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Noise Level Analysis of KM. Sabuk Nusantara 71 to Increase Ship Passengers Comfort Based on BKI Rules

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Abstract

Noise is an unwanted sound or sound source which can distract or harm human health and comfort. According to experts, a sound that exceeds the level of human listening senses can cause deafness. Such danger can also be found in ships. An alternative to reduce noise in ships is by modifying the construction. This research aims to compare noising before and after adding a side deck girder in the engine room of a 2000 DWT ship. The result showed that in the engine room, after adding a FB 180 x 8 mm FP 75 x 10 mm sized T profile, for 0-30 seconds intervals, the maximum noise was down from 127 dB to 62 dB or a 0.47% decrease. Meanwhile, the maximum noise was down from 98.6 dB to 57 dB in the accommodation room or decreased by 0.41%. The maximum noise was down from 83 dB to 37 dB or a 0.56% decrease in the navigation room. Such modification had reduced the average noise range from 80-40 dB to 55-20 dB.

Keywords: *noising; side deck girder; engine room; profil T; construction*

1. Introduction

Noise is an unwanted sound or sound source which can have an impact on human health and comfort. According to experts, a sound that exceeds the level of the human listening senses can cause deafness (Cianferra, Petronio, & Armenio, 2019; Soares, Antunes, & Debut, 2021). In operating a tool, noise is a significant problem, especially in terms of comfort (Learn, 2021; Zhang, 2020). Excessive noise can harm human body function (Li, Hallander, & Johansson, 2018), either health, psychological or technical-related issues (Kurt et al., 2017). Hearing impairment is an example of the health issues related to noise, while the psychological impacts can be in the form of emotional disturbances. From a technical point of view, noise can indicate a problem with existing equipment(Carter, Tregenza, & Stevens, 2020).

Noise intensity has a significant impact on human health, and if exposed for too long, it will cause health problems. The sound generated from machine operation affects the environment and the system around it (Williams, 2019; Zhang, 2020). The types and numbers of sound sources (noise) in the workplace vary widely, including machine sounds, collisions between work tools and workpieces, flows, materials (gas, water, or liquid materials flows in pipes), and humans (Guo, 2020; Learn, 2021). To control the noise occurring on a ship, it is necessary first to learn how noise spreads (Xue, 2020). Noise spread and propagation from various spaces on the ship can go through two routes: (1) starting and through the air, thus called air-borne noise, and (2) occurring and through parts of the hull construction, thus called structure-borne noise (Viola, 2017). Upon entering a walled room, an air-borne noise spread by a noise source can cause vibrations. The vibrating wall causes noise(Zhang, Meng, & Zhang 2020). Thus the air-borne noise can transform into a structure-borne noise.

On the other hand, structure-borne noise that propagates and hits another room's wall can be delivered by the air in the room, thus turning into air-borne noise (Zhang, 2019). Such phenomena require corrective steps to reduce the noise occurring in the ship's engine rooms. Noise measuring was carried out in several parts of KM Sabuk Nusantara 71. The result indicated considerable noise in the engine room (see Figure 1).

Previous research showed that the Refined Composite Multi-Scale Depersion entropy (RCMDE) method demonstrated the new effectiveness of the

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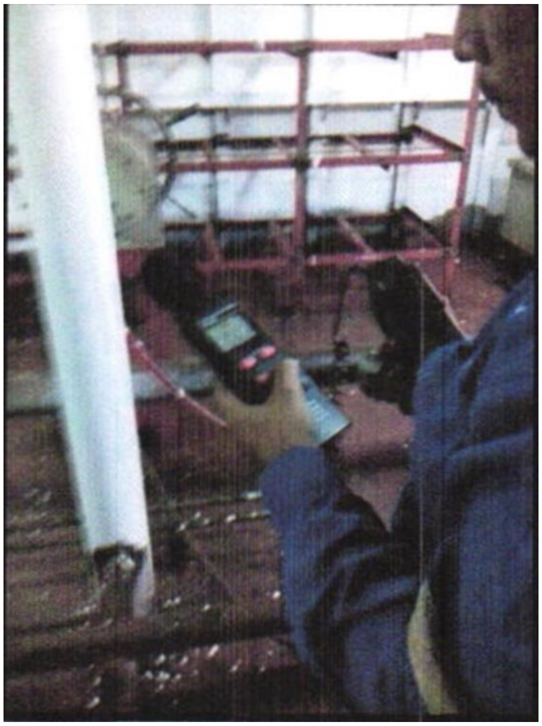

