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Evaluation of work posture using Rapid Upper Limb Assessment (RULA) methods: a case study

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Abstract

Ergonomic work posture assessment is a method for evaluating the physical condition of work and employees' posture when working. Lack of knowledge about ergonomics in work activities carried out by informal sector workers leads to health problems. Health problems that arise, namely musculoskeletal disorders, occur in the work of the bean roasting process with an unnatural standing posture coupled with excessive muscle exertion. This study aimed to evaluate the work posture of bean-roasting process workers. The Rapid Upper Limb Assessment (RULA) method is used for eight workers. The results obtained were work posture with a low category of 25%, risk with a medium category of 38%, and risk with a high category of 50%. The conclusion of this study, namely the evaluation of work postures that have been carried out in this small industry with the RULA tool, is that a significant proportion of workers are in unsafe and insecure positions, as found by the author. This is due to small and medium enterprises' lack of ergonomic knowledge and awareness.

1. INTRODUCTION

Small-scale industries, or household industries, play an essential role in development in Indonesia, and they play an important role in employing some of the workforce. Most of the workforce suffers from musculoskeletal disorders, Indonesia's most common work-related problems. In small industries or households, most of the work is done conventionally, including standing and manual labor, so musculoskeletal disorders and work-related injuries in various body parts are of great concern (McAtamney & Nigel Corlett, 1993).

Rapid Upper Limb Assessment (RULA) is a survey method developed for ergonomic investigations in workplaces where work-related upper extremity disorders are reported. Doing work in a long-standing position unnaturally or ergonomically has contributed to health disorders such as work-related musculoskeletal disorders, chronic venous insufficiency, premature birth and spontaneous abortion, and carotid atherosclerosis. However, the injury can be minimized by applying technique and administrative controls (Halim & Omar, 2011).

The lack of knowledge about ergonomics in occupational activities results in workers being at risk of musculoskeletal disorders. Musculoskeletal disorders occur in bean roasting workers with a non-ergonomic standing posture, coupled with excessive muscle

deployment, which results in workers experiencing the risk of health problems, namely musculoskeletal disorders. Applying ergonomic principles, such as working in an ergonomic work posture, will help avoid the occurrence of musculoskeletal disorders and can improve work performance and productivity (Suarjana, Pomalingo, Palilingan, & Parhusip, 2022). Workers under difficult conditions perform the desired task. This severe condition usually causes various musculoskeletal disorders in workers. This disorder appears in the worker's body due to repeated manual handling, workstations that do not match the worker's body size, relatively long working conditions, extreme environmental conditions, etc (Sachdeva & Gupta, 2011). Each construction task is unique and complex, with varying time frames. In the case of worker MSD, the duration of time is very important. Research shows that the current awkward posture of construction workers is not safe or suitable for modified workstations (Palikhe, Lee, Kim, Yirong, & Lee, 2022).

Ergonomics as a discipline that studies the interaction between humans and their work environment is a central aspect of the effort to create optimal working conditions (Bridger, 2003). An in-depth understanding of how factors such as workstation design, tools, equipment, and the work environment interact with humans helps to improve worker well-being, reduce the risk of injury or musculoskeletal disorders, and maximize productivity. More so, ergonomics also plays a key role in worker safety by identifying and mitigating potential hazards in the workplace. A human-centered approach in product and system design is at the core of ergonomics, which ultimately leads to the development of better working environments suited to human needs and capabilities.

The importance of ergonomics as an appropriate technology, improvement of the working environment, and its influence on workstations in the industry is that ergonomics plays a key role in optimizing worker productivity and well-being in diverse work contexts. Ergonomics as an interdisciplinary science integrates knowledge from various disciplines such as psychology, biomechanics, anthropology, and engineering to design workstations and work systems that suit human characteristics. The study revealed several gaps in the work environment, equipment, and supplies that affect occupational health and safety in the workplace. Ergonomics related to the design of methods and processes can help eliminate or reduce work-related risks and improve the quality and productivity of the company. Awkward posture, lifting, strong movements, and high-intensity manual work contribute to health risks, namely musculoskeletal disorders (Suarjana, Pomalingo, Parhusip, & Attaufiq, 2022). Current studies focus on assessing workers' working posture in the peanut roasting process. Ergonomic risks occur during the nut roasting due to awkward positioning and repetitive activity. The body functions best in a neutral posture, around the middle range of joint movement for most body parts.

Meanwhile, awkward posture refers to the body's position that deviates significantly from the neutral position when performing work activities. When workers are in awkward positions, the muscles work less efficiently, and they must exert muscle strength to complete the task. Regarding this, repetition can be defined as a cyclical or repetitive work activity involving repetitive movements in a specific body part. Repetition refers to a task or series of movements performed repeatedly with little variation over some time (Sriagustini & Supriyani, 2022).

