International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 9, Issue 12, 2019

Analysis of Noise Effects on Defect Levels and Work Productivity at PT. IndustriMarmer Indonesia (IMI)

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The research is a cross-sectional experimental study. This study used earplugs for operators working in production processes, to determine the effect of noise on product defect levels and productivity. The noise level received by each operator exceeded the allowed Hearing Threshold Level (HTL). Noise affects hearing health and operator comfort. After controlling noise through the use of Protective Equipment Ear (PEE), the work of operators cutting blocks increased, defective products decreased 1.73%, and the labour productivity index results increased 45.37%. For cross-cutting operators, defective products declined 3.38%, and labour productivity increased 44.47%. From research carried out the company was expected to pay attention to the comfort and health of workers, to control noise by increasing the damping material on a noisy machine, in addition to using ear protection such as ear plugs or earmuffs.

Key words: *Noise, Noise Effect Against Product Defects and Labour Productivity.*

Introduction

Along with the development of today's society, marble is one commodity that has a large market opportunity both inside and outside the country. Marble is normally used for tiles, ornaments, and waste can be used for multiple items. ‘PT Indonesia Marble Industry’ (IMI) is a company that processes marble. IMI is located in the village of Besole Tulungagung. To meet the need for raw materials, the company has its marble mine situated in Besole. In mining activities of it uses an excavator and hydraulic rock breaker.

IMI is a private company. Its activities include mining, namely the processing of marble (onyx). The company needs a highly optimized performance. Employees become a factor that realizes optimal performance. Marble is produced sequentially, with processes including marble cutting. A block is used to cut marble blocks into slabs. A large slab sheet is then cut at the edges so that the average worker uses the cross-cutting machine. Then the process of flattening on one of its surfaces occurs, and marble is cut back to the desired size using a calibrated machine, which is a less flat surface with holes - small holes coincidence process will be conducted. The latter method is smoothing marble surface with a polishing machine so that the marble surface is smooth and beautiful.

From the processes mentioned above, noise exceeds the threshold (Susihono and Rini, 2013). That is especially so in the engine block cutting and the cross-cutting machine that has a noise threshold of 99.3 dB in the engine block cutting, and cross-cutting machine parts; namely 109.7 dB.

Noise can cause hearing loss in the operator or people near the process, causing communication disorders and decreased work productivity (Hasanuddin, 2014). The number of defective products resulting from operator error while processing the marble rocks resulted in losses for the company (Sajiyo and Prasnowo, 2017). Hence the effort to control high noise levels, resulting in companies having to implement safety management systems in the work environment (Wignjosoebroto, 2000). The carrier block cutting and cross-cutting are particularly required to use Protective Equipment Ear (PEE). Earplugs can reduce the noise level of 10-20 dB, and earmuffs can parse the noise level between 20-35 dB, to prevent accidents at work which would result in losses for the company (Kurnia, 2005). The existing frequencies determine the tone of the noise (Widiastuti, 2011; Gamba, 2017). The intensity or energy flow per unit area was expressed in logarithmic units called decibels (dB) by comparing it with the fundamental strength of 0.0002 dyne / cm2; the power of sound with the proper frequency of 1000 Hz can be heard by the ordinary ear (Manuaba, 1992).

Methods

The research is a cross-sectional experimental study (Sudjana, 1996). Experiments in this study used earplugs for operators working in the production process, to determine the effect of noise on the level of product defects and productivity. Research data was drawn from the machine operator cutting blocks, and a cross-cutting machine operator. Measurement was implemented for six days, with sampling as much as five times for every production, and to process the data validity a statistical test assessed the adequacy of the treatment of data, through a normality test and a homogeneity test (Walpole and Myers, 1995).

Results and Discussion

Wearing earmuffs is usually more efficient than earplugs and can reduce the intensity of the noise to the auditory nerves. These tools can reduce the intensity of sound about 10-25 dB (Suma'mur, 1981). The noise level before using the earmuff on the cutting block operator was measured at 106.3 dB, and the cross-cutting operator at 94.2 dB. Thus, noise level exposure on both carriers exceeded the allowed Hearing Threshold Level (HTL), which is 85 dB continuously for 8 hours. Earmuff then controlled the damping power by 35 dB. Table 1 compares the noise levels before and after control.

Table 1: Comparison of noise levels before and after control

No.	Description	Before Controlling	After controlling
1	Operator of Block Cutting	106.3dB	71.3 dB
2	Operator of Cross Cutting	94.2 dB	74.2 dB

From Table 1, the noise level after control for the cutting block operator using the earmuff with damping power of 35 dB, and for a cross-cutting operator using the earplug with 20 dB damping power, is reduced.

