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Ergonomic Risk Evaluation to Minimize Musculoskeletal Disorders in SMEs Leather Shoes at Indonesia

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Abstract. *This study was carried out at SME for the purpose of making leather shoes in the manufacturing process. Pattern, upper printing, finishing, and 16 other workstations are among the three workstations. Production operations are performed manually in a seated position that includes squatting, bending, or standing position that is repeated, and workers operate at average to rapid speeds for 7 hours each day. This signifies that the action is hazardous and may result in Musculoskeletal Disorders (MSDs). The Job Strain Index (JSI) and Muscle Fatigue Assessment (MFA) methodologies will be used in this study to identify working posture conditions. The MFA method is used to analyze the level of effort, duration of labor, and frequency of work motions in order to determine muscle tiredness in each section of the worker's body. The 14 activities were subjected to the JSI method investigation, and the high risk was achieved by printing the top right hand SI 20.25 and installing the right-hand sole 13.5. The MFA approach was used to accept high to extremely high-risk body parts, such as the back, neck, and right hand, and make recommendations for how to reduce muscle fatigue in each body part. The findings of this study can be used to improve the upper printing station's design, as well as the table design for designing and drawing patterns and the chair design for sewing activities.*

Keywords: *musculoskeletal disorders, JSI method, MFA method, leather shoes, ergonomics*

I. INTRODUCTION

There are six activities in the process of creating leather shoes for SMEs in Kabupaten Magetan, Indonesia, at three work stations, namely the pattern work station: There are seven activities on the upper printing work station, and one activity on the finishing work station. Workers carry out various operations in the manufacturing process using machines and tools, according to the findings of the first observations on SMEs. Hand muscles are used vigorously, repetitive work is performed, and extreme hand postures are all characteristics of the activities. SME has five workers and a working system that is tailored to the number of orders placed, which is 30 pairs every day. The workday runs from 08.00 WIB to 16.00 WIB every day, with irregular rest hours due to workers' obligations to complete orders and meet targets. Workers undertake repetitive motions, particularly in the upper body, such as the elbows, forearms, wrists, and hands, during the manufacturing process, according to observations. These movements are matched to the needs of the task and workplace norms. Manual labor is performed in a crouching, bending, or standing position, which is repeated seven times a day, six days a week, at a normal to rapid speed. JSI approach was used to determine the number of complaints and the level of risk in the production of leather shoes in the distal upper extremity (DUE). Work speed and duration, effort duration, action intensity, and hand/wrist posture effort per minute are all assessed by the JSI (Garg, Moore and Kapellusch, 2007).

The danger of damage to DUE sector workers is constantly present because they labor in unusual positions such as squatting, bending, tilting, and neck bending. As a result, workers complain of pain in their backs, shoulders, necks, and wrists. This signifies that the action is hazardous and may result in musculoskeletal problems MSDs. MSDs are a group of disorders

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that affect muscles, tendons, synovial membranes (joint nerve tissue), fascia (connective tissue), and ligaments, and are caused by work (Tsekoura Maria et al., 2017). Muscles bear a large load and monotonous movements will cause muscle tissue, tendons, and ligaments to rupture (Muslimah, Pratiwi and Rafsanjani, 2006).

Studies on MSDs that have been carried out in various industries show that the muscles that are often complained of are the skeletal muscles covering the neck, shoulders, arms, hands, fingers, back, waist and lower muscles (Maula, Suwandi and Nilamsari, 2016). The adverse effects of these disturbances will result in reduced skills to carry out work, minimize work productivity, and increase health care costs (Oktaviannoor, Helmi and Setyaningrum, 2015). MSDs have three factors, namely occupational factors, environmental factors, and individual factors (Oktaviannoor, Helmi and Setyaningrum, 2015). MSDs result in increased costs and compensation for wages and health, lower productivity, and quality of life (Kee, 2007). The importance of ergonomic adjustments in work is a step towards effective prevention of MSDs, such as regular monitoring of workers' health (Boschman et al., 2012). In some types of work, unnatural work postures occur over a long period, causing complaints of pain in body parts, product defects, and even body defects (Prasetyo, 2012). In light of the state of this SME, research was undertaken utilizing MFA to assess the muscle fatigue that happens in each region of the worker's body in relation to work facilities in the manufacturing process. Muscle fatigue is assessed using MFA by determining the amount of effort/energy expended in each part of the body, the duration of work at each work intensity on the body part, and the frequency of work movements at each work intensity, all of which are the same in all elements of the body (Arthur et al., 2012).

