Analysis of Work Posture and Proposed Improvement for Workers of Kaysa Taylor Clothing Home Industry

Umi Suci Melinda, Rani Aulia Imran, and Amanda Sofiana
Industrial Engineering Department, Faculty of Engineering
Jenderal Soedirman University
Purbalingga, Indonesia
umisucimelinda18@gmail.com, rani.aulia.imran@unsoed.ac.id, amanda.sofiana@unsoed.ac.id

Abstract

Kaysa Taylor is one of the home industries in apparel production, located in Cilacap Regency. Some workers have complained of some pain in the body parts such as the legs, hands, hips, buttocks, and back based on the preliminary interview. They are working their limbs repeatedly with improper postures such as bending, picking up, and putting clothes on in their activities. Therefore, this study was conducted to comprehend the complaints of body parts experienced by workers using the Nordic Body Map (NBM) and understanding the level of risk of work posture experienced by workers using Rapid Entire Body Assessment (REBA). Workstation redesign is proposed to reduce complaints and risks of worker work posture in Kaysa Taylor's home industry. Based on the NBM results, the majority of workers complaints were pain in the neck, back, waist, hips, and buttocks. The results also showed that all workers were at a moderate risk level. The level of risk for work posture based on the REBA results experienced by the worker is at a medium risk with scored 5 to 11. Further investigation and change needed to reduce musculoskeletal disorders.

Keywords
Clothing Home Industry, Complaints, NBM, REBA, and Work Posture.

1. Introduction

In today's modern era, the apparel industry is up-and-coming. The textile and clothing industry is one of five manufacturing sectors that are a priority in its development based on the Making Indonesia 4.0 roadmap launched by the Indonesian government (Kementerian Perindustrian 2020). This industry is in great demand, but if the workstation does not prioritize ergonomic factor, it will also cause complaints, injuries and cause work accidents related to the work (Osni 2012). Ergonomics risk is a potential hazard that is often found in the workplace, especially the garment industry or clothing production, for this reason it is necessary to pay attention to safety and health for the activities carried out by tailors so that complaints of musculoskeletal disorders can be suppressed (Wulandari et al. 2017).

Kaysa Taylor is one of the home industries of clothing production located in Salebu Village, Majenang District, Cilacap Regency. Some workers have complained of some pain in the body parts such as the legs, hands, hips, buttocks, and back based on preliminary interview. Their activities require them to move using their limbs repeatedly with awkward postures, such as bending over when picking up and setting up the clothes. Clothing production activities usually dealing with the activity of both hands which are always on the sewing machine table to hold the stitch object and both feet pressing the dynamo drive saddle, with the neck inclined forward. This is coupled with the workstation arrangement that does not yet provide a particular place for sewing materials and finished sewing products. Because items are still on the floor, workers have to bend over to the side and reach down to pick up and/or place stitches. This condition if neglected can cause health complaints to workers.

In identifying and finding the location of complaints felt by workers on their body, Nordic body map (NBM) is widely used. Through this questionnaire, it will be seen which parts of the body are experiencing complaints. Research by Osni (2012) used NBM to analyze the complaints on informal sector sewing workers in the Home Industry Area of Tangerang City. Wulandari et al. (2017) used NBM to investigate the pain complaints in sewing workers at Banyuwangi. Andriani et al. (2020) 68% tailor have complaints/experiencing MSDs on their waist. Based on these three studies, most of the complaints were the neck, arms, shoulders, waist, back, buttocks, elbows, hands, wrists,

calves, knees, ankles, and feet. For this reason, this study also uses the NBM method, which is based on previous research. This method can be used to determine which parts of the body of workers that experience complaints.

According to Chan et al. (2002), tailors have a non-neutral joint posture in performing high-continuous and continuous precision tasks and highly repetitive movements that cause muscle complaints. Other study (Kanniappan and Palani 2020) concluded 88% of sewing machine workers had a lower back pain in the last 12 months. Based on the studies, the results of the posture risk level were moderate and high. Work posture assessment is carried out to measure the risk level of work posture of tailors. The method for assessing work posture can use several ways. One of them is the Rapid Entire Body Assessment (REBA) method, an update of the NIOSH method (Budiman and Setyaningrum 2012). The REBA method is used to assess the posture of a worker's neck, back, legs, arms, and wrists. In this study, the REBA method is used in the Kaysa Taylor home industry to assess the level of posture risk in tailor workers.

