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RULA: POSTURAL LOADING ASSESSMENT TOOLS FOR MALAYSIA MINING INDUSTRY

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Abstract

The ergonomics and environment factors have been the core issue for the mining industry for many years, and its profiles are rising. To ensure an ergonomics work environment, it is possible to require specific attention especially in this industries sector. It is becoming increasingly difficult to ignore the essential issue in Malaysia due to lack of ergonomics knowledge and low awareness among the engineers in the mining sector. The focus of this study is to evaluate and validate the physical risk factor associated with work-related musculoskeletal disorder (WMSDs) by using Rapid Upper Limb Assessment (RULA) among mining industry workers. All the physical risk factors involved the main body regions such as upper arm, lower arm, wrist, trunk, neck and leg that has been identified associated with WMSDs. There were 18 subjects selected to involve in this study. Those subjects were chosen according to their job task. To increase the reliability of the result, each subject was evaluated thrice in the trials. From the analysis, the average of final score of the RULA is 7 indicates high risk and calls for engineering/or work method changes to reduce or eliminate muscular disorder risk. The results of the analysis were used to improve the process of work, design of workstation and also improving the work posture to enhance the comfort level of operators. This study is crucial among the mining industry that is a lack of the information and research about the ergonomics issues in the industry. The overall finding indicated that the whole process of selected work task will contribute to musculoskeletal disorder either for a short or long time exposure.

Keywords: Ergonomics, RULA, Risk factor, Mining.

Abbreviations

DOSH	Department of Occupational Safety and Health
MSD	Musculoskeletal DIsorder
RULA	Rapid Upper Limb Assessment
SOCSO	Sosial Security Organisation
WMSDs	Work-related Musculoskeletal Disorder

1. Introduction

In recent years, there has been an increasing interest in quality, health and safety requirement in several occupations. Researchers have increased interest in occupational safety and health issue for mining industries in Malaysia. It is becoming gradually more difficult to ignore the issue related to occupational workplace ergonomics risk assessment due the recent studies and statistics. According to a statistic report by the Department Of Occupational Safety and Health, Malaysia (DOSH) about occupational accidents for the category of death until August 2010, 51 of victims were reported by construction industry. Manufacturing industry was the second highest where 45 of victims were reported behind the agriculture (26 of victims) and transportation (10 of victims) [1]. Furthermore, according to statistics report on the number of accidents by industry for the past year 2012 conducted by Social Security Organisation, (SOCSO), 9 cases were reported for fatal accident and 417 cases were reported for disability in mine and quarry industry [2]. As far as the concern of this study is to evaluate and validate the physical risk factor associated with work-related musculoskeletal disorder (WMSDs) by using Rapid Upper Limb Assessment (RULA) among mining industry workers.

However, those accidents can be minimized throughout the application of engineering and administrative controls [3]. Lack of information about ergonomics is observed in the various industries in which task are carried out. Musculoskeletal disorders are observed in the welding process where workers are working in kneeling posture, and it shows that there is need to adjust the body postures [4]. The purpose of ergonomic principles would help to enhance machine performance and productivity, help workers to be comfortable and safe [5]. Some workers work under harsh conditions to carry out the required task. These tough circumstances normally increase to various MSD within the workers. These disorders emerge within the workers body due to repetitive lifting, differential lifting height, ambient conditions, etc. [6]. The significance of ergonomics should be product design, working environment, and industrial workstation design, in order to increase productivity and reduce MSD among the workers.

The study revealed that there had been numerous gaps in the work environment, tools, and equipment that affect the health and safety of workers at the work site [8]. Ergonomics related to the design of methods and processes can help reduce or decrease works related risks, as well as advance the company's quality and productivity [9]. Awkward posture, lifting, forceful movement and physical work at rapid rate contribute to the musculoskeletal disorder. The current study is focused on assessing the work posture of worker occupied in different activities of casting [10]. The application of ergonomic principles not only help to increase machine performance and efficiency, but also help the human operator to

be comfortable and protected [11]. It was found that there was the lack of ergonomics development and methods in small scale forging industry. A significant proportion of the workers were working in very terrible postures. It is recommended that the implementation of ergonomics intervention with accurate awareness among worker [12]. The Study recommended that an ergonomic workstation design can contribute widely to improve the physiological performance of the operators [13].

MSD is a regular disorder characterized by ergonomics. Whereby, 448 cases were reported by, SOCSO [2]. The increasing cases reported can be the major issues for the workers are at high risk of developing WMSDs that are associated with exposure factors in this work environment. Despite the high prevalence of work-related musculoskeletal disorder (WMSDs) in mining industries, therefore the aims of this study is to investigate the physical risk factor among the workers in selected job task by using Rapid Upper Limb Assessment (RULA) introduced by Mctamnney and Carlett [14].

2. Methods

2.1. Subjects and selected job task methods

Selected mining companies in Pahang and Kelantan states were randomly selected as a field study in this research. From the three workplace of the mining industry, 18 workers in the selected job were randomly selected as subjects. The selected job task was wet screening that related to screening the raw material by using manual handling water hose.

