

Design Of Portable Lawn Mower Using Rapid Entire Body Assessment (Reba) Method

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ABSTRACT

To facilitate their activities, humans will create or design tools to help their activities. Design is the process of manifesting initiatives carried out based on supporting basic theories. The process can be carried out through the stages of selecting components, understanding characteristics and physical, then making a conceptual series according to the selected components so that the tool can be made as expected. The process of mowing the grass commonly carried out by the community is using a machine that is shouldered which is a machine that uses fuel oil, for a long time workers will feel fatigue in the back and especially in the shoulders. The method that will be used in this research is REBA (Rapid Entire Body Assessment), the REBA method is a method used to measure and analyse the posture of workers. From the results of the analysis of work positions and through the Nordic Body Map questionnaire with the REBA method that has been assessed, a score is obtained which is used for consideration of work posture improvement.

Keywords: Design, Rapid Entire Body Assessment, Ergonomics, Nordic Body Map, Workposture

Introduction

To facilitate their activities, humans will create or design tools to help their activities. Design is the process of manifesting initiatives that are carried out based on basic theories that support the design.[1]–[6] The design of the tool must be adjusted to the dimensions of the body of the worker or user, this must be done because if the tool is used repeatedly, if the tool does not match the dimensions of the user's body, it will cause complaints and fatigue.[7]

The grass cutting process commonly carried out by the community is using a shouldered machine which is a machine that uses fuel oil, for a long time workers will feel fatigue in the back, especially in the shoulders. Shoulders that bear a heavy enough load will cause the effect of injury in the long term. Work postures that have moderate to high risk require improvement so as to reduce the risk of fatigue.[8] Designing a new tool with the NordicBody Map questionnaire results in a tool that is more comfortable to use, which will increase work efficiency.[9] The *NordicBody Map* is used for the measurement of worker fatigue and to take some samples of complaints from previous tools from several workers considering the source of anthropometric variability as in the research.[10]

Fatigue in the shoulder or in the shoulder muscles is called Musculoskeletal disorders. Musculoskeletal disorders are complaints in the parts of the skeleton that are felt by someone starting from very light to very painful complaints, this causes the need for education for workers on the comfort of work positions.[11] Musculoskeletal disorders are not a clinical diagnosis, but rather pain due to uncomfortable or unergonomic working positions.[12] Conditions when doing work are recommended to be in a reliable condition or in an ergonomic position. Reliable conditions without muscle fatigue can contribute to the formation of safe, comfortable, healthy and productive work.[13]

The method that will be used in this research is REBA (Rapid EntireBody Assessment), the REBA method is a method used to measure and analyse the posture of workers. From the results of the analysis of work postures with the REBA method that has been assessed, a score is obtained which is used for consideration of work posture improvement.[14]

Research Methods

Literature Study and Observation

The first stage for this research is to collect literature references both primary and secondary. After collecting references, data processing is carried out then abstracted and make conclusions.[15] Field data collection is also carried out

to find out directly the complaints experienced by users and to support research.[16] Data taken in the form of anthropometric data and data from questionnaires.

Location and Object of Research

The research location was carried out on users / workers of the Pati Regency Public Works Office (Cluwak, Tayu areas), users of lawn mowers on plantations that reach the villagers' houses, Semarang City Park Cleaners, Unisbank Kendeng Campus Housekeeping Officers.

Population and Sample

A sample of 30 users of conventional tools or lawn mowers with an age range of 20 to 60 years and using simple random sampling and univariate analysis to determine the frequency distribution of subject characteristics including age, pain intensity, body position score, and length of work.[17] Samples were taken through the Nordic Body Map questionnaire to subjectively determine the muscle fatigue felt by users or workers.[18]

Ergonomics

Ergonomics is the science of designing work that pays attention to human aspects to improve physical and mental well-being to get a better work system..[19]

Nordic Body Map

The Nordic Body Map is a questionnaire-based method that is most often used to detail body parts that experience pain or fatigue..[20] Nordic Body Map can be said to be a simple ergonomic measurement tool. [21]

Anthropometri

Anthropometry is data concerning the measurement of the dimensions of the human body. [22] This data is used for data processing at the analysis stage with the REBA method.