1.1 Objectives

This study will be carried out by assessing the complaints experienced by workers using the NBM questionnaire (Kuorinka et al. 1987), observing the level of work posture risk using REBA (Hignett and McAtamney 2000), and proposing work station design to reduce complaints and the level of risk of worker. Kaysa Taylor. The use of anthropometric data is used as one of the considerations in making workstation design proposals to adjust the worker's body dimensions. The redesign is expected to improve the worker's work posture to reduce or eliminate complaints and work posture risks to achieve the best work system in the Kaysa Taylor home industry.

2. Literature Review

Regarding the position or posture of workers when carrying out activities in their work is a step in complying with the comfort and health of workers (Noviarmi and Ningtiyas 2018). Posture is the relative position of a specific body part of a person when carrying out work activities determined by the design of the work area, body size, task requirements, and the size of other equipment used at work. Non-ergonomic work postures can cause muscle complaints, fatigue, injury, and work accidents. Muscle complaints are complaints that occur in the skeletal muscles ranging from mild to very painful complaints. If the muscles receive repeated static loads for a long time, it can cause complaints such as damage to tendons, joints, and ligaments (Tarwaka et al. 2004).

According to Santoso (2004), to find out which body parts are experiencing complaints or pain in more detail, we can use the Nordic body map method. Nordic body map is a commonly used tool to identify musculoskeletal complaints or discomfort in certain body parts. Although it is subjective, this questionnaire has been standardized and validated for use. Respondents were asked to provide an assessment according to a predetermined Likert scale on the part of their body that they felt had complaints during work activities. Then the respondent filled out the Nordic Body Map questionnaire by placing a checkmark on the part of the body that felt pain according to the complaint level.

The Rapid Entire Body Assessment (REBA) method is a method used to assess the overall level of ergonomic risk from the neck to the worker's feet. This method aims to evaluate the level of risk and musculoskeletal disorders (MSDs) based on an assessment of posture at risk to take corrective action (Osni 2012). The REBA method has several advantages: a fast approach to assessing the whole body with clear assessment guidelines and a scoring system that can be applied easily. The interpretation of the REBA risk level is described in Table 1.

Table 1. Classification of risk levels based on the REBA score

Score	Risk Level	Corrective action
1	negligible risk	Change not be needed
2 or 3	low risk	Change may be needed
4 to 7	medium risk	Further investigation and change needed
8 to 10	high risk	Investigation and immediate change needed
11 >	very high risk	Very immediate change needed

3. Methods

The type of research used is descriptive, using a quantitative approach. Researchers will identify an assessment of the complaints experienced by workers and a description of the work posture of workers in the Kaysa Taylor home industry. The proposed redesign used secondary anthropometric data obtained from the Indonesian Anthropometry database. The location of this research is in the home industry Kaysa Taylor Jl. H. Suhemi Dusun Nyakra, RT 05 RW 07 Salebu Village, Majenang District, Cilacap Regency. Data collection in this research on the Kaysa Taylor home industry is carried out in June - December 2020, in accordance to health protocol in the area. The method used in purposive sampling, which all workers are the respondents. The population in this study was five workers in the Kaysa Taylor home industry.

4. Data Collection

Data and data sources in this study are using primary data and secondary data. The primary data sources collected in this study were obtained from observations (Figure 1), direct interviews, and questionnaires in the Kaysa Taylor home industry. The primary data in this study are complaints and work posture data. Secondary data collected in this study is anthropometric data obtained from Indonesian Anthropometry database (Antropometri Indonesia 2021). The data collection in this research is observing the actual conditions in the home industry to obtain appropriate and accurate information on the Kaysa Taylor conditions. A literature study was also carried out by searching and studying literature such as those related to the research methods used by researchers.

