Analysis of Work Posture and Manual Handling on the Material Transport Activities of Indonesian Traditional Market Worker

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ABSTRACT

This research is about the observation of workers transporting sacks in a traditional market. The worker complained about pain in many body parts like the shoulders, waist, and arms, which are presented in the results of the Nordic Body Map questionnaire. This problem can be solved by massaging the body section to reduce musculoskeletal disorders. Because it is often get massaged, it makes the completion time of sack transport become longer. Work posture must be improved because too much pain piles up over long periods and can impact condition health and decrease productivity. The purpose of this research is to evaluate the working posture while doing manual handling. Evaluate work posture using Rapid Entire Body Assessment (REBA) and Manual Handling Assessment Chart (MAC Tool). As a result, work posture and manual handling have a higher level of risk of injury, so we need to investigate and implement change. The level of risk must be reduced to at least medium risk. Using auxiliaries can improve work posture, reduce health risks, reduce load sacks, and increase work productivity. The recommended outcome is adding a skid box to improve the value of REBA and manual material handling by providing a hand trolley cart.

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Keywords: Nordic Body Map (NBM), Rapid Entire Body Assessment (REBA), Manual Handling Assessment Chart (MAC Tool), musculoskeletal disorders, manual handling.

Research Type: Research Paper

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1. INTRODUCTION

This research scope is the Indonesian traditional market setting. In a traditional market, the worker has a job transporting sacks of vegetables, meat, flour, snack, and other ingredients. A worker is a person who transports sacks with manual handling works every day. An example of manual handling is when workers use body parts like shoulder, back, and arms to lift and carry sacks from a truck to the traditional market with no auxiliaries to help transport sacks. Workers are always in a bent position and upright position when lifting and carrying sacks. Worker body posture always changes from lifting and carrying sacks in 1-2 hours over long distances. In every activity, workers feel pain in some body parts almost daily. Sometimes, workers complain about pain in body parts because the pain always locates on the same body parts. To reduce pain, workers always take a break from massaging body parts while in work hours. The pain makes workers uncomfortable, and lives an unhealthy lifestyle. These problems must be resolved because they can impact workers' health conditions and decrease productivity (Majid et al., 2016). That cases are known as musculoskeletal disorders, which are acknowledged by painful posture, handling heavy loads, and repetitive movement of body parts (Lind et al., 2020). Musculoskeletal disorders are also affected by repetitive and heavy manual handling (Lind et al., 2022). Worker complaints are included in the Nordic Body Map questionnaire, which identifies the complaint body part and level of complaint. Researchers have utilized Nordic Body Map to evaluate pain in the body (Ghasemi et al., 2021). Improvements are needed regarding the complaints experienced by workers. The result of this

research will give recommendations to change work posture to reduce musculoskeletal disorders, reduce load sacks, and increase work productivity.

2. LITERATURE REVIEW

2.1. Musculoskeletal Disorders (MSDs)

Musculoskeletal disorders are disorders of pain in the joints, muscles, bones, and ligaments in the body part (Sirisawasd et al., 2018). Musculoskeletal disorders are caused due to high physical work demands (Oestergaard et al., 2022). The disorder is influenced by age, especially in the elderly (Liu et al., 2022). Thus, it can be said that the demands of physical work and the age of the worker influence musculoskeletal disorders. Musculoskeletal disorders cause workers to experience continuous pain in parts of their body, and one of these factors is the length of working time. A long duration of work increases musculoskeletal disorders. The long working time factor also affects musculoskeletal disorders; the longer you work, the higher the risk of musculoskeletal disorders (Siddiqui et al., 2021). The disorder is caused by excessive work conditions (Asuquo et al., 2021). Musculoskeletal factors are influenced by the individual and society, where the individual is related to age, while social is related to conditions and work. The risk factor of musculoskeletal disorders related to work are bent position incorrectly and lifting heavy loads (Laithaisong et al., 2021). Musculoskeletal disorders include some pain in the body. Cause of that, musculoskeletal disorders can affect work efficiency and cause accumulating pain for a long period (Clari et al., 2019).