J. Steven Moor and Arun Garg in 1999 developed a method known as the JSI method (Garg, Moore and Kapellusch, 2007). The use of the JSI method as a tool used to measure and evaluate the position in work against musculoskeletal disorders found in the DUE section includes the hands, forearms, wrists and elbows. A study using JSI has been carried out by Lukasz, Jozef and Izabela on milkmaids. The results show that milking work at the Herringbone salon results in a higher risk of problems with the milker's musculoskeletal system (Łukasz, Jozef and Izabela, 2015). Research using JSI has also been carried out by (Permana, Adelina Simanjuntak and Yusuf, 2018) One work activity is at a moderate risk level with a JSI score of 3 - 7, and four work activities are at a high-risk level 0 with a JSI score > 7. In tofu-making SME, the results are one work activity is at a moderate risk level with a JSI score of 3 - 7.

Rodgers created the MFA as his first muscle fatigue test. This method is often used in job analysis and is useful for assessing the risk of accumulating tiredness on work activities or jobs that take an hour or more to complete, as well as determining difficult postures and the frequency with which force is applied (Arthur et al., 2012). In an electrical appliance manufacturing workshop, MFA research was conducted. The MFA approach is favored when all body parts must be assessed, as it demonstrates that the right wrist and waist are 66.7 percent, the neck and right shoulder are 60 percent, and the MFA method is preferred when all body parts must be assessed (Safety et al., 2020). Research using MFA has also been carried out by (Wibisono and Triyanti, 2016) in the wood furniture workshop, the assembly activity has a higher level of risk than the other two activities. Assembly activity affects almost all body areas, from the neck to the lower limbs. While the other two activities, only the upper limbs are affected. The Standard Nordic Questionnaire (SNQ) approach was also used by (Ginting and Malik, 2018), to conduct research on Leather Shoes SME, with the results revealing that the most frequently complained-about body parts are the left calf, right calf, right shoulder, back, and arm. Back, upper right, and upper neck.

The goal of this study is to discover and assess working posture circumstances, as well as to suggest modifications based on the results of measuring ergonomic risk in workers using the JSI and MFA methodologies. In this research proposal, industrial ergonomics is considered, but ergonomics design improvements are the other side of this review (Naeini et al., 2018).

II. Research Method

This research was conducted at the center for making leather shoes, namely SMEs Magetan District, in Kabupaten Magetan, Indonesia. SMEs has ten workers at three work stations consisting of 14 activities, including: (1) Designing patterns; (2) Draw patterns; (3) Cut out the pattern; (4) Pattern setting; (5) Pattern gluing; (6) Sewing pattern; (7) Shoe Upper Printing; (8) Gluing the bottom base; (9) Installation of the bottom plinth; (10) Gluing the sole; (11) Insole Mounting; (12) Shoe pressing; (13) Withdrawal of shoes; (14) Shoe painting. This study observed the overall work activity at each workstation at 08.00-16.00 WIB and rest hours at 12.00 - 13.00 WIB.

Data was gathered by direct or indirect observations, documentation, and interviews. Documentation is the retrieval or gathering of data that is accomplished by photographing or videotaping workers' work activities. Pulse rate data is gathered by utilizing a pulse meter to measure each worker's pulse after they have completed the work activities being evaluated. The official Indonesian anthropometric website, https://antropometriindonesia.org, is used to acquire anthropometric data required to make improvement ideas. Videos and photographs taken at SME provide the data for the JSI and MFA methodologies. The JSI method requires the following data: (1) body position; (2) working time; (3) work duration; and (4) heart rate. (1) body posture data; (2) labor time data; (3) working frequency data are all required by the MFA approach.

