Posture analysis of the workers of railway maintenance unit

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ABSTRACT

Maintenance of railways is done periodically by the railway maintenance unit. The work activities executed in uncertain weather and with the use of relatively heavy equipments are done in a quick manner. Therefore, work posture examination is required using *Rapid Entire Body Assessment* (REBA) and *Nordic Body Map* (NBM) methods. This study aimed to find out the work posture of the workers in the railway maintenance unit of Resort IV.6 Ketapang, North Lampung. The study was qualitative in nature using a case study approach. The data were collected through interviews and observation using Nordic Body Map (NBM) forms. Data collection from informants was conducted using purposive sampling with 1 key informant and 4 triangular informants, with the characteristics of already working for more than 3 years and also being the workers in the railway raising projects. The results of the study showed that, based on REBA calculation, the score obtained upon the observation of the informants' working posture was 10, which was categorized as high. As such, immediate identification is required regarding the informants' working posture. Based on the results of the study, it is concluded that working postures of the workers in the railway maintenance unit have effects on the pain in the muscle parts of the workers. Therefore, Improvement on working postures should be made immediately. In addition, during their work using working equipments, they should do short stretching to reduce the pain complained.

1. Introduction

Railway maintenance is an inspection and repair activity conducted by PT KAI (PT Kereta Api Indonesia or Indonesian Railway Company) in order to improve and restore the service quality of PT KAI as well as to maintain it so that it can continue operating. The maintenance conducted by PT KAI includes Routine Maintenance activities as preventive measures such as: daily, monthly, and yearly maintenance (Menteri Perhubungan, 2011). Railway inspection is made by railway checking by *Kepala Unit Pelaksana Tugas* or KUPT (Head of Work Operation Unit) to identify any damage or trouble of railway tracks. KUPT itself is a position responsible for ensuring the viability of railway tracks for safe train passage. The problems found in railways in certain areas are analyzed by the KUPT and the inspection results will be the basis for the preparation of priority programs. The work

activities under uncertain weather conditions should be completed in quick and responsive manners to prevent train passages from being disrupted (Rusdiana, 2014).

Lifting of light mechanical equipment with relatively heavy weight which should be done quickly may result in a bad working posture. The *Nordic Body Map* (NBM) questionnaire is required to evaluate working postures using the *Rapid Entire Body Assessment* (REBA) method. The *Nordic Body Map* (NBM) questionnaire is required to find out the pain points of a worker's body. The *Rapid Entire Body Assessment* (REBA) is a method in the field of ergonomy which is utilized in evaluating a worker's working posture.

Nordic Body Map (NBM) is a subjective evaluation method which could be used to measure complaints of muscular pain among workers. Nordic Body Map questionnaire is a checklist of ergonomy which is standardized and clearly organized which is the most commonly used to check discomforts experienced by workers. Using the completely filled Nordic Body Map (NBM) questionnaire, information on the painful body parts of the workers prior and after a work can be obtained. The questionnaire is subjective but is standardized so that it is effective to use (Megawati, 2021).

The *Rapid Entire Body Assessment* (REBA) is one of the methods in the field of agronomy to evaluate workers' working postures. The postures to be evaluated include wrists, arms, backs, necks, and feet of workers. Every REBA form is used to evaluate the postures, use of force, types of movements, repetition, and coupling. REBA is made in such a way that it is simple to use and does not require either special skills or expensive tools (Tiogana & Hartono, 2020).

The Province of Lampung has 28 railway stations. One of them is Ketapang Station which has an area length of 26.600 m. Railway track inspection conducted by two workers who do the job by going on foot. These two PPJ or Petugas Pemeriksa Jalur (Track Inspection Officers) of the Resort IV.6 Ketapang (or Ketapang Station) go on foot to do the inspection on the railway tracks. One PPJ officer walks in the direction of Negara Ratu Station, while the other walks in the direction of Kotabumi Station. These two officers will then meet the officers from Negara Ratu and Kotabumi Stations respectively in the halfway points between two stations.

The inspections by PPJ officers would result in the finding of track lowering or slumping. The handling of the railway lowering is done in 60 minutes by adding ballast rocks, continued with raising in the same height between right and left, and continued with compacting using a number of equipments, one of them is a light mechanical equipment or Hand Tie Tamper weighing 15 kg. The final step is measuring to ensure the uniform height between the right and the left. The work to handle railway lowering involves 15 people.