The work task was based on the main procedure of selecting the best raw material before the next process continues. Those workers handle the hose manually to screening all the raw material from 8.00 am in the morning until 5.00 pm afternoon with 30 to 45 minutes break at 1.00pm. The hose weight more than 20kg under strong pressure, and their body was excessively exposed to repetitive motion throughout the working hours. All subjects were exposed to standing position while handling the hose manually. The investigation was taken three times, in the morning, at noon and after the noon session.

2.2. RULA method

For this study, the RULA method was used to explore the subsurface of MSDs Problems among the mining workers. Mctamney and Corlett [15] designed RULA to assess operator who may expose to musculoskeletal loading that is known to contribute to upper limb disorder. RULA is one of the more practical way to assess biomechanical and postural loading on the whole body with particular attention to the neck, trunk, and survey method developed for use in ergonomics investigation for workplace where work related upper limb disorder are reported. Beach et al. [16] study of the impact of such demands on upper body kinematics, trunk muscle activation, and lumbar spine loading during a repetitive lifting task and the results suggest that upper limb kinematic adaptations to precision placement constraints in repetitive lifting may alter the risk of reporting low back pain. A significant association between trunk and neck scores and all self-reported pains, aches or discomforts in the trunk or neck regions in all subjects.

In particular, the neck score was significant in both postures, reflecting high loading of the neck (Massaccesi et al [17]). Nicolas Viganis et al. [18] studied that the innovative system for real-time ergonomic feedback in industrial manufacturing. This study presents a system that permits real-time ergonomics assessment of manual tasks in an industrial environment. First of all the biomechanical model of the upper body has been developed by using inertial sensor placed at different parts of the upper body. Based on this model a computerized RULA ergonomics assessment was implemented to permit a glob risk assessment of MSD in real time. Then local score were calculated per segment and gave information on the local risks for MSD, visual information was feedback to the user by using a seethrough head mounted display. In a user study (N=18 participants) a group with the RULA feedback was compared to a control group. Results demonstrate that the real-time ergonomics feedback significantly decreased the risk of MSDs at global and segmental levels. The real-time ergonomics tool presented in this study could be used directly to reduce the risk of MSDs in an industry and to optimize the long-term performance of workers.

3. Result and Discussion

3.1. Description of the subjects

From the wet screening job, out of 18 workers, the age range from 19 to 36 years (mean 2.44±0.86). The working experience ranges was from less than a year to 5 years (mean 1.89±0.47). Table 1 shows the demographics of the workers in wet screening.

Table 1. Demographics of the workers in wet screening job.

Job	Age (year)			Working experience (year)		
	Mean	SD	Range	Mean	SD	Range
Wet Screening	2.44	0.86	19-36	1.89	0.47	< 1-5

3.2. Rapid upper limb assessment (RULA)

Table 2 revealed RULA assessment during the morning session. Upper arm mean score was 2.67±0.49 with the maximum score was 3 as the arm was raised from 20º to 45º throughout performing of the job task. Meanwhile, the lower arm mean score was 1.78±0.43 with the maximum score stated at 2 as, the lower arm was stated at 0º to 60º until 100º throughout to performing of the job task. Wrist score was stated at 2.22±0.43 as the highest score was 3 as the wrist position is bent from the midline or moved towards 15º above and 15º below the midline of the wrist. Most of the wrist showed it twisted in mid-range along the job performance among all workers. The force score stated the highest as the load was more than 10kg with repeated and shocks handling with the equipment.

The neck position was a score at 1.56±0.51 as the neck was exposed to 10º to 20º throughout the job performing of the job operators and the highest score among the operators was 2. Most of the operators were standing with 0º to 20º of trunk position throughout the job assessment. The score for the trunk was 2.22±0.43 as the highest score was 3 as the trunk position getting bent forward from 20º to 60º.

This is because the operators were getting tired throughout the job task, and the upper body of operators getting forward as time goes by. Legs mean score was 1.06±0.24 as the highest score was 2 as a few of operators did not support their leg during the job task throughout the work day. Final score foe RULA assessment is finalized by the addition of neck, trunk and leg score plus with a wrist arm score. From the Table 2 the mean score from both scoring were 6.94±1.11 and 7.22±0.81. The mean score from both parts as the final score was 7 in which the task is needed to immediate investigate and implement the change of the task.

Table 2. Morning assessment.

	Morning Score				
Operator(N=18)	**Mean**	**Max**	**Min**	**(SD)**	**Range**
Upper Arm (1-6)	2.67	3.0	2.0	0.49	2-3
Lower Arm (1-3)	1.78	2.0	1.0	0.43	1-2
Wrist (1-4)	2.22	3.0	2.0	0.43	2-3
Wrist Twist (1-2)	1.0	1.0	1.0	0.0	1
Force (0-3)	3.0	3.0	3.0	0.0	3
Neck (1-6)	1.56	2.0	1.0	0.51	1-2
Trunk (1-6)	2.22	3.0	2.0	0.43	2-3
Leg (1-2)	1.06	2.0	1.0	0.24	1-2
Neck Trunk Leg score (1-7)	6.94	9.0	6.0	1.11	6-9
Wrist Arm score (1-8)	7.22	8.0	6.0	0.81	6-8
Final Score (1-7)	7.0	7.0	7.0	0	**?**

*The RULA score unit was based on each body part of scoring range.