Figure 1. The current condition of the workstation

5. Results and Discussion

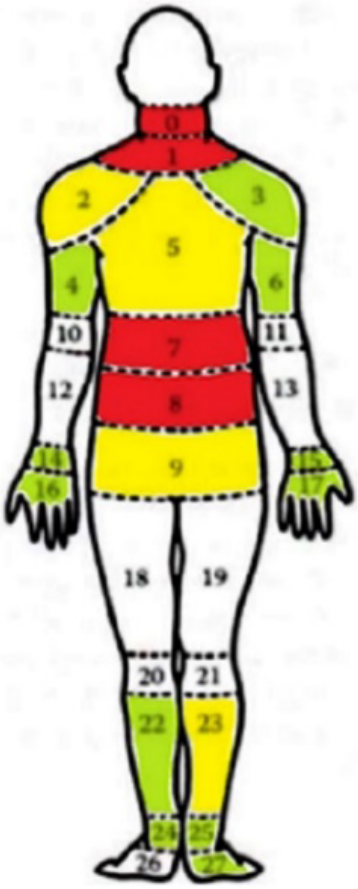
The results of the NBM, REBA, and the proposed new workstation design are as follows:

5.1 Nordic Body Map (NBM)

There were some musculoskeletal complaints experienced by the worker of Kaysa Taylor. Complaints of body parts experienced by worker 1 using a sewing machine with mild pain were felt in the right shoulder, left upper arm, left and right hand. Complaints of pain are felt in the left shoulder, back, buttocks, right calf, right ankle. Complaints of very pain are found in the upper and lower neck, waist, and hips. Total individual score was obtained of 54, which means that it is included in the moderate risk level. This risk level corrective action may be needed. Worker 2 is a worker who works using a sewing machine. Based on the NBM questionnaire, data on complaints of body parts experienced by worker 2 of mild pain were felt in the left and right shoulders, right upper arm, left and right wrist, right ankle, and right leg. Complaints of pain in the left upper arm and right calf. Extreme pain was felt in the upper and lower neck, back, waist, hips, and buttocks. Total individual score of 56 is obtained, which means that it is included in the moderate risk level. With this risk level, corrective action may be needed.

Worker 3 experienced of mild pain works using an overlock machine on the left and right shoulders, left and right upper arms, left knees, left calves, and left ankles. Complaints of pain in the back and buttocks. Complaints of very pain are felt in the upper and lower neck, waist, and hips. Total individual score of 51 is obtained, which means that it is included in the moderate risk level where corrective action may be needed. Data on complaints of body parts experienced by workers 4 works using an overlock machine of mild pain were felt in the left and right upper arms, hips, left wrists, left and right hands, left calves, and left ankles. Complaints of pain are felt in the upper and lower neck, left and right shoulders, back, and buttocks. Complaints of severe pain in the waist. Total individual score of 51

is obtained, which means that it is included in the moderate risk level where corrective action may be needed. Complaints of body parts experienced by workers 5 of mild pain were felt in the left and right shoulders, left and right upper arms, left and right forearms, left and right wrists, left and right hands, right calves, right ankles, and right feet. Complaints of pain are on the buttocks and severe pain was felt in the upper and lower neck, back, waist and hips. Total individual score of 58 was obtained, which means that it is included in the moderate risk level where corrective action may be needed. Prevalence of workers complaints can be seen in Figure 2, which the highest musculoskeletal complaint on the body felt were upper back, lower back, waist, and hips. This result is in accordance to other researches findings (Wulandari et al. 2017, Osni 2012, Kanniappan and Palani 2020).



Number	Musculoskeletal Complaints	None	Some	High	Very high
0	Upper neck	0%	0%	20%	80%
1	Lower neck	0%	0%	20%	80%
2	Left Shoulder	0%	60%	40%	0%
3	Right Shoulder	0%	80%	20%	0%
4	Left Upper Arm	0%	80%	20%	0%
5	Back	0%	0%	60%	40%
6	Right Upper Arm	20%	80%	0%	0%
7	Waist	0%	0%	0%	100%
8	Hips	0%	20%	0%	80%
9	Butt	0%	0%	80%	20%
10	Left Elbow	100%	0%	0%	0%
11	Right Elbow	100%	0%	0%	0%
12	Left Forearm	80%	20%	0%	0%
13	Right Forearm	80%	20%	0%	0%
14	Left Wrist	40%	60%	0%	0%
15	Right Wrist	60%	40%	0%	0%
16	Left hand	40%	60%	0%	0%
17	Right hand	40%	60%	0%	0%
18	Left Thigh	100%	0%	0%	0%
19	Right Thigh	100%	0%	0%	0%
20	Left Knee	80%	20%	0%	0%
21	Right Knee	100%	0%	0%	0%
22	Left calf	60%	40%	0%	0%
23	Right calf	40%	20%	40%	0%
24	Left Ankle	60%	40%	0%	0%
25	Right Ankle	40%	40%	20%	0%
26	Left Foot	100%	0%	0%	0%
27	Right foot	60%	40%	0%	0%

