
IEEE
2016 International Conference
on Industrial Engineering and
Engineering Management
IEEM2016
4-7 DECEMBER 2016
BALI, INDONESIA
www.IEEM.org

IEEE Catalog Number: CFP16IEI-ART
ISBN: 978-1-5090-3665-3

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Poster

Redesign of Thresher Machine for Farmers Using Rapid Upper Limb Assessment (RULA) Method

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Abstract – **The use of thresher machines for threshing rice plants helped farmers in improving agricultural productivity. However, thresher machine design that is currently available has not fairly concerned on the working position and posture of the farmers using it. The working position that was modeled by farmers when operating a thresher machine tent to cause injury because of the dimensions of the engine and the body of farmers that did not conform to each other. RULA method was one of the methods that could analyze work postures. From the results of the data collection and the process using RULA method, it was clear that the measures that had to be taken to the thresher machines which used to be available were promptly modified in order to avoid musculoskeletal problem. Improvements that could be undertaken to avoid the musculoskeletal problem on farmers who used the thresher machine were redesigning the thresher machine based on farmers working posture. One of these ways was by adjusting the dimensions of the farmers' body with the dimensions of the machine. In addition, the use of adjustable concept in the design could probably assist the farmers adjust the working position with the machinery they used.**

Keywords: **Design, Musculoskeletal, Thresher Machines, RULA method**

I. INTRODUCTION

The advent of several kinds of machinery and technology in assisting farmers to manage crops would be fairly useful in balancing the inhabitants' growth rate by the existing crops. One of the examples was thresher machine used by farmers to thresh rice plant. The use of thresher machine in defoliating the rice plants remarkably assisted the farmers in elevating agricultural productivity. In terms of time, the use of thresher machine was faster than using traditional method. Apart from that, in terms of energy released, the traditional method demanded greater energy to separate the rice from the straw. It was found that from the preliminary study conducted in which cardiovascular load (% CVL) spent by the farmers using traditional method was much greater that using thresher machine.

It could possibly happen due to the fact that the amount of energy used by farmers when defoliating the rice from the straw. The working position modeled by the farmers was prone to cause injury since they had to bend down ample of times to plum the rice down traditionally. It can be seen in the Figure 1. Figure 1 shows the farmers positions operating the thresher machine. However, according to Figure 1 it can be seen that the farmers position when operating the thresher machine was prone to cause musculoskeletal disorder (MSD) problem.

Fig 1 Thresher machine use

Musculoskeletal problem is a kind of ergonomics matter which is relatively found in a working place particularly relating to physical work that required power and endurance. This matter used to experience by workers commenced constant and continuous movements, and could automatically slow down the workers' productivity [1]. Chang et al. [2] revealed that working posture criteria is one of the common causes of MSD which consider from material or tool usage.

The farmers' work using thresher machine could also lead to musculoskeletal matter as the working positions were constant. Besides, the body's position while operating thresher machine was leaned and straightness when the body's position slightly bended down. It could be clearly seen because the farmers' back formed an angle, and did not stand straightly towards the thresher machine. Besides, the farmers' legs also did not straightly stand as the farmers needed to keep the balance the machine height towards the standing position while operating the machine. Once the farmers straightened the legs, they had to bend down to balance the machine position as well as the body's position.

The greatest complaint experienced by the farmers, which collected using Nordic Body Map questionnaire, was in their waists. From 30 samples observed, 24 of respondents said that there was a problem in their waists while operating the machine or even after operating the thresher machine. Other than that, there were also several

complaints felt by the respondents in one of their body part while operating the machine.

Working position evaluation in this study was conducted by using Rapid Upper Limb Assessment (RULA) method. RULA designed by McAtamney and Corlett (1993) [3] is a widely used tool designed for the investigation of the work posture. RULA was developed specifically to examine the level of risk associated with upper limb disorder of individual workers. It is used to investigate working postures at one instant in time by using a coding system of RULA [4]. This method used a diagram from body posture along with three score tables in determining the risk factor evaluation. The risk factors evaluated as the external load factors were a number of movement, statics body mass activity, power/energy, determining working posture by equipment and working period without taking a rest [3].