Noon session of RULA assessment can be seen in Table 3. The upper arm score was 2.39±0.5 as the maximum score among the operator was 3. The upper arm position was at between 45º to 90º throughout the job assessment. The lower arm mean score was 1.33±0.49 as most of the operators move, the lower arm position in between 60º to 100º throughout the job task. The wrist means score was 2.06±0.24 as the most wrist were adjustable bent throughout the job task. Meanwhile, the score for wrist twist was maintained at 1.0±0.0 same goes with the morning session score. Force mean score also stated the same score as morning session assessment at 3.0±0.0 as the load was more than 10kg. Neck mean score was 1.22±0.43 as the neck position was always at 10º to 20º throughout the job task. Trunk score was 2.06±0.24 as the position of the trunk was between 0º to 20º for the whole job performance assessment. The leg and feet of operators were supported, and the mean score was 1.06±0.24. The final score was 7 as the neck, trunk and leg mean score was 6.39±0.92 combine with the wrist arm mean score 7.17±0.62. The final score represents the level of MSD that need to be changed with very high risk for the operators.

After the noon session of RULA assessment, Table 4 revealed a slight different of the score throughout the assessment. From the scored data, it is apparent that the score of the upper arm was 2.56±0.51, and it is higher than morning and noon session. The lower arm score was 1.56±0.51, and the score also showed it is higher than morning and noon session assessment. The mean score for wrist was 2.28±0.46 and also show the higher score compare to morning and noon session. Meanwhile, the wrist twist score was 1.0±0.0 stated same score with the morning and noon session. Force score was 3.0±0.0 and same goes with

the morning and noon session assessment as the load was more than 10kg throughout the job task. At the same time, neck mean score was 1.28±0.46, and it shows slight different score between morning and noon score assessment. The trunk score was 2.28±0.46 and had higher score compare to morning and noon session. As the leg score did not show, different score compare to morning and noon session assessment. The leg score was 1.06±0.24 as the position of the legs did not have changes throughout the assessment. As the final score shows the highest at 7 which means the level of Musculoskeletal disorder at very high risk and need implement change now.

Table 3. Noon assessment.

	Noon Score				
Operator(N=18)	**Mean**	**Max**	**Min**	**(SD)**	**Range**
Upper Arm (1-6)	2.39	3.0	2.0	0.5	2-3
Lower Arm (1-3)	1.33	2.0	1.0	0.49	1-2
Wrist (1-4)	2.06	3.0	2.0	0.24	2-3
Wrist Twist (1-2)	1.0	1.0	1.0	0.0	1
Force (0-3)	3.0	3.0	3.0	0.0	3
Neck (1-6)	1.22	2.0	1.0	0..43	1-2
Trunk (1-6)	2.06	3.0	2.0	0.24	2-3
Leg (1-2)	1.06	2.0	1.0	0.24	1
Neck Trunk Leg score (1-7)	6.39	9.0	6.0	0.92	6-9
Wrist Arm score (1-8)	7.17	8.0	6.0	0.62	6-8
Final Score (1-7)	7.0	7.0	7.0	0	7

*The RULA score unit was based on each body part of scoring range.

Table 4. After noon assessment.

	After Noon Score				
Operator(N=18)	**Mean**	**Max**	**Min**	**(SD)**	**Range**
Upper Arm (1-6)	2.56	3.0	2.0	0.51	2-3
Lower Arm (1-3)	1.56	2.0	1.0	0.51	1-2
Wrist (1-4)	2.28	3.0	2.0	0.46	2-3
Wrist Twist (1-2)	1.0	1.0	1.0	0.0	1
Force (0-3)	3.0	3.0	3.0	0.0	3
Neck (1-6)	1.28	2.0	1.0	0.46	1-2
Trunk (1-6)	2.28	3.0	2.0	0.46	2-3
Leg (1-2)	1.06	2.0	1.0	0.24	1
Neck Trunk Leg score (1-7)	7.17	9.0	6.0	1.1	6-8
Wrist Arm score (1-8)	7.0	8.0	6.0	0.77	6-8
Final Score (1-7)	7.0	7.0	7.0	0	7

*The RULA score unit was based on each body part of scoring range.

4. Conclusions

The result of this assessment shows that the subjects were exposed to all the physical risk factors such as neck, trunk, and upper extremities. As a conclusion, we can say that the wet screening task was in very high-risk level and need to be change immediately. The task needs to be revamped change for the health concern to the workers involve. The present study was designed to

determine the level of physical MSD risk among the workers in mining. The further study needs to be done to ensure the cause of significant risk factors to the WMSDs among the mining workers.

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