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Evaluation of Work Posture in Sohun Noodles Workers using OWAS and WERA Method

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Abstractct: ***The research was conducted on the process of making Sohun Noodle in Klaten, Central Java. The manufacturing process was carried out by five workers at four work stations with 18 activities. The purpose of this study was to observe, evaluate and analyze the worker posture using The Ovako Working Analysis System (OWAS) and The Workplace Ergonomic Risk Assessment (WERA) method. The steps of the study using the OWAS method are: taking a picture of work posture, identifying the weight of the load, the process of assessing work posture, and categorizing risks. The steps of the research using the WERA method are: taking pictures of work postures, identifying body postures on the neck, shoulders, back, wrists and legs, identifying weight loads, duration of work, vibrations, contact stress, identifying risk factors, assessing work postures, and categorizing risks. The next step is processing statistical data, namely: normality test, comparative test, and correlation test using Statistical Package for the Social Science (SPSS) Version 21.0 for parts shoulders/arms, back, legs posture, weight/strength. The result of the OWAS method shows that there are two very risky activities and needs improvement now, i.e. the activity of inserting zinc into a press machine, and the activity of putting zinc containing sohun noodle into first drying. The result of the WERA method indicates that all activities are included in the medium level actions so that further investigation and change is needed. The results of statistical tests using SPSS Version 21.0 are: a comparative test on shoulders/arms and back there is a significant difference and in legs posture and weight / strength there is no significant difference. Whereas in the correlation test for shoulders/arms, back, and weight / strength there is a significant correlation between the OWAS and WERA methods.***

Keywords : OWAS, WERA, Sohun Noodle, Work Posture, MSDs

I. INTRODUCTION

Almost all activities/jobs require the use of arms and hands. Therefore, generally work musculoskeletal disorders (WMSDs) affect the hands, wrists, elbows, neck, and shoulders. Work using feet can lead to WMSDs in the legs, hips, ankles, and feet. Some back problems are also caused by repetitive activities. WMSDs disorders are related to work and public health problems. Musculoskeletal disorders begin to spread widely in workers in developing countries. The prevalence of WMSDs varies from 15 to 42% [1] highest in informal workers. MSDs that occur is around 65% of work accidents and have significant economic and social impacts [2] resulting in reduced quality and work productivity. Risk factors for MSDs often occur in movement repetition, heavy workload, vibration, and awkward posture [2], manual material handling [1], improper lifting method [3]. WMSDs disorders are mainly occured in groups of female workers rather than male, although male or female sufferers may have gender equality [4]. According to [1] WMSDs are often associated with work as a public health concern. The prevalence of WMSDs changes from 15-42%, the highest prevalence is found in unskilled workers, such as in agriculture, forest workers, and construction workers. Physical ergonomics factors including a combination of load and posture, posture activity, awkward work posture, lifting heavy loads, manual material handling (MMH), walking or standing for long periods, working with long shifts, looking necks, working monotonically or repetitively, bad work conditions, is the cause of WMSDs especially low back pain (LBP). Handling material that is done manually can cause musculoskeletal disorders (MSDs), the disorder can be muscle injury, nerve tendon injury, tendon injury, bone and cartilage injury, joint injury [5]. In the Production activities for making sohun noodle, there are activities carried out in the form of MMH. The problem is the unnatural work posture i.e. bending, standing, and sitting. Working postures that are carried out continuously for a long duration can cause ergonomic risks. Research on making sohun noodle has been done by [6] using the ManTRA method. The production process consists of four work stations, namely: dough-making work stations, pressing work stations, drying work stations, and packaging work stations. Ergonomics evaluation is needed to assess and to analyze risk factors and also to evaluate and to improve efforts to minimize the risks that occur. The OWAS method is a method to produce categories of work attitudes that can pose a risk to the musculoskeletal by evaluating the back, arms, legs and weight. The OWAS method can be easily and quickly used to identify work attitudes that can lead to workplace accidents. By using the OWAS method, information can be obtained on the assessment of posture at work, so that an early evaluation of the accident of the human body can be carried out consisting of important parts such as the back, arms, legs, and also analysis and evaluation of the weight of the body [7]. Attitudes of body parts observed for analysis and evaluation in the OWAS method are: back attitude, arm attitude, legs attitude, and weight burden. Research using the OWAS method has been carried out in the batik cap manufacturing industry by [8] and in the tofu making industry [9].