II. METHODOLOGY

The benefit of RULA is to provide a quick method for screening a variety of workstation and to give results that can be explained the conditions of work posture. There are some previous researchers using RULA method to evaluate the working posture of workers. Choobineh et al. [5] evaluated 72 menders in carpet mending workstation. They used RULA technique to calculate scores for the posture of body parts in the operation of the task pre- and post- intervention. The mending table with an attached seat was redesigned. Choobineh et al. [6] also used the result of RULA analysis to improve the design of hand-woven carpet workstation in Iranian carpet industry. Rahman et al. [7] conducted the research in a selected ceramic factory in Bangladesh. They used RULA method to analyze working posture of workers in the production section of the factory and their impact on labor productivity.

Data Collection and Analysis Procedure

Data have been collected through RULA worksheet. The observed work postures have been assessed in terms of RULA score and the various score have been compiled according to RULA worksheet in order to get RULA grand score. The RULA produces a score to demonstrate the risk level of posture. Low scores of 1 or 2 indicate that the working posture is accpetable. Further investigation and changes are required for grand scores 3 or 4; prompt investigation and changes for grand scores of 5 or 6 and immediate investigations and changes for a grand score of 7. Data collected was the data in form of pictures' of farmers working posture when operating thresher machine and the size of angle or segment which is formed once the farmers operating the machine. The picture of the farmers' working posture operating thresher machine was taken by using a camera. An angle then was drawn depicting farmer's body position while working and an angle size was counted afterward. The body part angles counted were upper arm, lower arm, wrist, wrist twist, neck, trunk, and legs. Apart from that, the data collected was the pictures of thresher machine concept designed by Bifadhlih [8] after which was used to test RULA value.

At first, the initial and final arm and wrist posture scores have been assessed in association with the initial and final neck, trunk and leg posture scores. The resultant scores have been evaluated and compiled together with the muscle use and muscle force or carrying load score in order to assess the RULA grand score.

III. RESULTS

The accumulation of the working postures by the RULA method commenced by the farmers operating Thresher machine was by separating the body segments into 2 group segments, namely Group A and Group B. Body posture group A consisted of upper arm, lower arm, wrist, and wrist twist. Whereas, body posture group B comprised of neck, trunk, and legs. Following that were measuring the size of angle formed by the farmers' body while operating the thresher machine, and adjusting the size of the angle formed by the value of RULA table. Table I until Table III shown the total numbers of scores of body segments a, b, and the total scores of RULA overall on 12 farmers and the result of the RULA simulation test on the design created by Bifadhlih [8].

Table I Recapitulation of RULA Accumulation Result for Every Body Segment of Group A

	Upper Arm	Lower Arm	Wrist	Wrist Twist	Group A Activity Score
Operator 1	3	1	3	2	5
Operator 2	3	2	3	2	4
Operator 3	2	1	3	2	3
Operator 4	3	1	3	2	4
Operator 5	1	1	3	2	3
Operator 6	2	2	2	2	3
Operator 7	3	1	3	2	4
Operator 8	2	1	3	2	3
Operator 9	2	1	2	2	3
Operator 10	2	1	3	2	3
Operator 11	2	1	3	2	3
Operator 12	3	1	3	2	4
Bifadhlih Design	3	1	3	2	4

Table II Recapitulation of RULA Accumulation Result for Every Body Segment of Group B

	Neck	Trunk	Legs	Group B Activity Score
Operator 1	3	3	2	5
Operator 2	2	2	2	3
Operator 3	3	3	2	5
Operator 4	2	2	2	3
Operator 5	3	3	2	5
Operator 6	3	2	2	4
Operator 7	3	3	2	5
Operator 8	3	2	2	4
Operator 9	3	2	2	4
Operator 10	3	2	2	4
Operator 11	3	2	2	4
Operator 12	3	3	2	5
Bifadhlih Design	3	3	1	4