2. Materials and Method

This study applied qualitative research using a case study approach. Case study methods are similar to historical methods, but with addition of systematic observation and interviews. The types of proofs in a case study method are interviews, documents, observation tools, and in certain cases informal manipulation might be made in the observation of participants (Nur'aini, 2020).

This study was conducted at the Railway Station Office Resort IV.6 Ketapang, Labuhan Ratu Kampung, District of Sungkai Selatan, Regency of Lampung Utara, Province of Lampung. The subjects of the study were selected according to the needs of the researchers using a purposive sampling method in the area of Railway Maintenance Unit of Resort IV.6 Ketapang Lampung Utara. They were the field workers (3 to 5 people) who did the work program, namely the Work Unit (Satuan Kerja or Satker) selected according to the needs of the researchers.

The purposive sampling method was selected for sample taking. Purposive sampling is a sample taking technique which uses certain considerations so that the sample suits the required criteria to decide the number of samples to be studied.

The subjects of the study were selected according to the needs of the researchers using a purposive sampling method in the area of Railway Maintenance Unit of Resort IV.6 Ketapang Lampung Utara. They were selected according to the researchers' needs, namely the workers' characteristics of those already working for more than 2 years and who were the workers of the railway raising works. There was 1 key informant who was the leader of the work unit and has worked for 7 years, and 4 triangular informants of the work unit who had worked for more than 3 years.

3. Results and Discussion

The railway maintenance unit of Resort IV.6 is located at the Railway Station Office of Resort IV.6 Ketapang, Labuhan Ratu Kampung, District of Sungkai Selatan, Regency of Lampung Utara, Province of Lampung. On a daily basis, the railway maintenance unit executes railway repair works which have been programmed by one Head of Work Unit (Kepala Satuan Kerja or Kasatker), and the program is executed by 10 people. The maintenance by PT KAI is divided into two categories, namely routine maintenance and repair to restore the functionality. Routine maintenance as preventive action consists of: daily, monthly, and yearly maintenance. Maintenance works can restore the functionality when a component in a railroad crossing is considered unsatisfactory or has potential to cause disruption in the operation of railway trains which require repairs (Muhtarom & Ratih, 2021).

This study focuses on the work posture when the workers use a light mechanical equipment, namely hand tie tamper, where the activity is done repetitively with the position of lifting and lowering weight of the light mechanical equipment with a weight of ±15 kilograms with vibration of ±110-140 Hz. One of the repair works is raising the railway tracks. This work starts with working equipment checking, preparation, and is finished with execution of the work.

3.1. Work Posture of Railway Track Raising

The risk analysis of work posture in this study used the *Rapid Entire Body Assessment* (REBA) method by evaluating the work posture when the workers used the *Hand Tie Tamper* (HTT) which might cause complaints of pain. In this study, the work posture is defined as the standing posture when the workers operate the work equipment. The repetitive posture is the activitiy of moving the working equipment to a determined raising point.

Date taken: 08/18/2023, 18:11
a:30.8°

posisi leher

Figure 1. Posture and Angle of Neck
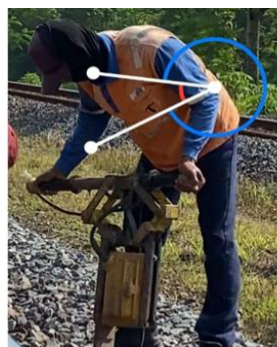
Date taken: 08/18/2023, 18:11
a:34.1°

posisi punggung

Figure 2. Posture and Angle of Back Part

Date taken: 08/18/2023, 18:11
a:146.2°

posisi kaki
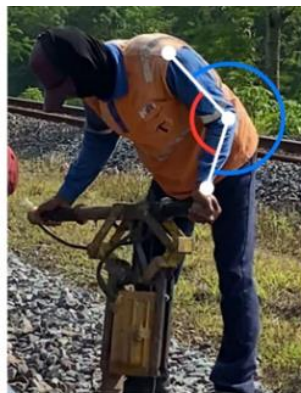
Figure 3. Posture and Angle of Leg