The steps in data processing using the JSI method are (1) collecting data from 6 task

(a) (b)

Figure 1. Printing Upper (a) right hand activity (b) left hand activity

Table 1. The results of the JSI assessment on the upperprinting right hand activity

Job Strain Index Method- Right hand			
Variable	Measurement	Rating Value	Multiplier Value
Effort Intensity (beats/minute)	99	1	1
Business Duration (%)	94,29	5	3
Efforts per Minute	30,43	5	3
Wrist (°)	25,39	3	1,5
Working Speed	Work at a fast but manageable pace	4	1,5
Duration (hours)	7	4	1
Strain Index Score			20,25

variables, including the intensity of effort (Intensity of Exertion / IE), which is an assessment of the intensity of action based on the pulse of worker, duration of effort (Duration of Exertion / DE) is the percentage of time an exertion takes place during a work cycle (Garg, Moore and Kapellusch, 2007), effort per minute (Effort per Minute / IE) is the total amount of effort used during the observation period divided by the total observation time in minutes (Garg, Moore and Kapellusch, 2007), hand/wrist position (Hand Wirst Posture / HWP) by determining the type of hand position including extension, flexion, or deviation at the ulnar (Garg, Moore and Kapellusch, 2007), work speed (Speed of Work / SW) is an estimate of how fast work activities are carried out by worker (Garg, Moore and Kapellusch, 2007), duration of work per day (Duration of work). Of Task per Day/ DD) is the total time of tasks performed by workers in (Garg, Moore and Kapellusch, 2007) day; (2) Weighting Each Work Variable (Rating Value); (3) Determine the Multiplier Value; (4) Calculating JSI Value (formula 1); (5) Risk Value.

$$Strain\ Index\ (SI) = IE \times DE \times EM \times HWP \times SW \times DD \quad \ldots (1)$$

This research used the MFA method to analyze three physical risk factors in the workplace: effort level, work duration, and work frequency (Restuputri et al., 2021). The stages carried out in the MFA method include (1) identification of problems in activities at work; (2) selecting job assignments and then analyzing

Table 2. Recapitulation of JSI Method Data Processing Results

Activity	Hand	E	E	M	WP	W	D	I	Risk
Designing Patterns	Right	1	3	1	1.5	1	1	5	Currently
	Left	1	3	0,5	1,5	1	1	2,25	Low
Pattern Drawing	Right	1	3	1	1,5	1	1	4,5	Currently
	Left	1	3	0,5	1,5	1	1	2,25	Low
Cutting Patterns	Right	1	1	1,5	1,5	1	1	2,25	Low
	Left	1	1	0,5	1,5	1	1	0,75	Low
Pattern Setting	Right	1	,5	2	1,5	1	1	1,5	Low
	Left	1	0,5	0,5	1,5	1	1	0,38	Low
Pattern Gluing	Right	1	0,5	2	1	1	1	1	Low
	Left	1	0,5	1	1,5	1	1	0,75	Low
Sewing Pattern	Right	1	1	1	1,5	1,5	1	2,25	Low
	Left	1	1	1,5	1,5	1,5	1	3,375	Currently
Upper Printing	Right	1	3	3	1,5	1,5	1	20,25	Tall
	Left	1	3	0,5	1,5	1	1	2,25	Low
Underlay installation	Right	1	0,5	3	1	1	1	1,5	Low
	Left	1	0,5	1	1,5	1	1	0,75	Low
Underlay installation	Right	1	1	1,5	1,5	1	1	2,25	Low
	Left	1	1	0,5	1,5	1	1	0,75	Low
Sole Gluing	Right	1	0,5	3	1,5	1	1	2,25	Low
	Left	1	0,5	0,5	1	1	1	0,25	Low
Sol Installation	Right	1	2	3	1,5	1,5	1	13,5	Tall
	Left	1	2	1	1,5	1,5	1	4,5	Low
Shoe press	Right	1	0,5	1,5	1,5	1	1	1,13	Low
	Left	1	0,5	1	1,5	1	1	0,75	Low
Shoe Withdraw	Right	1	1	1,5	1,5	1,5	1	3,375	Currently
	Left	1	1	1,5	1	1,5	1	2,25	Low
Shoe Painting	Right	1	1	0,5	1,5	1	1	0,75	Low
	Left	1	1	0,5	1,5	1	1	0,75	Low

