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Nomor : ST – 219 /FT/UM/V/2024

- Dasar** : 1. Program Kerja Fakultas Teknik Universitas Merdeka Malang, Semester Genap TA. 2023/2024
2. Permohonan Surat Tugas dari Program Studi Teknik Industri No :464/PSTI/FT/UM/V/2024 tentang Permohonan Surat Tugas Pengelola Jurnal Program Studi Teknik Industri *Journal Of Industrial View* Semester Genap 2023/2024.
- Menimbang** : Bahwa perlu segera mengeluarkan Surat Tugas Dekan Fakultas Teknik Universitas Merdeka Malang sebagai realisasi tersebut Bab Dasar.

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- Untuk** : 1. Seterimanya Surat Tugas ini disamping Tugas Pokok ditunjuk sebagai Pengelola Jurnal Program Studi Teknik Industri *Journal Of Industrial View*.
2. Laporan atas pelaksanaan Surat Tugas ini kepada Dekan Fakultas Teknik Universitas Merdeka Malang guna menerima petunjuk lebih lanjut.
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Pada Tanggal : 31 Mei 2024

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Tanggal 31 Mei 2024

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Evaluating Musculoskeletal Disorder Risk Factors through Quick Exposure Check: A Case Study in a Crumb Rubber Factory

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Abstract

Manual Material Handling (MMH) is the activity of lifting, moving, carrying, pulling, and lowering materials or finishing goods. It relies on human power manually. MMH's work was also carried out at the packaging workstation in the crumb rubber factory. Activities on workers at the packaging workstation is a lifting and moving bandela weighing about 35 kg. This activity continues every day without the help of assistive devices so workers have the potential risk of musculoskeletal disorders. This study aims to evaluate the work posture of workers at the packaging workstation against the risk of musculoskeletal disorders in the crumb rubber factory. The method used is Quick Exposure Check (QEC). Data were collected using the QEC questionnaire. The total number of workers involved in this study was 15 workers. The results showed that 13 out of 15 workers had a high risk of developing musculoskeletal disorders with an exposure level score of more than 70% and needed improvements and changes as soon as possible. On the other hand, 2 out of 15 workers are at an exposure level below 70%, so urgent repairs are needed. To reduce this value, it is necessary to improve the work system by reducing work that causes bending at work and the addition of a conveyor belt can be an alternative solution to reduce walking and lifting movements for workers

Keywords: manual material handling, musculoskeletal disorders, quick exposure check, exposure level, crumb rubber

Abstrak

Manual Material Handling (MMH) adalah kegiatan mengangkat, memindahkan, membawa, menarik, dan menurunkan material atau barang jadi. Hal ini bergantung pada tenaga manusia secara manual. Pekerjaan MMH juga dilakukan pada stasiun kerja pengemasan di pabrik karet remah. Kegiatan pada pekerja di workstation pengemasan tersebut merupakan bandela pengangkut dan pemindah dengan berat sekitar 35 kg. Aktivitas ini terus dilakukan setiap hari tanpa bantuan alat bantu sehingga pekerja mempunyai potensi risiko terjadinya gangguan muskuloskeletal. Penelitian ini bertujuan untuk mengevaluasi postur kerja pekerja pada workstation pengemasan terhadap risiko gangguan muskuloskeletal. Metode yang digunakan adalah Quick Exposure Check (QEC). Data dikumpulkan dengan menggunakan kuesioner QEC. Total pekerja yang terlibat dalam penelitian ini adalah 15 pekerja. Hasil penelitian menunjukkan bahwa 13 dari 15 pekerja mempunyai risiko tinggi mengalami gangguan muskuloskeletal dengan skor tingkat paparan lebih dari 70% dan memerlukan perbaikan dan perubahan sesegera mungkin. Sebaliknya, 2 dari 15 pekerja berada pada tingkat paparan di bawah 70% sehingga perlu dilakukan perbaikan segera. Untuk mengurangi nilai tersebut maka perlu dilakukan perbaikan sistem kerja dengan cara mengurangi pekerjaan yang menyebabkan terjadinya pembungkakan pada tempat kerja dan penambahan conveyor belt dapat menjadi alternatif solusi untuk mengurangi gerakan berjalan dan mengangkat pada pekerja.

Kata kunci: manual material handling, gangguan muskuloskeletal, Quick Exposure Check, tingkat paparan, karet remah

1. Introduction

Manual Material Handling (MMH) is the activity of lifting, moving, carrying, pulling, and lowering goods or materials that rely on human power manually. Manual Material Handling (MMH) activities that are not carried out correctly can cause work-related injuries, one of which is the risk of musculoskeletal disorders (MSD) [1]. Musculoskeletal disorders (MSD) are related injuries to the body including muscles and tendons, bones, nerves, and areas of the spine. Factors that affect disorders of the musculoskeletal

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system are age, gender, load carried, lifestyle, working conditions, body posture, and so on [2]. MMH activities can also occur in crumb rubber-producing companies.