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The WERA method is used to assess work risk factors by classifying low, medium, and high levels [10]. There are six physical risk factors assessed, namely posture, repetition, strength, vibration, stress contact, and duration. The assessment process in the WERA method is using nine combinations namely, a combination of shoulder posture with shoulder repetition, wrist posture with wrist repetition, back posture with back repetition, neck posture with neck repetition, legs posture with duration of work, strength with back posture, risk of vibration with wrist posture, contact stress with wrist posture, and duration of work with strength [11]. The purpose of this study was to find out how the conditions of work posture of the manufacture of sohun noodle using the OWAS and the WERA method, to know the comparison and correlation in 4 assessment parts, namely the shoulders/arms, back, legs posture, and weight of the load or strength.

II. RESEARCH METHODOLOGY

The study was conducted on five workers making sohun noodle in Klaten Regency - Central Java. Statistical data processing is conducted at the Industrial Engineering Laboratory - UMS. Research time in January 2018.

The research steps are as follows: (1) Collected data is in the form of identity, age, length of work, work assignments, and production processes. Work attitude recording uses videos to find out work activities and to analyze work postures. Weight weighing is used for classification in the calculation of work posture. Step (2) Data Processing Phase, i.e: (a) sequences of calculation of work posture using the OWAS method are: (i) identifying back, arms, legs, and weight posture, (ii) the process of assessing OWAS work posture, (iii) categorizing the OWAS method. The categories in OWAS are: category 1 meansn that there is no action that needs to be done for repairs, category 2 means that repairs need to be done later, category 3 means that repairs need to be done as soon as possible, category 4 means that repairs are needed now. (b) calculation of work posture using the WERA method, the sequence is: (i) identifying body posture on the shoulder (posture and repetition), wrist (posture and repetition), back (posture and repetition), neck (posture and repetition), feet (posture and duration of work), strength (strength and posture), vibration (vibration and posture), contact stress (contract stress and posture), and duration of work (duration of work and strength); step (ii) WERA work posture assessment process; step (iii) categorizing the WERA method. The low action level category with a score of 18-27 means that the task can be accepted, the medium action level with a score of 28-44 means that the task needs further investigation and needs change, high action level with a score of 45-54 means that the task is unacceptable and immediately changes. Step (3) Perform statistical tests using SPSS tools Version 21.0, namely: normality test, comparative test, correlation test.

III. RESULTS AND DISCUSSION

There are 18 activities with four work stations, namely dough-making work stations, pressing work stations, drying work stations, and packaging work stations. At the pressing work station there is an activity of inserting zinc into the press machine done manually by hand.

Figure 1. Pressing Work Station with Activities Inserting Zinc into the Press Machine

A. Processing Work Posture using the OWAS Method

At the pressing station the activity of inserting zinc into the press machine is done manually by hand (see Figure 1). Identification of work posture using the OWAS method is shown in table 1.

Table 1: Identification of OWAS Work Postures for The Activity of Inserting Zinc into The Press Machine

Attitude	Code	Description
Back	3	Leaning sideways
Arm	1	Both arms are under the shoulder
Legs	5	Stand on one leg with the knees bent
Weight of the load	1	1 Kg

Based on Table 1, the identification of the OWAS work posture obtained back attitude with code 3, which is leaning sideways, arm attitude with code 1 are both arms under the shoulder, legs attitude with code 5, stand on one leg with knees bent, and weight of the load 1 kilogram with code 1.

OWAS assessment is carried out by entering and linking the identified codes into the OWAS assessment table. Table 2 is an assessment of the OWAS method for the activity of inserting zinc into the press machine.

Based on the results of the OWAS method evaluation in Table 2 with the 3151 posture identification code obtained the OWAS score 4. Analysis of work posture is included in category 4, which needs to be improved now, because work attitudes are very dangerous to the musculoskeletal system.

