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Analysis of working posture on muscular skeleton disorders of operator in stamp scraping in ‘batik cap’ industry

Wiyono Sutari^{a*}, Yusuf Nugroho Doyo Yekti^b, Murni Dwi Astuti^c, Yuvie Mutiara sari^d^{a,b,c,d}Telkom University, Bandung 40257, Indonesia

Abstract

Batik Cap’ is a technique of wax-resist dyeing applied to a cloth made by printing the fabric with a copper stamp called a ‘cap’ acting as mold. One of the processes of making batik mold is to scrape mold surface. The existing such process rely on a simple tool that does not count the ergonomic aspects especially on a working posture. Inappropriateness of working postures will lead the operator to obtain a variety of muscle and bone disorders, especially in the legs, arms and wrists which degrade the quality of work. The suitability of work postures is measured by RULA scores, while the fatigue level was measured by a start time parameter emergence of disorders/complaints in the muscles and bones (musculoskeletal disorder) using Nordic Body Map Questionnaire. In this study, the more suitable working posture was arranged by adjusting the height of the workbench to result a better working posture. An experiment was conducted with involved a new and existing working posture to examine its effect on operators. The results showed significant advantages in term reducing musculoskeletal disorder

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1. Introduction

Hazardous work activities may lead to workers affected by Musculo Skeletal Disorders (MSDs). Factors that cause MSDs include activities with heavy burden, the work with repetitive motion, awkward postures, and work sitting

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .

E-mail address: wiyono@telkomuniversity.ac.id

or squatting position in a long time, (Luttmann, et.al., 2003), as well as exposure body vibration on workers (Conway and Svenson, 2001).

MSDs is a disease that needs to be avoided, because it is very harmful to workers and the company (Boschman, et.al., 2012), (Neumann, 2004). MSDs have a negative impact on the performance of the company. MSDs cause workers become ill, job quality is lowered, and even not able to continue the work. Furthermore, the productivity of the company may be down.

Hazardous work activities that allegedly occurred in the activity of making batik stamp tool in SMEs Batik in Indonesia. In general, the activities require workers to scrape mold on squatting position in the long term. In addition, it also require workers to perform repetitive activities. Risks associated with a mold making work activities is worsens in the absence of equipment that supports the workers to work safely and comfortably.

This study focuses on efforts to reduce the risk of musculoskeletal disorders in workers stamp batik making tools in 'Batik Komar' SMEs. The purpose of this study was to identify MSDs risks and devise solutions to problems. Efforts to reduce the risk of MSDs can be reached in several ways, one of which is effective for reducing MSDs are engineering intervention (Norman and Wells, 1998), (Meyer et al 2006), (Silverstein and Clark, 2004). Therefore, solutions to problems that will be explored is the solution in the form of engineering intervention.

Tools that are used to determine the working posture problem is RULA (Rapid Upper Limb Assessment) that considered an effective tool for measuring the quality of work posture in a job that involves a lot of upper body, but the legs are working on static conditions (McAtamney and Corlett, 1993). RULA score explain the severity of MDS experienced by operator who work under certain conditions. According to RULA, Score = 1-2: Posture acceptable if not maintained or repeated for long periods; Score = 3-4: Further investigation is needed, and changes may be required; Score = 5-6; Investigation and changes are required soon; Score = 7, the highest, investigation and changes are required immediately.

2. Research Methodology

First, preliminary study was conducted in form of field studies to examine the problems exist in the company that consist of existing work processes, existing work postures, working methods in Rumah Batik Komar. Four operators acting as respondents are involved in this study. Then this step followed by literature studies to understand relevant theories underlying the problems in term of concepts of ergonomics especially awkward working postures, fishbone diagrams, nordic body map, methods Rapid Upper Limb Assessment (RULA), and journals related troubleshooting RULA analysis method.

Next step is problem identification aims to determine the specific symptoms of MSDs and cause of MSDs. The symptoms of MSDs can be known by distributing questionnaires using Standardized Nordic Questionnaire (SNQ) as a standard, valid, and has proven accuracy in measuring symptoms of MSDs on various kinds of work activities, such as agricultural work (Taylor-Gjevre, et.al., 2015), manufacturing workers (Menegon, FA, et.al . 2012), construction workers (Derros, et.al., 2014).