2.2. Nordic Body Map (NBM)

Nordic Body Map is a questionnaire to analyze complaints of musculoskeletal disorders on a body part (Ariyanti et al., 2019). Complaints on the body are examined based on feelings by pointing to the body's position that is experiencing complaints (Thamrin et al., 2021a). The nordic Body Map questionnaire is used by almost every country worldwide (Adiyanto et al., 2022). The Nordic Body Map questionnaire can identify the presence of musculoskeletal disorders as well as the level of complaints felt. Nordic Body Map questionnaire use feeling to identify work posture complaints. The nordic body map analyzes nine pain symptoms from the neck, upper back, lower back, shoulders, wrist or hands, hips or thighs, elbows, knees, to ankles or feet (Abdollahi et al., 2020). The nordic body map has 28 points to analyze body part complaints for identified complaints in 4 levels (Suryoputro et al., 2018). Levels of complaint consist of no, mild, moderate, and severe pain (Sombatsawat et al., 2019). The advantage of this method is analyzing pain in any part of the body, from the upper limbs to the lower limbs. The weakness of this method is that workers only provide complaints of pain based on the approximate assessment of pain in the questionnaire. This method implies that there is no significant improvement if the pain is known in a part of the body. There needs to be a clear solution when the pain is known. However, if it has recovered, workers can do their activities better. The limitation of this method is that it is only used in individual posture analysis by collecting manual data on interviews.

2.3. Rapid Entire Body Assessment (REBA)

REBA (Rapid Entire Body Assessment) is a method used to assess working posture. On the work posture method analysis, OWAS inspired complex methods like REBA because these methods can be used in observations to examine hazard scores in activities (Wilhelm et al., 2020). Also, the SMED model used REBA for posture because the SMED model can apply ergonomics in a systematic, structured, and detailed (Afonso et al., 2022). Thus, the REBA is one of the methods used to assess working posture. REBA assessment is carried out on the posture of the neck, trunk, and leg (score A), the posture of the upper arm, lower arm, and wrist (score B), and score C (score A + score B) (Andriani et al., 2021). The REBA method analyzes the working posture and risk value of the working posture. The level of risk is obtained after the total score is calculated. The total score is obtained based on assessing the working posture image (Thamrin et al., 2021b). REBA is adopted to analyze the postural effect during handling load by body parts, evaluate activity by static and dynamic position, evaluate body parts neck, trunk, upper & lower body parts, and determine the level of risk injury (Haekal et al., 2020). The Rapid Entire Body Assessment has the main advantage and limitations in its method. The main advantage is easy to collect data manually or with a computer, identifies each part body in a conflictive ergonomic aspect, and is effective for the cost (Hita-Gutiérrez et al., 2020). The main limitation of the method is that it can only be adopted by task evaluation body parts, analyzed for individual postures, and only analyzed effort (Hita-Gutiérrez et al., 2020). The REBA method has weaknesses in the analysis of body parts. Analyzed data of the body parts are only seen from the large parts of the body, not including the sidelines of the body. This method implies that workers can move with a more effective and comfortable posture if it has healed. The limitation of this method is that it is only used in the analysis of individual postures and only in dynamic movements.

2.4. Manual Handling Assessment Chart (MAC Tool)

MAC is a method used to reduce the risk of injury to the job. Manual handling assessment can be done using MAC because it can assess the risk of injury and eliminate or reduce the risk of injury (Okunribido & Gingell, 2014). MAC Tool can analyze the risk of injury to manual handling. MAC Tool is one method for determining lift and carry activities. A score of MAC consists of levels. Level 1 is no action demanded if the score is 0-4, level 2 is action demanded in the near future if the score is 5-12, level 3 is action demanded shortly if the score is 13-20, and level 4 is action demanded immediately if score reaching 21-31 (Jari et al., 2022). The stages of evaluating manual material handling are identifying the type of operation like lifting, carrying, or team handling, categorizing score variables, recapping the total score, and determining the total score based on the level of risk (Munawir, 2020). The advantages of this method are

analyzing activities that affect performance, analyzing environmental factors that can affect performance, and this method effectively minimizing costs. The weakness of this method is that the analysis is only carried out from an observer's point of view, and the results of the method are obtained from one decision at a time, even though the job position applied to workers may change at any time. This method implies that if the pain has recovered, workers can move around with the help of material-handling tools to make their work more efficient. The limitation of this method is that it only evaluates work to lift and carry goods.