Figure 2. Prevalence of workers complaints

5.2 Rapid Entire Body Assessment (REBA)

The working posture on worker 1 to 5 can be seen in Figure 3 respectively. The angle calculation and the required components in the REBA worksheet are calculated from that angle. From that angle, it is assessed based on the provisions in the worksheet, then the value of each component is entered into the calculation table. The final REBA assessment for the material-taking process in posture in Figure 3a of worker 1 resulted in a final score is 8, it means a high-risk level where this level of risk requires investigation and implementation changes.

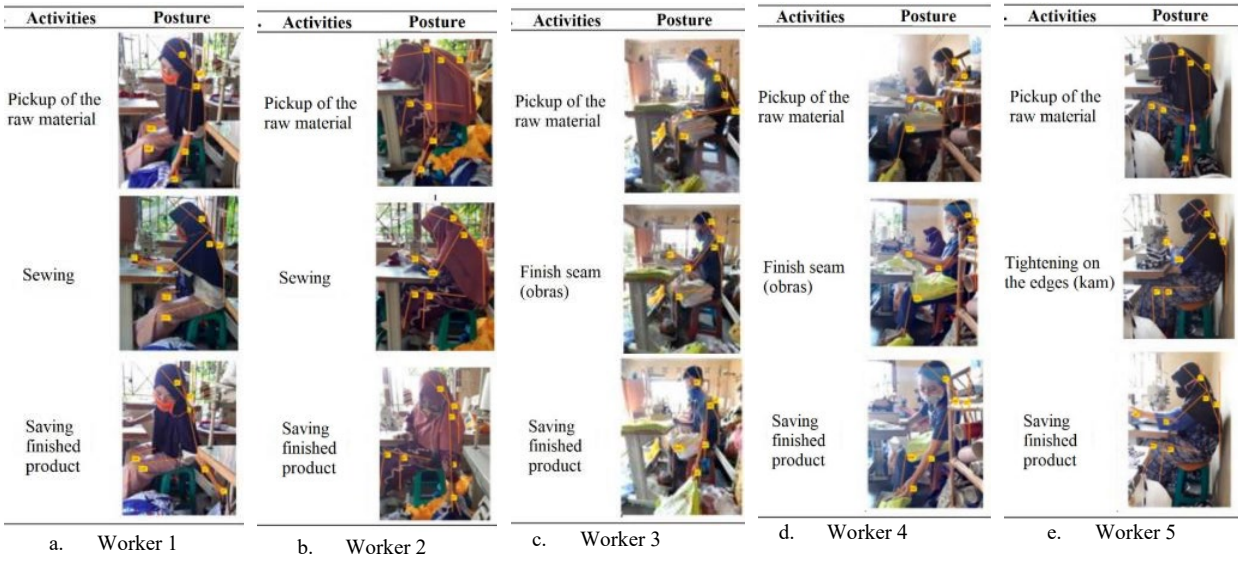


Figure 3. Work postures assessment using REBA

The final assessment for the suturing process resulted in a final REBA score of 5. This means the medium or medium risk level where requires further action and correction of awkward posture changes while working. The final assessment for the process of laying materials resulted in a final score of 6, which means a medium or medium risk level where requires further action and correction of body posture while working. Table 2 is the summary of the worker posture risk levels based on the activities carried out. It can be seen that the highest level of posture risk is when the worker picks up the material on the floor with a value of 7.2, followed by the worker's posture when placing the material on the floor with a value of 6.6. The lowest value is the worker's posture during the sewing process is finishing seam, with a value of 5.6. Nevertheless, most of the work element and job task was in medium risk, although some element and job task have a high level of musculoskeletal risk. The results is similar with the other study (Wulandari et al. 2017, Andriani et al. 2020) that the tailor has a risk level above 5 which needs further investigation.