Figure 1. Ship noise measurement

dynamic non-linear method used in diagnosing signal processing. It shows the compatibility of ship noise radiation. Performance classification is described in a scale where the basis of the method is to compare the multi-scale permutation entropy (MPE) and k-nearest neighbor (KNN) methods. The classification results show the effectiveness of the calculation method of noise radiation generated from the ship (Yu-xing, 2020). On the other side in the research on the denoising method for ship noise shows if this method can reduce the noise in the real series of the signal generated by the ship. The noise reconstruction process can be described based on empirical data and a variety of decomposition modes. The purpose of the decomposition is to show the noise level of the signal that is obtained.

In addition, the dominance of the Spearman method results in Intrinsic mode function (IMF), which can improve the ratio from 2 dB to 4 dB or otherwise (Yang, Cheng, & Li, 2021). Meanwhile, in research about onboard ship noise, explain the need for an analytical discussion of noise in the passenger room of a passenger ship. Evaluations are presented in the form of criteria, types of sound sources that may be produced, such as the effect of using HVAC (Heating, ventilation, and Air Conditioning) as well as noise from the canteen, recreation room. This effect is different from the operation of the engine. The propulsion and the generator have different indicators. The results of the study show that the normative results are limited. The effectiveness based on the noise source component is the critical component (Borelli, 2021). Other experimental research shows the results extracts noise based on two-scale parameters. The results of the extraction of these methods can be used as an archive for the comparative classification of the noise radiation generated by the ship (Yu-xing, 2021).

Table 1. Ship main size

Description	Score	Unit
LOA (Length of Over All)	68.5	meter
LBP (Length between Perpendicular)	63.00	meter
B (Breadth)	14.00	meter
H (Hight)	6.20	meter
T (Draught)	3.50	meter
DWT	2000	Ton

Nevertheless, in each of these studies, the application is carried out on passenger ships, considering that this passenger ship has a level of comfort that must be considered. The concept of noising calculation is only centered on the simulation and not correlated with field measurements. This research tries to prove the difference in noise produced before or after the construction addition. What is more of concern is that in this section, the measurement in the engine room construction affects the noising of the part of the ship.

The method used in this research is to compare the calculation of noising in the conditions before the addition of construction and after the addition of construction for later comparison with numerical calculation data. This study aims to obtain the characteristics noising value before and after adding the side deck girder in the engine room of 2000 DWT ship. The result is expected to provide some recommendations to increase the comfort of ship passengers based on BKI Regulations.

2. Materials and Methods

In this study, the ship used was KM. Sabuk Nusantara 71 with the main sizes, as can be seen in table 1. The flow of the method used is based on the measurement of the noise level and then compared with the BKI rules. Then after an unsuitable result is obtained, an evaluation of the factors that can reduce noise can be carried out. The evaluation results are then compared with the analysis of the results of noise measurements, as shown in Figure 2.

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Table 1. Main Size of the Ship

Description	Score	Unit
LOA (Length of Over All)	68.5	meter
LBP (Length between Perpendicular)	63.00	meter
B (Breadth)	14.00	meter
H (Hight)	6.20	meter
T (Draught)	3.50	meter
DWT	2000	Ton

