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Potential Hazards and Risk Factors of the Work Environment in the Foundry Industry X

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Workers have a risk of work accidents and Occupational Diseases (PAK) caused by the work process, behavior at work, and the work environment. Identification of potential hazards and risk assessment is the first step to find hazards in the workplace and then carry out control measures to create a safe and healthy workplace. Knowing potential hazards, environmental risk values, and physical working conditions in the Metal Casting Industry of X. The method used in this study is a descriptive survey. The number of samples in this study were 36 workers. Data collection techniques are carried out through observation activities using sheetsJob Safety Analysis (JSA) and risk assessment sheets, interviews using interview guides, and measurements of physical working conditions usingenvironment meter. The data analysis carried out is descriptive analysis which provides an overview of potential hazards and environmental risk values. Potential hazards found in the metal casting industry CV Dwi Jaya Logam, namely 54 potential hazards which are divided into 2 levels of risklow, 10 levels of riskmoderate, 30 levels of risk high, and 12 levels of riskextreme. CV Mulya Jaya Metal casting industry identified 28 potential hazards divided into 4 risk levelslow, 4 levels of riskmoderate, 12 levels of risk high, and 8 levels of riskextreme. These potential hazards come from the physical work environment (temperature, lighting, and noise) and the production process at each work step. The results of measurements of the physical working environment in the form of temperature do not meet the requirements according to the Regulation of the Minister of Manpower of the Republic of Indonesia No. 5 of 2018, the average lighting measurement results are also. do not meet the requirements according to Regulation of the Minister of Health No. 70 of 2016, and the average noise measurement results meet the requirements according to the Indonesian Minister of Manpower Regulation No. 5 of 2018.

1. Introduction

CV Mulya Jaya's Metal Casting Industry has contributed to the Local Original Revenue (PAD) of Klaten Regency however, there are still several incidents of work accidents from mild to severe levels in the last 1 year in the molding, smelting, and finishing areas. The work accident cases include eyes exposed to iron gram grains, scratches caused by machines, pinched, crushed by steel material, tripping over work tools, touched by hot slabs, exposed to metal melts, and burns. This condition can occur because the work environment ignores government programs in the form of Occupational Safety and Health (K3).

CV Mulya Jaya's metal casting industry uses metal materials as raw materials for metal casting, namely aluminum, steel, iron, lead, copper, zinc, nickel, inoculants, magnesium. According to the Directorate of Occupational Health and Sports of the Republic of Indonesia (2012), workers who work using metal or producing metal are very at risk of health problems. Workers exposed to dust or aluminum vapors are at risk of respiratory tract disorders, eye irritation, impaired motor function, and accelerate the onset of Alzheimer's disease. Workers exposed to nickel are at risk of headaches, nausea, sinus cancer, lung cancer, and so on. Workers exposed to lead are at risk for chronic renal failure, nerve paralysis, hematologic anemia, etc.(1).

Law Number 1 of 1970 concerning Work Safety which regulates the obligations of management in conducting guidance in terms of accident prevention, fire eradication, improving occupational safety and health efforts, and providing first aid in accidents to workers. It is also regulated in the Regulation of the Minister of Health of the Republic of Indonesia No. 70 of 2016 that the industry must carry out hazard control efforts, environmental health efforts, and / or occupational health surveillance (2).

The results of the preliminary study showed that workers carried out work activities with physical environmental conditions that did not meet the requirements based on the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016, obtained the average lighting in the finishing area was only 76.24 lux, the average noise of the finishing area reached 87.46 dB, and the temperature of the casting area was 30oC. The purpose of this study is to know the potential hazards, environmental risk values, and physical working environment conditions in the form of temperature, lighting, and noise in the X Metal Casting Industry. The theoretical benefits of this research are to increase knowledge and add studies in the field of environmental health, especially Occupational Safety and Health (K3), while the practical benefits for CV Mulya Jaya managers and workers are as input and basis in the implementation of Safety and Health Work (K3).