Date taken: 08/18/2023, 18:11
a:46.3°

lengan atas

Figure 4. Posture and Angle of Upper Arm

Date taken: 08/18/2023, 18:11
a:120.6°

lengan bawah

Figure 5. Posture and Angle of Lower Arm

Date taken: 08/18/2023, 18:11
a:28.4°

pergelangan tangan

Figure 6. Posture and Angle of Wrist

Table 1. Table of Group A in the Use of *Hand Tie Tamper (*HTT*)*

Table A	Leg	Neck											
		1				2				3			
		1	2	3	4	1	2	3	4	1	2	3	4
Back	1	1	2	3	4	1	2	3	4	3	3	5	6
	2	2	3	4	5	3	4	5	6	4	5	6	7
	3	2	4	5	6	4	5	6	7	5	6	7	8
	4	3	5	6	7	5	6	7	8	6	7	8	9
	5	4	6	7	8	7	8	9	7	7	8	9	9

Table 2. Table of Group B in the Use of *Hand Tie Tamper* (HTT)

Table B	Wrist	Lower Arm					
		1			2		
		1	2	3	1	2	3
Upper Arm	1	1	2	2	1	2	3
	2	1	2	3	2	3	4
	3	3	4	5	4	5	5
	4	4	5	5	5	6	7
	5	6	7	8	7	8	8
	6	7	8	8	8	9	9

Table 3. Table C in the Use of *Hand Tie Tamper* (HTT)

Score A	Table C											
	Score B											
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	1	1	2	3	3	4	5	6	7	7	7
2	1	2	2	3	4	4	5	6	6	7	7	8
3	2	3	3	3	4	5	6	7	7	8	8	8
4	3	4	4	4	5	6	7	8	8	9	9	9
5	4	4	4	5	6	7	8	8	9	9	9	9
6	6	6	6	7	8	8	9	9	10	10	10	10
7	7	7	7	8	9	9	9	10	10	11	11	11
8	8	8	8	9	10	10	10	10	10	11	11	11
9	9	9	9	10	10	10	11	11	11	12	12	12
10	10	10	10	11	11	11	11	12	12	12	12	12
11	11	11	11	11	12	12	12	12	12	12	12	12
12	12	12	12	12	12	12	12	12	12	12	12	12

It was found that the final score obtained from the observation of informants' working posture was 10, which was categorized as high so that immediate identification was required with regard to the informants working posture.

Based on the calculation, the researchers found that the work was done with standing, slightly bending legs, repetitive movements, fast movement of wrists, bending body, and neck and back bending to the front postures. From the evaluation of railway track raising activities, it was found that the body parts were in a static position or withholding position in a certain posture for more than 1 minute, and repetitive activities for the duration of the railway track raising work. Based on the REBA calculation, it was found that the final score upon the observation of the informants' working posture was 10, which was categorized as high so that immediate identification was required with regard to the informants working posture.

Based on the interviews regarding the respondents' knowledge of correct working postures, it was found out that the key informant had not known the correct working postures. Meanwhile, most of the triangular informants did not know either how to apply correct working postures to prevent themselves from complaints of pain. Whereas, based on the interviews, regarding the incorrect or bad postures, the key informant knew the incorrect or bad postures. On the other hand, based on the interviews, the triangular informants did not know the incorrect or bad postures which might result in complaints of pain.

Uncommon or strange postures which are significantly deviating from the normal postures during the execution of a work is called awkward postures. The required energy would increase from time to time when a person is working in awkward postures. Awkward or uncomfortable positions would easily result in fatigue since the transfer of energy from the muscles to bone tissues runs less effectively (Purbasari et al., 2019). Based on the researchers' observation on 1 key informant and 4 triangular informants who were the workers of the railway maintenance unit of Resort IV.6 Ketapang, it was found that the following postures were applied: body bending position, head bowing, wrist holding working equipment and withholding the movement of working equipment, and leg slightly bending.

According to the previous study, there was a significant correlation between musculoskeletal pain and working postures among brick making workers in Karangsono Village, Mranggen District, Demak Regency. A high risk working posture would have 7 times higher risk in causing musculoskeletal pains compared to medium or low risk working postures (Hardiyati et al., 2022). A study conducted by Setiorini on the workers of a bag industry center using the REBA method revealed the existence of non-low risk, meaning that the workers required immediate treatment. The source of the REBA high final score among the model and warehouse workers was the limited working posture. Meanwhile, awkward postures among workers of the main unit were mostly caused by the lifting of non-light objects without the use of equipment. The posture evaluation using the REBA method revealed that the work had high risks, meaning that posture changing and investigation were immediately required (Setiorini et al., 2019).