Table 3. Upper Printing Activity MFA Data

Job : Upper Shoe			Analyst : Tiara Adhitama and Mr. Eko				
Task : Shoe Upper Printing			Date : 11 Juli 2021				
	Enterprise Level			Skor			Priority
Parts of body	Low-1	Medium-2	Weight-3	Effort	Dur	Frek	
Neck	Head turned partially to the side, backward or slightly forward	Head turned sideways, head fully back, head forward about 20 °	Same as moderate but with force or weight, head stretched forward	3	2	2	322
Shoulder	Arms slightly away from sides of body, Arms are given more reach by some aids (tools)	Arms away from body, unaided, working hard	Exerting force or bearing weight with arms away from the body	Right 2	Right2	Right3	Right 223
				Left 1	Left 3	Left 1	Left 131
Back	Leaning sideways or bending backwards	Bending forward, no weight, lifting moderately, heavy weight close to the body, working hard	Lifting or exerting force when twisting, high force when bending	3	3	2	332
Arm/Elbow	Arms away from body, no weight, little effort to lift those located near the body (things)	Rotating arm when using moderate effort	Using high effort with body turning, lifting with extended arms	Right 3	Right 2	Right 3	Right 323
				Left 2	Left 3	Left 2	Left 232
Wrist/ Hand/ Fingers	Light strength to handle weight close to the body, straight wrist, comfortable grip	Grasping with a wide or narrow, angle that allows for risk (moderate), ecially during flexion, using gloves with moderate effort.	Small grip, strong wrist angle, smooth surface.	Right 3	Right 2	Right 3	Right 323
				Left 1	Left 4	Left 2	Left 142
Legs/ Knees	Standing, walking without bending or leaning; weight on both legs	Bending forward, leaning on the table; one-sided weight; rotating while exerting force	Exerts high force while pulling or lifting; crouching while exerting strength	Right 1	Right 1	Right 1	Right 111
				Left 1	Left 1	Left 1	Left 111
Ankle/ Feet/ Toes	Standing, walking without bending or leaning; weight on both legs	Bending forward, leaning on the table; one-sided weight;rotating while exerting force	Exerts high force while pulling or lifting; crouching while exerting strength	Right 1	Right 1	Right 1	Right 111
				Left 1	Left 1	Left 1	Left 111
Continuous business duration	<6 s 1	6-20 s 2	20-30 s 3	>30 s 4 (in very high category)			
Operating frequency	<1/ mnt 1	1-5/ menit 2	>5-15/mnt 3	>15/menit 4 (In very high category)			

them; (3) determining the level of effort/energy used in each body part. (4) determine the duration of work in seconds for each work intensity; (5) determine the frequency of work movements in minutes at each work intensity which is the same for each body part; (6) using the three-number ranking generated from steps 4 to 6 to determine the priority of score changes; (7) determine the priority of changes from the highest to the lower; (8) develop strategies to address the leading causes of high scores (9) redefine the order of tasks on all limbs to determine the impact of changes related to work comfort and complaints (Arthur et al., 2012).

III. RESULT AND DISCUSSION

Calculations with the two methods are complementary, in which the JSI method first calculates all work activities at each work station. Data processing using the MFA method is carried out based on calculations from the JSI method using the moderate to high-risk category.

One of the calculations using the JSI method, which has a high value, is at the upper activity printing work station 2.1 on the suitable hand activity. The posture performed by shoe craftsmen during the shoe upper printing activity is shown in Figure 1.