3. METHODS

3.1. Job description

This research was an observation about workers transporting sacks in the traditional market. A worker is a person who transports sacks with manual handling work every day. In a traditional market, the worker has a job transporting sacks of vegetables, meat, flour, snack, and other ingredients. The sack weight is 8-17 kg. An example of manual handling is when workers use body parts like shoulder, back, and arms to lift and carry sacks from a truck to the traditional market with no auxiliaries to help transport sacks. Every worker is always in a bent position and upright position when lifting and carrying sacks. Worker body posture always changes from lifting and carrying sacks in 1-2 hours over long distances.

3.2 Method assessment

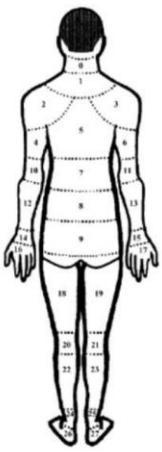
The methods used to identify musculoskeletal disorders in work posture are NBM, REBA, and MAC Tool. These methods are combined into interrelated methods for solving the problem of musculoskeletal disorders. NBM is used to identify work posture complaints shown in Figure 1. In Figure 2, NBM is determined based on the level of complaints felt by workers. The complaint level category is 0 (no pain), 1 (mild pain), 2 (moderate pain), and 3 (severe pain). The anthropometric data of worker 1 are 46 years old, with a height of 175 cm and a weight of 78 kg, and worker 2 is 42 years old, with a height of 166 cm and a weight of 73 kg.

Workers transport sacks by using the body part to lift and carry sacks with dynamic movement, so the analysis of working posture using the Rapid Entire Body Assessment method. The Rapid Entire Body assessment score level category is 1 (negligible risk), 2 or 3 (low risk), 4 to 7 (medium risk), 8 to 10 (high risk), and 11+ (very high risk). The work position of the worker can be seen in Figure 3, and the result of REBA can be seen in Table 1.

The results of the Rapid Entire Body Assessment on worker 1 are right side 9 and left side 8. While the results on worker 2 are right side 8 and left side 7.

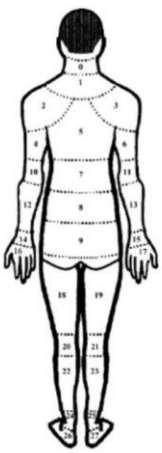
The similarity between REBA and NBM methods is the same pain value in the neck, trunk, legs, upper arm, lower arm, and wrist. Comparison using the highest

WORKER 1



No	Location	Grade of complaints			
		A	B	C	D
0	Pain/stiff in the upper neck	√			
1	Pain in the lower neck	√			
2	Pain in the left shoulder		√		
3	Pain in the right shoulder		√		
4	Pain in the left upper arm		√		
5	Pain in the back			√	
6	Pain in the right upper arm		√		
7	Pain in the waist				√
8	Pain in the buttock				√
9	Pain in the bottom		√		
10	Pain in the left elbow		√		
11	Pain in the right elbow		√		
12	Pain in the left lower arm			√	
13	Pain in the right lower arm			√	
14	Pain in the left wrist		√		
15	Pain in the right wrist		√		
16	Pain in the left hand		√		
17	Pain in the right hand		√		
18	Pain in the left thigh		√		
19	Pain in the right thigh			√	
20	Pain in the left knee	√			
21	Pain in the right knee		√		
22	Pain in the left calf		√		
23	Pain in the right calf			√	
24	Pain in the left ankle		√		
25	Pain in the right ankle		√		
26	Pain in the left foot		√		
27	Pain in the right foot		√		

