Risk analysis of hearing loss among the employees in ceramics sanitary industry

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Abstract. Industrial sector has a high risk of work accidents. So, it is necessary to apply occupational health and safety management to monitor the work process. The aims of this study are to evaluate and analyze the risk of noise exposure in the production process at sanitary industries. The study was conducted in the sanitary ceramics industry which produces sanitary equipment, in the production area and other sanitary equipment. The method used was cross sectional design study, there was seven samplings location and 98 respondents to determine the perceptions of health risks. The results obtained that the highest noise is 101.9 dB (A) in the forging section, 92.6 dB (A) in the casting section, 91.7 dB (A) in polishing belt section, and 89.6 dB (A) in polishing section buff. According to The Government No. 13/2011 the noise quality standard for the industry at 80 dB (A). The highest risk of noise exposure is to complaints of headaches (OR = 2.44), high blood pressure (OR = 1.24), fatigue (OR = 2.21), hearing loss (OR = 1.99). Suggestions that can be given are the need for training and outreach to workers about the risks associated with specific work on 8 hours work noise exposure to avoid work accidents.

1. Introduction
The workers’ occupational Safety and Health have an important role in production activities, among others, as one aspect of labor protection against occupational diseases and work accidents. According to Minister of Manpower Decree No.13 Year 2011, noise is all unwanted sounds originated by production equipmen
t and/or working tools at a certain level that might cause hearing disorders [1].

Noise can cause a variety of disorders such as physiological and psychological disorders, which could occur permanently. Physiological disorders are elevated blood pressure or hypertension, rapid muscles tense, and the blood vessels constriction phase (tingling) [2]. These are the spontaneous mechanisms of the human body in responding to dangers. Noise level above 85 dB (A) will disrupt workers hearing ability if they are continuously exposed to it. Based on the information that human Hearing Threshold Value (HTV) is limited to 85 dB (A) it can be interpreted that human will remain safe if exposed to noise under that value [3].

Research result in ceramic sanitary production area show maximum noise level of 98.6 dBA, which indicate that noise level in this area is already exceed the recommended maximum noise limitation [4,5]. The objective of this research is to evaluate and analyses the danger and risk of noise exposure in ceramic sanitary production process in Jakarta.
2. Research methodology
The implemented research design is a cross sectional design. The study was conducted in fitting and sanitary production unit in Serpong Sub-District, Tangerang, Banten from June to July 2018. Tools utilized in this research are Sound Level Meter (SLM) Tenmars 103 - ranges from 10 dB to 200 dB at frequency between 30 HZ and 100 HZ to measure noise, and Stop Watch to measure measurement time interval [6,7].

![Sampling location.](image)

To determine the amount of respondent sampled from worker’s population, the following formulation is utilized:

\[
n = \frac{N}{1+N(d)^2}
\]

N = population; n = sample; d = Confidence level/expected accuracy 0.1

Statistical Analysis was conducted by using Odds Ratio (O.R) epidemiologic calculation, which is a formula to acknowledge the level of health risk on workers stationed in working environment with high and low levels of noise [7,8]. Noise level distribution is pictured in a contour map in order to acknowledge areas safe from noise exposure with noise value under threshold limitation. Contour map production was conducted by using Surfer Version 10 program.

3. Results and discussion
Noise observation in forging area results noise average of 101.9 dBA. This area has the most noise exposure among other areas. The company equips the workers with earplugs that can reduce noise as much as 10 to 30 dB to protect the workers. According to a research conducted by Fredianta et al [8] and Mostaghaci et al [9] in similar company, earplug can reduce noise intensity to protect workers stationed in areas with high level of noise exposure. Meanwhile, based on the research of Fredianta et al [8] ear muff can reduce noise as much as 40 to 50 dB.

Production area of forging and polishing is located in one large room. Because of that, noise from polishing area is a result of noise accumulation from forging area. The average level of noise in polishing area is at 89.6 dBA (Table 1 and Figure 2.)