REBA (Rapid Entire Body Assesment)

The Reba method is a method that can effectively reduce fatigue in workers by analysing all parts of the oekerha's body with a focus on overall posture. sulaimanThis method is suitable for analysing work positions that involve all parts of the body.[23] Measurements are made with a sample of workers who are physically and psychologically healthy in order to get the right decision to reduce the probability of worker risk.[24] This REBA method is detailed in its complaint analysis compared to the OWAS (Ovako Work Analysis System) method.[25]

Data Management

Test for Data Uniformity

To do this test, the following formula is used:

- Determine the total amount of data (Σx)
- Determine the true average with the formula :

$$\bar{X} = \frac{\Sigma Xi}{N}$$

- Determine the Standard Deviation with the formula:

$$\sigma = \sqrt{\frac{\Sigma (Xi - \bar{X})^2}{N - 1}}$$

Information :

- Xi = the i-th data
- N = amount of data
- Z = the confidence level constant
- x = average score
- σ = the standard deviation

Data Coverage Test

This data processing aims to test whether the data collected is sufficient or still lacking, if the amount of data is still insufficient then additional data observations will be made.[26] The data and number of measurements in the data sufficiency test are uniform data and measurements, with the formula :

$$N' = \left[\frac{\frac{k}{s} \sqrt{N \sum_{j=1}^n X_j - (\sum_{j=1}^n X_j)^2}}{\sum_{j=1}^n X_j} \right]^2$$

Where,

- k = trust level
- s = level of accuracy
- X_i = data values in the measurement
- N' = Number of measurements required
- N = Number of measurements

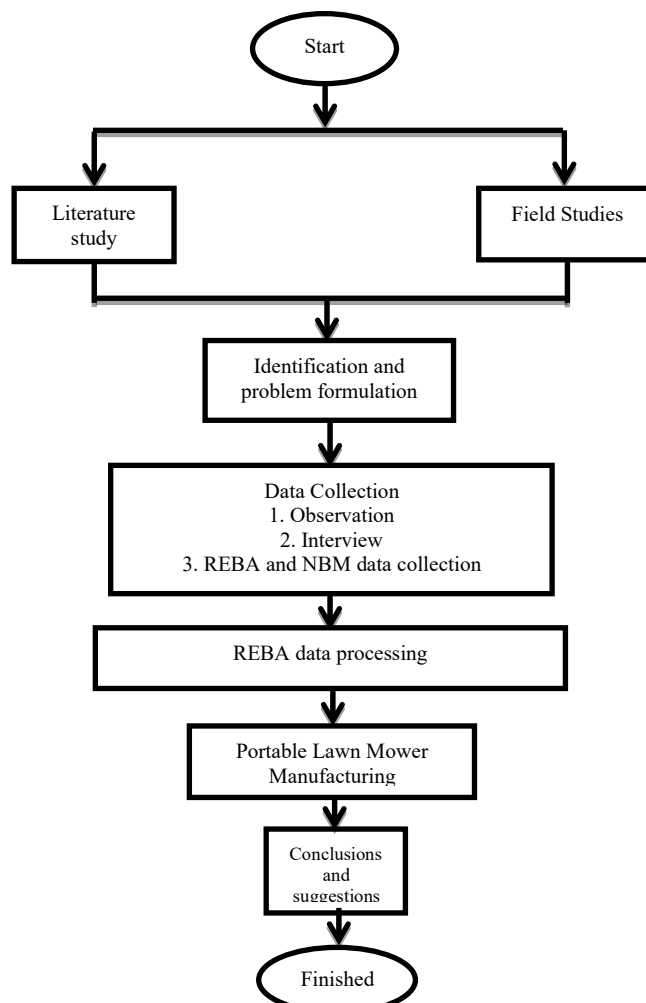
Percentile

percentile is a point or score that divides the entire frequency distribution into one hundred equal parts.[27]

Table 1. Percentiles

Percentile	Calculations	Percentile	Calculations	Percentile	Calculations
1	$\bar{x} - 2,325 \times \sigma$			90	$\bar{x} + 1,280 \times \sigma$
2,5	$\bar{x} - 1,960 \times \sigma$	50	\bar{x}	95	$\bar{x} + 1,645 \times \sigma$
5	$\bar{x} - 1,645 \times \sigma$			97,5	$\bar{x} + 1,960 \times \sigma$
10	$\bar{x} - 1,280 \times \sigma$			99	$\bar{x} + 2,325 \times \sigma$

Research Flowchart



Picture 1. Flowchart of Research

Results and Discussions

Nordic Body Map Questionnaire

Based on the processing of questionnaire data conducted through direct interviews to tool users, the biggest complaints are found in the shoulders, back with a percentage of 100%, a little pain in the left hand (wrist) and the effect of the load on the back that causes fatigue on the legs. The questionnaire is the basis for taking immediate corrective action to reduce pain in workers / users.