Table 2. REBA risk summary

Job Task	Worker	Pickup material	Sewing/finishing seam/kam	Finishing	Mean	Risk by job Task
Sewing	1	8	5	6	6.8	Medium
	2	10	6	6		
finishing seam	3	5	6	6	5.8	Medium
	4	5	5	8		
Kam	5	8	6	7	7	Medium
Mean		7.2	5.6	6.6		
Risk by Element		Medium	Medium	Medium		

5.3 Proposed Improvements

Based on the results of NBM and REBA where the level of risk of worker complaints is at a moderate level of risk, and the risk of the posture of taking materials has a high score. This is then followed by the value of the posture of laying materials, and as (Sealetsa and Thatcher 2011) concluded, if the workstation heights were not appropriate, it can cause high incidence of MSDs. It is necessary to be improved by designing work stations in the form of chairs and tables to place clothing materials before and after in the process of sewing/finishing seam/kam. The design of the workstation was made considering the results of NBM, REBA, and body dimensions obtained from Indonesian Anthropometric database. The Indonesian Anthropometry data was obtained from the age range of 28 to 47 years according to the age of the worker in Kaysa Taylor's home industry. Anthropometric data can be seen in Table 3.

Table 3. Body dimensions (cm)

No	Dimension	P5	P50	P95	SD
1	Height in Sitting Position	70,7	77,47	84,23	4,11
2	Elbow Height in Sitting Position	30,93	34,33	37,74	2,07
3	Popliteal Length	32,87	35,63	38,39	1,68
4	Popliteal Height	41,65	46,18	50,71	2,75
5	Upper Shoulder Width	32,01	39,57	47,13	4,6
6	Hip Width	35,56	39,88	44,2	2,63
7	Forward Arm Length	63,58	65,95	68,33	1,45
8	Hand Span to Side	166,25	170,59	174,93	2,64

Based on the anthropometric data obtained, Figure 8 is a figure of the proposed new work station design. several considerations as a reference in the workstation design proposal (Chan et al. 2002, Sutalaksana 2006, Noviarmi and Ningtiyas 2018, Pheasant and Haslegrave 2018, Aribowo et al. 2020). The design of the table of the clothing material is divided into two, which are the table used for 3 workers and the table used for 2 workers. The length of the table takes into account of the workbench width and the distance between the workbenches. The width of the workbench is 48 cm, and the distance between the workbench is 40 cm. The table where the workers use the workstation requirement approach for one worker and is duplicated by the number of workers. For a three-person table, the workstation is multiplied by three (table length is 264 cm), and for a two-person table, it is multiplied by two (table length is 176 cm). The table's width, for both three workers and the table used for two workers, has a width of 48 cm following the table's width (sewing/finishing). The table height is obtained from the popliteal height plus the elbow height in a sitting position at the 50th percentile. With this measure, it is expected that workers with long legs will still feel comfortable. As a table height that is too high will make it difficult for workers with short legs, the table height is then designed at the 50th percentile so that all workers can use it comfortably. Popliteal height is 46.18 cm, and elbow height in a sitting position is 34.33 cm, so the final table height is 80.51 cm or rounded up to 81 cm.

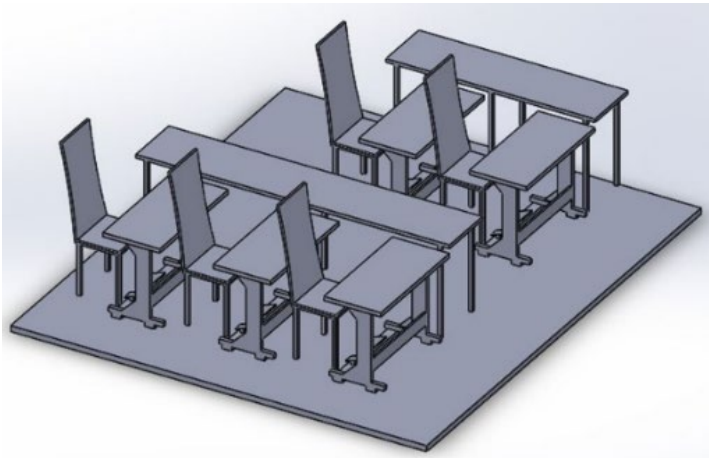


Figure 8. Redesigned workstation proposal

The seat height is obtained from the popliteal height at the 50th percentile. This measure is intended to sit comfortably with all workers, both with long and short legs. The popliteal height was 46.18 cm, then rounded to 46 cm, which became the designed seat height. The back seat height is obtained from the height in the sitting position at the 50th percentile. The 50th percentile is used to accommodate people who have high or short shoulders. According to Pheasant (1987) the optimal backrest angle of the chair is 100°-120° for workers to be able to sit comfortably. Chair back is one of the important things in reducing complaints, especially those who work tend to be in a static sitting position, to support the back (Vandyck et al. 2013). The height in the sitting position is 77.47 cm or rounded up to 77 cm, which is the height of the back seat, and the chair has a slope of 100°.