The company is a producer and exporter of crumb rubber to countries such as America, Canada, Japan, and India. Characteristics activities include selecting raw materials received from suppliers and processing them into wet processes and dry processes. After completing the dry process, crumb rubber in the form of bandela. The Bandela has been dried in the dryer and will be lifted manually to the weighing areas. After being weighed, the bandela will be transferred to the press machine and packaged at the packaging workstation. This activity is carried out repeatedly and takes place every day without any tools. The weight of the bandela is around 35 kg. The body postures when lifting, moving, and lowering are excessive bending. The weight of the bandela being moved does not match the recommended weight, or a maximum of 25 kg [1].

Several methods or approaches can be used to address MSD-related problems in several types of industries. The Quick Exposure Check (QEC) method has been used in several industries to evaluate body posture [1]-[6] and combined with the Nordic Body Map (NBM) [7], the RULA method, REBA, WERA [8]-[10], as well as the PLIBEL method at PT. Karsa Wijaya Pratama [11]. The results obtained are that the posture of the worker's MMH activities is considered to need immediate corrective action with a high level of risk and the proposed improvements in the form of design and use of assistive devices are considered acceptable as a preventive step to reduce MSD problems at work. The use of work aids accompanied by a reduction in standard time can have a significant impact on reducing the risk of MSD [12]. Proposed improvements in the form of an ergonomic desk design can also be an alternative solution for improvement [13].

In other studies, evaluation of work posture in workers using the Cornell Musculoskeletal Discomfort Questionnaires [14], JSI [15]-[17], RULA, REBA, and BRIEF [18]-[22] found that workers experience complaints in the body and needs further corrective action. These results are by Riskesdas's data from the Indonesian Ministry of Health (2018) which found that injuries to the workforce in 2018 amounted to 8.2% and mainly were suffered by men [23]. The proportion of body parts that were injured was back by 6.5%, the upper limbs by 32.7%, and the lower limbs by 67.9% [24].

Based on previous studies, workers' complaints on the upper limbs can be evaluated for posture at work using the QEC method. This is because the QEC method considers two points of view, namely from the observer and the operator/worker [2]-[4]. For this reason, this study aimed to analyze the risk of musculoskeletal disorders (MSD) on the back, arms or shoulders, wrists, and necks in the packaging workstation workers in the crumb rubber factory using the Quick Exposure Check (QEC) method. Based on the results of the QEC method, suggestions for improvements will be given that are considered appropriate to be applied to workers at the crumb rubber factory.

2. Material and Methods

This study was conducted at the packaging workstation in the crumb rubber factory. The data used is primary data in the form of a Quick Exposure Check (QEC) questionnaire involving 15 workers in the packaging workstation. The sampling technique used is saturation sampling, where all workers in the packaging section will be sampled. The method used in this research is Quick Exposure Check (QEC). Data was collected using a questionnaire filled out by observers (researchers) and all workers.

The steps involved in processing the data are first, conducting an MSD risk assessment using the QEC questionnaire consisting of sheets for observers and workers. Second, combining the results of the observer's assessment with the workers to obtain an exposure score from each body part assessed (table 1) [2].

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Commented [RV3]: Reference?



Table 1. Exposure Score

Category	Exposure Score			
	Low	Moderate	High	Very High
Back (Static)	8-15	16-22	23-29	29-40
Back (Moving)	10-20	21-30	31-40	41-56
Shoulder/ Arm	10-20	21-30	31-40	41-56
Wrist/Hand	10-20	21-30	31-40	41-56
Neck	4-6	8-10	12-14	16-18

Third, grouping the level of exposure score for each part of the body that is assessed. Fourth, calculate the exposure level based on the division between the total exposure score and the X_{max} value. X_{max} is a fixed constant of the type of work used, where an X_{max} value of 162 is used for static work, and an X_{max} value of 176 is used for dynamic manual material handling work. Fifth, classify the types of action levels (table 2) which are used as the basis for improvement. Last, provide appropriate improvement suggestions based on the results of the action level that has been obtained.

Table 2. Action level

QEC Score (E)	Action
≤40%	Acceptable risk
41-50%	Investigate further
51-70%	Investigate further and change soon
>70%	Investigate and change immediately

3. Results and Discussion

Workers Characteristics

The number of workers at the packaging station is 15 people. Based on Table 3, all workers are male with an age range of 29-45 years and the majority of workers are in the age range of 36-40 years. All of these workers are smokers and tend to exercise rarely. Individual factors, such as smoking, are one of the factors that need to be considered [20]. As for working time, workers work for 8 hours, including 1 hour rest time, starting at 07.00 to 15.00 from Monday to Saturday.