The following is how the data is processed using the JSI method: (1) the effort intensity is 99 beats per minute, so the effort intensity multiplier value is 1; (2) the duration of business is 94.29 percent, so the business duration multiplier value is 3; (3) the percentage value obtained from the calculation is 94.29 percent, so the percentage value obtained from the calculation is 94.29 percent, so the percentage value obtained from the calculation is 94.29 percent, so the percentage value obtained from the calculation is 94.29 percent, so the percentage value obtained from the calculation is (3) The multiplier number is 3 because the effort per minute is calculated using 30.43 times per minute and a rating value of 5. (4) The worker's wrist forms a flexion angle of 25.39°, resulting in a rating value of 3 and a multiplier value of 1.5; (5) work speed is based on the assumption that it works at a fast speed but can be maintained, resulting in a rating value of 4 and a multiplier value of 1.5; (6) the duration of work per working day is 7 hours/day, resulting in a rating value of four and a multiplier value of one; (7) Table 1 shows the findings of the JSI assessment of upper right-hand printing activity.

These occupations can be classified as activities with a high risk of harm or hazardous job, according to Table 1. Table 2 summarizes the findings of data processing for all work activities investigated using the JSI approach

Data processing using the MFA method is carried out based on calculations from the JSI method selected from moderate to high-risk values to make more efficient suggestions for

Table 4. Recapitulation of MFA Data Processing Results

Activity	Parts of body	Accumulation	Priority
1.6 Sewing Pattern	Neck	322	Very high
	Back	322	Tall
	Right Foot	142	Very high
1.1 Designing Patterns	Neck	223	Tall
	Back	322	Tall
1.2 Drawing Pattern	Neck	322	Tall
	Back	322	Tall
2.1 Upper Printing	Neck	322	Tall
	Right Shoulder	223	Tall
	Back	332	Very high
	Right arm/Elbow	323	Very high
	Right Wrist	323	Very high
	Left Wrist	142	Very high
2.5 Installation of soles	Neck	332	Very high
	Back	322	Tall
	Right Wrist	223	Very high
2.7 Shoe withdrawal	Right arm/Elbow	313	Tall
	Left arm/Elbow	313	Tall
	Right Wrist	223	Tall
	Right Foot	142	Very high
	Left Foot	142	Very high