The application of ergonomic principles will help improve the performance and productivity of the machine. Still, it mostly helps human operators to be safe, comfortable, healthy and efficient so productivity is as high as possible. It concluded that there is a lack of planning and ergonomic methods in small-scale industries. Most workers work in a posture that is not physiological. This study recommends that it is urgently needed to implement ergonomic interventions with proper awareness for workers. Studies conclude that an ergonomic workstation design can significantly improve the operator's physiological performance. Overall, it showed that the frequency and extent of the incidence of discomfort were at a lower risk for all parts of the body. Although the practice of a combination of work systems stands static and dynamic, varying the position of the legs while standing helps reduce discomfort when working

with a standing posture. This work aims to develop a design methodology for preventive ergonomics and comfort analysis of the human-machine interface (HMI).

Ergonomics

Ergonomics is the scientific discipline concerned with understanding interactions among humans and other elements of a system and the profession that applies theory, principles, data, and methods to design to optimize human well-being and overall system performance (International Ergonomics Association, 2000). The main goal of applying ergonomics is to achieve an optimal quality of human life in the place where the human being is located (Tarwaka, Solikhul, & Sudiajeng, 2004).

The definition of ergonomic risk is a condition or situation created intentionally or unintentionally that contributes to the emergence of conditions that do not follow the principles of ergonomics. It is potentially harmful to health and comfort during and after work (Suarjana, Parhusip, Pomalingo, & Ataufiq, 2022). Ergonomics risk factors have the potential to cause harm or negative effects on health in connection with ergonomics. Some risk factors for ergonomics are posture, frequency, duration, force, and object factors (Purbasari & Siboro, 2018).

Biomechanics

In the industrial world, the performance of employees is a very important to pay attention to because work performance is an important factor in the production process. Biomechanics is a branch of ergonomic research. Biomechanics describes workers' burden and minimizes it to reduce accidents and occupational health. Biomechanics measures the physical strength that labor possesses, such as the strength of physical power and the ability of the body mechanically at the time of carrying out activities and ways of working, as well as facilities and equipment designed to match the capabilities of the human body when performing work (Manuaba, 2000).

Work Posture

Working posture is the posture when working. Different work attitudes will produce different strengths. When working, the posture is designed so that it occurs naturally, so that it can reduce the onset of musculoskeletal injuries. Comfort is manifested. Workers perform appropriate and comfortable working postures. In the human body, there is a type of force that is (Wignjosoebroto, 2009):

1. Gravitational force, which is the force that passes through the center of mass of each segment of the human body in a downward direction (F = m.g).
2. Reaction force, that is, the force that occurs due to a load on a segment of the body or the weight of the body segment itself.
3. Muscle force occurs in the joint part, either due to friction in the joint or due to the force on the muscles attached to the joint. This style describes the magnitude of the muscle moment force.

This style describes the magnitude of the muscle moment force. The human body has six links, among others (Tarwaka et al., 2004):

1. Forearm link, constrained by palm and elbow joints
2. Link the upper arm, constrained by the elbow and shoulder joints
3. Backlink, bordered by shoulder and hip joints
4. Link thighs, bordered by hip and knee joints
5. Calf link, bordered by knee and ankle joints
6. Foot link, restricted to the ankle and sole joint

Time measurement is the work of observing and recording the work time of each element or cycle using tools that have been prepared (Rafian & Muhsin, 2017).

Good working posture is determined mainly by the movement of body organs when working. Movements performed while working include flexion, extension, abduction, adduction, rotation, pronation, and supination. Flexion is a movement in which the angle between two bones occurs a reduction; extension is a stretching motion in which there is an increase in the angle between two bones, and abduction is a sideways movement away from the middle axis of the body. Adduction is the movement towards the middle

axis of the body. Rotation is the rotation of the upper part of the arm or forelimb. Pronation is the rotation of the limb's middle part (towards the inside). Supination is the rotation towards the side (towards the outside) of the limb (Rinawati, 2016).

Musculoskeletal Disorders

Complaints of the musculoskeletal system are complaints of parts of the skeletal muscles that a person feels, ranging from very mild to very painful (Tarwaka et al., 2004). Complaints in the form of damage to the joints, ligaments, and tendons will occur if the muscles receive a static load repeatedly and for a long time, usually termed complaints of MSDs or injuries to the musculoskeletal system.

