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Postural Risk Analysis Based on Rapid Upper Limb Assessment (RULA) Method for Manual Handling Workers in the Food Industry

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ABSTRAK

Manual handling activities in the production process at PT XYZ pose a significant risk of musculoskeletal disorders due to non-ergonomic working postures. This study aims to assess postural risk levels among workers in the palletising section using the Nordic Body Map (NBM) and Rapid Upper Limb Assessment (RULA) methods. Based on responses from 15 workers, NBM results indicated an equal distribution of risk: five workers each were classified as low, moderate, and high risk. The most commonly reported areas of discomfort included the lower back, wrists, upper back, upper arms, elbows, and neck. RULA analysis yielded scores of 7 (very high risk) for lifting and placing boxes and 6 (high risk) for carrying boxes, indicating the need for immediate corrective action. These findings underscore the importance of ergonomic interventions, such as workstation redesign, ergonomic training, and assistive devices, to reduce the risk of chronic injury, improve worker well-being, and sustain productivity while minimising long-term healthcare costs.

Keywords: *Manual Handling, Nordic Body Map, RULA, Work Posture, Ergonomics.*

Introduction

Human resources play a crucial role in the production process, especially in manual work involving manual handling. Several factors may influence performance and productivity, such as physical condition and workload, to improve performance and productivity.

Manual handling activities can pose various risks to occupational safety, particularly when the work environment is not suited to the worker's capabilities, equipment is inadequate, and techniques used are not ergonomic. Working with an unattended system can lead to ergonomic problems. Poor body posture in the workplace may result in musculoskeletal disorders (MSDs), injuries or conditions affecting the skeletal muscles and bones.

Musculoskeletal Disorders (MSDs) are complaints related to the muscles and skeletal system that range from mild to severe. These disorders are commonly caused by excessive muscle strain or prolonged load durations, which can damage joints, ligaments (connective tissues between bones), and tendons (connective tissues between muscles and bones). Initial symptoms may include pain, soreness, numbness, tingling, swelling, stiffness, tremors, sleep disturbances, and burning sensations. Such conditions can impair a person's ability to move and coordinate properly, which reduces work efficiency, leads to lost work time, and ultimately decreases productivity.[1]–[3].

According to the World Health Organisation (WHO), musculoskeletal disorders affect muscles, bones, joints, tendons, and ligaments. In 2019, WHO reported that 1.71 billion people were affected by MSDs, making them the leading cause of disability worldwide and the major contributor to lost productivity at the workplace. Data from the International Labour Organisation (ILO) in 2018 revealed that 2.78 million workers died due to work-related diseases and occupational accidents.[4]–[6]. Of this number, around 2.4 million deaths (86.3%) were due to occupational diseases, while more than 380,000 deaths (13.7%) resulted from workplace accidents. According to Indonesia's Basic Health Research (RISKESDAS) 2018, the prevalence of musculoskeletal disorders in Indonesia was 7.9%. The highest prevalence was in Aceh at 13.3%, Bengkulu at 10.5%, and Bali at 8.5%.

PT XYZ, a company engaged in the food industry, conducts manual handling activities daily. Thus, maintaining occupational safety and health during these activities is paramount[7]–[9]. The common complaints experienced by operators include: pain in the lower back, left wrist, right wrist, back, right upper arm, left upper arm, right elbow, left elbow, and neck. At PT XYZ, workers must use lifting and moving techniques correctly, use assistive tools when necessary, and communicate effectively with team members to minimise the risk of injury. It is also essential to regularly assess the work environment and promptly report any conditions that may

increase the risk of injury to supervisors or the safety team. Given the risks of MSDs among operators at PT XYZ, this study aims to assess the level of postural risk at work.

The Nordic Body Map (NBM) and Rapid Upper Limb Assessment (RULA) are two methods to achieve this research objective. The Nordic Body Map is a method used to assess muscle pain complaints in workers through an ergonomic questionnaire. NBM helps identify and evaluate the pain experienced by workers. Since NBM is a questionnaire, the results may be subjective.[10]–[12].

Meanwhile, the Rapid Upper Limb Assessment (RULA) method, developed by Dr. Lynn McAtamney, is used to assess upper body postures such as the hands, arms, back, neck, and wrists. This method also evaluates workload, energy expenditure (static and dynamic), and other factors such as motivation and work systems. RULA requires no special equipment for posture assessment and can be conducted quickly. It provides critical information regarding poor posture, muscle activity, and exertion when lifting loads, which can cause injury if done repeatedly. RULA also offers recommendations to reduce the risk of physical injury. The NBM questionnaire often complements RULA to assess workers' complaints about posture and work position.[13]–[15].