Table III Recapitulation of RULA Risk Level

No	Operator	Age	Risk Level	Treatment
1	**Operator 1**	35 years	High	Treated now
2	**Operator 2**	18 years	Medium	Treated soon
3	**Operator 3**	40 years	Medium	Treated soon
4	**Operator 4**	38 years	Medium	Treated soon
5	**Operator 5**	45 years	Medium	Treated soon
6	**Operator 6**	49 years	Medium	Treated soon
7	**Operator 7**	47 years	High	Treated now
8	**Operator 8**	45 years	Medium	Treated soon
9	**Operator 9**	40 years	Medium	Treated soon
10	**Operator 10**	50 years	Medium	Treated soon
11	**Operator 11**	42 years	Medium	Treated now
12	**Operator 12**	50 years	High	Treated soon
13	**Bifadhlih Design**	-	Medium	Treated soon

RULA accumulation result above shows that a treatment was required to be undertaken to decrease RULA risk level to the farmers operating thresher machine. A treatment commenced was modifying the thresher machine in order to neutralize farmers' working position. Figure 2 until Figure 4 shown the redesign of thresher machine which can be executed.

Fig. 2 Thresher Machine

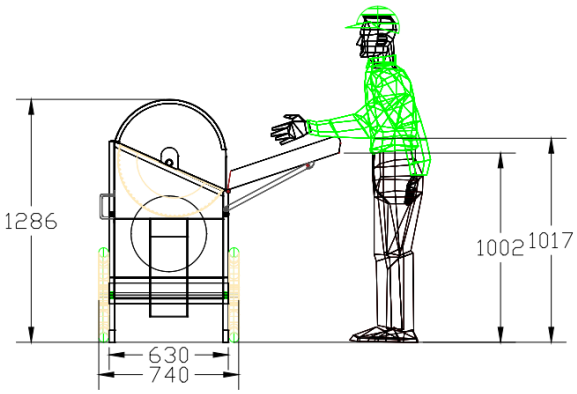

Fig. 3 Thresher Machine Side View

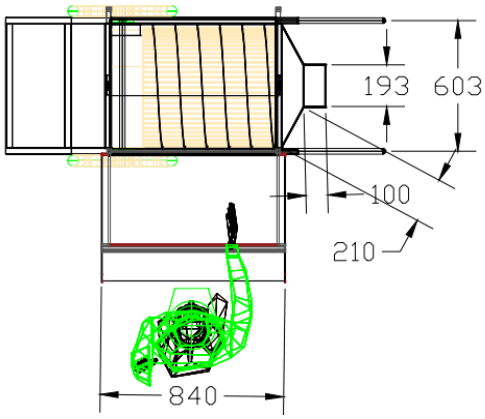

Fig. 4 Thresher Machine Top View

The RULA accumulation was subsequently applied to the redesigned of the thresher machine to find out whether the designed machine has showed lower RULA risk level compared to the previous ones. Table IV and Table V depict the recapitulation of RULA scores from the re-design machinery.

Table IV Total Score of Group A

Upper Arm	Lower Arm	Wrist							
		1		2		3		4	
		Wrist Twist		Wrist Twist		Wrist Twist		Wrist Twist	
		1	2	1	2	1	3	1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	2	3	3	3	4	4
2	1	2	2	2	3	3	3	4	4
	2	2	2	2	3	3	3	4	4
	3	2	2	3	3	3	3	5	5
3	1	2	3	3	3	4	4	5	5
	2	2	3	3	3	4	4	5	5
	3	2	3	3	4	4	4	5	5
4	1	3	4	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	3	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	7	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table V Total Score of Group B

Score Group A	Score Group B						
	1	2	3	4	5	6	7
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
.+8	5	5	6	7	7	7	7

Due to the fact that the operators undertook consecutive movements during work, the total score of group A and B were added to one score. Hence, the total score of group A and B were 4. It can be seen in Table VI and Table VII.