Additionally, the factors that contribute to causing MSDs, such as working posture, heavy loads, exposure to vibration, movement and repetition also determined. Meanwhile, the determination of load level, vibration exposure, and the number of repetitive movement were done by direct observation.

The new workbench that consider ergonomics aspects in its design was proposed to improve working posture. To examine the effects of the design, an experiment was performed by involving the same respondents. Again, a survey was conducted using RULA method and the results compared with the existing workbench effects.

3. Result

There are allegations that the highest risk of MSDs can be experienced workers are at the waist and upper right arm. All the workers felt very ill at the waist, while one worker to feel very ill and three other workers to feel pain in the right upper arm. Here are the results of the Standardized Nordic questionnaire Questionnaire (SNQ):

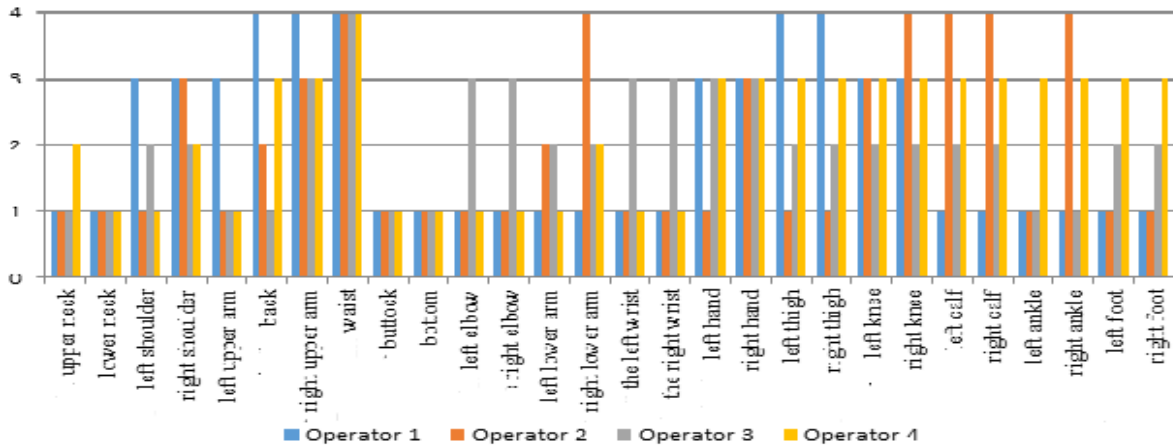


Fig. 1. Symptoms of MSDs problems that occur on Workers

Furthermore, analysis of the working posture was performed to determine the root cause of the problem in scraping mold stamp. The collected data will then be assessed using RULA method as follow.

Table 1. RULA Score for Existing Work Activities

| Body Section | Score | |
|------------------|-------|------|
| | Right | Left |
| Upper Arm | 3 | 3 |
| Lower Arm | 1 | 2 |
| Wrist | 1 | 1 |
| Wrist Twist | 1 | 1 |
| Neck | 4 | |
| Trunk | 5 | |
| Leg | 1 | |
| Muscle Use | 1 | |
| Force/Load | 0 | |
| RULA Total Score | 6* | |

*) Note: total score 6 show that working posture caused severe MDS so the working condition need to be investigated and improve soon.