The results of a study by Hidayati who analyzed correlation between working postures and low back pain complaints showed that there was a correlation between low back pain and working postures. The finding is supported by the theory by Tarwaka et al. (2004) regarding ergonomy for Safety, Health, and Productivity that non-ergonomic postures would have non-low risk of back pain (Setyawan et al, 2022).

A study on working postures among rice farmers conducted by Setyawan using the ERBA method and NBM questionnaire suggested that the farmers' postures require immediate investigation and improvement. The researcher suggested the farmers take a break during their work to relax their muscles to reduce muscle pain in order to maintain normal joint mobility and reduce break hours to do some stretching to minimize the risk of *musculoskeletal disorders* (MSDs) (Prawira et al., 2017).

3.2. Working Posture Point

The observation to help identify the degree of complaints of muscular pain was done using the observation sheet of the Nordic Body Map (NBM) method with the objective to identify the incorrect

points of the body parts. The total result of the calculation using NBM can then be obtained. The following Table 1 is the result of pain evaluation using the Nordic Body Map (NBM).

Table 4. Results of *Nordic Body Map* (NBM)

Respondent No.	Final Score	Risk Level	Improvement Measure
1	42	Low	Action level 1, low risk level and does not require improvement measures
2	42	Low	Action level 1, low risk level and does not require improvement measures
3	46	Low	Action level 1, low risk level and does not require improvement measures
4	40	Low	Action level 1, low risk level and does not require improvement measures
5	45	Low	Action level 1, low risk level and does not require improvement measures

Table 5. Category of *Nordic Body Map* (NBM)

Score Range	Risk Level	Improvement Measure
28-49	Low	Does not require improvement measures
50-70	Medium	May require improvement measures later
71-90	High	Require immediate measures
91-122	Extremely High	Require entire measure as soon as possible

Based on the interviews conducted by the researchers to better find out the complaints of pain among the workers of the Railway Maintenance Unit of Divre IV, all the respondents working on the railway raising work applied slightly uncomfortable positions. This was because, when working with the equipment, they had to stand with their bodies bending and their heads bowing. In addition, they had to work quickly since the job should be completed on time using equipment each weighing 15 kg. The informants experienced pain in certain parts of their bodies both during and after work, since their working postures had not been in accordance with the ergonomy. If done repetitively, those postures would cause complaints of pain. The body parts suffering the pains would be the neck, right arm, right lower arm, left lower arm, waist, hip, right hand, left hand, right foot, left foot, left thigh, right thigh, right calf, and left calf.

The results of this study are consistent with the study by Dewi explaining that there were ergonomic risks of musculoskeletal disorders among the nurses evaluated using the Nordic Body Map (NBM) questionnaire. The study concluded that a number of the nurses' body parts which had injury risks were nape, neck, right shoulder, waist, back, and hip (Dewi, 2020). Similar results were also shown in a study by Permatasari & Widayati evaluating home industry workers in Surabaya. A number of musculoskeletal disorders were found in right shoulder and back. These complaints occurred because the workers worked in awkward positions repetitively for a long duration so that they did not pay attention to the ergonomic working postures (Permtasari & Widjajati, 2018).

4. Conclusion

Based on the evaluation of observation using the REBA method on the workers during the execution of railway track raising work with bending standing position, a final score of 10 is obtained, meaning that it is categorized as a high risk so that identification of the informants' working posture is immediately required. This high level of risk is due to the occurrence of complaints of pain in the crossing of angles in the body which cause the workers to work in awkward positions so that they feel uncomfortable. The uncomfortability would require more energy, especially during the works of railway track raising, use of hand tie tamper, and moving of the hand tie tamper from one place to another.

Based on the Nordic Body Map (NBM) calculation among the informants, the body parts suffering from complaints of pain were left shoulder, right shoulder, back, left arm, right arm, left calf, right calf, left foot, and right foot with low level of risk which had not required measure of repair.