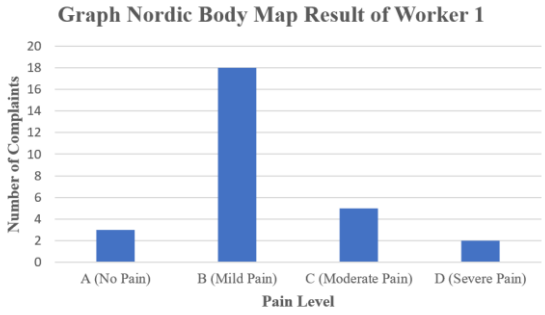
WORKER 2

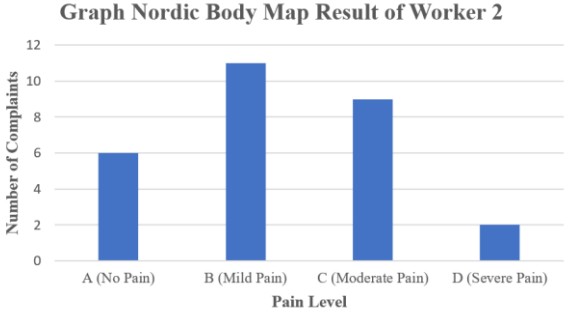


No	Location	Grade of complaints			
		A	B	C	D
0	Pain/stiff in the upper neck		√		
1	Pain in the lower neck			√	
2	Pain in the left shoulder				√
3	Pain in the right shoulder				√
4	Pain in the left upper arm			√	
5	Pain in the back		√		
6	Pain in the right upper arm			√	
7	Pain in the waist		√		
8	Pain in the buttock		√		
9	Pain in the bottom		√		
10	Pain in the left elbow			√	
11	Pain in the right elbow			√	
12	Pain in the left lower arm			√	
13	Pain in the right lower arm			√	
14	Pain in the left wrist		√		
15	Pain in the right wrist		√		
16	Pain in the left hand	√			
17	Pain in the right hand	√			
18	Pain in the left thigh	√			
19	Pain in the right thigh	√			
20	Pain in the left knee		√		
21	Pain in the right knee		√		
22	Pain in the left calf			√	
23	Pain in the right calf			√	
24	Pain in the left ankle	√			
25	Pain in the right ankle	√			
26	Pain in the left foot		√		
27	Pain in the right foot		√		

(a) (b)

Figure 1. Nordic Body Map Questionnaire Worker 1 (a) and Worker 2 (b)





(a) (b)

Figure 2. Result Nordic Body Map Questionnaire Worker 1 (a) and Worker 2 (b)

Figure 3. Work Posture Worker 1 (a) and Worker 2 (b)

Table 1. Result REBA Data

Activity Elements	Worker 1		Worker 2	
	Score REBA (Right Side)	Score REBA (Left Side)	Score REBA (Right Side)	Score REBA (Left Side)
Neck	2	2	1	1
Trunk	3	3	2	2
Legs	4	3	1	1
Total A	7	6	2	2
Add Force/Load Score	2	2	1	1
Score A	9	8	3	3
Upper Arm	2	2	4	4
Lower Arm	1	2	2	2
Wrist	1	1	2	1
Total B	1	2	6	5
Coupling	1	1	2	2
Score B	2	3	8	7
Score C	9	8	7	6
Activity	0	0	1	1
Final Score	9	8	8	7

REBA and NBM score is taken as summarized in Table 2.

Based on the combination of both methods, it can be concluded that:

a. Neck has a mild pain category,
b. The trunk has a severe pain category,
c. Legs have a severe pain category,
d. The upper arm has a severe pain category,
e. The lower arm has a moderate pain category,
f. The wrist has a moderate pain category.

The Manual Handling Assessment Cart method is used for workers who lift and carry transport bags. The lift and carry work process is carried out individually by each worker. The Manual Handling Assessment Chart method has color codes G, A, R, P and numerical scores. Final score level categories are 0 to 4 (no action demanded), 5 to 12 (action demanded in the near future), 13 to 20 (action demanded shortly), and 21 to 31 (action demanded immediately). The Result MAC tool can be seen in Table 3 and Table 4.

The results of the MAC Tool on worker 1 lift 12, carry 13, and worker 2 lifts 8, carry 12. The final score of worker 1 is 25, and worker 2 is 20.

The similarity between REBA, NBM, and MAC Tool methods is the same pain value in the neck, trunk, legs, upper arm, lower arm, and wrist. In comparison to the lift & carry MAC Tool, the highest REBA, and NBM scores can be seen in Table 5.

Based on the combination of methods, it can be concluded that:

a. MAC Tool method produces the conclusion of action demanded shortly, and action demanded immediately.
b. However, when workers lift and carry, the REBA method produces very high-risk conclusions and needs to implement change.
c. NBM method also produces an average value of severe pain when workers lift and carry.

Based on this statement, change must be implemented to reduce risk.