2. Research Method

This type of research is a descriptive survey research to provide an overview of potential hazards and environmental risk values. Data collection techniques are carried out by observation using Job Safety Analysis (JSA) sheets and risk assessment sheets, interviews using interview guide sheets, and measurements using environment meter tools. Identification of potential hazards using JSA sheets starts from detailing the steps of the work from the beginning and analyzing the potential hazards contained in each step of the job, then

a risk assessment is carried out and control recommendations are given to reduce exposure to hazards of each type of work.

The analysis carried out is a descriptive analysis that provides an overview of potential hazards and environmental risk values. The analysis was carried out after field observations and interviews with workers. Identification of potential hazards is carried out using the Job Safety Analysis (JSA) method on work activities in the foundry industry CV Mulya Jaya and CV Dwi Jaya Logam. The hazard identification results are then assessed for the level of likelihood (likelihood) and impact (severity) expressed in the range from lowest to highest using the AS/NZS 4360:2004 standard. Furthermore, providing recommendations for occupational hazard control in the foundry industry CV Mulya Jaya and CV Dwi Jaya Metal.

3. Result and Discussion

Factors that cause hazards that cause work accidents in industry are unsafe conditions originating from the work environment, tools, materials and unsafe actions including lack of caution when working, not using PPE, and haste

Potential Hazards and Risk Values in CV Dwi Jaya Metal (Printing and Smelting Area)

Table 1. Results of Risk Assessment in Print and Smelting Areas

No.	Process	Bahanya Potential	Impact/Risk	Likeli-hood	Seve-rity	Risk level
1.	Print Manufacturing (Wet and Dry Process)	The average temperature of the print area does not meet the requirements of 34.9^{oC}	*Heat cramps*, *heat exhaution*, *heat stroke*	A	3	*Extreme*
		Silica-containing dust from printing sand can be inhaled	Respiratory distress, eye irritation, cough in favor, silicosis	A	3	*Extreme*
2.	Mold Making Kering method CO_2	Silica dust display	Diseases of silicosis, skin irritation, eye irritation, cancer	C	3	*High*
		Exposure to silica-containing dust from printing sand	Ciliatic disease, skin irritation, eye irritation, lung cancer	C	3	*High*
		Very smell of CO_2 gas sting	Nausea, headache, Turning,difficulties breathing,weak, visual impairment	C	3	*High*
		Smoke from pouring molten metal into print	Perch eyes, distractions breathing, change pulmonary function, pneumonia interstitial	C	3	*High*
3.	Metal smelting	Metal dust	Asthma, cancer, *pneumoconiosis*, irritation, dan *allergic alveolitis* eye irritation, disorders pernafasan	A	3	*Extreme*
		Inhaled gram iron powder	ARI, cough, disturbance breathing	A	3	*Extreme*
		Exposure to melting vapors from copper, iron and other materials	Eye irritation, skin irritation, System Interference	A	3	*Extreme*

			pernafasan			
		Smoke display from the furnace	Shortness of breath and impaired lung function-Published	A	3	*Extreme*
		Induction furnace used explode	Severe burns up to death	D	5	Extreme
		Hit by sparks and metal great liquid	Burns	A	3	*Extreme*
		Temperature conditions of the working environment which is high at 33.8^{oC}	*Heat stress,* dehydration, *heat exhaustion*	A	3	*Extreme*
		The display of metal smoke from the furnace peleburan	Eye irritation, disorders respiratory, and visual impairment	A	3	*Extreme*
4.	Liquid metal pouring into print	Ste Melting yield am	Eye irritation, respiratory distress	A	3	*Extreme*
5.	Mold Disasse mbly	Exposure to dust particles	Respiratory disorders, lung tissue damage	A	3	*Extreme*

Based on the identification of potential hazards in CV Dwi Jaya Logam, namely the printing area and the smelting area as a whole, 54 potential hazards were found from low, moderate, high, to extreme levels. Table 1 shows the potential hazards with the highest level of risk in each process. Work activities in the mold manufacturing process pose a potential hazard with the highest level of extreme risk, namely the average temperature of the print area that does not meet the requirements and dust containing silica from the mold sand can be inhaled. Based on measurement activities in the mold making area, an average temperature of 34.9oC was obtained which has exceeded the quality standard according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. Temperatures exceeding the Threshold Value (NAV) can cause heatstress, dehydration, fatigue, and workplace accidents(4).

