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To cite this article: M Hustim *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **419** 012167

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Study of correlation between noise and disturbance to workers in the Soekarno Hatta Area of Makassar

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Abstract. Soekarno Hatta Port, located in Makassar City, is one of the largest ports in Indonesia. Activities with a tight schedule at this port are giving many impacts on the surrounding environment, one of them is noise. This study aims to analyze, predict and to map noise levels in the Soekarno Hatta port area and find out the correlation between noise and disturbance to workers. This study has seven observation points in the work environment and the environment of port interests, which are divided into 3 zones. The study was conducted on 29 November 2018 and 6 - 7 December 2018. The results showed that the average noise level was 75.1 dB. This figure has exceeded the noise threshold set in Minister of Environment No.48 in 1996. Predicted results using the 2008 ASJ RTN model show a large difference with the noise measured, which is 64.5 dB without horn sound and 64.7 dB with sound horn. Contour depiction and noise distribution mapping using Surfer 12 program which represents red, yellow and green contours for the highest to lowest noise levels. For the relationship between noise and interference with workers, it was analyzed using the SPSS program through a questionnaire distributed to 32 respondents. The results show a correlation coefficient of 0.398 and a significance of 0.024 which means that the disturbance in workers has a relationship with the noise level in the workplace.

1. Introduction

As an archipelago that has a large sea and a long coastline, the maritime and marine sector plays an important role for Indonesia. Indonesia's geographical position is very strategic. Indonesia is located between a crossing of two continents and two oceans, which makes the Indonesian sea area the vein of world trade.

Despite its status as a maritime country, Indonesia still experiences imbalances in development. The uneven development is caused by several factors, including difficulty in distribution and transportation, lack of attention from the government and the community, and the lack of adequate supporting facilities. One way that the government can do to overcome the above problem is to use the Sea Toll concept. One of the major ports that are expected to be able to support the Sea Toll concept is the Soekarno Hatta port managed by PT Pelindo IV (Persero) Makassar [1]. This port plays an important role in terms of transportation and economy in eastern Indonesia. Activities undertaken in this port area include as a place for berthing, as a means of transportation of goods and people, as well as a place for loading and unloading of goods. Activity at this port impacting the country's economy. Therefore facilities such as terminal docks, cranes, and warehouses are needed [2]. The impact that



will arise from activities at the port is noise. Noise is an unwanted sound, which can disturb humans, animals, to other natural components. Noise at the port arises due to port activities, especially leaning and anchoring of ships and loading and unloading of goods, which involve humans, motorized vehicles, and heavy equipment [3].

Therefore, it is very important to know about the noise level at the port and how to control it. The high level of noise due to the unloading of goods and people can be handled using prediction models. The noise prediction model used in this study is the 2008 ASJ-RTN model that can provide an overview of traffic noise conditions [4]. Based on the results of the prediction model, it is expected to provide an overview of traffic noise conditions in the Soekarno Hatta Makassar port area, where later on these results can provide a solution on how to overcome the noise problem. This type of study is quantitative research. Primary data obtained directly from observations in the port area, while secondary data are other supporting information. Data obtained from the direct measurements are the number of traffic volume, vehicle speed, number of horns, vehicle classification, environmental conditions, noise levels and worker perceptions of disturbance.

2. Methodology

2.1. Research time and location

The study was conducted in approximately six months, starting with collecting some literature studies, preliminary surveys, data collection and data processing. The data collection process was carried out for three days on working days, namely November 29, 2018, and December 6-7 2018 from 08.00-18.00 WITA. The study was conducted on seven sections of the Soekarno Hatta port area consisting of loading and unloading zones, warehousing, offices and trade, and the port of interest. The research location can be seen in figures 1 and 2.