References

Dewi, F. N. (2020). Identifikasi risiko ergonomi dengan metode Nordic Body Map terhadap perawat poli RS X. *Jurnal Sosial Humaniora Terapan*, *2*(2), 125-134. https://scholarhub.ui.ac.id/jsht/vol2/iss2/15/

Hardiyati, S., Anggraini, M. T., & Fuad, W. (2022). Hubungan postur kerja dan masa kerja dengan nyeri Muskuloskeletal (Analisis pada pekerja pembuat batu bata di Desa Karangsono Kecamatan Mranggen Kabupaten Demak) Fakultas Kedokteran, Universitas Muhammadiyah Semarang. *Jurnal Kesehatan Masyarakat Indonesia*, *17*(3), 1–6. https://jurnal.unimus.ac.id/index.php/jkmi/article/view/9140

Megawati, E. (2021). Edukasi pengurangan resiko terjadinya Musculoskeletal Disorders (MSDs) dini, pada penjahit keliling di Ngaliyan Semarang. *Budimas : Jurnal Pengabdian Masyarakat*, *3*(2), 450–456. https://doi.org/10.29040/budimas.v3i2.3478

Menteri Perhubungan (2011). *Peraturan menteri perhubungan nomor : PM 32 tahun 2011 tentang standar dan tata cara perawatan prasarana perkeretaapian*. Menteri Perhubungan Republik Indonesia. https://peraturan.bpk.go.id/Details/106028/permenhub-no-32-tahun-2011

Muhtarom, Z., & Ratih, S. Y. (2021). Analisis kondisi jalan rel kereta api pada lintas Sragen-Solo berdasarkan nilai Track Quality Indeks (TQI). *Jurnal Teknik Sipil*, *17*(1), 01–13. https://doi.org/10.28932/jts.v17i1.3440

Nur'aini, R. D. (2020). Penerapan metode studi kasus Yin dalam penelitian arsitektur dan perilaku. *INERSIA: LNformasi dan Ekspose Hasil Riset Teknik SIpil Dan Arsitektur*, *16*(1), 92–104. https://doi.org/10.21831/inersia.v16i1.31319

Permatasari, F. L., & Widajati, N. (2018). Hubungan sikap kerja terhadap keluhan Musculoskeletal pada pekerja home industry di Surabaya. *The Indonesian Journal of Occupational Safety and Health, 7*(2), 220–239. https://doi.org/10.20473/ijosh.v7i2.2018.230-239

Prawira, M. A., Yanti, N. P. N., Kurniawan, E., & Artha, P. W. (2017). Faktor yang berhubungan terhadap keluhan muskuloskeletal pada mahasiswa Universitas Udayana tahun 2016. *Journal Industrial of Hygiene and Occupational Health*, *1*(2), 101–118. https://doi.org/10.21111/jihoh.v1i2.888

Purbasari, A., Azista, M., & Siboro, A. B. (2019). Analisis postur kerja secara ergonomi pada operator pencetakan Pilar yang menimbulkan risiko Musculoskeletal. *Sigma Teknika*, *2*(2), 143-150. https://doi.org/10.33373/sigma.v2i2.2064

Rusdiana. (2014). *Manajemen operasi*. CV Pustaka Setia.

Setiorini, A., Musyarofah, S., Mushidah., & Widjasena, B. (2019). Analisis postur kerja dengan metode reba dan gambaran keluhan subjektif Musculoskeletal Disorders (Msds) (Pada pekerja sentra industri tas Kendal tahun 2017). *Jurnal Kesehatan,* (1), 24-32. https://doi.org/10.23917/jk.v0i1.7669

Setyawan, H., Hendrawan, T. A., & Untari. E. (2022). Analisis Postur Kerja Pada Petani Padi dengan Metode REBA Untuk Mengurangi Keluhan Muskuloskeletal di Desa Suguhrejo Magetan. *Jurnal Keilmuan Teknik*, *1*(1), 74-83. https://doi.org/10.25273/set-up.v1i1.13439.74-83

Tiogana, V., & Hartono, N. (2020). Analisis postur kerja dengan menggunakan REBA dan RULA di PT X. *Journal of Integrated System, 3*(1), 9–25. https://doi.org/10.28932/jis.v3i1.2463