Table VI Total Score

Score Group A	Score Group B						
	1	2	3	4	5	6	7
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
.+8	5	5	6	7	7	7	7

Table VII Treatment Category

Category	Risk Level	Treatment
1-2	Minimum	Posture is acceptable if it is not maintained and repeated for long periods
3-4	Small	Further investigation is needed and change of posture may be required
5-6	Medium	Further investigation and changes are required soon
7	High	Investigate and changes are required now

RULA risk level category found was small. It caused the need for specific treatment towards the machine or operator's working position.

IV. ANALYSIS

A. An Analysis of Working Posture and RULA Value on Existing Thresher Machine

Based on the result of RULA method evaluation data processing on working posture for the farmers operating thresher machine was found that the risk level of the farmers was on the medium and high position. Both had distinctive treatments where the medium risk required to be treated immediately, and for the high risk required to be treated at current time. However, either medium risk level or high risk level basically needed to be treated as soon as possible in order that any injuries or musculoskeletal problem would not turn up. Musculoskeletal matter was a kind of ergonomic problem which was frequently encountered in a working place particularly with regards of human power and endurance in commencing their work. This matter was commonly experienced by workers who underwent almost exactly the same movements continuously and would likely lead the working productivity gradually dipped.

The risk level obtained was caused by farmers' working position which was prone to not ergonomic and the machine condition was incompatible to the farmers' working position. The angle created by the farmers' body while operating thresher machine tent to result higher RULA score; as the consequence, it caused bad impacts towards the farmers' body. The following Figure 5 shows inappropriate thresher machine placement.

Fig. 5 the Placement of the Thresher Machine

RULA value could be dropped by some ways one of which was the modification of the existing thresher machine. The improvement could be done through adjusting the machine dimension towards farmers' body dimension. By this improvement, it was expected that RULA value could be decreased; thus, it would not cause musculoskeletal problem to the framers using the machine. One of the examples of the thresher modification was adjusting the machine size with anthropometry of the farmers using it in order that the imbalance between machine dimension and farmers' body dimension could be avoided. Apart from the segment of group A, group B, and the machine position, the number of repetitions undertaken and the weight of the load lifted by the farmers also determined the total score of the RULA value. As a lot of the repetitions/activities undergone by the farmers, the load would also go up; thus, the RULA value resulted were greater, and vice versa.

B. An Analysis of Working Position and RULA Value on the Thresher Machine Designed by Bifadhlih

Bifadhlih [8] designed a closed drum-type (cylinder) thresher machine according to the costumers' preferences. The distinction between the thresher designed by Bifadhlih and the existing thresher was the thresher constructed using wheels to ease for mobilization, the thresher teeth designed using bolt-like screw to ease the control suited the operator's need (portable), and the collector board dimension was designed using anthropometry data to alter the operators' working position better. According to the evaluation resulting from the operators' working position using thresher machine through RULA method and the assistance of AutoCAD Software, the risk level of RULA value obtained was medium. The medium risk level in RULA required a prompt treatment. The improvement which could be done

was the modification of the thresher machine used by the operators.

The accumulation and evaluation of the working position by using RULA method depicted several segments which had high score that was wrist twist and trunk. It was due to that fact that the machine height has not been compatible to the operators' body dimension which was using it and the inclination of the steam roller board which was not compatible to the operator's arm condition. The thresher board was considerably leaned so that it did not conform the operator's working posture, the farmers. Therefore, the redesign of the thresher machine was required to suit the farmers' body dimension particularly in West Sumatera and the reparation of the leaned thresher machine in order that the operator felt more comfortable when using the thresher machine.

C. An Analysis of the Redesign of the Thresher

The thresher machine re-designed in this research was closed drum-type thresher machine (cylinder). Figure 6 illustrates the closed drum-type thresher machine (cylinder).