The seat base length is obtained from the popliteal length at the 50th percentile. Consideration using the 50th percentile of workers was to make sure the chair did not feel excessive length nor feel the seat length was insufficient. The value

of the popliteal length is 35.63 cm or rounded up to 36 cm, which is use as the length of the seat base. The back seat width is obtained from the upper shoulder width at the 50th percentile. The consideration for using the 50th percentile is that people with a percentile score that is less than or more than the 50th percentile can lean back comfortably. The value of the upper shoulder width is 39.57 cm or rounded up to 40 cm, which is use as the width of the back seat. The width of the seat base is obtained from the width of the hips at the 95th percentile. The consideration of using the 95th percentile is that only a small portion of the hips protrudes or does not fit in the seat base. At the same time, people who have a hip width of less than 95th percentile will have an excess of the seat base width which is not reducing the level of comfort when sitting. The value of the hip width is 44.2 cm or rounded up to 44 cm, which is use as the width of the seat base.

5.4 Study limitations

The redesigned workstation has not yet been implemented and tested in order to reduce worker's complaints. There some limitation of time and restriction of health protocol so that the data taken was not using worker anthropometric data. More detailed measurements is needed relating to the room allocation of the workplace. Further investigation needed in the design proposal which include the material of the table, chair, and chair cushion to make sure the proposed workstation will reduce musculoskeletal complaint. This is exemplified by Chan et al. (2002), ergonomics interventions have to consider the machine used by the worker, seating improvement, posture, cost estimates, and combined with a health education program to the worker and employer. It is also necessary to pay attention to the tailor's work posture, both static and dynamic in carrying out his work. As Andriani et al. (2020) stated that tailor work of more than 4 hours has greater risk of experiencing MSDs than less.

6. Conclusion

Based on the results of the NBM questionnaire, the majority of workers complained of pain in the neck, back, waist, hips, and buttocks. The level of risk of complaints experienced by workers, namely as many as 5 workers (100%) who work at Kaysa Taylor's home industry, are included in the moderate category of complaints. A moderate level of risk means that corrective action is required at a later time. The level of posture risk based on REBA results experienced by the worker, namely the posture of taking materials, has a moderate level of risk with a final REBA value of 7.2. The sewing/finishing posture has a moderate risk level with a final REBA value of 5.6. And the posture of laying the material has a moderate level of risk with a final REBA value of 6.6. A moderate level of risk means that further action is needed and correction of any abnormal posture changes also needed. The proposed design of a new workstation in chairs and tables for clothing materials before and after the sewing/finishing process is presented. The seat redesign aims to allow the worker to sit in a comfortable position by adding a backrest and cushioning in the seat base. The table is designed so that workers do not have to bend down during the process of picking up and placing items. With these proposed chair and table design, it is expected that it can reduce the complaints and improve awkward postures when the workers are doing their jobs.

References

Andriani, B., Camelia, A. and Faisya, H. . F., Analysis of working postures with musculoskeletal disorders (Msds) complaint of tailors in Ulak Kerbau Baru Village, Ogan Ilir, *Jurnal Ilmu Kesehatan Masyarakat*, vol. 11, no. 1, pp. 75–88, 2020.

Antropometri Indonesia, Rekap Data Antropometri Indonesia, Available: https://antropometriindonesia.org/index.php/detail/artikel/4/10/data_antropometri, June 2021.

Aribowo, I., Suhardi, B. and Pujiyanto, E., Analysis of working posture on musculoskeletal disorders of vocational garment student's in garment assembly operations practice, *AIP Conference Proceedings*, Surakarta, Indonesia, April 14 , 2020, pp. 30016.

Budiman, E., and Setyaningrum, R., Perbandingan metode-metode biomekanika untuk menganalisis postur pada aktivitas manual material handling (MMH) Kajian Pustaka, *J@ Ti Undip: Jurnal Teknik Industri*, vol. 1, no. 3, pp. 46-52, 2012.

