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Improvement of Work Facilities in the Wooden Batik Production Process in Krebet Peni Studio to Minimize *Muscoloskeletal Disorders* (MSDs)

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Abstract *. The production process of wooden batik at Sanggar Peni Krebet plays an important role in preserving local culture and supporting the economy, but workers face the risk of musculoskeletal disorders due to unergonomic working positions when performing activities such as sculpting, sanding, batik making, and boiling . Based on the NBM questionnaire on 15 workers, the highest complaints were found in the right upper arm (100%), right wrist (100%), and waist (88%). Research using the RULA and REBA methods revealed the batik activity to have a very high risk (RULA 7, REBA 11), requiring immediate improvement, while boiling had a medium to high risk (RULA 5, REBA 9), requiring investigation and change. The EFD emphasizes the importance of designing batik boiling stoves, chairs and tables that consider height according to the worker's body size, ergonomic working positions, and comfortable strainer handles. Tool development should focus on improving comfort, safety and efficiency, with design adjustments to support workers' postures and use lightweight yet strong materials. The application of these elements is expected to improve safety and productivity in the batik industry.*

Keywords *: EFD , Musculoskeletal Disorders, Nordic Body Map wooden batik production, REBA, RULA*

1. BACKGROUND

Workers' right to decent working conditions is essential to support their health and safety at work. A non-ergonomic or suboptimal working environment is often the main cause of work accidents (Norina & Adriyanti, 2021). Ergonomics plays a key role in reducing the risk of injury by reducing excessive physical stress. Poor posture during activities, such as lifting objects, can trigger spinal problems and disorders of the musculoskeletal system (Rosada et al., 2023).

The process of producing wooden batik, such as that carried out at UKM Sanggar Peni, contributes significantly to the local economy and cultural preservation. However, intense physical activities such as carving, dyeing, and drying carry the risk of causing musculoskeletal disorders (Ginting & Prastawa, 2024). Sanggar Peni produces various products made from teak and mahogany wood, such as masks, key chains, and souvenirs, with a production volume reaching hundreds of units each month. The production process is mostly done manually in a bent working position for hours (Prasetyo et al., 2024).

Significant physical complaints based on the results of the NBM questionnaire in 15 workers included pain in the right upper arm (100%), right wrist (100%), right hand (100%), right shoulder (93%), back (93%), and waist (88%). Work activities carried out for an average

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of 8 hours per day with non-ergonomic positions worsen the risk of injury. These complaints can reduce productivity, reduce work quality, and increase the risk of musculoskeletal disorders and chronic fatigue in workers (Septiari et al., 2024).

2. THEORETICAL STUDY

Nordic Body Map (NBM) is a questionnaire used to analyze work activities and the environment, focusing on the level of musculoskeletal discomfort in various parts of the body. Data from NBM is the basis for improving work posture (Geovania Azwar, 2020). The achievement of the NBM questionnaire is then calculated by carrying out weight calculations or scoring in each person's NBM questionnaire, so that the level of risk and the corrective actions to be carried out can be known (Widianto Bagus Rojab, 2023).

Ergonomic Function Deployment (EFD) is a development of *Quality Function Deployment* (QFD) that integrates user needs with ergonomic product design. If QFD uses *the House of Quality* for analysis, EFD utilizes *the House of Ergonomic* as a tool to evaluate correlations. (Akao, 1990 in Dwi et al., 2019). The processing stage of the method is determining attributes based on the ergonomic aspects of ENASE (Effective, Comfortable, Safe, Healthy, and Ergonomic), designing a questionnaire, and forming HoE (Nasirly et al., 2020).

HoE is designed based on consumer needs and preferences that are used as a reference in developing batik coloring aids. The HoE formation process includes various stages of processing according to these objectives (Rahmadani & Yuamita, 2024), determining the level of consumer interest, consumer satisfaction, *Goals, Improvement Ratio, Sales Point, Raw Weight, Normalized Row Weight, Technical Response, Matrix Relationship* , and *Technical Relationship* (Susanti, 2024).

ErgoFellow 3.0 is ergonomics software for improving working conditions and productivity. *It* supports analysis with 17 methods, including REBA, RULA, OWAS, QEC, and NIOSH, as well as tools for video analysis and heat stress measurement.(Julian Firdaus & Angga Sujarno, 2023)

3. RESEARCH METHODS

This study uses a quantitative descriptive approach, with direct observation techniques of activities at Sanggar Peni Krebet, Yogyakarta. Data collection includes the use of NBM questionnaires to identify the level of complaints and pain experienced by workers, recording employee activities during the batik wood production process in *the workshop* via video or

photos, to determine the angle of their body posture. Open and closed questionnaires will also be distributed based on the highest RULA and REBA scores for EFD data processing. In addition, measurements of workers' anthropometric dimensions will also be carried out (Mauluddin et al., 2023).