Table 2. Comparison of REBA and NBM Result

Activity Elements	REBA		NBM	
	Worker 1	Worker 2	Worker 1	Worker 2
Neck	2	1	0	1
Trunk	3	2	3	1
Legs	4	1	2	2
Upper Arm	2	4	1	2
Lower Arm	1	2	2	2
Wrist	1	2	1	1

Table 3. Result MAC Tool Data Worker 1

Lift & Carry				
Risk Factors	Color Code		Numerical Score	
	Lift	Carry	Lift	Carry
Load weight	A	A	4	4
Hand distance from the lower back	A	A	3	3
Vertical lift region	A		1	
Torso twisting/sideways bending & Asymmetrical torso/load	A	A	1	1
Postural constraints	G	G	0	0
The grip on the load	R	R	2	2
Floor surface	A	A	1	1
Other environmental factors	G	G	0	0
Carry distance		R		2
Obstacles on route		G		0
Communication, coordination, and control				
Final Score	1R5A2G	2R4A3G	12	13

Table 4. Result MAC Tool Data Worker 2

Lift & Carry				
Risk Factors	Color Code		Numerical Score	
	Lift	Carry	Lift	Carry
Load weight	G	G	0	0
Hand distance from the lower back	A	R	3	6
Vertical lift region	A		1	
Torso twisting/sideways bending & Asymmetrical torso/load	A	A	1	1
Postural constraints	G	G	0	0
The grip on the load	R	R	2	2
Floor surface	A	A	1	1
Other environmental factors	G	G	0	0
Carry distance		R		2
Obstacles on route		G		0
Communication, coordination, and control				
Final Score	1R4A3G	3R2A4G	8	12

Table 5. Comparison of MAC Tool, REBA, and NBM Result

Risk Factors	**MAC Tool**				**REBA**		**NBM**	
	Lift	**Carry**	**Lift**	**Carry**				
	Worker 1		**Worker 2**		**Worker 1**	**Worker 2**	**Worker 1**	**Worker 2**
Load weight same as add force/load score	4	4	0	0	2	1		
Hand distance from the lower back used in lower arm + legs	3	3	3	6	1+4	2+1	2+2	2+2
Vertical lift region used in upper arm + trunk	1		1		2+3	4+2	1+3	2+1
Torso twisting/sideways bending & asymmetrical torso/load used in wrist + neck	1	1	1	1	1+2	2+1	1+0	1+1
Postural constraints are the same as the activity score	0	0	0	0	0	1		
The grip on the load is the same as add coupling score	2	2	2	2	1	2		
Floor surface	1	1	1	1				
Other environmental factors	0	0	0	0				
Carry distance		2		2				
Obstacles on route		0		0				
Communication, coordination, and control								
Final Score	12	13	8	12	16	16	9	9

4. RESULTS AND DISCUSSION

4.1. Problems obtained

Based on the Nordic Body Map score, it can be seen that worker 1 has categorized severe pain in the waist, and buttocks and moderate pain in the back, left lower arm, right lower arm, right thigh, and right calf. Worker 2 there are categorized as having severe pain in the left shoulder and right shoulder and moderate pain in the lower neck, left upper arm, right upper arm, left elbow, right elbow, left lower arm, right lower arm, left calf, and right calf. Based on the Rapid Entire Body Assessment (REBA) Assessment, it can be seen that worker 1 has the highest score of 9 and worker 2 have the highest score of 8. These scores are categorized as high risk. Workers whom transport sacks have problems with work posture, which is caused by several factors such as painful posture, handling heavy loads, and repetitive movement of a body part. Based on the Manual Handling Assessment Chart (MAC Tool) Assessment, it can be seen that worker 1 has a final score of 25, and worker 2 has a final score of 20. The most influencing factors in the final score are on carrying work method.

4.2. Solutions based on Rapid Entire Body Assessment (REBA) method

The results assessment of the Rapid Entire Body Assessment method of worker transport sacks has a high-risk category. Worker 1 and worker 2 have the highest scores on the right side. The explanation is that worker 1 has activity elements in total A column has neck, trunks, and legs in a bent position, load sacks have >22 lbs, and total B column has the upper arm, lower arm, and wrist in a bent position; the coupling is acceptable but not ideal hand hold or coupling and has final score 9. Worker 2 has activity elements in total. A column has neck, trunks, and legs in an upright position, load sacks have 11 to 22 lbs, total B column has the upper arm, lower arm, and wrist in the raised position, the coupling is hand hold not acceptable but possible, activity is repeated small range actions more than 4x per minute and have final score 8. It is necessary to investigate and implement change. The solution is to add a skid box use to improve work posture. The results of work posture after the use skid box can be seen in Figure 4.