The advantage of using both the NBM and RULA methods is that NBM provides subjective data on musculoskeletal complaints, while RULA offers an objective analysis of working posture. This combination presents a comprehensive overview of workers' ergonomic conditions.[16]–[18].

Accurate Risk Identification and Preventive Measures — NBM helps identify the body parts with the highest complaint levels, while RULA determines high-risk postures or movements. This facilitates the design of more specific and effective ergonomic interventions for each identified risk point.[19]–[21].

Improved Validity and Data Accuracy—Using two different but complementary methods enhances the validity of the research findings, as they capture both subjective aspects (complaints) and objective aspects (posture). Therefore, the researcher is interested in conducting a study entitled Postural Risk Assessment Based on the Nordic Body Map (NBM) and Rapid Upper Limb Assessment (RULA) Methods for Manual Handling Workers at PT XYZ.[22]–[24].

However, most previous studies have focused on the construction or warehouse sectors, and few have highlighted the fast-food sector, such as the soy sauce industry, particularly in the context of palletising work. This represents the research gap addressed in this study.[25]–[27]. Therefore, this research aims to identify the level of work posture risk and provide improvement recommendations based on the RULA and NBM methods, specifically for manual handling workers in the palletising section of PT XYZ.

Research Methods

According to NIOSH (1997), musculoskeletal disorders are a series of pathological conditions that affect the normal functioning of the delicate tissues of the musculoskeletal system, such as nerves, tendons, muscles, and other supporting structures, including intervertebral discs (Hutabarat, 2017). The NBM method is an ergonomic assessment technique that aims to identify and assess the severity of disorders of the musculoskeletal system. The RULA method was developed by Dr. Lynn McAtamney and Dr. Nigel Corlett at the Institute of Occupational Ergonomics, University of Nottingham. RULA is designed to evaluate upper body posture in the field of ergonomics, with a specific goal to assess musculoskeletal risks that may arise during work, especially repetitive strain injuries (Hutabarat, 2017).

The research flowchart is used to plan and illustrate the stages of the study from the beginning to the end. It serves as a visual guide to help ensure that each step of the research process is clearly defined, systematically executed, and aligned with the research objectives.