Rapid Upper Limb Assessment (RULA)

Rapid Upper Limb Assessment (RULA), developed by Dr Lynn Mc Atamney and Dr Nigel Corlett, is the ergonomics department of the University of Nottingham (University of Institute of Occupational Ergonomics). First described in the form of a Journal of Ergonomics Applications in 1993, RULA is a method developed in the field of ergonomics that examines and evaluates the working position of the upper body. The Nordic Body Map is a system that measures pain symptoms in the body, called the musculoskeletal system (Henny, Andriana, & Ramadhan, 2022).

In line with the functioning of muscles and external loads supported by the body, ergonomic technology evaluates the muscles' posture, strength, and activity that cause injuries due to repetitive activities. RULA was developed to detect work postures at risk and make improvements as soon as possible (McAtamney & Nigel Corlett, 1993). Assessment using this method is a method that has been carried out by McAtamney and Nigel Corlett (1993).

2. METHODOLOGY

This research was conducted in a case study of small and medium enterprises in Rimawar, Kawangkoan District, Minahasa Regency, North Sulawesi Province, in Indonesia. The design of this study is descriptive-observational, that is, research by describing a problem or situation objectively. The sample in this study involved eight workers. The stages carried out in this study are preliminary studies, collection of work posture photo data, processing and analyzing work posture data using the RULA method, and analyzing RULA scores. The RULA method is a rapid method of assessing disorders in the upper posture, Namely, posture (palms, upper arms, forearms, back, neck, and leg position), the weight lifted, the energy used (static or dynamic), and the number of jobs (McAtamney & Nigel Corlett, 1993). Then, an assessment of each posture is carried out based on an assessment from the RULA for each part (upper arms, forearms, wrists, wrist rotation, back, neck, and leg position), after which it determines the risk level based on the results of the final score from the combined results of the calculation of the A score and B score in Table C (final score), indicating whether the posture requires corrective action or not.

3. RESULTS

The assessment using the RULA worksheet is presented in Table 1 which presents the different categories of risk levels obtained after analyzing the posture, and the results of the RULA analysis. These results suggest that all categories of risk levels are present in the job posture. The table shows that 50% of workers in high-risk work postures need to make changes as soon as possible. The table also shows that none of the working postures of workers are at a safe level or a level that is not at risk.

Table 1. Risk Categories by RULA Level

Level RULA	0	1	2	3
Score RULA	1-2	3-4	5-6	7
Risk level	Negligible	Low	Moderate	High

Action Recommendations	Acceptable	Investigate further	Investigate further and make changes immediately	Investigate and intervene immediately
Percentage of workers	--	25%	38%	50%

Figure 1 shows one of the workers in a working position that produces a large RULA score at action level 4. The frying process shows that the position of the upper arm is in extension at 700 and acts on the body's midline. The forearm is in flexion at 900 and acts on the body's midline. The position of the wrist is flexion on the 120 and acts on the midline of the hand. The wrist twist is on the midline. The neck flexes at 460 and acts on the body's midline. The back is a flexion on 130 and acts on the body's midline. This working process allows more than four movements per minute and loads >10 kg.