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Table 2: Assessment of The OWAS Method for The Activity of Inserting Zinc into The Press Machine

Back	Arms	1			2			3			4			5			6			7			Legs	Use of Force
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3		
1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1		
	2	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1		
	3	1	1	1	1	1	1	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1		
2	1	2	2	3	2	2	3	2	2	3	3	3	3	3	3	3	2	2	2	2	3	3		
	2	2	2	3	2	2	3	2	3	3	3	4	4	3	4	4	3	3	4	2	3	4		
	3	3	3	4	2	2	3	3	3	3	3	4	4	4	4	4	4	4	4	2	3	4		
3	1	1	1	1	1	1	1	1	1	2	3	3	3	4	4	4	1	1	1	1	1	1	X	
	2	2	2	3	1	1	1	1	1	2	4	4	4	4	4	4	3	3	3	1	1	1		
	3	2	2	3	1	1	1	2	3	3	4	4	4	4	4	4	4	4	4	1	1	1		
4	1	2	3	3	2	2	3	2	2	3	4	4	4	4	4	4	4	4	4	2	3	4		
	2	3	3	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4		
	3	4	4	4	2	3	4	3	3	4	4	4	4	4	4	4	4	4	4	2	3	4		

B. Processing Work Posture using the WERA Method

Based on Figure 1 it can be seen that shoulder posture forms an angle of 32.3 degrees, wrist posture forms an angle of 43.2 degrees, back posture forms an angle of 25.3 degrees, neck posture forms an angle of 16.9 degrees, and legs posture forms an angle of 40.1 degrees. For more details, identification of physical risk factors in the activity of inserting zinc into press machine is presented in the following Table 3.

Table 3: Identification of Physical Risk Factors in The Activity of Inserting Zinc into Press Machine

No	Physical Risk Factor	Description	Risk Level		
			Low	Medium	High
1	Shoulder	1.a. Posture		√	
		1.b. Repetition	Movement Without Rest		√
2	Wrist	2.a. Posture			√
		2.b. Repetition	10- 20 Times/Minute	√	
3	Back	3.a. Posture	25.3 Degree		√
		3.b. Repetition	10- 20 Times/Minute		√
4	Neck	4.a. Posture	16.9 Degree	√	
		4.b. Repetition	Movement Without Rest		√
5	Legs	5.a. Posture	40.1 Degree	√	
		9. Work Duration	< 2 Hours	√	
6	Strength	6. Strength	1 Kg	√	
		3.a. Posture	25.3 Degree		√
7	Vibration	7. Vibration	Using no vibration tools	√	
		2.a. Posture	43.2 Degree		√
8	Stress Contact	8. Stress Contact	Using partial gloves	√	
		2.a. Posture	43.2 Degree		√
9	Work Duration	9. Work Duration	< 2 Hours	√	
		6. Strength	1 Kg	√	

After identificating risk factors and are included in the level of low, medium and high risk. The next step is to assess physical risk factors. Table 4 is the table of assessment of physical risk factors in the activity of inserting zinc into press machines. From the results of the assessment of physical risk factors for each factor, it can be seen that the score on shoulder posture obtained a score of 5, wrist posture obtained a score of 5, back posture obtained a score of 6, neck posture obtained a score of 5, foot posture obtained a score of 3, risk factors for strength obtained a score of 4, vibration risk factors obtained a score of 4, stress contact risk factors obtained a score of 5, and risk factorsx for work duration obtained score 2. Total score is 39 included in the medium risk level with information on task level action needs further investigation and needs for change.

Table 5 is the result of data processing using the OWAS and the WERA method of 18 work activities at 4 work stations. The result of the OWAS method assessment indicates that the risk level 1 category is that there are no actions that need to be taken to improve as many as 8 work activities. Activities that are quite risky are included in the risk category 2, which needs to be repaired in the future as many as 5 work activities. The risky activities included in the risk category 3 are necessary to make repairs as soon as possible as many as 3 work activities, as well as very risky activities included in the risk category 4, which is necessary to repair now as much as 2 work activities. The result of the WERA method assessment indicates that the WERA score results are between 28-44 which is included in the medium level action so the task needs further investigation and needs change.