Metal casting industry CV Dwi Jaya Logam uses a type of silica sand (SiO2) to make molds. The silica content is harmful to human health because it contains crystalline silica with the risk of experiencing silicosis disease and even causing death (5). Based on observations of workers in the print area, all workers had direct contact with the printing sand and did not use masks. Based on the risk assessment, the likelihood value is A and the severity is 3 with the extreme risk level. The process of making dry molds of the CO2 method also uses silica sand, based on observations on workers who grind silica sand and waterglass, workers do not use masks so that the results of the risk assessment obtained a likelihood value of C and consequency of 3 with a high risk level.

Workers drain CO2 gas through holes in the mold, this activity has the potential danger of a strong CO2 gas smell. Workers who often inhale CO2 gas have the potential to experience health problems including nausea, shortness of breath, headaches, dizziness, loss of consciousness. Based on the risk assessment, a likelihood value of C and severity of 3 is obtained with a high risk level. The dry mold drying process produces smoke from CO2 gas. The potential danger of fumes from CO2 chemical gas inhaled by workers can cause shortness of breath and lung disease.

Workers exposed to metal dust are at risk of asthma, cancer, pneumoconiosis, irritation, and allergic alveolitis. Workers also take and weigh grams of iron, it has the potential danger of inhaling grams of iron. Workers who inhale grams of iron are at risk of developing ARI. Based on the risk assessment, the likelihood value is A and the severity is 3 with the extreme risk level. Based on observations, there is a lot of metal vapor from the melting process. Workers exposed to metal vapors are more susceptible to increased symptoms of respiratory and lung function disorders. Workers are also exposed to furnace fumes, which pose a potential risk of respiratory distress.

The metal smelting process uses an induction furnace that has the potential to explode due to thinning of the furnace layer, the presence of an explosion can result in the risk of burns to death6). Based on observations, workers do not use Personal Protective Equipment, workers only use daily T-shirts and pants, flip-flops, and cloth gloves so that they cannot protect workers from sparks. The potential danger of sparks can cause minor burns, in addition to sparks that are in direct contact causing the clothes worn by workers to have holes.

The process of pouring liquid metal produces melted vapor, Inhalation of metal vapors can pose a risk of shortness of breath and impaired lung function. Workers are also directly exposed to dust from casting due to the absence of mask use when disassembling molds. Workers who breathe dust in the work environment have the potential to experience lung tissue damage, respiratory problems7). Based on the risk assessment, the likelihood value is A and the severity is 3 with the extreme risk level.

Table 2. Results of Risk Assessment in the Finishing Area

No.	Process	Potential Hazards	Impact/Risk	Likeli-hood	Seve-rity	Level Risk
	Dust from grinding	Respiratory disorders, pneumonia, bronchitis, pleural effusion, pulmonary edema		A	3	*Extreme*
	The average temperature *of* the unqualified	*Heat cramps*, *heat exhaution*, *heat stroke*, dehidrasi dan miliaria		A	3	*Extreme*

1	outer finishing area is 33.3^{oC}					
	Iron cutting powder	Pneumoconiosis, cancer, asthma, allergic alveolitis, and irritation		A	3	*Extreme*
	Dust from drilling iron, steel, and others	Annoyance Respiratory tract e.g. lung disorders		A	3	Extreme
	The average temperature of the unqualified inner finishing area is 32.5^{oC}	*Heat cramps*, *heat exhaution*, *heat stroke*, dehidrasi dan miliaria		A	3	*Extreme*
	Dust from turning containing metal	Central nervous system disorders, damage to blood cells, lung disorders to death		A	3	*Extreme*
	Scrap dust	ARI, skin irritation, eye irritation, respiratory tract disorders		A	3	*Extreme*
	Dust arising from the workpiece	Inspection Acute Respiratory Tract (ARI), skin irritation, decreased vital capacity of the lungs, disorders respiratory tract		A	3	Extreme
	Welding smoke display containing carbon monoxide gas, manganese, ozone, nitrogen dioxide, hydrogen florida	Damage to the kidneys and nervous system, asphyxia, deterioration lungs, fertility disorders		B	3	*High*
	Beam from welding machine	Cataracts, skin cancer, inflammation of the cornea to blindness	C		3	*High*
	Inhalation of solvents in the form of *thinner* containing toxic substances, namely lead and VOCs (*Volatille Organic Compouds*)	Cancer Respiratory disorders		C	3	*High*