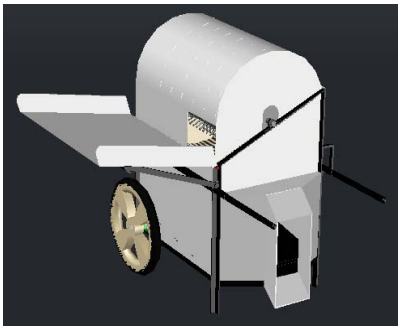

Fig. 6 the Re-design Product

Designing product was conducted by applying anthropometry approach in order that RULA value on the operator (the farmer) was smaller than the existing product. The percentage taken in this design was the percentile of 50. Taking the percentile of 50 aimed that the product which was being designed used the relative size of the user. The anthropometry used was the anthropometry of the height of the user's elbow while standing to determine the height of the working board on the thresher machine, the height of the palm's user used to determine the height of the machine handle, and the anthropometry of the stretching arm used to determine the width dimension of the working board on the designed machine. Table IX shows the value of the anthropometry data used in designing the thresher machine.

Table VIII Anthropometry Data of the West Sumatera Inhabitants

Dimension	Code	Percentile 50
Elbow's height while standing	EHS	101.7
Palm's Height	PH	71.9
Stretching Arm	SA	166.9
Body height while standing	BHS	163.1

On the board of the thresher machine was used adjustable principle in order that the board's height and could be adjusted based on the operator's height. It was slightly different from Bifadhlih's design [8] which did not design the board with the adjustable principle and the board height that could not be adjusted. The use of the adjustable principle aimed to decrease musculoskeletal problem. The musculoskeletal problem was an ergonomic matter which frequently encountered in the working place particularly with regards to human power and endurance while working. By designing the product with the adjustable principle, it was expected to minimalize the inconvenience while using the product due to the imbalance between the dimension of the product and the operator using it. On the thresher's board, the height could be set up into three heights, they were; 89 cm height, 101 cm height, and 111 cm height. The height has been adjusted to the loose and the anthropometry data of the farmers' standing elbow in West Sumatera based on the percentile of 5.50 and 99. The loose was defined due to the fact that the farmers worked dynamically/movable and the adjusting on other new tools could be operated while working such as, shoes; slippers; etc. Figure 7 and 8 illustrate the level of the working board height on the thresher machine along with the height.

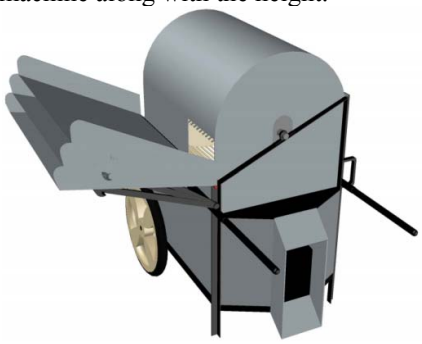

Fig. 7 Adjustable Principle on the Working Board

Apart from the use of the adjustable principle, the design improvement was also conducted on the funnel where the rice resulting from greater threshing plants fell out. The funnel where the rice plants fell out on the existing thresher machine caused the looser number of the threshing rice plants was bigger. It was because the space where the rice plants fell out was considerably wide;

hence, the after threshing rice was scattered by wind either from the machine or the surrounding.

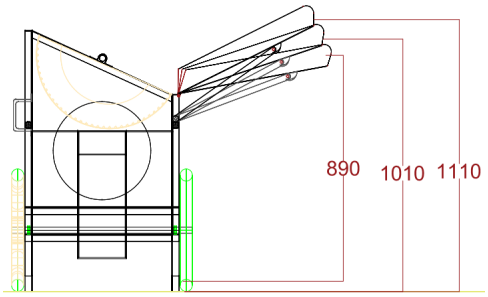

Fig. 8 The Dimension of the Thresher Machine Working Board

Figure 9 illustrated the funnel where the rice plants threshing out of the machine.