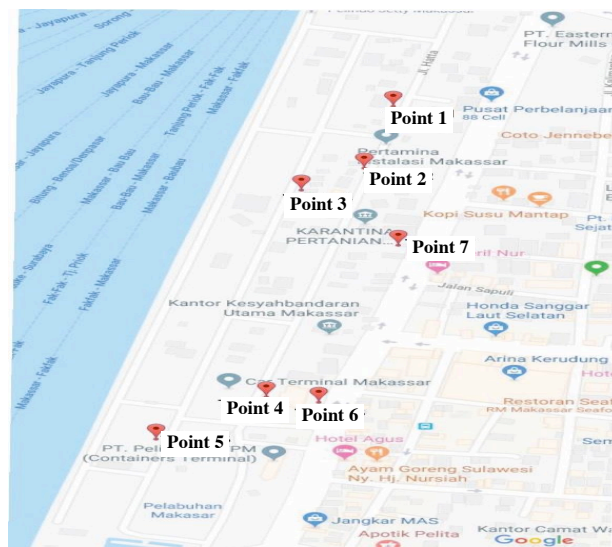


Figure 1. Observation point location map

2.2. Data collection techniques

Data collected are noise level, traffic volume, vehicle speed, and the number of horns. Vehicles that are the object of research are Motorcycle, Light Vehicles, and Heavy Vehicles. Measurements of 10 minutes represent 1-hour condition, and the measurement conducted for 11 hours. Other than vehicle data, coordinates and geometric data of the measurement point road were recorded as well as. Questionnaires were distributed to 32 workers to obtain the perception of noise around their working space.

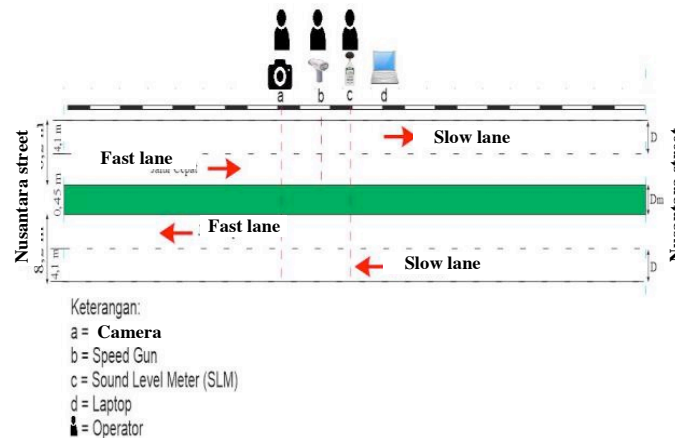


Figure 2. Survey Tools and Operator’s Position

2.3. Data analysis

First analysis of the noise level by measurements, after that analysis of noise level prediction using the 2008 ASJ-RTN method. Analysis of predictive noise levels is calculated using the 2008 ASJ RTN method to facilitate data input and running output using Fortran 95. Data needed for inputting are average speed, the volume of each type of vehicle, number of horns for each type of vehicles, number of lanes, lane width, median width, distance of the prediction point to the sound source, and noise data. The distribution of the noise can be known using the Surfer12 program. This program needed to draw the pattern of noise distribution, which is classified by color. The relationship of noise levels with disturbances for workers during their work can be known by analyzing the questionnaire data using the Guttman scale method [5].

3. Results and Discussion

3.1. Noise level measurement results

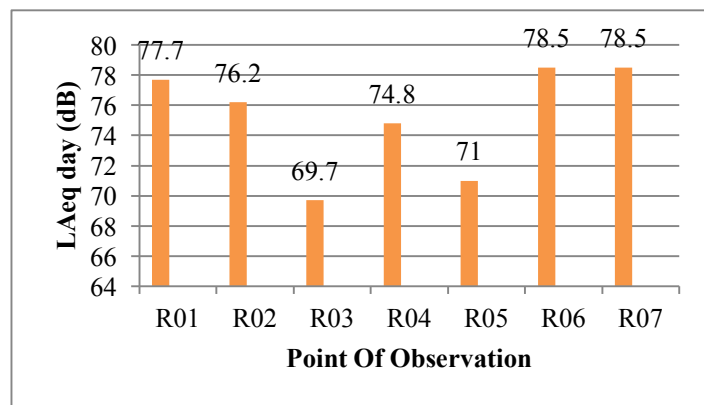


Figure 3. Traffic noise level throughout all observation points.

From figure can be seen that the average traffic noise level of all observation points in the Soekarno Hatta harbor area is 75.1 dB. The average value did exceed the noise level quality standard, which is 70 dB.

3.2. Traffic volume

Traffic volume on A.P. Pettarani can be seen in figure 4.

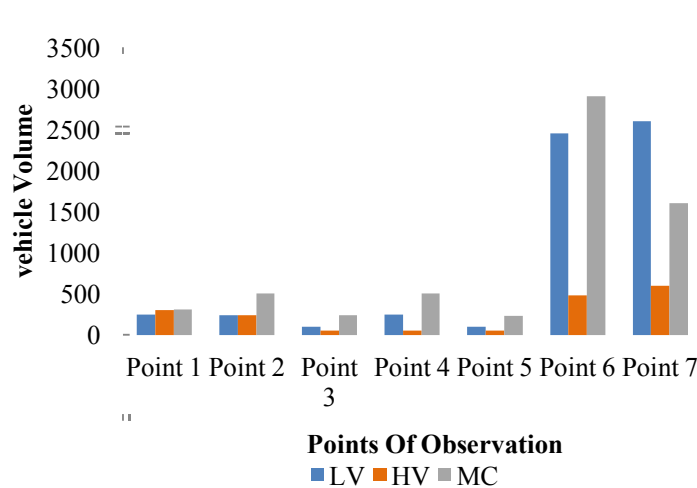


Figure 4. The volume of road traffic in the Soekarno Hatta port area.