Measurement at the Casting area shows the highest Leq level was in Sunday and Thursday 96.4 dB(A). This is caused by the LPDC (Low Pressure Die Casting) tool for printing adjacent cores, causing noise above the threshold value. The lowest Leq value is found on Monday at 90.4 dB (A). While the
value of Leq week 2 with the highest Leq value is 91.6 dB (A) on Tuesday. The lowest Leq value is found on Thursday in the first-time segment of 90.4 dB (A), this is because the operating machine is doing maintenance.

Measurement at the Forging point shows that the highest Leq value at Point 2 on Week 1 is on Monday at 102.2 dB (A). This is due to the stamping tool maintenance activities and inspection of other supporting equipment [9]. The lowest Leq value is on Tuesday 101.7 dB (A), because there are no normal maintenance and production activities. On the second week the highest Leq value is 102.3 dB (A) on Thursday. That is caused by the activities of repair, inspection, testing, use of maintenance support equipment and the activities of more workers than usual [10]. While the lowest Leq value is on Tuesday 101.6 dB (A), it is because there are no additional activities in the form of maintenance and worker activities.

Table 1. Noise measurement (L 8 hour) for 5 days.

| No. | Testing Point | Measurement Result (dBA) |
|-----|---------------|--------------------------|
|     |               | L 8 Days (1) | L 8 Days (2) | L 8 Days (3) | L 8 Days (4) | L 8 Days (5) | L 5 days Week 1 | L 5 days Week 2 Total |
| 1   | Casting       | 90.4          | 93.0          | 93.2          | 96.4          | 93.6          | 93.7          | 92.6          |
| 2   | Forging       | 102.2         | 101.7         | 102.0         | 102.1         | 101.9         | 102.0         | 101.9         |
| 3   | Polishing Belt| 91.8          | 91.1          | 91.6          | 90.2          | 91.6          | 91.3          | 91.7          |
| 4   | Polishing Buff| 89.4          | 91.0          | 91.1          | 89.2          | 89.2          | 90.1          | 89.6          |
| 5   | Plating       | 77.5          | 76.8          | 77.0          | 76.4          | 77.8          | 77.1          | 77.4          |
| 6   | Assembling    | 81.1          | 83.4          | 83.4          | 80.3          | 80.3          | 81.9          | 81.5          |
| 7   | Office        | 57.9          | 58.0          | 57.9          | 57.3          | 58.9          | 58.0          | 58.3          |

Polishing Belt area shows the highest Leq value at this point in the first week of sampling are 91.8 dB (A). That is because there are a lot of production activities to pursue sales targets for the month. While the lowest Leq value is on Thursday at 90.2 dB(A), this is because there are no other additional activities. On the second week the highest Leq values is 92.7 dB (A) on Tuesday in the second time segment. Due to additional production activities for the sales target. While the lowest Leq value is found on Wednesday in the second time segment of 91.8 dB (A), this is because there are no additional activities in the form of maintenance and other worker activities.

Figure 2. Noise graphic.
Measurement at the Polishing Buff area shows that the highest Leq value at this point is on Wednesday of 91.1 dB (A). This is caused by additional maintenance activities on some Buff tolls and chasing sales targets. While the lowest Leq value is found on Friday at 89.2 dB (A), this is because the Buff machine works normally. On the second week the highest Leq value is 90.1 dB (A) on Tuesday. This was caused by an increase in production to pursue sales targets. While the lowest Leq value is on Wednesday of 87.7 dB(A), this is because there are no additional activities.

Measurement at the Plating point shows the highest Leq value at point 5 on Friday is 77.8 dB (A). This is due to the coating process using chemicals so it is not as important as the other production processes. While the lowest Leq value is on Thursday at 76.4 dB (A), this is because the coating process is in the drying stage. On the 2nd week for the highest Leq value which is 78.4 dB (A) on Tuesday. This is caused by the process of draining chemicals. While the lowest Leq value is found on Thursday at 77.4 dB (A), this is due to the activity of drying goods and no other activities.

