Design of standard operating procedure (SOP) based at ergonomic working attitude through musculoskeletal disorders (Msd's) complaints

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Abstract. PT PJC is a company synthetic resin. Synthetic resin is that produced by PT PJC is sold to the market in three types of packing, one of then is the drum packing type that weigh 208 kg. One of the activities that use the manual handling product (manual material handling) is the activity of filling, the drum-packed product will be transfered with drum packaging to the finishing goods area which done by the man force. Manual material handling concept has several advantages, one of which is easy to do by humans. However, manual handling material handling becomes an issue if the material load exceeds the maximum lifting of the worker because of the potential risk of injury to the human body, especially if it is carried out simultaneously for a relatively long period of time. One of the risks of human injury that can be experienced is Musculoskeletal Disorders (MSDs). This research will investigate the musculoskeletal complaints on Filling workers which will form the basic of the ergonomically-based Standard Operating Procedure (SOP) design basic. Data is taken by a Nordic Body Map (NBM) questionnaire. The result shows that most of the dominant body pain felt by the worker as the impact of previous day's work was the complaints of pain on the left and right wrists, left and right palms, left and right knees, left and right calves, left and right ankles, while the pains felt by the workers after the activity are pain in the back, waist, left and right elbow, left and right thighs, left and right calvs, left and right ankles. The pain work will disappear after the night rest, but there is no guarantee that the worker's body will be fit in the morning, because of the remnants of body pain that have not been fully fit, thus affecting the readiness of physical conditions at work in the morning. These body pain can be reduced by designing the right standard operating procedure (SOP) based on an ergonomic work attitude. Musculoskeletal pain before the activity were 39.3 ± 10.6 and after activity was 76.5 ± 14.9 or an increase in musculoskeletal pain of 94.66%.

1 Introduction

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PT PJC is a company that engage in the production of synthetic resin. Synthetic resin is produced by PT PJC is sold to the market in three types of packing, namely packing of cans, bottles, and drums. Especially the drum packaging has the greatest weight among the other which weighs 208 kg. In the production activities, PT PJC still using human as part of the work completion process. Although the use of machines is categorized as high technology, but various supporting activities can not be separated from the use of human force.

Human have limited abilities including muscle ability to carry load and material loads, because these problems will have implications for the performance of the company in general. As to be seen from the some perspective of ergonomic glass panels, various aspects of human beings can be seen from the factors of energy use or the necessary nutrients, the strength of muscle power, the condition of body posture at work, working environment condition, time consumed for work and rest, socio-cultural circumstances that exist in the community and internal enterprise, the condition of information available within the company and others and, human-machine interaction. From these eight aspects it can be concluded that the main problem of the workers is the aspect of muscle strength or energy.

Until now, the work pattern has been using the correct rules, which is the existence of standard operating procedures that issued by the management company to operate the machine and other manual material handling, but as time passed the process and attitude of human work, there still found various problems that occur in the production such as workers bent below 900, the round of bodies that cause pain in certain body part and generally occurs to L5 / S1. There are complaints from several body parts. The work that done repeatedly and for a long time will cause premature aging or musculoskeletal disolders. The effort taken by the company's management for the recovery of each personnel specifically on the fulfillment of energy or nutritional status which provids in the form of mineral water, coffee, and the sweets. Meanwhile, at the break time the operators are given lunch that contains carbohydrates, proteins, and vitamins.

Furthermore, it is found on the production floor that the operator's work attitude is relatively unnatural on material transfer activities. Manual Material Handling (MMH) is all load-lifting work that includ rotating, bending, grabbing, damping, pushing, and pulling, activities performed by the workers in order to move the load from one ponit to a particular destination location (Nurmianto, 1998). Manual Material Handling (MMH) is still widely used by the company because it has several advantages, such as more flexible movement of material transfer in an irregular or untidy work location, cheaper, and easier for light load (Santiasih, 2013).

Based on this phenomenon, it is found that manual material handling is still needed in order to complete the production process so it is still important to note. MMH can facilitate the activity of the material displacement with heavy load or relatively light material. In the company heavy PJC manual drum manually packaged material (manual material handling) is 208 kg. So with the weight, manual handling material becomes unnatural and can cause the risk of injury to the limb due to over-exertion-lifting and carrying damage body tissue caused by excessive weight lifting. The injury will be more severe if the activity is done continuously for long periods with improper work posture. One type of injury that can arise from over-exertion lifting and carrying is Musculoskeletal Disorders (MSDs). Musculoskeletal Disorders is a pain on the skeletal muscle sections felt by a person ranging from very mild to very painful complaints (Nugraha, 2013).