From figure can be seen that the maximum vehicle volume is MC, and the minimum vehicle volume is HV. The average volume of MC is 890 vehicles/day. The average volume of LV is 815 vehicles/day. The average HV volume is 249 vehicles/day.

3.3. Speed

The graph of the average speed on the road section of the Soekarno Hatta port can be seen in Figure 10. In figure 5, it can be seen that the average LV speed is 25 km/hr, the average HV speed is 23 km/hr and the average speed of MC average is 25 km/hour.

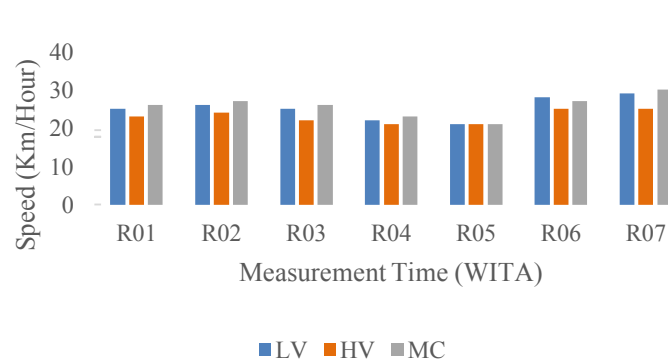
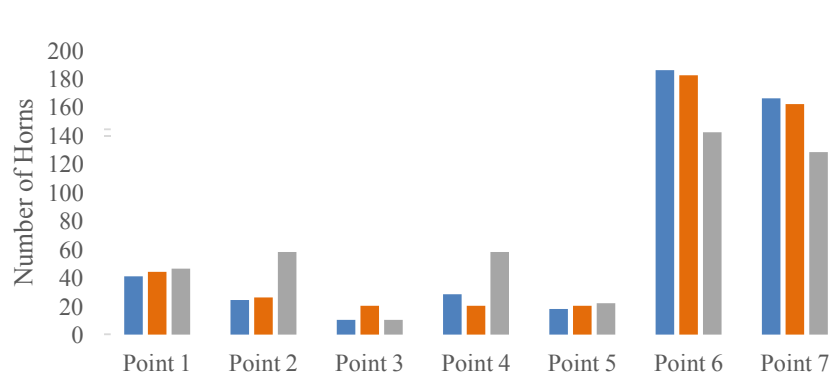


Figure 5. The average speed of Soekarno Hatta port area vehicles.

3.4. Number of Hons

The number of horns on Soekarno port area seen in below.



number the Hatta can be figure

Figure 6. The number of horns in Soekarno hatta harbor area

Based on figure 6, it can be seen that the average number of LV horns 73 times/hour, the average number of HV horns is 70 times/hour. And the average number of MC horns is 67 times/hour.

3.5. Noise prediction

The prediction model used in this study is the 2008 ASJ-RTN. The 2008 ASJ-RTN model is divided into two conditions. They are steady and unsteady states. The noise prediction this time uses the ASJ-RTN 2008 model for a steady-state. It is because the results of predictions using unsteady traffic produce noise level data above from the results of measurement noise levels, which can indicate that the predicted value is invalid. And referring to previous research that steady traffic is better for traffic noise prediction in Makassar City even though the speed is still low, that is, 20 km / h to 40 km / h and the traffic flow is heterogeneous. Prediction results for both situations can be seen and compared in table 1 below.

Table 1. Prediction results.

Point of observation	LAeq,day Measurement (dB)	LAeq, day Prediction		Difference	
		No horn (dB)	With horn (dB)	No horn (dB)	With horn (dB)
R01	77.7	63.4	63.8	14.3	13.9
R02	76.2	63.2	63.7	13.0	12.5
R03	69.7	57.6	57.7	12.1	12.0
R04	74.8	64.2	64.4	10.6	10.4
R05	71.0	58.1	58.2	12.9	12.8
R06	78.5	73.1	73.4	5.4	5.1
R07	78.5	71.9	72.1	6.6	6.4

An overview of the predicted results of the two situations can be seen and compared in figure 7 below.