Table 3. Worker characteristics

Characteristics	Range	Total
Gender	Male	15
	Female	0
Age	< 31	2
	31-35	4
	36-40	5
	> 40	4

The working posture of workers in the packaging section tends to be done by bending repeatedly to lift a bandela weighing 35 kg without tools and done by themselves. The lifting activity is carried out to move it to the weighing section and to the press machine section.

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Quick Exposure Check (QEC)

The exposure score is based on the total score for each part of the body being assessed. The categories assessed include the back, shoulders/arms, wrists, and neck. The following is a recapitulation of exposure score calculations for 15 workers at the packaging workstation.

Table 4. Exposure Score for worker 1

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	12	6	8
Score 2	10	10	6	6
Score 3	12	12	10	-
Score 4	-	12	6	-
Score 5	10	10	8	-
Score 6	10	-	-	-
Total	54	56	36	14
<i>Exposure</i>	160			

Based on table 4, the exposure score for worker 1 obtained a total score for all parts of the body assessed at 160 with the highest score being on the shoulder/arm and the lowest on the neck with scores of 54 and 14.

Table 5. Exposure Score for worker 2

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	12	8	8	-
Score 6	10	-	-	-
Total	56	48	42	14
<i>Exposure</i>	160			

Based on Table 5, the highest score for worker 2 is in the area of the back and the lowest is in the neck area of 14. The total score for all parts of the body is 160.

Table 6. Exposure Score for worker 3

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	12	8	8
Score 2	10	10	8	6
Score 3	12	12	10	-
Score 4	-	12	8	-
Score 5	10	10	8	-
Score 6	10	-	-	-
Total	54	56	42	14
<i>Exposure</i>	166			



Based on Table 6, the total score for all parts of the body assessed was 166 with the highest score on the body part of the shoulder/arm which was 56, and the lowest on the neck by 14.

Table 7. Exposure Score for worker 4

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	12	8	8
Score 2	8	10	8	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	8	8	8	-
Score 6	6	-	-	-
Total	44	52	42	14
<i>Exposure</i>		152		

Based on table 7, the highest score is on the shoulder/arm with a total score of 52 and the lowest on the neck by 14. The total for all parts of the body is 152.

Table 8. Exposure Score for Worker 5

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	8	6	8
Score 2	10	6	6	6
Score 3	12	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	52	42	38	14
<i>Exposure</i>		146		

Based on Table 8, the total score obtained by worker 5 is 146 with the highest body part score being 52 on the back and the lowest on the neck of 14.

Table 9. Exposure Score for Worker 6

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	6	6	4	6
Score 2	6	6	6	6
Score 3	10	10	8	-
Score 4	-	6	6	-
Score 5	6	6	8	-
Score 6	6	-	-	-
Total	34	34	32	12
<i>Exposure</i>		112		



Based on Table 9, the total score obtained by worker 6 is 112 with the highest body part score being 34 on the back and shoulders/arms, and the lowest being 12 on the neck.

Table 10. Exposure Score for Worker 7

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	10	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	50	46	42	14
<i>Exposure</i>		152		

Based on Table 10, the total score obtained by worker 7 is 152 with the highest body part score being 50 on the back and the lowest on the neck of 14.

Table 11. Exposure Score for Worker 8

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	10	8	8
Score 2	10	8	8	6
Score 3	10	12	10	-
Score 4	-	8	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	50	46	42	14
<i>Exposure</i>		152		

Based on Table 11, the total score for all parts of the body assessed was 152 with the highest score on the back body at 50 and the lowest on the neck at 14.

Table 12. Exposure Score for Worker 9

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	10	4	6
Score 2	6	6	4	4
Score 3	10	10	6	-
Score 4	-	8	6	-
Score 5	10	4	6	-
Score 6	6	-	-	-
Total	42	38	26	10
<i>Exposure</i>		116		

Based on Table 12, the total score of all parts of the body assessed is 116 with the highest score on the back body of 42. The lowest score on the neck is 10.



Table 13. Exposure Score for Worker 10

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	10	6	10
Score 2	10	8	8	6
Score 3	12	12	8	-
Score 4	-	12	6	-
Score 5	12	10	8	-
Score 6	10	-	-	-
Total	56	52	36	16
<i>Exposure</i>		160		

Based on Table 13, the total score obtained by worker 10 is 160 with the highest body part score being 56 on the back.

Table 14. Exposure Score for Worker 11

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	10	6	6
Score 2	6	6	4	4
Score 3	10	10	8	-
Score 4	-	10	8	-
Score 5	10	6	6	-
Score 6	6	-	-	-
Total	42	42	32	10
<i>Exposure</i>		126		

Based on Table 14, the total score obtained by worker 11 is 126 with the highest body part score being 42 on the back and shoulders/arms. The lowest score on the neck is 10.