When judged from the aspect of the working environment, the physical environment of the work varied form of lighting, noise, temperature, humidity, and wind speed slightly above the critical point of the threshold value, so that the physical environment can affect the operator's work activities. This is caused by the physiology of the human body which sensitive to the state of the physical environment.

For the aspect of information, as seen from the flow of coordination and communication of the superiors and the subordinates are very good and in accordance to the structure that has been set at the company, in addition to the delivery of information related to job, cleanliness of the work area, findings on the work area, and activities in each day at a briefing before the work begun. For information in the form of hazard info, warning, regulations, and safety induction had been done in the form of picture display, as well as voice display from company radio. PT PJC applies the culture of wearing personal protective equipment in the form of helmet, mask, cloth gloves, and safety shoes. So that in the interaction between man and machine hopefully could minimize the work accident. In addition, the work instruction manual has been provided in the form of standard operational procedure (SOP) based on work process, but in SOP there is only work instruction in the form of each process stage, not in giving instruction in the form of work attitude on each process, so that in between one operator to another operators, the varying body movements are still exist. This condition caused the occurrence of musculoskeletal pain that varies between one operator to another operator. Based on the eight aspects of ergonomic identified has the dominant problem is musculoskeletal pain that caused by the variation of work attitude of the operator in manual material handling activity and the absence of work-based SOP.

To overcome the afformentioned problems, the company has made improvements in the form of procurement of material handling tools in the form of hand forklifts, but in the application, the use of such tools slows down the production process because of its operation which is considered to be complicated and heavy by the operator. So that the operator re-do material handling activities manually without tools. The Company also made SOP improvements for each period, but SOP has not paid attention to the operational attitude aspect of the operator so there is no significant decrease in risk of musculoskeletal disorders between before and after. Msukuloskeletal pain are also experienced by physical workers in general (Choobineh, et al., 2007; Choi, et al., 2009; Errico, et al., 2010; (Bernards, et al., 2011; Nonnenmann, et al., 2010)

In order to reduce the risk of musculoskeletal disorders in the operation, it is important to have a standard operational procedure (SOP) based on good working attitude and correctness in the manual activity of drum manual handling material. This intervention is an alternative to decrease musculoskeletal pain through the ergonomic approach improvement. Improvements with ergonomic approaches could reduce the impact of musculoskeletal complaints of workers (Das, et al., 2013; Kirkhorn, et al., 2010). So it is necessary to conduct a research in the form of identification of musculoskeletal filling operator's complaints as the basis for improvement of Standard Operational Procedure (SOP). To find out the type and magnitude of pain complaints experienced by operators in the filling section, this study used a questionnaire Nordic Body Map (NBM). Nordic Body Map is one of the subjective measurement methods to measure workers' muscle pain (Wilson, 1995). The Nordic Body Map is the most commonly used questionnaire for discomfort to workers, and it is most commonly used because it is standardized and well-organized (Kroemer, 2001).

2 Methods

The design in this research is cross sectional. Data were analyzed descriptively and quantitative. Descriptive research is a research that aims to make a description of a social phenomenon or natural in a systematic, factual, and accurate (Wardiyanta, 2006). While quantitative research is a study by obtaining data in the form of numbers or qualitative data that is suspected (Sugiyono, 2003). Cross sectional is an approach that is momentary or in and not followed in a certain time (Hadjar, 1996). Subjects in this study were all

(population) operator of filling section at PT PJC (N = 10 people). Data were collected using a Nordic Body Map (NBM) questionnaire with Likert scale. Criteria subject in this study is the operator with age between 23-48 years, weight 50-68 kg, at least have worked for 1 month.