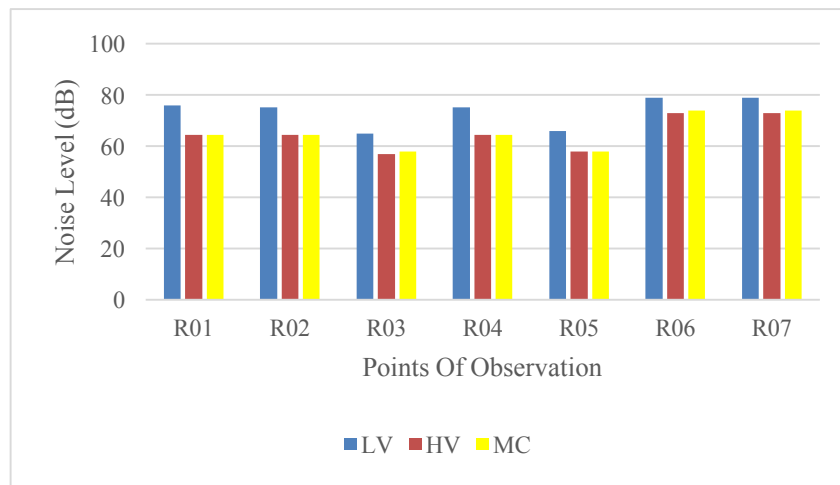


Figure 7. Comparison of noise level measurement results and ASJ RTN-2008 prediction results.

All noise level prediction values, both without horns and horn sounds, are below the measured noise level. The average measured noise level was 75.1 dB; meanwhile the average noise prediction without a horn sound is 64.5 dB, and the average noise prediction with a horn sound is 64.7 dB. The difference between LAeq, day prediction results with measurements at points R01 - R05 ranges between 10, 4 dB - 14.3 dB, while the difference at points R06 - R07 ranges from 5.1 dB - 6.6 dB. It shows that there is a quite big difference between the observation points in the port work environment, i.e., R01 - R05 and the observation points in the port interests' environment, R06 - R07 on Nusantara Road. This big difference occurred on five points, and there are other factors that affect noise besides the volume, speed, and number of vehicle horns. Those other factors include loading and unloading of goods, parking of vehicles, especially heavy vehicles (HV), checking and repairing of trucks carried out by drivers that occur around the observation point. Goods loading and unloading activities carried out using heavy equipment such as cranes, pallets, and forklifts can be said to be another factor that greatly influences the environmental conditions around the observation site.

The big difference between measured noise level results with predictions can be influenced by the loading and unloading of goods using heavy equipment. The sound pressure level produced from heavy equipment is 100 dB. It will certainly affect the noise level measured. Based on the calculation of the 2008 ASJ-RTN noise level, data validation was performed. First of all, a t-test is performed to determine the relationship between the noise of the measurement results and the predicted results. Noise level prediction without horns and with a horn of $8.23 > 2.44$ and $8.09 > 2.44$. So it can be concluded that there is a significant difference between the measurement results and the predicted results (H_0 is rejected, H_a is accepted).

The prediction results are tested to determine the suitability of the calculation with the prediction. This test is done by calculating Pearson correlation and Root Mean Square Error (RMSE). Pearson correlation and RMSE function to measure the level of success and accuracy of the model we use in predicting. For prediction results without horns obtained Pearson correlation value of 0.87 and RMSE 2.05. As for the prediction results with the sound of the horn, Pearson correlation values obtained 0.88 and RMSE 2.04. The validation results show that this model has a high enough RMSE value so that the value produced by this model is not so close to the variation in its observation value. So, this model is not yet reliable enough to be used to predict noise in the port area. It proves that the observation point on the port's road section has a big difference between measured LAeq, day, and predicted LAeq, day.

3.6. Noise level spread patterns

Noise level distribution patterns can be created using the Surfer program. The map is created by entering the coordinates of the measurement location point. Latitude and longitude as variables X and Y then LAeq day value as variable Z. The results of the mapping of the distribution of noise levels in the Makassar Soekarno Hatta port area can be seen in figure 8.

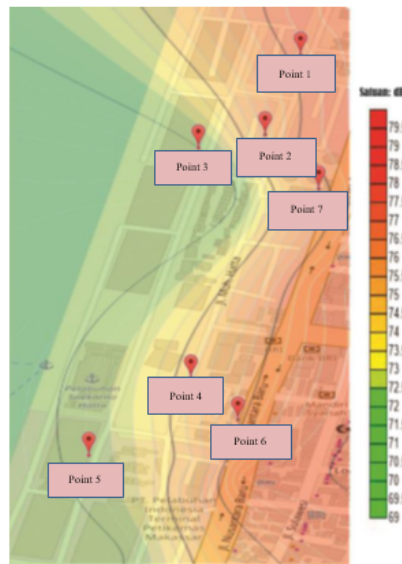


Figure 8. Noise level distribution pattern.