The data analysis methods applied include the RULA and REBA approaches to analyze body posture using *Ergofellow 3.0 software* through documentation (Julian Firdaus & Angga Sujarno, 2023).

4. RESULTS AND DISCUSSION

Nordic Body Map (NBM)

The most common body complaints felt by workers are in the upper right arm (100%), right wrist (100%), and lower back (88%). Therefore, a posture analysis using the RULA, REBA, and EFD methods is needed to design work facilities that are more in accordance with workers' needs (Geovania Azwar, 2020).

Rula and REBA Data Processing

After assessing the level of work risk faced by workers, the next step is to calculate the RULA and REBA scores. These two methods are used to evaluate employee posture with the help of *Ergofellow software.* (Sptiari et al., 2024).

1. **Batik**

Figure 1Batik Posture Angle

Source: Data Processing (202 4)

In the batik process, the position of the work body obtained is at certain angles, namely in the *Trunk section* at *6.1°, neck 143°, upper arm 13.3°, lower arm 81°, wrist 45.2 °*, and for *legs 52.3°* . The next step taken is to analyze body position using *Ergofellow software* . The results of the analysis show RULA and REBA values which provide information related to the level of risk faced in carrying out the activity.

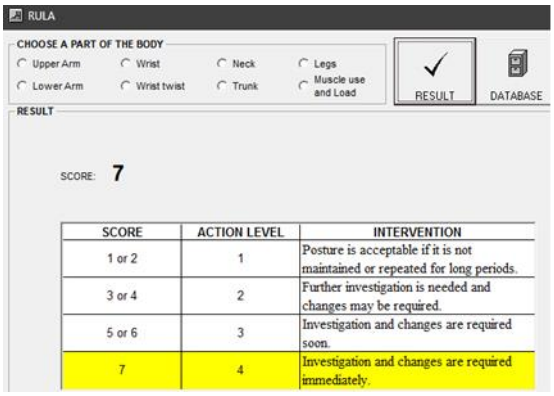


Figure 2RULA Score of Batik

Source: Data Processing (2024)

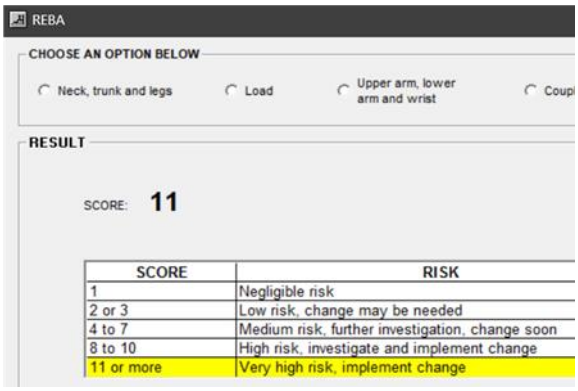


Figure 3REBA Score of Batik

Source: Data Processing (2024)

Based on the output of *the Ergofellow software* showing the body position of batik workers, the RULA score obtained was 7, which means that immediate investigation and change are needed. The REBA score obtained was 11, which indicates a high risk, so investigation and implementation of changes are needed (Fatimah Hunusalela et al., 2023).

2. Boiling

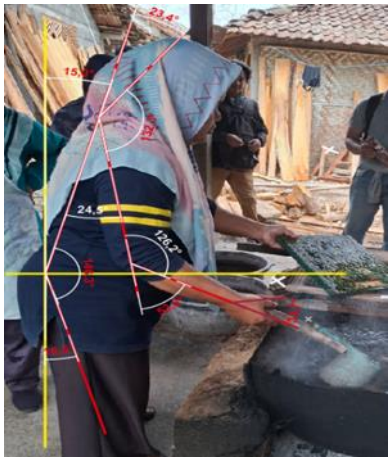


Figure 4Boiling Posture Angle

Source: Data Processing (202 4)

In the boiling process, the angles obtained at the working position are: *trunk 15°, neck 132.3°, upper arm 24.5°, lower arm 126.2°, wrist 33.7°* , and *legs 16.5°*. The next step is to analyze the body position using *Ergofellow software* . The results of the RULA and REBA analysis show the following values:

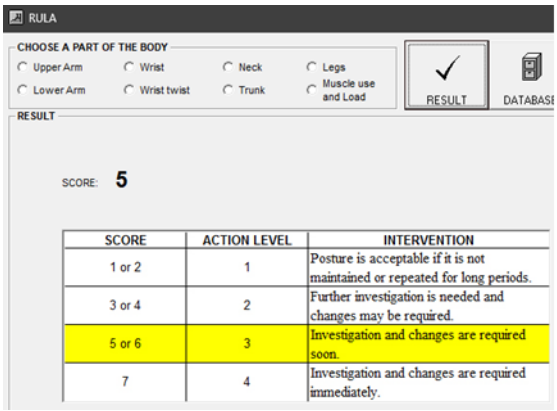


Figure 5. Boiling RULA Score
Source: Data Processing (2024)

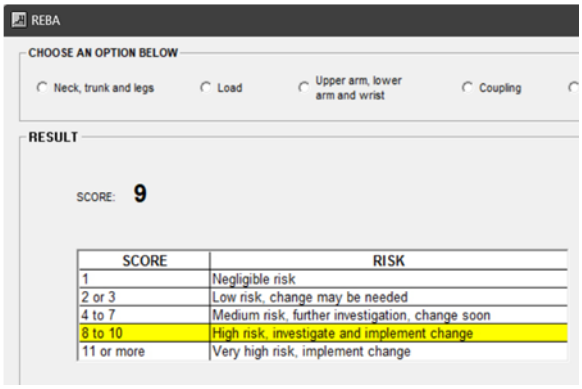


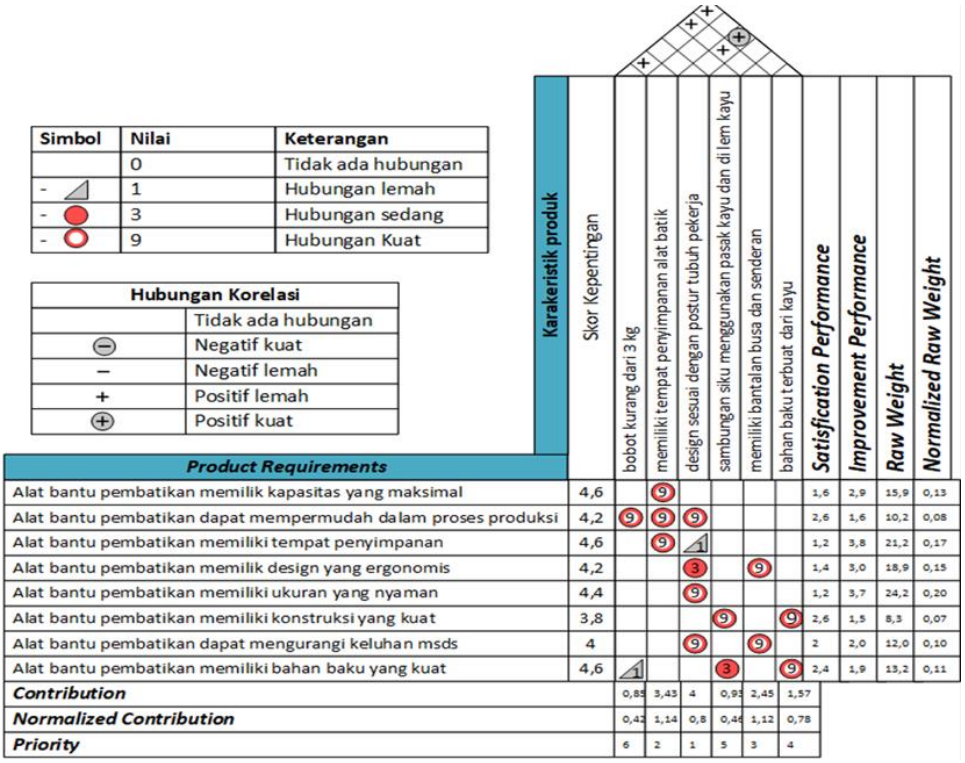
Figure 6. Boiling REBA Score
Source: Data Processing (2024)

Based on the output results from *the ergofellow software* showing the position of the worker's body during the boiling process, a RULA score of 5 indicates that an investigation and immediate changes are needed. While a REBA score of 9 indicates a high risk, so an investigation and implementation of changes are needed. (Fatimah Hunusalela et al., 2023).