Table 2. *Nordic Body Map* Questionnaire Results

Skeletal Muscle	TS		SS		S		SS	
	JML	%	JML	%	JML	%	JML	%
0 top of the neck	11	37%	19	63%				
1 lower neck	19	63%	11	37%				
2 left shoulder			0		30	100%		
3 right shoulder			0		30	100%		
4 left upper arm			5	17%	25	83%		
5 back			0		30	100%		
6 right upper arm			5	17%	25	83%		
7 waist			0		30	100%		
8 left forearm	18	70%	11	37%	1	3%		
10 Right forearm	21	70%	9	30%				
11 left wrist	8	27%	19	63%	3	10%		
12 right wrist	17	57%	13	43%				
13 left hand	10	33%	18	60%	2	7%		
14 right hand	18	60%	12	40%				
15 left knee	19	63%	11	37%				
16 right knee	19	63%	11	37%				

Worker Anthropometry

Anthropometric data can help to reduce musculoskeletal complaints because this data includes the most important fatigue felt by users.[28] The data taken is related to the human physique, size and shape, and from this data can be utilised to produce the mean, standard deviation of a sample taken.[29] The anthropometric data below is taken from 30 users or workers through interviews, taking pictures and observations :

Table 3. User / worker Anthropometry Data

No.	Name	Gender	TP	JTD	DGT
1	Soleh	L	95	62	3,5
2	Agus	L	96	64	3,5
3	Supri	L	88	68	3
4	Gunawan	L	94	70	3,5
5	Yanto	L	91	72	3
6	Kasrin	L	93	69	3
7	Anwar	L	95	68	2,5
8	Harto	L	89	69	3
9	Wawan	L	90	67	3,5
10	Kasim	L	98	67	3,5
11	Kasan	L	96	68	3
12	Agus Kacak	L	95	65	3
13	Agus BKK	L	97	65	3
14	Lasdi	L	91	68	3,5
15	Warsudi	L	90	71	3,5
16	Sancoko	L	91	70	3,5
17	Ubed	L	92	72	3
18	Tarmi	P	95	67	3
19	Dadi	L	96	70	3
20	Lasmi	P	95	64	3
21	Kus	L	92	66	3

22	Heri	L	89	64	3	
23	Jan	L	90	67	3,5	
24	Nahrowi	L	96	70	3,5	
25	Ali	L	91	69	3	
26	Fuad	L	87	70	3,5	
27	Wahyu	L	97	69	3	
28	Tukiran	L	94	68	3,5	
29	Rozi	L	93	69	3,5	
30	Fahmi	L	98	65	3,5	
			Σx	2794	2033	96,5
			$\Sigma \bar{x}$	93,13	67,76	3,216
			Standart Deviation	3,09319	2,441029	0,25371
			UCL	99,32	72,68	3,740
			LVL	86,95	62,9179	2,725
			Percentile 50	93,1333	67,800	3,2333
			Percentile 95	293,16729	169,517259	1,237597
			Percentile 5	282,980487	161,486273	0,4029675

Information :

- TP = Tinggi Pinggul (Hip Height)
- JTD = Jangkauan Tangan ke Depan (Forward Hand Reach)
- DGT = Dimensi Genggaman Tangan (Hand Grip Dimension)

Analysis with REBA Method

Analysis of several parts of the body that experience fatigue will then be added to the coupling factor, the load carried, and the type of work activity. [30] Based on the results obtained after data processing on conventional lawn mower users, the body score for group A Back trunk, Neck, Legs has a score of 2 then added with a workload of 5kg which gets a score of 1, so the total score of group A is 3. Then for group B scores (Upper Arm, Lower Arm, Wrist) has a score of 3 and is summed up with a coupling poor score of 2, the total score of group B is 5. Then combining the group A score and group B score, the risk level in group C is obtained in the risk assessment of conventional lawn mower users who have a REBA score of 4 coupled with an activity score of 1, the total score of group C is 5. This indicates a medium risk level and action level 2 which means that it is necessary to immediately improve work posture.