4. Analysis

Based on observation, poor work postures caused by the interaction between workers with a work table. The worker performing awkward posture when he scrapped the mold on the workbench. Stamp mold was scrapped for one hour with high frequents of repetitive movements as much as 30 movement per minute on average. Here's the sketch of working posture:

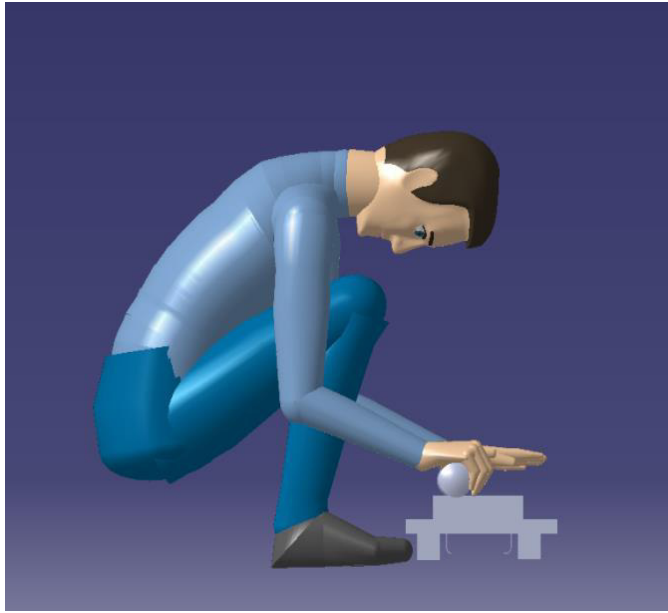


Fig. 2. Existing Working Posture

Learning from the existing conditions, the new workbench which has been corrected by adjusting the height of a table refer to the operator posture was proposed. Based on the anthropometric data, the specifications of new design of workbench was determined.



Fig. 3. Mold Scraping Using Proposed Workbench

Then, the experiment that involved all of four operators was performed and the result can be seen in the following table:

Table 2. RULA for Proposed Work Activities

| Body Section | Score | |
|-----------------|-------|------|
| | Right | Left |
| Upper Arm | 2 | 2 |
| Lower Arm | 1 | 1 |
| Wrist | 2 | 1 |
| Wrist Twist | 2 | 2 |
| Neck | 2 | |
| Trunk | 2 | |
| Leg | 1 | |
| Muscle Use | 1 | |
| Force/Load | 0 | |
| RULATotal Score | 3 | |

It can be shown that there are some improvements of working condition with the new proposed method. While the existing working condition has overall final score of 6, the proposed score is 3. It means that further investigation is needed, and changes may be required, but it is much better than the existing one. Some of the factors that cause the problems can be grouped comes from the movement of the neck and body movement.

On the neck, first worker makes 35.31° angle, second worker makes 14.6° angle, third worker makes 41.04° angle, and fourth worker makes 20.86° angle. Neck worker's position makes 14.6° - 41.04° angle happened because of existing scrap desk that is too low around 7cm. The second worker makes an angle of 14.6° on the neck in the RULA category has a score of 2 and when coupled with a score of 1, because the workers have to bend the neck, the score for his neck to be 3. The first, third and fourth workers make angle 10.86° - $41, 04^\circ$ in the RULA category has a score of 3 and when coupled with a score of 1 because the worker's neck have to bowed, their scores to be 4. Of these four workers, the neck posture still not ergonomic as indicated RULA score on 3 and 4.

The second factor is the position of the body, where all of the four workers is making angle 21.05° , 35.87° , 23.15° and 31.7° , respectively. The position of the workers make the angle 21.05° - 35.87° occurs when workers have to scrape by bending the body caused by the existing work table was set too low, at just 7cm height. They make the angle between $21, 05^\circ$ - 35.87° in the RULA categories will get score of 3 and coupled with a score of 1 because the agency workers bent over, their score became 4.

After using the new tables improvements occur in the neck position and a score RULA to be 2 because of the table height was adjusted, which is 92 cm, so that the operator does not have to bow the neck. It also happens to the whole working posture.

5. Conclusion

From the final score of 6 means that existing RULA into the category of investigation and changes are needed soon. As for the overall final score RULA proposals are included in the category 3 means required further investigation may be required and the necessary changes. As RULA Score decline the risk of Musculo-Skeletal Disorders will also decrease.

It was noted that the major differences between these two working conditions are squatting and standing positions. Squatting put a strain on the body's lower leg and also cause the static position during work. Keeping static working postures for a long time will causing trauma to the particular muscle. However, if the operator is already familiar with then he / she will be all right, but unwittingly cause MDS.

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