant with the sound of the other patients.

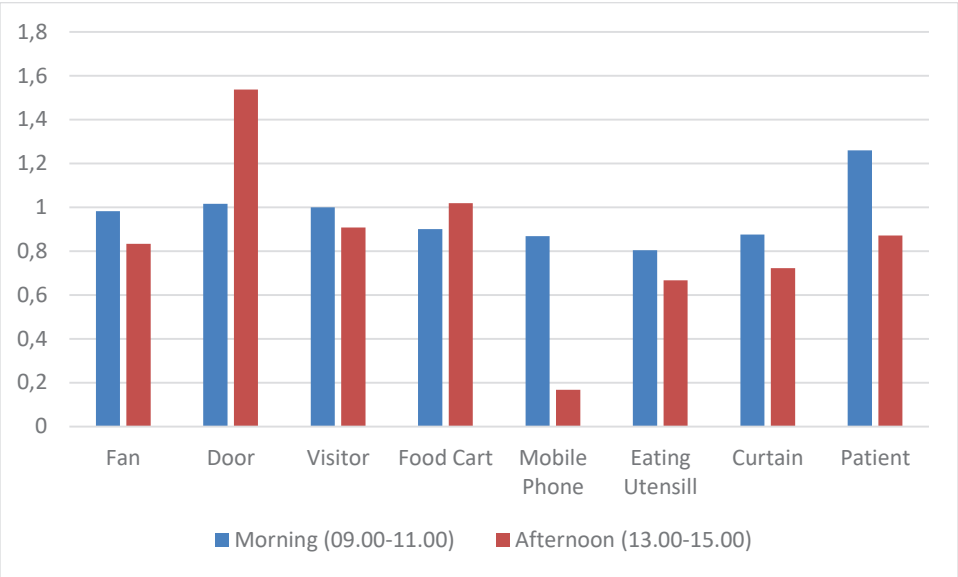

Figure 6 – Annoyance rating of a different sound source at different time

In general, the study indicates that the dominant sound source might not be the problem to the sound environment. In this case, the problem occurred due to the not dominant sound sources. The result also might be different at a different time. The result shows that the soundscape analysis for the environment that makes people need to be in the environment for a long time need to be done thoroughly with the consideration of different perception in a different time.

4. Conclusion

Soundscape analysis in a hospital ward in two different times (morning and afternoon) indicates that the soundscape is different. The sound level is higher in the afternoon. In the morning, the patients feel more boring, less satisfied, less private, less dynamic, slower, fuller, and more annoying in the morning compared to in the afternoon. The dominant sound source is similar between two different times, but the sound source annoyance rating shows different scores. The result indicates that the soundscape intervention in a hospital ward must consider the time.

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