Chan, J., Janowitz, I., Lashuay, N., Stern, A., Fong, K. and Harrison, R., Preventing musculoskeletal disorders in garment workers: preliminary results regarding ergonomics risk factors and proposed interventions among sewing machine operators in the San Francisco Bay Area, *Applied Occupational and Environmental Hygiene*, vol. 17, no. 4, pp. 247–253, 2020.

Hignett, S. and McAtamney, L., Rapid entire body assessment (REBA), *Applied ergonomics*, vol. 31, no. 2, pp. 201–205, 2000.

Kanniappan, V. and Palani, V., Prevalence of musculoskeletal disorders among sewing machine workers in a leather

industry, *Journal of Lifestyle Medicine*, vol. 10, no. 2, pp. 121–125, 2020.
Kementerian Perindustrian, Kemenperin: Industri Tekstil Siap Keluar dari Tekanan Global, Available: https://kemenperin.go.id/artikel/21508/Industri-Tekstil-Siap-Keluar-dari-Tekanan-Global, July 2021.
Kuorinka, I., et al., Standardised nordic questionnaires for the analysis of musculoskeletal symptoms, *Applied Ergonomics*, vol. 18, no. 3, pp. 233–237, 1987.
Noviarmi, F. S. I., and Ningtiyas, M. K., Design of operator station work on line packing PT. X Surabaya, *Journal of Industrial Hygiene and Occupational Health*, vol. 2, no. 2, pp. 112-121, 2018.
Osni, M., Gambaran faktor risiko ergonomi dan keluhan subjektif terhadap gangguan musculoskeletal disorders (MSDS) pada penjahit sektor informal di kawasan home industry, *Skripsi Universitas Indonesia*, 2012.
Pheasant, S., Some anthropometric aspects of workstation design, *International journal of nursing studies*, vol. 24, no. 4, pp. 291-298, 1987.
Pheasant, S. and Haslegrave, C. M., *Bodyspace: Anthropometry, ergonomics and the design of work*, 3rd Edition, CRC Press, United States, 2018.
Santoso, G., *Manajemen Keselamatan dan Kesehatan Kerja*, Prestasi Pustaka, Jakarta, 2004.
Sealetsa, O. J., and Thatcher, A., Ergonomics issues among sewing machine operators in the textile manufacturing industry in Botswana, *Work*, vol. 38, no. 3, pp. 279–289, 2011.
Sutalaksana I. Z., Anggawisastra, R., and Tjakraatmadja, J. H., *Teknik Perancangan Sistem Kerja*, ITB Press, Bandung, 2006.
Tarwaka, Bakri, S. and Sudiajeng, L., *Ergonomi untuk keselamatan, kesehatan kerja, dan produktivitas*, UNIBA Press, Indonesia, 2004.
Vandyck, E., Oppong, S., Senayah, W. and Ba-ama, E., A review of ergonomically designed work seats ; the situation of small-scale garment producers in Ghana, *International Journal of Educational Research and Review*, vol. 2, no. 5, pp. 17–22, 2013.
Wulandari, D. R., Moelyaningrum, A. D., and Hartanti, R. I., Risiko ergonomi dan keluhan muskuloskeletal disorders pada pekerja jahit (studi di UD. Ilfa Jaya Konveksi Banyuwangi - Indonesia), *Prosiding Seminar Nasional dalam Rangka OSH Week,* Surabaya, Indonesia, Oktober 22, 2017.

Biographies

Umi Suci Melinda is a graduate of Industrial Engineering Department, Universitas Jenderal Soedirman, and holds a Bachelor of Engineering degree.

Rani Aulia Imran is a lecturer at Industrial Engineering Department, Universitas Jenderal Soedirman**.** She holds a Bachelor of Engineering degree in Industrial Engineering from Universitas Hasanuddin and a Master of Engineering degree in Industrial Engineering and Management from Institut Teknologi Bandung. She is a member of PEI.

Amanda Sofiana is a lecturer at Industrial Engineering Department, Universitas Jenderal Soedirman**.** She holds a Bachelor of Engineering degree in Industrial Engineering and a Master of Engineering degree in Industrial Engineering from Universitas Sebelas Maret. She is a member of ISLI.