Table 4. Group C Score before REBA Analysis

		Score A											
		1	2	③	4	5	6	7	8	9	10	11	12
Score B	1	1	1	2	3	4	6	7	8	9	10	11	12
	2	1	2	3	4	4	6	7	8	9	10	11	12
	3	1	2	3	4	4	6	7	8	9	10	11	12
	4	2	3	3	4	5	7	8	9	10	11	11	12
	⑤	3	→	④	5	6	8	9	10	10	11	12	12
	6	3	4	5	6	7	8	9	10	10	11	12	12
	7	4	5	6	7	8	9	9	10	11	11	12	12
	8	5	6	7	8	8	9	10	10	11	12	12	12
	9	6	6	7	8	9	10	10	10	11	12	12	12
	10	7	7	8	9	9	10	11	11	12	12	12	12
	11	7	7	8	9	9	10	11	11	12	12	12	12
	12	7	8	8	9	9	10	11	11	12	12	12	12

Tool design and Analysis after handing with REBA method

After data processing, the tool design was obtained by eliminating the burden on the back and adding wheels to the new tool. In this study, the size of the tool to be made uses the 5th percentile and 50th percentile. Taking the 50th percentile so that the size is not too large and too small, while the 5th percentile is so that the

smallest population can use the tool comfortably. Then the driving machine uses a dynamo that uses electrical energy to participate in reducing air pollution

Table 5.Tool size

No.	Part Name	Size
1.	Tool Height	107 cm
2.	Tool Length	40 cm
3.	Length of Knife Axle to Pulley	22 cm
4.	Tool Width	37cm
5.	Distance of Large Pulley Axle and Small Pulley	27 cm



Picture 2. Tool Design

Based on the results obtained after data processing after tool design and work posture improvement, the body score for group A (Trunk, Neck, Legs) has a score of 1, then added with a workload of 0, which is a score of 0, so the total score of group A is 1. Then for group B scores (Upper Arm, Lower Arm, Wrist) have a score of 2 and are summed up with a couplingfairs score of 1, the total score of group B is 3. Then for the group B score (Upper Arm, Lower Arm, Wrist) has a score of 2 and is summed up with a couplingfairs score of 1, the total score of group B is 3. Then combining the group A score and group B score, the risk level in group C is obtained in the user risk assessment on the Portable Lawn Mower Design has a REBA score of 1 coupled with an activity score of 1, the total score of group C is 2.

Table 5. Group C Score after REBA Analysis

		Score A											
		①	2	3	4	5	6	7	8	9	10	11	12
Score B	1	1	2	3	4	5	6	7	8	9	10	11	12
	2	2	3	4	4	6	7	8	9	10	11	12	12
	③ → ①	2	3	4	4	6	7	8	9	10	11	12	12
	4	2	3	3	4	5	7	8	9	10	11	12	12
	5	3	4	4	5	6	8	9	10	10	11	12	12
	6	3	4	5	6	7	8	9	10	10	11	12	12
	7	4	5	6	7	8	9	9	10	11	11	12	12
	8	5	6	7	8	8	9	10	10	11	12	12	12
	9	6	6	7	8	9	10	10	10	11	12	12	12
	10	7	7	8	9	9	10	11	11	12	12	12	12
	11	7	7	8	9	9	10	11	11	12	12	12	12
	12	7	8	8	9	9	10	11	11	12	12	12	12

Table 6. REBA risk table



Action Level	REBA Score	Risk Level	corrective action
0	1	can be ignored	not necessary
1	2-3	Low	It may be necessary

2	4-7	Medium	necessary
3	8-10	High	need to immediately
4	11-15	Very High	necessary right now

The action level after designing the tool becomes 1 and the risk level becomes 2, which means that the workload on the user has been significantly reduced and an ergonomic work posture is obtained.

Comparison of tool design before and after with the REBA method

Table 6. Tool Comparison

Before				After			
Final Score	Action Level	Risk Level	Action	Final Score	Action Level	Risk Level	Action
5	2	Necessary	Medium	2	1	Low	It may be necessary
							

From the table above before the improvement is made, the REBA Score is 5 which means that immediate action needs to be taken to improve work posture because the load on the back which also affects the shoulder muscles causes fatigue (Musculoskeletal disorders (MSDs)) which is quite serious for users. After improvements were made, the REBA score became 2 which means the risk of fatigue decreased. This is due to the removal of the load on the back and the addition of wheels that can facilitate user work.

Conclusion

The conclusion of the research that has been done is that the portable lawn mower can reduce fatigue based on analysis after the design of the tool on users who previously had a high level of risk of work becoming a low level of risk of work, because the burden on the back has been eliminated and also adjustments to the size of the tool through the data processing above. The use of the REBA method is effective for analysing fatigue in workers.

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