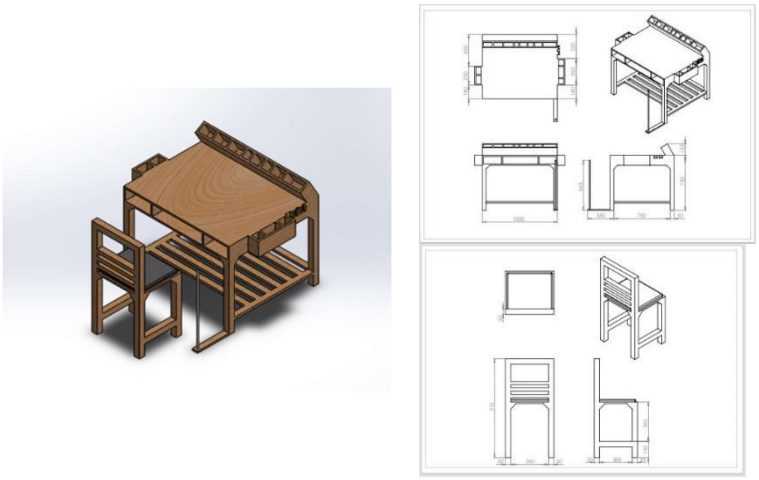

Figure 2. Proposed Design of Upper Printing Station Table and Chair

Table 5. Simulation Results of Upper Printing Activity Reassessment

Parts of body	Repair Activities		After	Priority
Neck	Provide suggestions for improvements in work desks and chairs, with additions, the height of the work chair and the addition of unique shelves for tooling so that the reach is closer and the neck posture is not too bent.	322	222	Currently
Right Shoulder	With the addition of special shelves on the table meant to be within easy reach of workers, it will be easier to take and find tools.	223	123	Currently
Back	Provide suggestions for improvements in the form of work desks and chairs, with the addition of work chair heights and special shelves for tooling so that the back is not too bent.	332	223	Currently
Right arm/elbow	Special shelves on the table are designed to be near to the reach of workers, making it easier to take and find tools.	323	123	Currently
Right Wrist	The size of the tool grip (hammer, knife set, etc.) that is adjusted to the length of the worker's hand grip.	323	123	Currently
Left Wrist	The size of the tool grip (hammer, knife set, etc.) that is adjusted to the length of the worker's hand grip.	142	123	Currently

improvement. Table 6 is a calculation using the MFA method at the upper activity printing station 2.1, while the recapitulation of the MFA results is in Table 4.

Results of data processing utilizing the JSI and MFA methods, followed by suggestions for improvement. Upper molding activities, inserting soles, and pulling shoes are all suggestions for improvement that have a high risk of MSDs. Improvements to the table and chair design that are different from what was previously proposed. The initial table is 150 cm long, 85 cm wide, and 75 cm high, and the initial chair is 40 cm long, 40 cm wide, and 80 cm high, which is risky because it forces the worker's posture, such as bending over, resulting in complaints of pain in the musculoskeletal muscles, tingling in the buttocks, and back pain. Back and neck tired from sitting on a chair with no backrest and no seat cushion on occasion.

The proposed table design is 100 cm long, 85 cm broad, and 73 cm tall, with seats that are 40 cm wide, 45 cm long, 51.5 cm tall from the bottom to the base, and 40 cm tall for the back of the body. Chemical substances, such as various types of glue that were formerly mixed on the table with other tools and supplies, are now stored on shelves beside the table in the

proposed table design. The suggested table design includes a patented letter S (hang) tool to ensure that the back does not suffer muscle injury when doing shoe pulling activities. Workers will be more comfortable in the proposed chair repair design because there is a backrest for their bodies when they are fatigued. Seat cushions are provided to make workers more comfortable. The chairs are made to fit the anthropometry of the workers. Figure 2 shows the comparison of the actual Upper Printing workstation with the proposed Upper Printing workstation.

From the proposed improvements, a reassessment simulation was then carried out using the MFA method as shown in Table 5.

The JSI approach can be utilized to analyze the work posture of Restu cracker factory workers in Purworejo, according to research (Rifqi, Simanjuntak and Khasanah, 2019). There are four workers in the cracker production process milling workers with a JSI score of 4 on the dangerous level, printing workers with a JSI score of 2 on the safe level for hand posture, drying workers with a JSI score of 6 on the risky level, and frying workers with a JSI score of 2 on the safe level. To improve hand posture. The results of calculations using the JSI method, from 11 work activities there are 5 work activities with the low-risk level and 6 work activities with the moderate risk level (Pratiwi et al., 2019).

Research (Restuputri, Masudin and Putri, 2020) on printing companies using the JSI method showed a correct hand value of 9, meaning that the right hand was categorized as having a risk of dangerous injury that needed to be analyzed as soon as possible. At the same time, the left-hand JSI value is 4.5, categorized as an activity that has a low risk of injury or a safe job. This is because the value of the correct hand/wrist position is greater than the left hand. Based on the comparison of the JSI and OCRA methods, it was found that the right hand needed to be repaired immediately because the risk was great, especially the activity of turning the lever machine to cut the paper together and the distance between the lever and the existing machine table was considered too high. Even though left-hand activity is considered excellent and optimal.