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Table 4: Assessment of Physical Risk Factors WERA in The Activity of Inserting Zinc into Press Machines

Risk Factor Assessment Score

Shoulder Factor					Wrist Posture					Back Posture				
Repetition	Risk Level	L	M	H	Repetition	Risk Level	L	M	H	Repetition	Risk Level	L	M	H
	L	2	3	4		L	2	3	4		L	2	3	4
	M	3	4	5		M	3	4	**5**		M	3	4	5
	H	4	**5**	6		H	4	5	6		H	4	5	**6**

Neck Posture					Legs Posture					Strength				
Repetition	Risk Level	L	M	H	Work Duration	Risk Level	L	M	H	Back Posture	Risk Level	L	M	H
	L	2	3	4		L	2	**3**	4		L	2	3	4
	M	3	4	5		M	3	4	5		M	3	4	5
	H	4	**5**	6		H	4	5	6		H	**4**	5	6

Vibration					Stress Contact					Work Duration				
Wrist	Risk Level	L	M	H	Wrist	Risk Level	L	M	H	Strength	Risk Level	L	M	H
	L	2	3	4		L	2	3	4		L	**2**	3	4
	M	3	4	5		M	3	4	5		M	3	4	5
	H	**4**	5	6		H	4	**5**	6		H	4	5	6

Total Score = **39**

Table 5: Recapitulation Results of Processing of the OWAS and the WERA Method

No	Work Station	Activity	OWAS		WERA	
			Code	Level	Score	Level
1	Dough Making	1.1 Inserting sugar palm flour into a dissolving tube	2141	3	38	2
		1.2 Inserting water into a dissolving tube	1151	2	28	2
		1.3 Filtering the sugar palm solution	3131	1	33	2
		1.4 Inserting the sugar palm solution into the cauldron for cooking	2122	2	28	2
		1.5 Stirring the sohun noodle dough	2122	2	37	2
2	Pressing	2.1 Inserting the sohun noodle dough into press machine	1132	1	37	2
		2.2 Inserting zinc into press machine	3151	4	39	2
		2.3 Removing zinc containing sohun noodle from press machine	2141	3	37	2
3	Drying	3.1 Place zinc containing sohun noodle to first dry	4141	4	39	2
		3.2 Place zinc containing sohun noodle to another dry	3121	1	32	2
		3.3 Stacking dried sohun noodle zinc	3121	2	32	2
		3.4 Collecting dried sohun noodle	2171	2	38	2
		3.5 Place the empty zinc	2221	1	34	2
		3.6 Carrying sohun noodle stacks	3121	1	31	2
		3.7 Place the sohun noodle into drying pole stacks	1171	1	36	2
		3.8 Collecting zinc stacks to pressing work station	2142	3	39	2
4	Packing	4.1 Packing sohun noodle in 100gr packs	1111	1	30	2
		4.2 Packing sohun noodle in bal/packs	1111	1	38	2

C. Statistical Testing Process

The body parts being analyzed are: the arms/shoulders, back, legs posture and weight/strenght load. Shoulder/arm body part, in the OWAS method with three categories, namely: (1) arm posture both arms under the shoulder, (2) one arm at or above the shoulder, (3) both arms at or above the shoulder, on the WERA method with three categories namely: (1) neutral shoulder posture, (2) shoulder around the chest, (3) shoulder moving upwards. The back of the body, in the OWAS method with four back attitudes, namely: (1) straight, (2) bending, (3) turning or leaning sideways, (4) bending and turning or bending forward and sideways, on the WERA method with three angular formed categories, namely: (1) 0^0/neutral posture, (2) 0^0 - 20^0 up/down, (3) 20^0 - 60^0 up/down.