Based on the identification of potential hazards in CV Mulya Jaya, 28 potential hazards were found. Table 2 shows the potential hazards with the highest level of risk in each process. Work activities in the finishing process pose potential hazards with the highest level of extreme risk including grinding processes that produce dust. Dust inhaled by workers over a long period of time can cause health problems including pneumonia, bronchitis, and respiratory problems

(8). Iron cutting work activities produce cutting powder that can cause pneumoconiosis, cancer, asthma, allergic alveolitis, and irritation (9). Work activities using drilling machines, lathes, and scrap machines also have potential hazards in the form of dust. Exposure to heavy metal dust can cause health problems including impaired kidney function, central nervous system disorders, damage to blood cells, to death (10). Based on the risk assessment, the likelihood value is A and the severity is 3 with the extreme risk level.

The welding process produces potential hazards with a high level of risk derived from welding fumes and rays. Welding fumes contain dust and gases that are harmful to health because they cause respiratory tract disorders, visual impairment, and poisoning(11). The welding process also produces harmful rays or light in the form of very bright ultraviolet and infrared radiation. Workers who are exposed to welding rays in the long term can experience the risk of health problems including cataracts, skin cancer, corneal inflammation to blindness. Based on observations, workers carrying out welding activities do not use full PPE, the PPE used is only welding masks and ordinary shoes. Based on the risk assessment, a likelihood value of B and severity of 3 is obtained with a high risk level. The last stage in the finishing process is workers painting the product using iron paint mixed with thinner liquid. Painting using solvents in the form of thinner contains toxic substances, namely lead and VOCs (Volatille Organic Compouds), if inhaled in the long term can cause respiratory problems to cancer (12). Based on the risk assessment, a likelihood value of C and consequency of 3 are obtained with a high risk level.

Table 3. Measurement of Physical Working Environmental Conditions at CV Dwi Jaya Logam

No	Physical Environmental Conditions Work	Area	Day to -	Measurement Time			Average of all dress	Judging Criteria	
				Morning	Noon	Sore		MS	TMS
1.	Temperature	Mold Making	1	34,2	37,1	34,8	34,9oC		V
			2	34,3	35,6	28,4			
			3	34	36	35,8			
			Instalment-instalment	35,36	36,2	33			
		Peleburan	1	34,3	35,2	34,4	33,8oC		V
			2	35,1	34,5	30,5			
			3	32,5	33,5	35			
			Instalment-instalment	33,9	34,4	33,3			
2.	Lighting	Manufacture Mold	1	185,3	446,5	160,5	214,lux		V
			2	192,3	262,7	67.03			
			3	207,2	278,9	126,6			
			War-war	194,9	329,4	118,04			
		Peleburan	1	25,2	29,8	18,4	30 lux		V
			2	38,3	28,6	26,3			
			3	34,7	38,6	30,5			
			Instalment-instalmen	32,7	32,3	25,1			

			t					
3.	Noise	Manufacture Mold	1	73,5	72,1	50,6		
			2	71,5	72,9	69,6		
			3	78,5	59,7	72,5	69 dB	V
			War-war	74,5	68,2	64,2		
		Peleburan	1	80,4	77,8	80,5		
			2	81,76	79,4	80,13		
			3	77,9	77,5	78,12	79,3 dB	V
			War-war	80,02	78,2	79,6		

The work environment at CV Dwi Jaya Logam as a whole produces temperatures that exceed the Threshold Value (NAV) or Not Qualified (TMS) according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. The highest average temperature value is found in the printing area, which is 34.9oC because the entire area uses a roof with material in the form of zinc, adjacent to the melting area which produces heat exposure, and the amount of exposure to incoming sunlight. Temperatures exceeding the Threshold Value (NAV) can cause heatstress, dehydration, fatigue, and workplace accidents(13). Based on the risk assessment, a likelihood value of A and consequency of 3 are obtained with an extreme risk level.