Analysis of working measurement time below already passed the stage as follows:

1. adequacy test (Walpole and Myers, 1995)
2. normality test
3. homogeneity test

The data below is the processing data in a day that involves five observations whenever the production occurs, taking the average time in a day. More details are shown in Table 2 through to Table 11:

Analysis of the product defect levels, to determine how much influence the control of noise has, before and after control. The percentage of disability is calculated using the following formula 1:

Formula determining defective products (Sajiyo and Prasnowo, 2017)

$$\%Pc = \frac{\sum Pc}{\sum P}\ x\ 100\% (1)$$

Table 2: Working time measurement data block cutting operator before control

Days	Working Time (minutes/day)	Average Time (minutes/day)	*performance rating*	Normal Time (minutes/day)	allowance (%)	Standrd Time (minutes/ day)	Output Standrd (units/ day)
1	420	89	1,03	91,67	14,52	107,24	31,33
2	420	90	1,03	92,70	16,42	110,91	30,29
3	420	90,5	1,03	93,22	13,09	107,25	31,33
4	420	89,5	1,03	92,19	17,14	111,25	30,20
5	420	90,5	1,03	93,22	13,81	108,14	31,07
6	420	91	1,03	93,72	15,47	110,88	30,30
Average	420		1,03	92,79		109,28	30,75

Table 3: Working time measurement data block cutting operator after control

Days	Working Time (minutes/day)	Average Time (minutes/day)	*performance rating*	Normal Time (minutes/day)	allowance (%)	Standrd Time (minuts / day)	Output Standard (units/day)
1	420	78	1,03	80,34	9,52	88,79	37,84
2	420	78,75	1,03	81,11	11,19	91,33	36,79
3	420	78	1,03	80,34	9,28	88,56	37,94
4	420	80	1,03	82,40	9,76	91,31	36,80

Days	Working Time (minutes/day)	Average Time (minutes/day)	*performance rating*	Normal Time (minutes/day)	allowance (%)	Standrd Time (minuts / day)	Output Standard (units/day)
5	420	79,75	1,03	82,14	10	91,27	36,81
6	420	80,5	1,03	82,92	10,47	92,61	36,28
Average	420		1,03	81,54		90,65	37,08

Table 4: Working time measurement datas cross cutting operator before control

Days	Working Time (minutes/day)	Average Time (minutes/day)	*performance rating*	Normal Time (minutes/day)	allowance (%)	Standard Time (minutes/day)	Output Standard (units/day)
1	420	90	1,01	90,90	15,95	108,15	186,41
2	420	89,25	1,01	90,14	14,76	105,75	190,64
3	420	86,25	1,01	87,11	14,76	102,20	197,27
4	420	87	1,01	87,87	14,28	102,51	196,67
5	420	86,5	1,01	87,37	17,38	105,74	190,65
6	420	90,5	1,01	91,41	15,23	107,83	186,97
Average	420	88,25	1,01	89,13	15,39	105,36	191,43

Table 5: Working time measurement datas after block cutting operator before control

Days	Working Time (minutes/day)	Average Time (minutes/day)	*performance rating*	Normal Time (minutes/day)	allowance (%)	Standard Time (minutes/day)	Output Stndrd (units/ day)
1	420	78,75	1,01	79,54	9,04	84,17	239,52
2	420	79,25	1,01	80,04	10,71	84,70	238,01
3	420	80	1,01	80,80	7,14	85,50	235,78
4	420	78,5	1,01	79,29	9,52	83,90	240
5	420	79	1,01	79,79	8,33	84,43	238,77
6	420	81	1,01	81,81	7,61	86,57	232,87
Avera	420	79,42	1,01	80,21	8,73	84,88	237,54

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Table 6: Analysis of product defects before control on block cutting operator

No	Day / Date	Defect Types			Total Production per day	Percentage%
		Chunk side Marble	Marble Cracks	Marble Broken		
1	Monday	-	1	1	38	5,26 %
2	Tuesday	-	-	-	40	0,00 %
3	Wednesday	-	1	-	39	2,56 %
4	Thursday	-	2	-	38	5,26 %
5	Friday	-	-	-	40	0,00 %
6	Saturday	-	-	1	39	2,56 %
	Total	0	4	2	234	15,65 %
	Average	0	2	1	39	2,60 %