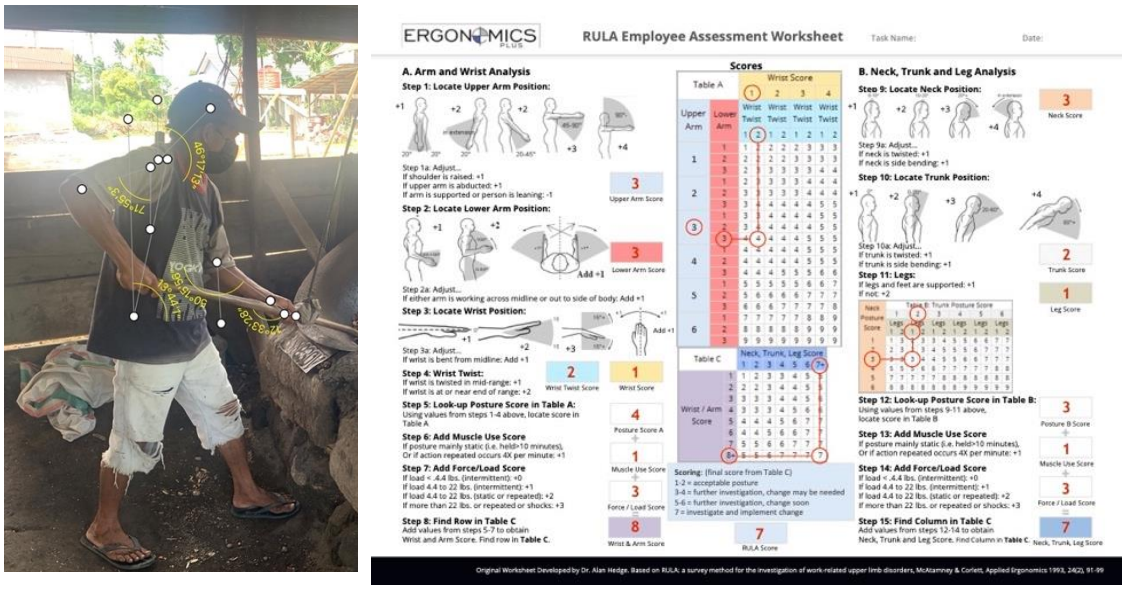

Figure 1. RULA Analysis using Worksheet

4. DISCUSSION

The ergonomic risk level analysis results, which was seen from the work posture using the RULA assessment on peanut roasting process workers, obtained a risk with a high category of 50%. Meanwhile, almost all work positions have risks ranging from low to high, with a low category percentage of 25% and a high category percentage of 38% of the eight workers sampled in this study.

A high RULA value means that the working posture can cause the worker's body pain if done repeatedly. A posture job with a SCORE of RULA 7 often causes pain in certain parts of the body and can lead to a high risk of musculoskeletal disorders (MSDs) (Djiono, 2013). The RULA approach is suitable for detecting the improvement of work posture from high-risk to low-risk conditions or more natural working postures. The RULA method can be used to turn unnatural working postures into more natural ones (Budiyanto, Adiputra, Sutjana, & Tirtayasa, 2019). Based on the results of research conducted by Palikhe et al. (2022), the interventions carried out will help normalize the level of injury in the future. Current countermeasures suggest that modified work placements are a way to reduce MSD stress among workers, consistent with the simulated results of this study. The most problematic working positions in all three tasks are turning the body, walking with weights, and maintaining the position of the arms.

Research conducted by Salimi et al. (2021) RULA and NERPA's final score on the worst and longest posture for a hairdresser is 7. The highest prevalence of WMSDs was reported in the body's shoulder, knee, and neck areas. There is a significant association between the age of hairdressers and the prevalence of WMSDs in the shoulder, back, waist, knee, and ankle regions. The prevalence of WMSDs was found to have a significant association with stand-around activity. Consistent with these findings, the research conducted by Sohail (2021) on small garment industries showed a high postural risk among workers (about 45% were at high risk). Studies have also revealed the prevalence of work-related MSD among workers, ergonomic deficiencies in the workplace, excessive seam area noise, and negligible personnel protective equipment. It can be concluded that the workers in these units face various shortcomings in occupational health and ergonomics.

Working in a neutral position is an ergonomic principle that can be applied to avoid musculoskeletal complaints. A neutral posture is one in which the body is aligned and balanced when sitting or standing, putting minimal stress on the body and maintaining balance. When the final RULA score shows level 4 action, then the correction of the working position should be carried out immediately. The change in the working position aims to reduce the RULA score so that the level of witnesses is classified as low risk. RULA measures the upper part of the body, consisting of the upper arm, forearm, and hand. Also, it measures the position of the back and neck. Therefore, A remedial measure that can be taken to correct an uncomfortable working posture is to make repairs on the workstation according to the anthropometry of the bean roasting worker.

The RULA score obtained for each stage of the manufacture of roast peanuts will give an idea of the ergonomic risks. Each level of action indicates the measures that should be taken to prevent the occurrence of musculoskeletal complaints. Excessive muscle stretching, repetitive activity, unnatural work posture, other secondary factors, and combined causes cause musculoskeletal complaints (CDC, 2017). Posture is defined as the position of different parts of the body. Awkward posture occurs when muscles, tendons, and ligaments are stressed and under pressure. This posture or work position is considered one of the occupational risk factors that most often causes musculoskeletal (MSD) complaints (Jaffar & Rahman, 2017).

One of the repairs to the workstation that needs to be made is to carry out the design of the combustion furnace following anthropometry because it will affect changes in work attitudes that risk musculoskeletal complaints experienced by workers compared to work postures that do not follow ergonomic rules. So, the complaints felt by workers are expected to be smaller than the work posture at the old workstation.

5. CONCLUSIONS

After an evaluation of the work posture that has been carried out in this small industry with the RULA tool, it can be concluded that a significant proportion of workers are working in unsafe and dangerous positions, as found by the author. This is due to small industries' lack of ergonomic knowledge and awareness. Thus, the risk of musculoskeletal disorders that workers feel is moderate to high based on the RULA assessment. This study recommends the application of ergonomic interventions with the proper knowledge among workers and health education, namely posture regulation, application, and monitoring of occupational health and safety management systems, to reduce morbidity due to musculoskeletal disorders.

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