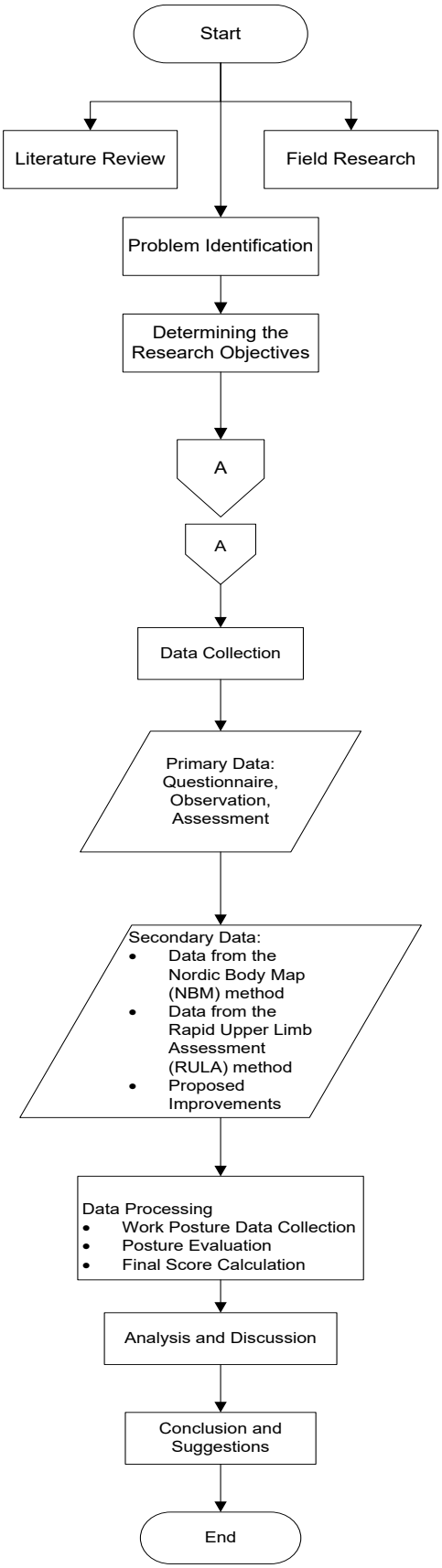

Figure 1. Worker Score Results

The selection of respondents in this study used purposive sampling by considering specific criteria to ensure the collected data was relevant and representative. The chosen respondents were active workers in the manual handling (palletising) section who were directly involved in lifting, carrying, and arranging product cartons. They had at least 6 months of work experience to ensure adequate task familiarity. Implementing the Rapid Upper Limb Assessment (RULA) method began with observations and documentation in photos or videos to capture body posture during work activities. Subsequently, upper body postures such as the upper and lower arms, wrists, neck, trunk, and legs were analysed and scored according to RULA guidelines. These scores were then combined with load and activity values to generate a final score, which was used to determine the level of ergonomic risk, ranging from low to very high. The higher the score, the greater the likelihood that the working posture is non-ergonomic and requires immediate intervention.

Results And Discussion

Questionnaire Data NBM (Nordic Body Map)

Each individual's score is calculated based on 27 muscle body parts being assessed. The minimum possible total score is 27, while the maximum is 112. The higher the score, the more severe the discomfort experienced, indicating the need for further attention. Corrective actions are taken based on the risk level in specific muscle areas, such as adjusting working posture or using assistive tools to reduce discomfort during work. The summary of the questionnaire data is presented in Table 1

Table 1. Questionnaire Data Recapitulation Results

No	Respoden														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
0	1	2	3	2	2	1	1	1	2	2	1	1	2	1	2
1	1	2	2	1	2	1	2	1	3	3	2	1	1	1	1
2	2	3	3	1	1	2	3	2	1	3	1	1	1	2	2
3	2	3	3	1	2	2	4	2	2	3	1	1	1	2	1
4	2	3	2	2	2	2	1	2	4	3	2	1	2	2	2
5	2	4	4	3	2	2	2	2	3	3	3	1	2	2	3
6	2	3	3	1	1	1	4	1	1	3	2	2	2	2	2
7	1	4	4	2	2	2	3	3	3	3	3	1	3	3	3
8	2	1	1	1	2	1	1	3	4	2	1	1	1	1	1
9	2	1	1	1	1	1	2	1	2	1	1	1	1	1	2
10	2	2	1	1	1	1	3	1	2	2	1	1	1	2	2
11	1	2	1	1	1	1	4	1	2	2	1	1	1	2	2
12	1	3	2	1	2	1	1	1	2	1	2	1	2	2	2
13	2	3	3	1	2	1	2	1	1	2	2	1	2	2	3
14	2	3	2	1	2	1	3	1	1	2	3	1	2	2	3
15	2	3	2	1	2	2	4	1	2	2	3	1	2	2	2
16	2	4	3	1	1	1	1	1	2	2	2	1	3	2	2
17	1	4	3	1	1	2	2	1	1	3	2	1	3	2	2
18	1	2	4	1	1	1	3	1	2	2	1	1	2	2	2
19	1	2	4	1	2	1	4	1	1	2	1	1	2	2	2
20	1	2	2	1	1	1	1	1	2	2	1	1	2	2	2
21	2	2	2	1	2	1	2	1	1	2	1	1	2	2	2
22	2	2	3	2	2	1	3	1	1	2	1	2	2	3	2
23	3	2	3	2	2	2	4	1	1	2	1	2	2	3	2
24	2	2	4	1	2	2	1	1	1	2	1	1	2	2	2
25	2	2	4	1	2	1	2	1	2	2	1	1	2	2	2
26	2	2	2	1	2	1	3	1	1	2	1	1	2	2	2
27	2	2	4	1	2	1	4	1	1	2	1	1	2	2	2
Result	49	72	78	39	52	43	77	44	60	72	54	43	65	69	72

Based on the scores obtained from each worker, the level of risk experienced in each body part can be identified. These scores are then classified according to predetermined criteria to highlight which body parts are at the highest risk. The risk levels are presented in Table 2

Table 2. Risk Level Score

Score Range	Risk Level	Color Category
28 – 49	Low	Blue
50 – 70	Moderate	Green
71 – 91	High	Yellow
92 – 112	Very High	Red

Based on the values obtained for each worker, we can determine how much risk they experience in each part of their body. These values are then classified according to predetermined rules, so that it can be more clearly seen which parts of the body are most at risk. The following is the Risk Level. In the risk level assessment, colour categories are used to make it easier to read the results. The score range between 28 and 49 falls into the low-risk category and is marked in blue. The score of 50-70 is in the medium category, with green. A score of 71-91 indicates a high risk, given yellow. Meanwhile, the score of 92-112 is in the very high category and is given a red colour. The following are the results of the recapitulation of the worker score based on the total individual score in Table 3:

Table 3. Worker Score Results

Workstation	Helper	Score	Risk Level
Transfer/Pick up goods, lift goods, put goods on pallets	H 1	49	Low
	H 2	72	Tall
	H 3	78	Tall
	H 4	39	Low
	H 5	52	Keep
	H 6	43	Low
	H 7	77	Tall
	H 8	44	Low
	H 9	60	Keep
	H 10	72	Tall
	H 11	54	Keep
	H 12	43	Low
	H 13	65	Keep
	H 14	69	Keep
	H 15	72	Tall

Bar Chart

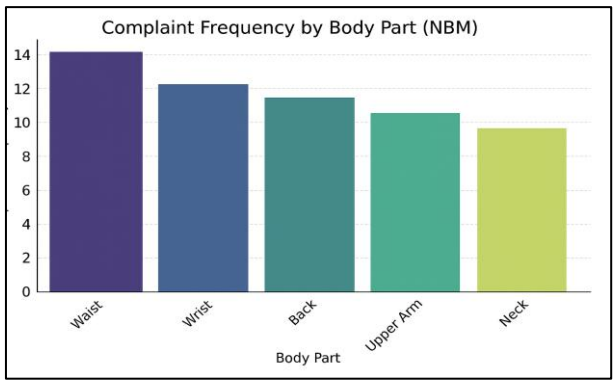

Figure 2. Bar Chart

The bar chart generated from the Nordic Body Map (NBM) results illustrates the body parts most frequently reported as experiencing discomfort, based on responses from 15 workers. The data reveals that the lower back received the highest complaints, followed by the wrists, upper back, upper arms, elbows, and neck. This pattern indicates that repetitive manual handling tasks—such as lifting, carrying, and placing boxes—place significant strain on the upper body and lower back. The high frequency of complaints in these areas suggests that the working postures are not ergonomically sound. Consequently, these findings serve as a valuable reference for designing corrective measures, such as posture training, assistive tools, or reorganising the workstation layout to help reduce muscle strain and prevent injury.

Data Rula (Rapid Upper Limb Assessment)

In this study, the object is the workers who carry out manual handling activities: moving, lifting and putting goods on pallets provided. Data for RULA (Rapid Upper Limb Assessment) analysis was collected by taking photos while workers carried out the manual handling process. After collecting the data, the RULA score is calculated to assess the work posture during manual handling activities. The assessment process using the RULA (Rapid Upper Limb Assessment) method is carried out by evaluating posture, style, and muscle activity while working. This approach determines the risk level using a scale from 1 to 7, where a score of 1 indicates a very low risk, while a score of 7 indicates a very high risk. The higher the value obtained, the greater the potential for injury to the musculoskeletal system, so immediate corrective action or intervention is needed to reduce this risk.

Final RULA Score of Manual Handling Activities

Table 4. Final RULA Score of Manual Handling Activities

No	Activity	RULA Score	Risk Level	Recommendation
1	Picking up soy sauce boxes	7	Very High	Immediate intervention
2	Carrying soy sauce boxes	6	High	Corrective action soon
3	Placing soy sauce boxes onto the pallet	7	Very High	Immediate intervention

The Rapid Upper Limb Assessment (RULA) assessment indicates that the three main activities involved in the manual handling process in the palletising section at PT XYZ carry ergonomic risk levels ranging from high to very high. The activity of lifting soy sauce boxes received a RULA score of 7, reflecting a very high risk caused by a bent posture, intensive use of the upper arms, and non-neutral wrist positioning, thus requiring immediate corrective action. The activity of carrying the boxes scored 6, which falls into the high-risk category due to the static body posture while handling the load, suggesting that improvements should be implemented promptly. The activity of placing the boxes onto the pallet also scored 7, indicating a very high risk resulting from bending, reaching, and twisting motions that exert considerable strain on the back, neck, and upper arms. These findings demonstrate that all three activities pose a significant risk of musculoskeletal disorders, emphasising the need for comprehensive improvements in the work system, including applying ergonomic principles, using assistive equipment, and training in proper and safe working techniques.