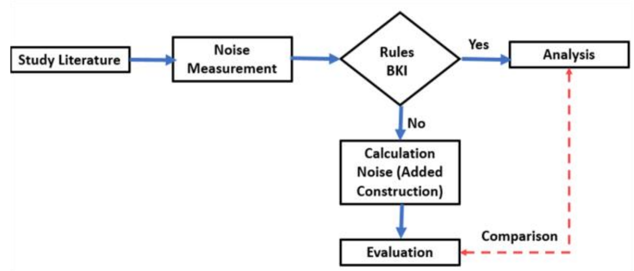

Figure 2. Research Flow

From the ship construction, the engine room section was previously seen from the need for additional construction. Very complex engine room construction design, the reinforcement system uses T-profile. The method used is the calculation according to the numerical approach assisted by computational software. The approximation to the calculation of the formula decomposition noising signal itself is outlined in the Equation 1.

$$u_k(t) = A_k(t)cos\,[\varphi_k(t)] \quad (1)$$

Where $A_k(t)$ is the amplitude of $u_k(t)$, and $A_k(t)>0$;$\varphi_k(t)$ is phase of $u_k(t)$ **.** After get equation 1 to get instantiated frequency of $u_k(t)$, calculation is done by following Equation 2.

$$\omega_k(t) = \frac{d\varphi_k(t)}{dt} \quad (2)$$

However, in equation 2 is assumed $\omega_k(t) > 0$. After that, in the analytical signal calculation, respond in the $u_k(t)$ as in Equation 3.

$$\left(\delta(t) + \frac{j}{\pi t}\right) * u_k(t) \quad (3)$$

Where $\delta(t)$ is impulse function on equation number 3, depiction of the sound signal at the sound source in the ship's engine room is presented in Figure 3. After the calculation values are obtained, they are grouped to be analyzed and compared. From equation number 1, the comparison uses a combined graph to determine the maximum value of noising after and before adding the side girder construction.

3. Results and Discussion

Based on the measurement results, it is reviewed into several points representing the noising that occurs on the ship while operating. The measurement results can be seen in Figure 4. Figure 4 shows the most critical noise conditions are found in the accommodation room, navigation room, and engine room. The three sections do not meet the standards of BKI rules. The engine room is the part that is most affected by the noise level, which is relatively high. After adding the T-profile side deck girder construction with the size of FB 180 x 8 mm, FP 75 x 10 mm. depicted in Figure 3 in the section shown in green color is an additional construction of the side deck girder.

Then the calculation is carried out according to equation 1, in the engine room showing the maximum value at intervals of 0-30 seconds, at a value of 62 dB. From the previous maximum value based on Figure 4 in the engine room, 127 dB, there is a decrease in value of 0.47%, as shown in Figure 5.

The accommodation room showed the maximum value at intervals of 0-30 seconds, at a value of 57 dB.

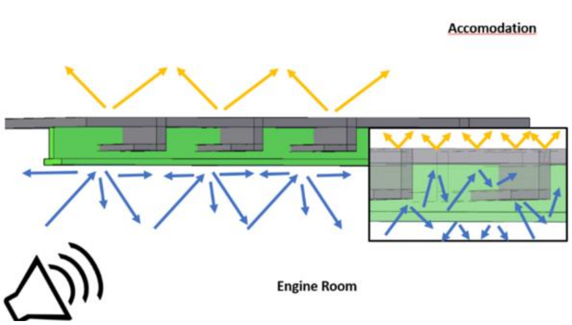

Figure 3. Noise Signal distribution

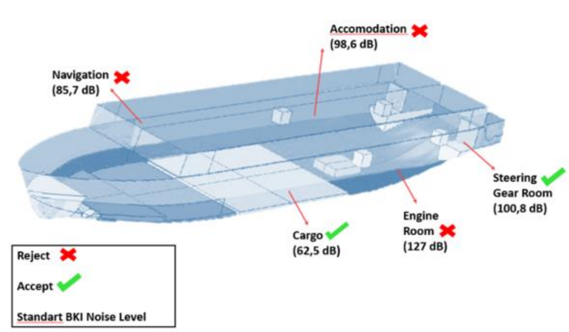

Figure 4. Result Noising Test

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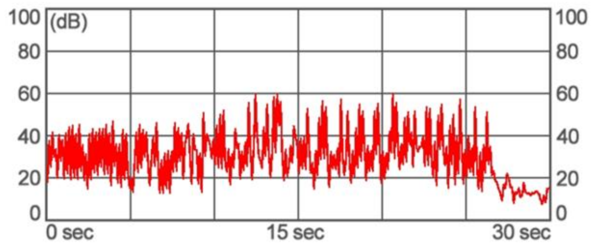