The intensity of lighting the work environment at CV Dwi Jaya Logam does not meet the requirements (TMS) according to the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016. The lowest average lighting is found in the melting area, which is 30 lux which is included in the category of Not Meeting the Requirements (TMS) because workers who work in the smelting area get at least 200 lux of lighting intensity. The intensity of lighting of the melting area does not meet the requirements due to the lack of natural and artificial lighting. Based on observations, the smelting area also has dark and dirty walls and roofs. This condition causes the efficiency of lighting to decrease by 50%(14). Based on the risk assessment, a likelihood value of A and consequency of 2 are obtained with a high risk level.

The work environment at CV Dwi Jaya Logam as a whole produces noise that still meets the Threshold Value (NAV) or Meets the Requirements (MS) according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. Based on the results of noise measurement, the highest average value is found in the smelting area, which is 79.3 dB, which means it meets quality standards. Noise in the smelting area has the highest average because it comes from machines that operate including induction machines, induction furnaces, hoist cranes, blowers and sounds from passing trains. Based on the risk assessment,

a likelihood value of A and consequency of 2 are obtained with a high risk level.

Table 4. Measurement of Physical Environmental Conditions at CV Mulya Jaya

No	Kondisi Lingkungan Fisik Kerja	Area	Hari ke-	Waktu Pengukuran			Rata-rata keseluruhan	Kriteria Penilaian	
				Pagi	Siang	Sore		MS	TMS
1.	Suhu	*Finishing* (Area dalam)	1	28,8	38,4	31,8	32,5°C		V
			2	32,2	35,5	32,7			
			3	32,7	34,4	34,5			
			Rata-rata	30,5	34,2	32,8			
		Finishing (Area luar)	1	33,4	34,8	34,4	33,3°C		V
			2	29,2	34,7	34,5			
			3	29,5	35	35			
			Rata-rata	30,7	34,8	34,6			
2.	Pencahayaan	*Finishing* (Area dalam)	1	41,2	90,3	75,9	69,9 lux		V
			2	61,7	69,1	30,4			
			3	63,7	65,4	131			
			Rata-rata	55,6	74,9	79,1			
		Finishing (Area luar)	1	261,5	496,6	76,3	172,4 lux		V
			2	138,4	151,7	63			
			3	130,6	155,1	78,4			
			Rata-rata	176,8	267,8	72,6			
3.	Kebisingan	*Finishing* (Area dalam)	1	79,3	82,4	79	78 dB	V	
			2	77,03	92,2	51			
			3	82,2	79,4	74,5			
			Rata-rata	79,5	85	68,2			
		Finishing (Area luar)	1	70,4	75,6	74,4	76,5 dB	V	
			2	68,5	80,8	85,3			
			3	77,0	78,8	76,0			
			Rata-rata	72,2	78,4	78,8			

The highest average temperature is found in the outdoor finishing area, which is 33.3oC which has not met the quality standard standards according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. This condition is influenced by the amount of exposure to sunlight and is adjacent to roads that are often passed by motorcycles, adding to air pollution which causes environmental temperatures to increase. Based on the risk assessment, a likelihood value of A and consequency of 3 are obtained with an extreme risk level.

The intensity of lighting in the inner and outer finishing areas as a whole is not qualified. The lowest average lighting measurement result is found in the inner finishing area, which is 69.9 lux so that it is included in the Unqualified (TMS) category according to the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016. Based on observations, there are ventilation holes covered by shelves of piles of goods which result in obstruction of sunlight. Based on the risk assessment, a likelihood value of A and consequency of 2 are obtained with a high risk level.

The highest average noise value is found in the inner finishing area, which is 78 dB, which means it meets quality standards according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. The inner finishing area has 3 drilling machines, 4 lathes, 2 scrap machines, and 1 milling machine which is the source of noise. Based on the risk assessment, a likelihood value is obtained which is A because it occurs repeatedly every day and consequenency is 2 with a high risk level.