Based on work posture improvement, the final Rapid Entire Body Assessment score is 4. Results of

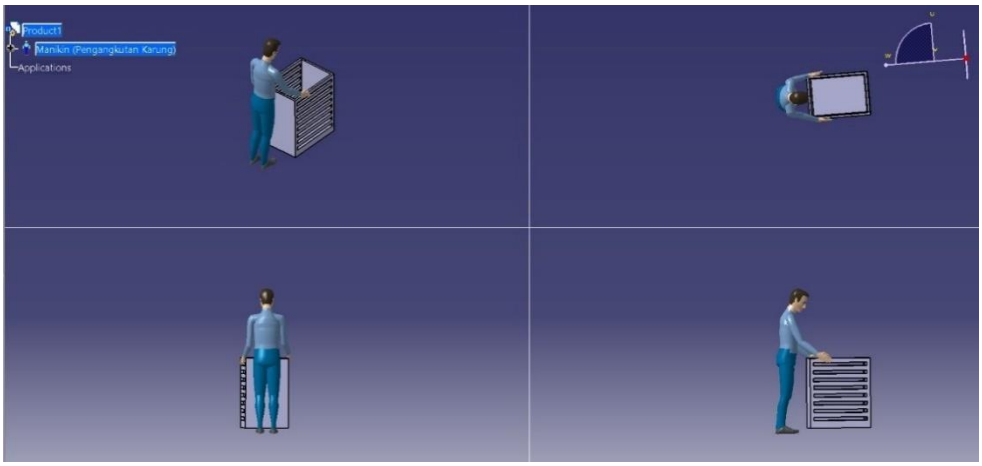


Figure 4. Work Posture Improvement

Figure 5. Manual Handling Improvement

improvement in worker transport sacks have a medium-risk category. There is a significant decrease in the REBA score of worker 1 in the legs and worker 2 in the upper arm. Improvement in work posture can make changes to body part angle and good work position.

4.3. Solutions based on Manual Handling Assessment Chart (MAC Tool) method

The results Manual Handling Assessment Chart of worker 1 have a total score of 25, and worker 2 has a total score of 20. Based on MAC assessment, factors that affect risk are load weight, hand distance from the lower back, grip on the load, and carry distance. The result was the same factors as those of (Yusof et al., 2020) research that the risk factors of manual handling are influenced by load weight, hand distance from the lower back, and grip on the load. The final score should be minimalized to increase productivity. The solution is adding material handling; a hand trolley cart can be used to improve manual handling. The results of manual handling after using the hand trolley cart can be seen in Figure 5.

Based on manual handling improvement, the score obtained is 11. There is a significant decrease in risk factors, especially in carrying weight load, hand distance from the lower back, torso twisting/load carry, and grip on the bag, especially on the carrying method. The improvement score has an action demanded in a near-future category. The process of carrying sacks using a hand trolley cart is considered more effective than carrying sacks with a manual process because the use hand trolley cart can load at least 2 sacks so that workers do not have an excessive load when carrying the sacks. The hand trolley cart design is created based on workers complaining about musculoskeletal disorders who feel pain in the waist, buttock, left shoulder, and right shoulder. This is the most effective solution to the problem.

4.4. Limitations

The limitation in this paper that can be addressed is that the model evaluation is the only one used to evaluate work posture. The result needs more subjects for transport sacks. In addition, the skid box and hand trolley cart model do not provide size suggestions and only provides recommendations of auxiliaries, models, and simulations when using auxiliaries.

5. CONCLUSION

The conclusions obtained from this research are:

1. Evaluation work posture for worker transport sacks has 4 scores of REBA (medium risk), and manual handling has seven scores of MAC Tool (action demanded in the near future.
2. The best recommendation is to add a skid box to reduce work pain and provide a hand trolley cart to increase productivity.
3. In future research, it is expected that this research can generate the size of auxiliaries using the ergonomics concept to find better work posture improvement.

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