***Ergonomic Function Deployment* (EFD)**

The results of data processing based on work posture assessments show that the batik and boiling processes cause pain in some parts of the muscles and bones. Therefore, immediate improvements need to be made. To overcome this, researchers plan to create ergonomic tools that can meet the needs and desires of employees using EFD (Kurniawan & Kusnadi, 2022).

1. **Batik**



Simbol	Nilai	Keterangan
	0	Tidak ada hubungan
-	1	Hubungan lemah
-	3	Hubungan sedang
-	9	Hubungan Kuat

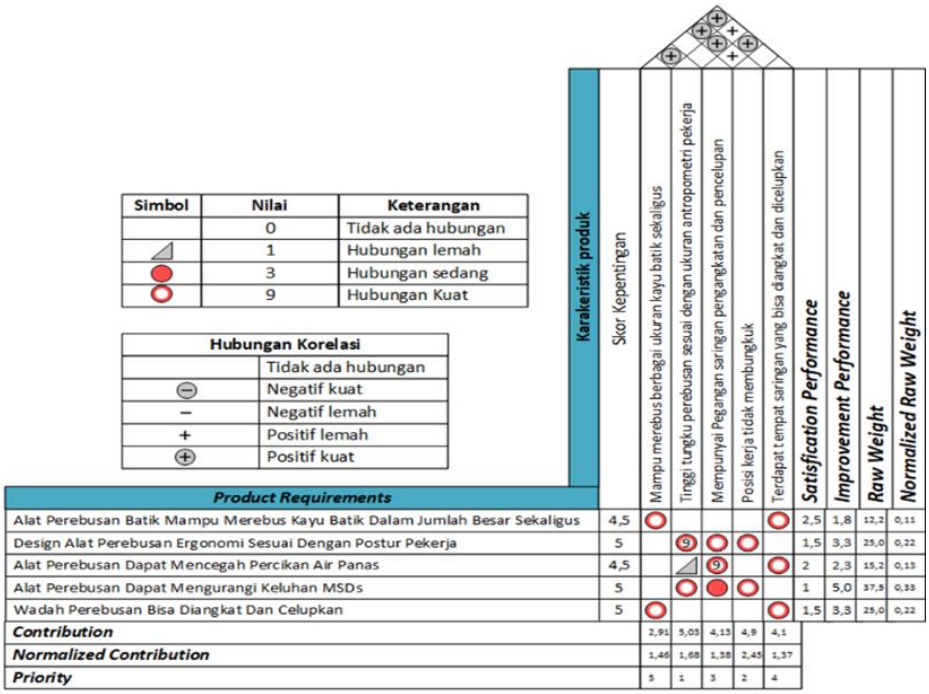
Hubungan Korelasi	
	Tidak ada hubungan
⊖	Negatif kuat
–	Negatif lemah
+	Positif lemah
⊕	Positif kuat

Karakteristik produk / Product Requirements	Skor Kepentingan	bobot kurang dari 3 kg	memiliki tempat penyimpanan alat batik	design sesuai dengan postur tubuh pekerja	sambungan siku menggunakan pasak kayu dan di lem kayu	memiliki bantalan busa dan senderan	bahan baku terbuat dari kayu	Satisfication Performance	Improvement Performance	Raw Weight	Normalized Raw Weight
Alat bantu pembatikan memilik kapasitas yang maksimal	4,6		9					1,6	2,9	15,9	0,13
Alat bantu pembatikan dapat mempermudah dalam proses produksi	4,2	9	9	9				2,6	1,6	10,2	0,08
Alat bantu pembatikan memiliki tempat penyimpanan	4,6		9	1				1,2	3,8	21,2	0,17
Alat bantu pembatikan memilik design yang ergonomis	4,2			3		9		1,4	3,0	18,9	0,15
Alat bantu pembatikan memiliki ukuran yang nyaman	4,4			9				1,2	3,7	24,2	0,20
Alat bantu pembatikan memiliki konstruksi yang kuat	3,8				9		9	2,6	1,5	8,3	0,07
Alat bantu pembatikan dapat mengurangi keluhan msds	4			9		9		2	2,0	12,0	0,10
Alat bantu pembatikan memiliki bahan baku yang kuat	4,6	1			3		9	2,4	1,9	13,2	0,11
Contribution		0,85	3,43	4	0,93	2,45	1,57				
Normalized Contribution		0,42	1,14	0,8	0,46	1,12	0,78				
Priority		6	2	1	5	3	4				

Figure 7Hoe Batik Results
Source: Data Processing (202 4)

Analysis using the EFD method identified that the ergonomic design of batik chairs and tables. User comfort, and sturdy construction are important elements in batik tools. The largest contribution comes from "Design that supports the worker's posture" (4), followed by the features "Storage of batik tools" (3.43) and "Use of foam pads with backrests" (2.45) (Sinaga et al., 2021). Ergonomic design plays a significant role in increasing work efficiency and reducing physical complaints and workload of workers. In addition, comfort of use and high-quality materials are essential to ensure durable tools, meeting the needs of the batik industry which requires functional and strong equipment (Hidayatullah et al., 2024).