4. Conclusion

The potential hazards found in the foundry industry of CV Dwi Jaya Logam are 54 potential hazards and the results of the identification of potential hazards in CV Mulya Jaya found 28 potential hazards derived from the physical environmental conditions of work (temperature, lighting, and noise) and the production process at each step of the work. The results of the risk assessment of 54 potential hazards in the foundry industry CV Dwi Jaya Logam are 2 levels of low risk, 10 levels of moderate risk, 30 levels of high risk, and 12 levels of extreme risk. The results of the risk assessment of 28 potential hazards in the CV Mulya Jaya metal casting industry are that there are 4 levels of low risk, 4 levels of moderate risk, 12 levels of high risk, and 8 levels of extreme risk. The results of measuring the physical working environment conditions in the form of temperature in CV Dwi Jaya Logam and CV Mulya Jaya do not meet the requirements according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018. The results of measuring the physical condition of the working environment in the form of lighting in CV Dwi Jaya Logam and CV Mulya Jaya do not meet the requirements according to the Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016. The results of measuring physical working environmental conditions in the form of noise in CV Dwi Jaya Logam and CV Mulya Jaya have met the requirements according to the Regulation of the Minister of Manpower of the Republic of Indonesia Number 5 of 2018.

5. References

1. Kesjaor RI. Occupational diseases due to exposure to heavy metals. Jakarta; 2012. 2–39 p.
2. Ministry of Health of the Republic of Indonesia. Regulation of the Minister of Health of the Republic of Indonesia Number 70 of 2016 concerning Industrial Work Environment Health Standards and Requirements. 2016.
3. Azady AAA, Widowati E, Rahayu SR. The Use of Job Hazard Analysis in the Identification of Work Safety Risks in Metal Craftsmen. HIGEIA (Journal Public Heal Res Dev.) 2018;

2(4):510–9.

4. Ihsan T, Silvia S, Derosya V, Edwin T, Dewi MS. Risk Assessment of Work Posture in Indonesian Rubber Factory Workers. J@ti Undip J Tech Ind. 2021; 16(2):116–22.
5. Bhirawa WT. Metal casting process using sand casting. J Tech Ind. [Internet].2021; 4(1):31–41. Available from: https://journal.universitassuryadarma.ac.id/ index.php/jtin/article/view/826
6. Salawati L. Silicosis. J Kedokt Shia Kuala. 2017; 17(1):19–25.
7. Wardhani AK, Rachmawati S, Rinawati S. Factors Associated with Symptoms of Respiratory System Disorders Due to Exposure to Silica Dust in the Area of Hand Moulding I, Hand Moulding II, Hand Moulding III, Fetling and Melting Factory Workers 1 Foundry PT. Barata Indonesia (Persero). J Wellness. 2018; 11(1):56–66.
8. Thursina RA. Hazard identification and risk assessment of grinding machine operators. Indonesia Occup Saf Heal. 2018; 7(1):30.
9. Sukmandari et al. Potential occupational hazards in metal manufacturing industry workers. Health Management Yayasan RS Dr Soetomo. 2018; 4 Nos. 2:170–7.
10. Lestari VD, Setiani O, Dewanti NAY. Differences in Blood Lead (Pb) Levels Based on Type of Work in Metal Casting Industry Workers in CV. Bonjor Jaya, Ceper, Klaten. J Health Masy. 2015; 3(3):819–31.
11. Qolik A, Yoto Y, Basuki B, Sunomo S, Wahono W. Dangers of Smoke and Welding Radiation to Welders in the Informal Sector. J Machine Tech and Learning. 2018; 1(1):1.
12. Makomulamin, Ramadhany F. Analysis of Risk Management Implementation in the Making of TNKB DITLANTAS Polda Riau Using HIRARC Technique at TNKB SAMSAT Selatan Workshop in 2016. Tower of Science. 2017; XI(78):62–70.
13. Ihsan T, Siti Salami IR. The Relationship Between Physical Hazards of Work Environment and Workload with Fatigue Level in Workers in the Stamping Division of PT. X Indonesia. A: Impact. 2015; 12(1):10.
14. Amin M, Winiarti W, Panzilion P. Lighting Relationship with Eye Fatigue in Taylor Workers. J Kesmas Asclepius. 2019; 1(1):45–54.
15. Ministry of Manpower R.I., Regulation of the Minister of Manpower of the Republic of Indonesia No. 5 of 2018 concerning Occupational Safety and Health of the Work Environment.