Measurement at the Assembling area shows the highest Leq value at this point on Wednesday is 83.4 db (A). This is due to washing tools before packing and leak testing. While the lowest Leq value is found on Friday at 80.3 dB(A). On the second week for the highest Leq value which is 82.3 dB (A) on Monday. This is due to washing equipment and packing that must meet sales targets. While the lowest Leq value is found on Sunday at 80.6 dB(A), this is due to the absence of additional activities.

Measurement at the Office area shows the highest Leq value at this point on Friday is 58.9 db (A). This is caused by the existence of weekly HSE activities, namely on Friday in the form of meeting activities, gathering of people at meeting, discussions, and speaking using loudspeakers [5]. While the lowest Leq value is on Thursday at 57.3 dB(A), this is because there is no weekly meeting at the HSE office. On the second week for the highest Leq value which is 59.7 dB(A) on Tuesday. That is because there are still smaller scale meeting activities, where the number of people gathered is limited to HSE workers. While the lowest Leq value is on Thursday at 58.0 dB(A), this is because there is no activity or almost all HSE workers are working in the field [4,11] (Table 2).

| Location       | Monday | Tuesday | Wednesday | Thursday | Friday |
|----------------|--------|---------|-----------|----------|--------|
| Casting        | 90.6   | 92.4    | 92.5      | 94.3     | 92.3   |
| Forging        | 102.0  | 102.0   | 101.9     | 101.9    | 102.0  |
| Polishing Belt | 91.8   | 92.0    | 91.7      | 91.3     | 91.8   |
| Polishing Buff | 89.3   | 90.6    | 89.7      | 89.1     | 89.3   |
| Plating        | 77.5   | 77.7    | 77.4      | 76.9     | 77.6   |
| Assembling     | 81.0   | 82.9    | 82.3      | 80.5     | 80.4   |
| Office         | 58.1   | 58.9    | 58.1      | 57.7     | 58.6   |
| Casting        | 90.6   | 92.4    | 92.5      | 94.3     | 92.3   |
| Forging        | 102.0  | 102.0   | 101.9     | 101.9    | 102.0  |
| Polishing Belt | 91.8   | 92.0    | 91.7      | 91.3     | 91.8   |

Table 2. Noise measurement results according to sampling day.

Noise exposure in production area generated from sanitary and fitting tools is illustrated in contour map as a mean to acknowledge the noise spreading pattern. The function of this contour map is to acknowledge which area that has the highest level of noise, and which area that considered safe with noise level under the threshold value. Contour map is generated by using surfer 13 program.

From the displayed contour map, we can say that area exposed to the highest level of noise are casting, forging, and polishing areas. In Figure 2, forging area is exposed to more than 100 dBA of noise. Because of that, the workers stationed in this facility are recommended to regularly take a quick break in a room safe from noise exposure. Noise contour map and noise measurement point in production area is pictured in Figure 3.
To understand the risk of noise exposure in the area, social analysis regarding age, years of service, and their health complaints caused by long exposure of noise in their working station are conducted. Table 3 summarizes the age level of workers appointed as samples in this study. The majority of workers is at 21 to 40 years old, with a percentage of 41.8%. Age is considered important as analysis factor because it influences the health complaints produced by workers. We also identify that workers on higher level of age produce heavier health complaints.

Table 3. The age level of workers in ceramic sanitary industry.

| Age (years) | Frequency (people) | Percentage (%) |
|-------------|-------------------|----------------|
| 18-20       | 33                | 33.7           |
| 21-40       | 41                | 41.8           |
| 41-60       | 24                | 24.5           |
| Total       | 98                | 100            |

Years of service is also an important analysis factor regarding health complaints. Based on that, this category is included in statistical analysis calculation to understand the risk of health problems faced by the workers (Table 4.).