2. Boiling



Simbol	Nilai	Keterangan
	0	Tidak ada hubungan
	1	Hubungan lemah
	3	Hubungan sedang
	9	Hubungan Kuat

Hubungan Korelasi	
	Tidak ada hubungan
⊖	Negatif kuat
−	Negatif lemah
+	Positif lemah
⊕	Positif kuat

Karakteristik produk / Product Requirements	Skor Kepentingan	Mampu merebus berbagai ukuran kayu batik sekaligus	Tinggi tungku perebusan sesuai dengan ukuran antropometri pekerja	Mempunyai Pegangan saringan pengangkatan dan pencelupan	Posisi kerja tidak membungkuk	Terdapat tempat saringan yang bisa diangkat dan dicelupkan	Satisfaction Performance	Improvement Performance	Raw Weight	Normalized Raw Weight
Alat Perebusan Batik Mampu Merebus Kayu Batik Dalam Jumlah Besar Sekaligus	4,5	○				○	2,5	1,8	12,2	0,11
Design Alat Perebusan Ergonomi Sesuai Dengan Postur Pekerja	5		⊖	○	○		1,5	3,3	25,0	0,22
Alat Perebusan Dapat Mencegah Percikan Air Panas	4,5		◢	⊖		○	2	2,3	15,2	0,13
Alat Perebusan Dapat Mengurangi Keluhan MSDs	5		○	●	○		1	5,0	37,5	0,33
Wadah Perebusan Bisa Diangkat Dan Celupkan	5	○				○	1,5	3,3	25,0	0,22
Contribution		2,91	5,03	4,13	4,9	4,1				
Normalized Contribution		1,46	1,68	1,38	2,45	1,37				
Priority		5	1	3	2	4				

Figure 8Boiling HoE Results
Source: Data Processing (202 4)

EFD method analysis shows that several main elements of the batik boiling tool are closely related to ergonomic needs. The characteristic attributes of the product that have high scores, namely, "The height of the stove is appropriate for the size of the worker's body" is the main priority *contribution* (5.03), followed by "Working position that does not bend" (4.9) and "Strainer handle for lifting and dipping" (4.13) (Ansyar Bora & Prasetyo, 2023). These aspects play an important role in increasing work flexibility, reducing physical complaints, and protecting workers from injury. The development of boiling tools should be focused on increasing comfort, safety, and efficiency. (Dwi et al., 2021).

Ergonomic design that fits the average posture of workers can reduce physical workload and increase productivity. For safety, a splash protection mechanism is needed. In addition, the use of lightweight but strong materials in the boiling container will facilitate lifting and

operation. With this approach, the boiling tool can meet ergonomic standards, improve work safety, and support the productivity of the batik industry (Amrussalam et al., 2023).

5. CONCLUSION AND SUGGESTIONS

This study indicates that activities with certain working postures, such as using the arms and waist, can cause significant discomfort for workers. Assessment of working postures in the batik and boiling processes showed high scores on RULA and REBA, indicating the need for immediate improvement. Complaints that arise have a negative impact on productivity and increase the risk of musculoskeletal disorders.

The analysis conducted using the EFD method emphasizes the importance of designing a batik boiling stove, chairs and tables that consider the height according to the worker's body size, an ergonomic working position, and a comfortable sieve handle. Tool development should focus on improving comfort, safety, and efficiency, with design adjustments to support the worker's posture and using lightweight but strong materials. The application of these elements is expected to improve safety and productivity in the batik industry.

REFERENCE LIST

Amrussalam, Rahmawati, & Efendi, J. (2023). Redesain fasilitas kerja yang ergonomis dengan menggunakan ergonomic function deployment (EFD). *Vol. 11*(1), 71–80.

Ansyar Bora, M., & Prasetyo, W. (2023). Implementasi ergonomic function deployment (EFD) pada perancangan alat bantu pembuka lempengan komstir sepeda motor. *Sigma Teknika*, *6*(2), 267–277.