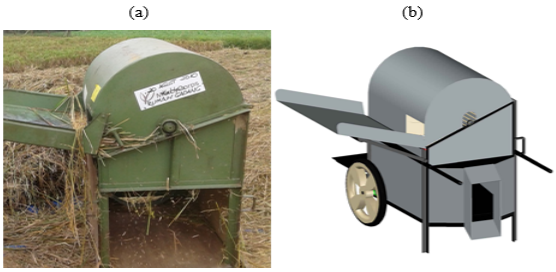

Fig. 9 The Funnel Form where the Rice Fell Out-Former Design (a) New Design (b)

V. CONCLUSION

The redesign of the thresher machine using anthropometry approach was aimed to adjust the machine dimension towards the operator. Apart from that, the re-design also used adjustable principle on the working board in order that the operator felt comfortable while using the thresher machine. From the evaluation of RULA on the designed product, it indicated smaller RULA risk level compared to the existing products. The result of the redesign of the thresher machine could elevate working productivity due to the fact that the operator operating the machine would not be exhausted as well as the musculoskeletal matter after working would not likely to pain the user. Other than that, the loser number on the threshing rice plants was slightly marginal since the funnel where the rice plants fell out was designed to accommodate the rice plants in order not to scattered after which passing through the thresher.

ACKNOWLEDGEMENT

The authors gratefully acknowledge the assistance rendered by Directorate General of Higher Education, Ministry of Research, Technology and Higher Education (Kemenristek Dikti) for funding this research in PUPT 2016 (Contract No. 07/H.16/UPT/LPPM/2016). The authors would also like to thank group of farmers as respondents in this research.

REFERENCES

[1] Meksawi, Supaporn, Boonsin Tangtrakulwanich, and Chongsuvivatwong, V. (2012). Musculoskeletal Problems And Ergonomic Risk Assessment In Rubber Tappers: A Community - Based Study In Southern Thailand. International Journal of Industrial Ergonomics, Vol. 42, No. 1, pp. 129 - 135.

[2] Chang, Yo Ju, Nguyen, The Duy, Finkbeiner, Matthias, and Kruger, Jorg. (2016). Adapting ergonomic assessments to Social Life Cycle Assessment. Procedia CIRP: 13th Global Conference on Sustainable Manufacturing, Decoupling Growth from Resource Use, Vol. 40, pp. 91 – 96..

[3] McAtamney, Lynn and Nigel, Corlett E (1993). RULA: a survey method for the investigation of world-related upper limb disorders. Applied Ergonomics, Vol. 24, No. 2, pp. 91 – 99.

[4] Rahman, Chowdury M. L. (2014). Study and analysis of work postures of workers working in a ceramic industry through Rapid Upper Limb Assessment. International Journal of Engineering and Applied Sciences, Vol. 5, No. 3, pp. 14 – 20.

[5] Choobineh, A, Tosian R, Alhamdi Z, and Davarzanie, M. (2004). Ergonomic intervention in carpet mending operation. Applied Ergonomics, Vol. 35, pp. 493 – 496. doi: 10.1016/j.apergo.2004.01.008.

[6] Choobineh, A, Lahmi, Mohammadali, Shahnavaz, Houshany, Jazani, Reza K., and Hosseini, Mustafa (2004). Musculoskeletal symptoms as related to Ergonomic factors in Iranian hand-woven carpet industry and general guidelines for workstation design. International journal of Occupational Safety and Ergonomics (JOSE), Vol. 10, No. 2, pp. 157 – 168.

[7] Rahman, Chowdury M. L., Uddin, Syed M., Karim, M.A., and Ahmed, Mohiuddin (2015). Evaluation of work postures-the associated risk analysis and the impact on labor productivity. ARPN Journal of Engineering and Applied Sciences, Vol. 10, No. 6, pp. 2542 – 2550.

[8] Bifadhlih, Nafroh (2015). Modifications Thresher Based on Customer Preferences in Padang City. B.Eng Thesis, Andalas University.

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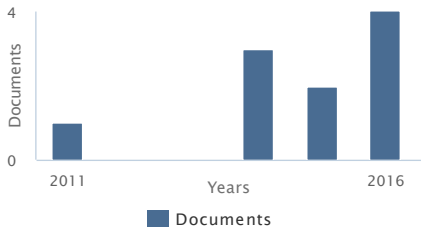

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