The foot of the body parts in the OWAS method with seven footsteps, namely: (1) sitting, (2) standing resting on both straight legs, (3) standing resting on one straight leg, (4) standing resting on both straight legs with knees bent, (5) standing on one straight leg with knees bent, (6) kneeling at one/both knees, (7) walking, on the WERA method identified using angles namely: (1) <30^0, (2) 30^0 - 60^0 up/bottom, (3) and> 60^0 up/down. The weight load in the OWAS method with three classifications, namely: (1) <10Kg, (2) 10Kg - 20Kg, (3)> 20Kg, in the WERA method the strength was identified by three classifications, namely: (1) 0-5Kg, (2) 5Kg - 10Kg, (3)> 10Kg. The back of the body and legs needs to be normalized because the division of categories is not the same (see Table 6). Statistical test results in the form of normality test, comparative test, correlation test using SPSS Version 21.0 tools can be seen in Table 7.

Table 6: Input Data for Processing Statistical Tests

Activity	Shoulder/Arms		Back		Legs		Weight Load	
	OWAS	WERA	OWAS	WERA	OWAS	WERA	OWAS	WERA
1.1	1	2	0.5	1	0.57	0.33	1	1
1.2	1	1	0.25	0.67	0.71	0.33	1	1
1.3	1	1	0.75	0.67	0.42	0.33	1	1
1.4	1	2	0.5	1	0.28	0.33	2	3
1.5	1	2	0.5	0.67	0.28	0.33	1	1
2.1	1	1	0.25	0.66	0.42	0.33	2	3
2.2	1	2	0.25	0.66	0.43	0.33	2	3
2.3	1	2	0.75	1	0.71	0.67	1	1
3.1	1	1	0.5	1	0.51	0.33	1	1
3.2	1	2	1	1	0.57	0.33	1	1
3.3	1	1	0.75	0.67	0.28	0.33	1	1
3.4	1	2	0.5	1	1	0.33	1	1
3.5	2	3	0.5	1	0.28	0.33	1	1
3.6	1	1	0.75	0.67	0.28	0.33	1	1
3.7	1	2	0.25	0.67	1	0.33	1	1
3.8	3	3	0.25	0.67	0.28	0.33	1	1
4.1	1	2	0.5	1	0.57	0.33	2	3
4.2	1	2	0.25	0.67	0.14	0.33	1	1

The results of the normal *shapiro wilk* test on the shoulder/arm, back, leg posture, and weight/strength showed the same results, which were not normally distributed, because the significance value was <0.05. *Mann Whitney* comparative test, the shoulder/arms and back asymp.ig (2-tailed) values <0.05 means that there are significant differences in the leg section and weight/strength asymp.ig (2-tailed) values> 0.05 means, there were no significant differences in either part. *Spearman* correlation test, on shoulder/arm, back, and weight/strength sig value (2-tailed) <0.05 means that there is a significant relationship in all three parts, and at the foot section sig (2-tailed) value> 0.05 means that there is no significant relationship between the two parts.

Table 7: Statistical Test in The Form of Normality Test, Comparative Test, Correlation Test

Test		Shoulder/Arms		Back		Legs Posture		Weight/Strength	
		OWAS	WERA	OWAS	WERA	OWAS	WERA	OWAS	WERA
Normality Test	Kolmogorov-Smirnov[a]	.000	0,00	.013	.000	.026	.000	.000	.000
	Shapiro-Wilk	.000	0,00	.006	.000	.027	.000	.000	.000
Mann Whitney U Test	Asymp. Sig. (2-tailed)	.000		.000		.906		.673	
Spearman's rho Test	Sig. (2-tailed)	.006	.006	.168	.168	.920	.920	-	-

IV. CONCLUSION

The process of making sohun noodle in Klaten - Indonesia is divided into four work stations and 18 activities. The results of the work posture risk assessment using the OWAS method, there are eight activities with a risk category 1 that is no action that needs to be done for improvement, there are five activities with risk categories 2 that need improvement in the future, there are three activities with risk categories 3 that need to be done repairs as soon as possible, there are two activities with risk category 4, which need to be improved now. The result of the work posture risk assessment using the WERA method indicates that the results of the WERA score between 28-44 are included in the medium level action so that the task needs further investigation and needs change.

The statistical test results using SPSS Version 21.0 show that between the OWAS and WERA methods on the four body parts of the data are not normally distributed, the comparison test shows that the legs of posture and weight/strength are not significantly different, and the correlation test on shoulder/arm, back, and weight/strength there is a significant correlations.

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