The stages of this research are preliminary study, research problem determination, data collection using Nordic Body Map (NBM) questionnaire, processed questionnaire data using graph comparison data between all population of operator before pre-test and after activity manual material handling (Post-Test)

3 Results and discussion

Based on the measurement of the physical environment in the work area, it is found that the physical environment measurement value obtained in the lighting aspect is 837.53 Lux, if the limitations of Lighting Threshold Level (NAB) is 100-200 Lux. Then for the noise aspect, the physical environment measurement value is 86.92 dB, if the NAB noise limit is 85 dB. Furthermore, for temperature measurement results show the results of 28.93 oC, if viewed NAB temperature is equal to 25.9 oC. Then the results of humidity measurements show the results of 63.84 oC, if viewed NAB moisture is equal to 40-60 oC. Then wind speed measurement results show the results of 0.48%, if viewed NAB moisture is equal to 0.25%. So it can be seen that the value of the physical environment when data collection Pre-Test and Post-Test there is a tendency above the NAV according to the Regulation of the Minister of Manpower and Transmigration RI No Per. 13 / MN / X / 2011. Work environment conditions affect the results of work done (Keun and Park, 2007).

Distribution of Nordic Body Map (NBM) questionnaires to all filling operators in the morning at 09.00 before the operator starts the activity (Pre-Test), and in the afternoon at 16.00 after the activity is completed (Post-Test). Based on the data of the questionnaire distributed, then the difference test is done on both data that is Pre-Test and Post-Test complaints data to know whether there is difference between questionnaire distribution result during Pre-Test and Post-Test. Hypotheses in this study are as follows:

H0: There is a difference between the results of the Pre-Test questionnaire and the Post-Test.

H1: There is no difference between the results of the Pre-Test questionnaire and the Post-Test.

Different test results using Wilcoxon Signed Rank Test on SPSS obtained results in Figure 1.

	POSTTEST - PRETEST
Z	-2.236[b]
Asymp. Sig. (2-tailed)	.025

Fig. 1. Test results of different wilcoxon signed rank test

Based on Figure 1, the results can conclude that H0 is accepted, meaning there is a difference between Pre-Test data with Post-Test data. After the differences between Pre-Test and Post-Test, the average calculation of musculoskeletal complaints of the operator before the start of the activity (Pre-Test) was obtained by 39.3 ± 10.6. Of the 28 items of the statement of pain complaints, obtained the top ten highest pain complaints felt by the filling operator at the time before the start of the activity (Pre-Test) presented in the graph below:

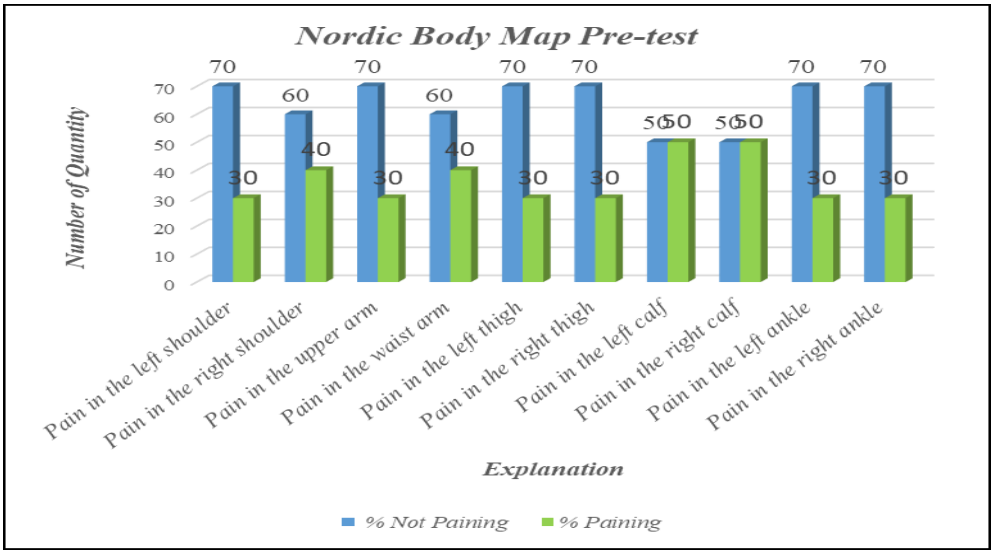

Fig. 2. Graph of nordic body map (nbm) pre-test

Based on Figure 2. Nordic Body Map Map Pre-Test, it can be seen that the highest pain complaints felt by filling operators before starting activity or work are complaints of pain in the left shoulder, pain in the right shoulder, pain in the right upper arm, waist, aching on left thigh, pain in right thigh, pain in left calf, pain in right calf, pain in left ankle, pain in right ankle. These painful causes of complaints in various dimensions of the body (Yokoyama, et al., 2006), if not immediately looked for solutions may cause stress symptoms (Lee, et al., 2005)