Table 4. Years of service in ceramic sanitary industry.

| Years of Service (years) | Frequency (people) | Percentage (%) |
|--------------------------|--------------------|----------------|
| 2- 4                     | 27                 | 27.6           |
| 5- 10                    | 42                 | 42.9           |
| > 10                     | 29                 | 29.6           |
| Total                    | 98                 | 100            |

The identified health problems complaints regarding noise exposure are headache, rapid tiredness, and hearing disorders. From 96 workers appointed as respondents it is acknowledged that the workers stationed in forging facility (with 101 dBA level of noise) has 2.44 times higher potential to experience headache than the workers unexposed to noise (OR=2.44), for example workers in platting and office areas. The analysis result is also in parallel with a study conducted on similar industry in North Sumatra.
Indonesia, which resulted that 66% of the worker’s experience headache as a result of noise exposure with a level of more than 85 dBA.

Complaints regarding rapid tiredness is also felt by workers stationed in area with high level of noise. Table 6 shows that 98 respondents mentioned this complaint. Rapid tiredness potential risk is majorly felt by the workers stationed in forging area, with 2.21 times more than other workers stationed in areas with low level of noise for example platting and office areas (OR: 2.21). Hearing disorders are the main complaints mentioned by industrial workers. Analysis on 98 workers as sample in this research reveals that they are exposed to 1.99 higher risk of hearing disorders than workers in lower noise level area (OR: 1.99). Higher noise intensity can cause deafness or hearing disorders [4,11].

With the existing reality of high level of noise in the industrial area, the company applies an effort to protect its employees by implementing work shift. For 8 hours of working time, the company divides it into 3 shifts and only allows its worker to be in the area for maximum of 6 hours. Besides that, the company also equips its workers with protective gears such as ear plug, ear muff, and safety helmet.

4. Conclusion

Noise level in the working area is already exceeds the allowed environment noise standard level regulated by the government with maximum level of 85 dB(A). The calculation result of noise equivalent (Leq) and noise during working hour resulted highest Leq value of 102.3 dB(A) in forging area, 96.4 dB(A) in casting area, 92.7 dB(A) in polishing belt area, and 59.7 dB(A) in office area. The workers stationed in areas with high level of noise is 2.44 more vulnerable to experience headache, 2.21 times more vulnerable to experience rapid tiredness, and 2.21 times more vulnerable to experience hearing disorders than worker stationed in areas with lower level of noise. Training and socialization regarding the working risk, especially regarding 8 hours of noise exposure is vital to avoid work accident.

References

[1] Ramli S 2010 OHSAS 18001 Occupational Health and Safety Management System (Dian Rakyat: Jakarta)
[2] Wolf S 2010 American National Standards Institute ANSI Standard No. Z87 Eye Protection
[3] American National Standards Institute 2010 ANSI Standard No. Z88.2.2010 Respiratory Protection
[4] OHSAS 18001 2007 Occupational Health and Safety Management System-Guideline for the Implementation of OHSAS 18001
[5] Paulutu P 2013 Environmental Quality Analysis (Universitas Negeri Gorontalo: Gorontalo)
[6] Ramli S 2010 Practical Guidelines for Risk Management in OHS OHS Risk Mangement Perspective (Dian Rakyat: Jakarta)
[7] Sugiyono S 2017 Quantitative, Qualitative Research Methods and R&D (Alfabeta: Bandung)
[8] Fredianta G D, Listiani N H and Elisabeth G 2013 Noise Level Analysis to Reduce the Noise Exposure Dose at PT. XYZ (Universitas Sumatera Utara: Medan)
[9] Mostaghaci M, Mirmohammadi S J, Mehrparvar A H, Bahaloo M, Mollasadeghi A and Davari M H 2013 Effect of workplace noise on hearing ability in tile and ceramic industry workers in Iran: A 2-year follow up study The Scientific World Journal
[10] Mehrparvar A H, Heidari F, Mostaghaci M, Sharifabadi M S and Zaresakhvdi M J 2017 Prevalence and pattern of noise-induced hearing loss in tile and ceramic industry International journal of occupational hygiene 9 2 60-65
[11] Kurniawidjaja L M 2010 Theories and Applications of Occupational Health (UI Press: Jakarta)