Research (Rosecrance, J., Paulsen, R., & Murgia, 2017) The results of the analysis on cheese making using the JSI method showed 224 pairs of assessments from 7 raters, each of which assessed 32 task functions using the SI and OCRA checklists. Of the 224 task functions, almost half (49.1%) were categorized as dangerous using the OCRA method checklist, while 60.2% were categorized as dangerous using the JSI method. Across all workers and activities performed, the overall mean JSI risk index was 25.6(SD 30.7), median 13.5, and ranged 0.1 to 161.9. The mean overall OCRA checklist score was 15.8 (SD 9.8), the median was 13.7, and the range was 0.0 to 47.6. More significant variance in score exposure was observed for the SI assessment than the OCRA checklist. JSI is devoted to DUE, while the OCRA checklist considers the entire upper extremity, including the shoulder. When conducting a risk assessment of industrial work assignments, the choice of analytical tool should be based on the purpose of the assessment and the complexity of the task function.

The MFA approach can be utilized to analyze the work posture of wooden furniture craftsmen, according to Research (Wibisono and Triyanti, 2016). Factors that impact workers were discovered using the manual job risk assessment approach and the muscle fatigue analysis method, including kind of effort, duration of effort, and frequency of effort, strength, speed, and duration. The risk level for the assembly activity is higher than for the other two activities. From the neck to the lower limbs, assembly activity impacts practically every part of the body. Only the upper limbs are influenced by the other two activities. The activity has three fixes: relocating assembly operations to a different area on the table, taking a short break in the middle of work to relax muscles, and changing workers' movement as they execute their activities to avoid unsafe motions. The deployment has a positive influence on risk reduction.

Research (Safety et al., 2020) The results of the MFA method in the manufacture of electric tools show that the right wrist and waist in 56

workers (66.67%) are at a "very high" priority level for corrective action that must be repaired quickly. It was stated that the neck and right shoulder in 50 workers (59.52%) were in the "very high" priority level for corrective action, in which the unsuitable ergonomic condition should be measured as soon as possible. The findings stated that the highest percentage of risk was associated with the right wrist of 56 workers (66/67%), waist of 56 workers (66.67%), the right shoulder of 50 workers (59.52%), neck of 50 workers (59.52%), left-right 44 workers (52.38%), right arm 39 workers (46.42%), left arm 33 workers (39.28%) and left wrist 28 workers (33.33%). The high risk of MSDs is different in each part of the worker's body, so corrective action or intervention is needed in this unit. Considering the prevalence of MSDs in the wrist and waist area has the highest percentage in this study, it is recommended to use chairs and tables that follow the anthropometric structure to improve work posture.

IV. CONCLUSION

The leather shoe production process carried out at SME has 14 work activities at three work stations, each activity has its own risks. The study found that six activities had medium and high risks, of which six would be further calculated using the MFA method. The research results using the MFA method were carried out on the six activities based on the calculation of the JSI method, namely the activities of designing, drawing, sewing, printing uppers, installing soles, pulling shoes and making suggestions for improvements.

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REFERENCES

Arthur, W. et al. (2012) Team Task Analysis, Human Factors: *The Journal of the Human Factors and Ergonomics Society.* doi: 10.1177/0018720811435234.

Boschman, J. S. et al. (2012) 'Musculoskeletal Disorders Among Construction Workers: a one-year follow-up study'. *BMC Musculoskeletal Disorders, 13*(1), pp. 2–9.

Garg, A., Moore, J. S. & Kapellusch, J. M. (2007). *The strain index to analyze jobs for risk of distal upper extremity disorders: Model validation'*, IEEM 2007: 2007 IEEE International Conference on Industrial Engineering and Engineering Management, pp. 497–499. doi: 10.1109/IEEM.2007.4419239.

Ginting, R. & Malik, A. F. (2018) 'Analisis Keluhan Rasa Sakit yang Dialami Pekerja pada Ukm Sepatu Kulit Di Kota Dengan Menggunakan Kuesioner SNQ', *Jurnal Sistem Teknik Industri, 18*(1), pp. 15–19.

Kee, D. (2007) 'A Comparison of Three Observational Techniques for Assessing Postural Loads in Industry observational technique OWAS RULA REBA musculoskeletal disorders', *International Journal of Occupational safety and Ergonomics, 13*(1), pp. 3–14.