Table 5. Manual Handling Activities Based on the 5W+1H Approach

No	Element	Question	Explanation	Problems found
1.	What	What are the main problems that occur?	Poor working posture can lead to problems with muscles and bones.	● Not knowing the correct way to lift ● Never trained in a safe way
2.	Who	Who experiences this problem?	Workers at PT XYZ often lift or carry goods manually.	● No tools ● Items are too heavy
3.	When	When did this problem occur?	When carrying out daily work activities that involve lifting, bending, or carrying heavy objects.	● The place is narrow ● Not designed to be easy for heavy work
4.	Where	Where does this problem occur?	In the workplace of PT XYZ, especially in the production department, lifting activities are required.	● Workers adjust to the speed of the machine. ● Workers work faster because too many goods are coming simultaneously.
5.	Why	Why is this issue important to investigate?	Because it can make workers tired quickly, unproductive, and even injured in the long run.	● Not knowing how to work safely ● Not aware of the danger of injury
6.	How	How do I know the level of risk?	By assessing the worker's posture, using the NBM (to see body complaints) and RULA (to check whether the work posture is ergonomic).	● No work supervision ● Not regularly checked for safety

Proposed Improvements

Table 6. Proposed manual handling improvement with a focus on workforce change

No	Aspects	Current Conditions	Problem	Proposed Improvements	Benefit
1.	Worker Rotation Schedule	There is no clear work rotation schedule	Workers Who Stay in The Same Position for Too Long Risk injury	Create a rotation schedule every 2–3 hours and set shift changes periodically	Reduces muscle fatigue, lowers the risk of muscle disorders (MSDS)
2.	Workload Sharing	Workload Not Evenly Divided	Some workers always get heavy tasks	Perform workload analysis and assign tasks fairly	Workload becomes more balanced, avoiding injuries due to excess
3.	Training and readiness	Not All Workers Know How to Handle All Kinds of Heavy Duty	Difficult to change positions due to limited skills	Encourage workers to have a lot of skills and be able to replace each other	It's easier to change positions, and teamwork is more flexible
4.	Rest Time	Irregular or too short rest time	The Workers' Body Doesn't Have Enough Time to Recover	Give short breaks (5–10 minutes) every 2 hours, plus adequate significant breaks	Reduce Fatigue, Maintain Work Concentration
5.	Monitoring & Evaluation	No monitoring of the rotation system or complaints from workers	Don't know if the current system is safe or not	Create a system to record muscle complaints and evaluate rotations at regular intervals.	There is precise data for improving K3 and improving working conditions.

The results of this study show that manual handling activities such as lifting, carrying, and stacking cartons received high RULA scores, indicating a significant ergonomic risk. These high scores are strongly linked to repetitive movements, non-neutral body postures, and continuous physical exertion. This finding is consistent with the research conducted by Nasution and Rizkiansyah (2021), which stated that repetitive tasks performed over long periods without sufficient rest can significantly increase RULA scores, particularly in manual labour settings such as the footwear industry. Furthermore, the results of the NBM questionnaire in this study indicate that the most frequent complaints were reported in the neck, back, and wrists. This is supported by the findings of Herdiana and Nugraha (2023), who concluded that repetitive work without ergonomic assistive tools tends to cause complaints in the neck and upper back, which are early symptoms of musculoskeletal disorders.

Conclusion

Based on the results of the NBM questionnaire administered to 15 workers, the risk levels were evenly distributed: five workers were categorised as low risk, five as medium risk, and five as high risk. The most commonly reported complaints were in the waist, back, wrists, upper arms, elbows, and neck. The RULA assessment showed that picking up and placing cartons on pallets scored 7 (very high risk), while carrying cartons scored 6 (high risk). These scores reflect poor ergonomic conditions during manual handling tasks, caused mainly by bent postures, high task repetition, non-neutral wrist positions, and heavy loads.

These findings highlight the urgent need for ergonomic intervention at PT XYZ. Immediate corrective measures such as redesigning workstations, introducing assistive tools, and conducting ergonomic training are essential to reduce the risk of musculoskeletal disorders. Without such improvements, workers will remain exposed to postural hazards that may result in long-term health consequences and decreased productivity.

In addition to posture-related risks, organisational factors also contribute to the problem. The company currently lacks a clear work rotation schedule, leading workers to remain in the same position for extended periods. Workload distribution is uneven, and workers cannot switch tasks due to skill gaps. Rest breaks are irregular and often too short, depriving the body of sufficient recovery time. Furthermore, a monitoring system for worker complaints prevents the practical evaluation of health conditions and the work environment. Addressing these systemic issues is critical for long-term risk reduction and improved workplace safety.

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