Table 7: Analysis of product defects after control at block cutting operator

No	Day / Date	Defect Types			Total Production per day	Percentage%
		Chunk side Marble	Marble Cracks	Marble Broken		
1	Monday	-	1	-	39	2,56 %
2	Tuesday	-	-	-	40	0,00 %
3	Wednesday	-	-	-	40	0,00 %
4	Thursday	-	-	1	39	2,56 %
5	Friday	-	2	-	38	5,26 %
6	Saturday	-	-	-	40	0,00 %
	Total	0	3	1	236	10,39 %
	Average	0	1,5	1	39,33	1,73 %

Table 8: Analysis of product defects before control on cross cutting operator

No	Day / Date	Defect Types			Total Production per day	Percentage%
		Chunk side Marble	Marble Cracks	Marble Broken		
1	Monday	8	5	3	224	7,14 %
2	Tuesday	10	7	-	223	7,62 %
3	Wednesday	15	-	-	225	6,67 %
4	Thursday	9	6	2	223	7,62 %

5	Friday	9	5	2	224	7,14 %
6	Saturday	12	3	-	225	7,14 %
	Total	63	26	7	1344	43,33 %
	Average	10,5	5,2	2,33	224	7,22 %

Table 9: Analysis of product defects after control on cross cutting operator

No	Day / Date	Defect Types			Total Production per day	Percentage %
		Chunk side Marble	Marble Cracks	Marble Broken		
1	Monday	5	2		2231	3.90%
2	Tuesday,	6			2-232	3.45%
3	Wednesday	3			3-234	2.56%
4	Thursday	7	-	-	233	3.00%
5	Friday	5			4-230	3.90%
6	Saturday	8	-	-	232	3.45%
	Total	36	18	2	1 387	20.26%
	Σ average	6	4	2	231.17	3.38%

The above measures how much noise affects the level of product defects by an operator. Productivity analysis determines how much influence the control of noise has, before and after control.
The formula for determining how to measure the Productivity Index is the formula 2:

$$\text{Productivity Index} = \frac{(\text{output after}/\text{output before})}{(\text{ST after}/\text{ST before})} \ x\ 100\%(2)$$

Table 10: Measurement percentage level of productivity before control and after control by operator block cutting

Days	Before Control		After Control		Productivity Index (%)
	Standard time (min)	Output (units)	Standard time (min)	Output (units)	
Monday	107,24	31,33	88,79	37,84	145,88
Tuesday	110,91	30,29	91,33	36,79	147,50
Wednesda y	107,25	31,33	88,56	37,94	146,65
Thursday	111,25	30,20	91,31	36,80	148,46
Friday	108,14	31,07	91,27	36,81	140,37
Saturday	110,88	30,30	92,61	36,28	143,36

average	109,28	30,75	90,65	37,08	145,37

Table 11: Percentage level of productivity measurement control before and after control on cross cutting operator

Day	Before Control		Control After		Productivity Index (%)
	Standard Time (min)	Output (units)	Standard Time (min)	Output (units)	
Monday	108,15	205,41	84,17	239,52	149,83
Tuesday	105,75	205,75	84,70	238,01	144,43
Wednesday	102,20	210,60	85,50	235,78	133,82
Thursday,	102,51	208,78	83,90	240,29	140,62
Friday	105,74	212,30	84,43	238,77	140,86
Saturday	107,83	200,71	86,57	232,87	144,52
Avg	105,36	204,09	90,65	237,54	144,47

From Table 10 the results of measurements of productivity levels after the control can be increased up to 144.47%.

Conclusion

From the discussion of the results, based on the measurements, the following can be concluded. The noise level before using the earmuff on the cutting block is 106.3 dB. Before earplugs were used on cross cutting, operator exposure to noise levels on the cutting block exceeded the Hearing Threshold Level (HTL), which allowed at 85 dB continuously for 8 hours. It was then controlled using earmuffs; the power and earplug damping 35 dB, with a 20 dB power damping effect on the level of product defects.

Based on the measurement results, the level of noise impacts work productivity. Controlling noise impacts increased the operator performance for block cutting and cross-cutting.

The conclusion has been based on solving the problem, then obtaining the following advice:
In view of the noise received by the operator, there should be an improved evaluation of the impact of noise. That would minimize the level of workplace noise by using PEE, and/or installing a reducer on the machine, especially those whose noise levels exceed the HTL.

Steps should be performed to control noise and improve education, training and supervision, as well as carriers engaging in the selection of which PEE is used.

More in-depth research is needed, as to the noise impact on the productivity of the operator PT. IMI. The risks of noise on the comfort and well-being of all operators can then be known. Thus, the noise can be attributed to the department with the highest noise levels and the most disturbing operator.

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