While based on the average calculation of operator pain after work activity (Post-Test) got value equal to 76,5 ± 14,9. Of the 28 items of the statement of pain complaints, obtained the top ten highest pain complaints felt by filling operators after the work activities (Post-Test) are presented in the graph below:

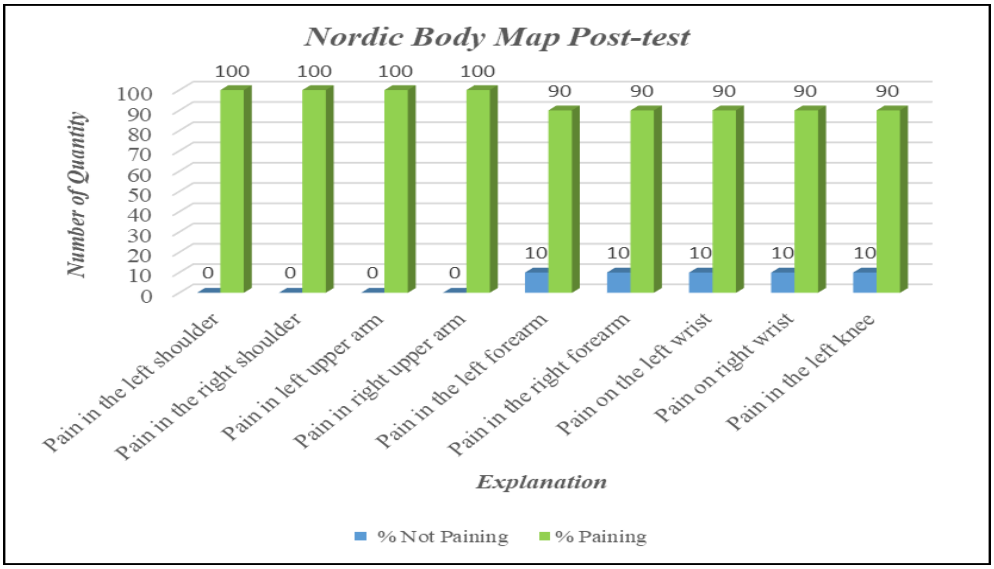

Fig. 3. Graph of nordic body map (NBM) post-test

According to Figure 3, the Nordic Body Map Post-Test graph, it can be seen that the highest pain complaints felt by operators of filling after work activity are complaints of pain in the left shoulder, pain in the right shoulder, pain in the upper left arm, pain in the upper right arm, pain in the left forearm, pain in the right forearm, pain in the left wrist, pain in the right wrist, pain in the left knee, and pain in the right knee.

Complaints in various parts of the body will cause a delay in work activities. Musculoskeletal complaints are closely related to subjective complaints (Jungsun, et al., 2006). This complaint begins with muscle fatigue. An immediate effort is to recover muscle tension (Gawke, et al., 2012). Increased fatigue causes the decline on the concentration and endurance . Decreased fatigue is caused by decreased occupational health and concentration (Nagai, et al., 2011). Ergonomic's SOP re capable of providing work improvements characterized by changes in musculoskeletal complaints. SOP-based ergonomic design among others is :

1. Use of work activities as a basis for designing SOPs
2. Consider the human factor as a major part of the work activity
3. Apply the job to the man fitting, before fitting the man to the job
4. Measuring ability, skill and human limitations
5. There is no forced body stance, it works naturally
6. Human machine interaction puts the human factor first

With the SOP based on ergonomy, workers achieve job satisfaction. Feasibility can be achieved if the worker considers the performance of the personnel (Hakansson, et al., 2011). Increased musculoskeletal complaints are consistent with length of work and the burden of work. Based on the average of musculoskeletal complaints of filling operators, the percentage of grievance change between before and after work was 95%. This condition is likely to change larger, if the work time continues to be added, such as soft work and additional work after the operator returned from the company. There needs to be a holistic evaluation of employee activity, and it is not advisable to do work on the worker's abilities.

4 Conclusion

After the discussion of results, then the conclusion is the musculoskeletal complaints of the filling section before the work activity is equal to 39.3 ± 10.6. Musculoskeletal operators of the filling section at the time after work activity is equal to 76.5 ± 14.9. The percentage change in musculoskeletal complaints between before and after work was 95%.

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