Based on the results of contour mapping and noise level distribution, it can be seen that there are three colors in this distribution, which are represented by green, yellow and red. Green indicates the level of noise between 69 - 72.5 dB; the yellow indicates noise of 73 - 76 dB, while the red color indicates the noise level of 76.5 - 79.5 dB. The pattern of noise level distribution is determined by color. We can see that the warehousing area (R05) and part of the stockpile area (R03) covered with green while the other stockpile areas, namely R01 and R02 and the Office area (R04) covered with yellow. It indicates that the two areas within the working area of this port have passed the noise level standard stated in the Minister of Environment Decree. No. 48 of 1996, which limited by 70 dB. Meanwhile, for the Nusantara road sections, R06 and R07, covered with red.

3.7. Analysis of the relationship between noise level and disturbance towards worker

A survey using a questionnaire was conducted to find out the correlation between noise level around the port and its disturbance towards workers in the Goods, Miscellaneous Business and Equipment (PBAU) division. The questionnaire survey was distributed to 32 workers with details of 17 operators and 15 tallymen who have work shifts from 08.00 - 16.00 WITA. The scale used in this study is the Guttman scale. The independent variable is the noise level in the port area, and the related variable is the disturbance experienced by workers such as emotional disturbance, communication, and worker productivity. From the variables above, the hypothesis that appears is: H_0 = There is no relationship between noise in the port area with H_1 workers = There is a relationship between noise in the port area with workers. Correlation Calculation in this study using the Spearman formula.

In calculating the Spearman correlation, the authors use the SPSS (Statistica Product and Service Solutions) application to get the correlation coefficient and the significance of the relationship. From the calculations in the SPSS application, a correlation coefficient value of 0.398 was obtained which proves that the correlation between the x and y variables is in the moderate category, it shows the relationship between the noise level and the disturbance experienced by workers. Then from the SPSS

program also obtained a significance value of a relationship of 0.024. This value is smaller than 0.05, proving the disturbance experienced by workers is influenced by the noise level.

Table 2. Correlation table.

			Y	X
Spearman's rho	Y	Correlation		
		Coefficient	1.000	.398''
		Sig.(2-tailed)		.024
		N	32	32
	X	Correlation		
		Coefficient	.398''	1.000
		Sig.(2-tailed)	.042	
		N	32	32

From the correlation above, we can see that noise affects the conditions of workers. The average noise for 5 points in the port work area is 73.8 dB. This figure has exceeded the noise standard for the port area determined by Government, which is 70 dB. Because the noise level had exceeded the standard, it is reasonable if the noise in the port area is high and influenced the physical and emotional of the workers. Besides KepMenLH no. 48 of 1996, noise can also be compared with PerMenKes No. 70 of 2016 concerning Standards and Requirements of the Industrial Work Environment. This regulation regulates the noise level received by workers based on the duration of work. The average noise for the 5 points in the port working area is 73.8 dB, which is still below the threshold value of noise that can be received by workers for 8 hours duration of noise exposure that is 85 dB. Even though this value is still below the worker's threshold, it has passed the noise threshold that can be discharged into the environment.

4. Conclusion

The average level of noise from the measurements in the port area of Soekarno Hatta is 75.1 dB. It can be seen that the value has exceeded the noise standard for the port area determined by Ministerial Decree of the Minister of Environment No. 48 of 1996, which stated the limit to 70 dB.

The predicted results of the average noise level with the 2008 ASJ - RTN model without a horn sound of 64, 5 dB, and has a Pearson Correlation value of 0.87 and RMSE of 2.04. While the average prediction results by adding the horn sound are 64.7 dB, which has a Pearson Correlation value of 0.89 and RMSE of 2.03, if the prediction results are compared with the results of direct measurements there will be a significant difference which indicates that the noise level is affected by the capacity of the road and other activities around the measurement location.

There are three colors to represent noise mapping in the Soekarno Hatta port area of Makassar. They are green for intervals of 65-70 dB, brown for intervals of 70-75 dB, and red for intervals of 75-80 dB. The dominant colors are brown and red for the goods stacking area and road section of Jalan Nusantara.

Workers' perception of noise in their workplaces had its H_0 rejected, and H_1 accepted. It shows the relationship between noise in the port area with disruption experienced by workers such as emotional disturbances, communication, and work productivity.

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