Azwar, G. (2020). Analisis postur kerja dan beban kerja dengan menggunakan metode Nordic Body Map dan NASA-TLX pada karyawan UKM Ucong Taylor Bandung. *Jurnal Techno-Socio Ekonomika*, *13*(2).

Dwi, N., Pratiwi, H., & Susanti, E. (2021). Perancangan fasilitas kerja aktivitas pengisian tanah hitam pada UKM Tanaman Hias Rasti Tunas Regency.

Firdaus, J., & Sujarno, A. (2023). Penilaian postur tubuh pekerja dan perbaikan sistem kerja dengan metode RULA dan REBA pada PT. Sharp Electronics Indonesia. *VIII*(2).

Ginting, C., & Prastawa, H. (2024). Analisis postur kerja proses pembuatan batik tulis dan gangguan otot tulang rangka akibat kerja (GOTRAK) pada pekerja di CV Batik Gemawang Kabupaten Semarang.

Hidayatullah, A. A., Mauluddin, Y., & Utama, D. T. (2024). Perancangan kursi dan meja penjahit yang ergonomis untuk meningkatkan produktivitas kerja. https://doi.org/10.33364/kalibrasi/v.21-1.1443

Hunusalela, Z. F., Nurfida, A., Ahmad, A., & Nugeroho, U. (2023). Analisis postur kerja pada pekerja bengkel Lampiri Auto Service dengan metode rapid upper limb assessment (RULA) dan rapid entire body assessment (REBA). *Journal of Industrial Engineering and Technology (Jointech), 3*(2), 71–79. http://journal.umk.ac.id/index.php/jointech

Kurniawan, F., & Kusnadi, K. (2022). Usulan perbaikan fasilitas kerja dengan pendekatan ergonomi pada UMKM Bani Marfu Farm. *Vol. 8*(7). https://jurnal.peneliti.net/index.php/jiwp

Mauluddin, Y., Rahmawati, D., & Faturachman, I. (2023). Perancangan alat bantu ergonomis pada proses produksi agar-agar. https://jurnal.itg.ac.id/

Nasirly, R., Aqilah, L., Syafei, D., Tinggi Teknologi Pelalawan, S., & Seikijang, B. (2020). Usulan hoe dalam perancangan alat pembelah buah pinang dengan metode EFD.

Norina, R., & Adriyanti, E. (n.d.). Perbaikan sistem kerja berdasarkan aspek biomekanika di PT. Cresco Indonesia. https://doi.org/10.34010/iqe.v9i2.5387

Prasetyo, Y., Aswin, B., & Reskiaddin, L. O. (2024). Kajian bahaya potensial ergonomi pada pengrajin batik: Studi kasus pengrajin batik di Kelurahan Ulu Gedong. *Jurnal Kesmas Jambi, 8*(1).

Rahmadani, D. A., & Yuamita, F. (2024). Perancangan alat bantu pewarnaan batik menggunakan metode job strain index dan metode ergonomic function deployment. *Jumantara: Jurnal Manajemen dan Teknologi Rekayasa, 3*(1). https://doi.org/10.28989/jumantara.v3i1.1944

Rojab, W. B. (2023). Analisis dan perbaikan postur kerja pada operator welding untuk mengurangi musculoskeletal disorders dengan menggunakan metode rapid upper limb assessment dan Nordic Body Map. 62–64.

Rosada, A., Sokhibi, A., & Primadasa, R. (n.d.). Analisis postur kerja dengan metode RULA, REBA, dan RWL pada operator pengiriman PT. Djarum GLT Kaliwungu. *Journal of Industrial Engineering and Technology (Jointech)*. http://journal.umk.ac.id/index.php/jointech

S, A. H., Septiari, R., Priyasmanu, T., & Studi Teknik Industri, S. (2024). Usulan desain ergonomis untuk alat perajang pisang berdasarkan evaluasi postur kerja di Indochips Alesha Trimulya. *Jurnal Mahasiswa Teknik Industri, 7*(2).

Sinaga, H. H., Siboro, B. A. H., & Marbun, C. E. (2021). Desain meja dan kursi tutorial laboratorium desain produk dan inovasi menggunakan metode 12 prinsip ergonomi dan pendekatan antropometri. *Jurnal Sistem Teknik Industri, 23*(1), 34–45. https://doi.org/10.32734/jsti.v23i1.4880

Susanti, A. H. (2024). Perancangan saklar Bluetooth dengan menggunakan metode EFD (ergonomic function deployment). *Agustus, 8*(ISSN), 2614–7602. https://doi.org/10.36352/jr