Łukasz, Jozef & Izabela (2015) 'Assessment of Workload on Musculoskeletal System of Milkers in Mechanical Milking Through the Use of Job Strain Index Method'. *Scientific Papers-Series Management Economic Engineering in Agriculture and Rural Development, 15*(1), pp. 249–254.

Maula, N. Z., Suwandi, T. and Nilamsari, N. (2016) 'Risk analysis of Musculoskeletal Disordes (MSDs) on Logistic Distribution Workers in Warehouse of PT . X Surabaya', *International Journal of Advanced Engineering, Management and Science (IJAEMS), 2*(7), pp. 1185–1188.

Muslimah, E., Pratiwi, I. and Rafsanjani, F. (2006) 'Analisis Manual Material Handling Menggunakan Niosh Equation', *Jurnal Ilmiah Teknik Industri, 5*(2), pp. 53–60. doi: https://doi.org/10.23917/jiti.v5i2.1566.

Naeini, H. S. et al. (2018) 'Economic effectiveness of ergonomics interventions', *International Journal of Industrial Engineering and Production Research, 29*(3), pp. 261–276. doi: 10.22068/ijiepr.29.3.261.

Oktaviannoor, H., Helmi, Z. N. & Setyaningrum, R. (2015) 'The Correlation between Smoking Status and BMI with The Complaints of Musculoskeletal Disorders on Palm Farmers', *International Journal of Public Health Science (IJPHS), 4*(2), pp. 140–144.

Permana, A. M., Adelina Simanjuntak, R. and Yusuf, M.

(2018) 'Analisis Ergonomi Fisik dengan Metode Job Strain Index dan Ergonomi Kognitif Guna Mengurangi Risiko Kecelakaan Kerja'. *Jurnal Rekavasi, 6*(2), pp. 75–81.

Prasetyo, W. S. & W. (2012) 'Perbaikan Postur Kerja untuk Mengurangi Keluhan Muskuloskeletal dengan Pendekatan Metode OWAS (Studi kasus di UD. Rizki Ragil Jaya – Kota Cilegon)', *Spektrum Industri, 10*(1), pp. 69–81.

Pratiwi, I. et al. (2019) '*Posture Analysis of Workers in Bare Core Production Workers using the Index and Job Strain Method Assessment of Repetitive Task Tool*', (2191), pp. 2191–2200.

Restuputri, D. P. et al. (2021) 'Analysis of Work Posture Using the Muscle Fatigue Assessment (MFA) and Novel Ergonomic Postural Assessment (NERPA)', *Jurnal Ilmiah Teknik Industri, 20*(1), pp. 9–20. doi: 10.23917/jiti.v20i1.13222.

Restuputri, D. P., Masudin, I. & Putri, A. R. C. (2020) '*The comparison of ergonomic risk assessment results using job strain index and OCRA methods*', in 2019 3rd International Conference on Engineering and Applied Technology (ICEAT), pp. 1–9.

Rifqi, M., Simanjuntak, R. A. & Khasanah, R. (2019) 'Analisis Postur Kerja Menggunakan Metode Rapid Entyre Body Assessment (REBA), Ovako Working Analysis System (OWAS), dan Job Strain Index (JSI) pada Pekerja Pabrik Kerupuk Restu di Purworejo', *Jurnal Rekavasi, 7*(1), pp. 43–50.

Rosecrance, J., Paulsen, R., & Murgia, L. (2017) 'Risk Assessment of Cheese Processing Tasks Using the Strain Index and OCRA Checklist', *International Journal of Industrial Ergonomics, 61*, pp. 142–148.

Tsekoura Maria et al. (2017) 'Work - Related Musculoskeletal Disorders Among Female and Male Nursing Personnel In Greece.', *World Journal of Research and Review (WJRR), 3*(1), pp. 8–15.

Wibisono, C. and Triyanti, V. (2016) '*Work Risk Assessment Towards Wood Furniture Production Activities Using Manual Task Risk Assessment Method and Rodgers Muscle Fatigue Analysis Method*', in Proceeding of 9th International Seminar on Industrial Engineering and Management, pp. 1–8.