Figure 5. Noising calculation in the Engine room

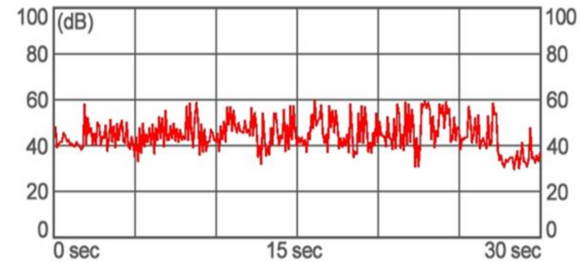

Figure 6. Noising calculation in the accommodation room

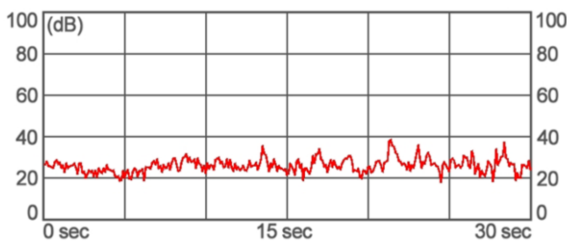

Figure 7. Noising calculation in the navigation room

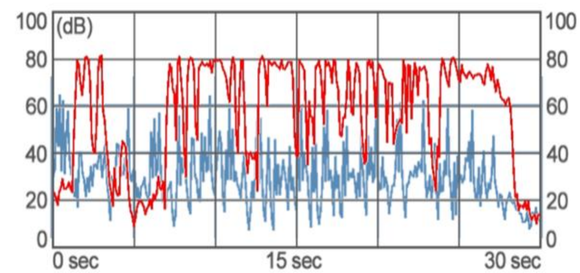

Figure 8. Comparison noising calculation in Engine Room

From the previous maximum value based on Figure 4 in the accommodation room, 98,6 dB, there is a decrease in value of 0.41% shown in Figure 6.

The navigation room showed the maximum value at intervals of 0-30 seconds, at a value of 37 dB. From the previous maximum value based on Figure 4 in the navigation room, there is a decrease in value of 0.56% shown in Figure 7. Then after comparing the noise calculations in the engine room before. After adding the side deck girder construction in the ship engine room, the results are obtained at intervals of 0-30 seconds, at a maximum value of 83 dB become a maximum value 62 dB. There is a decrease in value of 0.25% as shown in Figure 8. From Figure 8, the graph shows that the maximum and minimum values in the section before the addition of construction are on average between 80-40 dB. Then the maximum value and minimum value of the graph on the cross-section after the addition of construction has an average area of 55-20 dB. This shows that the effect resulting from the addition and planning of the modulus profile can influence the propagation of the sound wave signal in the vicinity. So from the comparison results of these calculations can be analyzed together, that the application of the addition of side deck girder construction is quite appropriate.

4. Conclusion

Noise becomes something that reduces the level of comfort. Therefore need an additional construction that can reduce the vibrations that occur. The construction planning modulus of calculation succeeds in making noise from the results shown at the beginning of the measurement. Adding construction is one of the alternatives in reinforcing to reduce the noise wave signal that occurs. Based on the analysis, there is a decrease of 0.47%, 0.41%, and 0.56% in the engine, accommodation, and the navigation room, respectively. Evaluation results from adding a sized T profile FB 180 x 8 mm FP 75 x 10 mm, able to reduce range curve of nosing on before the addition of the construction is on an average between 80-40 dB. After the addition of the construction has an average area of 55-20 dB. This shows that the effect resulting from the addition and planning of the modulus profile can influence the propagation of the sound wave signal in the vicinity.

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