Table 15. Exposure Score for Worker 12

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	10	6	6
Score 2	6	8	4	4
Score 3	10	10	8	-
Score 4	-	12	8	-
Score 5	10	8	6	-
Score 6	6	-	-	-
Total	42	48	32	10
<i>Exposure</i>		132		

Based on Table 15, the total score obtained by worker 12 is 132 with the highest body part score being 48 on the shoulder/arm and the lowest on the neck by 10.



Table 16. Exposure Score for Worker 13

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	10	12	6	8
Score 2	8	10	6	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	48	52	38	14
<i>Exposure</i>	152			

Based on Table 16, the total score obtained by worker 13 is 152 with the highest body part score being 52 on the shoulder/arm. The lowest score is on the neck with a value of 14.

Table 17. Exposure Score for Worker 14

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	12	6	8
Score 2	10	10	6	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	10	8	8	-
Score 6	8	-	-	-
Total	52	52	38	14
<i>Exposure</i>	156			

Based on Table 17, the total score obtained by worker 14 is 156 with the highest body part score being 52 on the back and shoulders/arms and the lowest on the neck with a score of 14.

Table 18. Exposure Score for Worker 15

Category	Back	Shoulder/ Arm	Wrist/ Hand	Neck
Score 1	12	12	6	8
Score 2	10	10	6	6
Score 3	12	12	10	-
Score 4	-	10	8	-
Score 5	12	8	8	-
Score 6	10	-	-	-
Total	56	52	38	14
<i>Exposure</i>	160			

Based on Table 18, the total score obtained by worker 15 is 160 with the highest body part score being 56 on the back and the lowest on the neck of 14.



Table 19. Exposure and action level

Worker	Total Score	Exposure Level	Action Level
1	160	91	Investigate and change immediately
2	160	91	Investigate and change immediately
3	166	94	Investigate and change immediately
4	152	86	Investigate and change immediately
5	146	83	Investigate and change immediately
6	112	64	Investigate further and change soon
7	152	86	Investigate and change immediately
8	152	86	Investigate and change immediately
9	116	66	Investigate further and change soon
10	160	91	Investigate and change immediately
11	126	72	Investigate and change immediately
12	132	75	Investigate and change immediately
13	152	86	Investigate and change immediately
14	156	89	Investigate and change immediately
15	160	91	Investigate and change immediately

Based on Table 19, it was found that the highest exposure score obtained was 166, and the lowest exposure score obtained was 112. The average exposure level (E) of labor jobs packaging work station is 84% and only 2 workers have an exposure level (E) value below 70%. While 13 other people are at an exposure level (E) above 70%. The highest exposure level is 94% and the lowest exposure level is 64%. If seen based on the characteristics of the workers, the workers are around 40 years old and active smokers. Based on the information provided by the respondents stated that age has an influence on the risk of musculoskeletal disorders.

Based on the exposure level value, 13 out of 15 workers needs action and change as soon as possible, while 2 out of 15 workers are at the action level and need improvement. The activities carried out by the workers at the packaging workstation is lifting, moving, and lowering the bandela whose working hours start from 7 am to 3 pm every day except



Sunday. The workload raised by the packaging workstation workers is 35 kg without the help of work aids so it exceeds the recommended weight. Some workers said that pain in their back, arms/shoulders, wrists, and neck sometimes began to subside even when they were doing activities such as a morning walk before going to work which was accompanied by light stretching movements while walking.

Based on previous calculations, it can be seen that 13 out of 15 workers needs corrective action as soon as possible, while the others need changes. For this reason, the change actions that need to be carried out are the need to improve the work system in completing the work of the workers at the packaging workstation. Posture while working at the packaging workstation is a lot of bending when placing the ball on the weighing station. This makes some workers experience complaints in the form of aches and pains in the back and neck and activities and body postures like this are repeated every day. Another improvement solution is the need to add working tools in the form of a conveyor belt. This is intended to minimize the walking and lifting movements that workers usually do. This proposal is in line with the results of research conducted by Setiawan et al. [5] and Sukania et al. [14] that awkward posture and repetitive activities increase the risk of musculoskeletal disorders in heavy lifting and strong movements.

4. Conclusion

Based on the results obtained using the Quick Exposure Check (QEC) method, it was found that 13 out of 15 workers had an exposure level of more than 70%, so immediate corrective action and changes were needed. On the other hand, as many as 2 out of 15 workers is at an exposure level below 70% and needs immediate improvement. However, there is a need for further research regarding work posture and the risk of musculoskeletal disorders so as to reduce the risk of injury and implement improvements. For further research, it is suggested to be able to provide and implement proposed improvements in the form of adding conveyor belt aids which are expected to be able to provide.

6. References

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