Advance Sustainable Science, Engineering and Technology (ASSET)
Vol. 5, No.1, April 2023, pp. 0230107-01 ~ 0230107-08
ISSN: 2715-4211 DOI: https://doi.org/10.26877/asset.v5i1./15036

Ergonomic evaluation of mechanical workshop activities to reduce musculoskeletal disorders

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Abstract. There are many brands of two-wheeled vehicles, one of which is Honda. Entering 1982 to 1984 Honda released the CB 100 and CB 125 with a more attractive appearance. In the type of CB in 1978 to Tiger Revo 2012 has a change in shape that shows the development of innovation. To fulfil the demands of work in the workshop, mechanics experience various types of movements such as moving, bending, turning, holding machines and installing manually without the help of ergonomic aids. This study was conducted on 5 workshop mechanics located in 33 districts/cities in Central Java province. The research results from 5 mechanics resulted in a high risk level using the NERPA, WERA and KIM methods. Then the improvement proposal is made with the design of a tool design in the form of a mechanical work table so that it can reduce the occurrence of Musculoskeletal Disorders. in calculation with tools to disassembling the machine obtained results in the NERPA method of 4 which means the activity has a medium risk. In the WERA method assessment, the final risk value is 33 with a medium risk value. The third calculation using KIM obtained a final risk value of 40 at level 2, meaning that the intensity increased slightly. The calculation of raising the machine obtained a NERPA value of 4 with a medium risk. The WERA method obtained a value of 38 with medium risk. The third calculation using KIM obtained a value of 35 with a level 2 value.

Keywords: MMH, NERPA, WERA, KIM

(Received 2023-03-22, Accepted 2023-04-20, Available Online by 2023-04-30)

1. Introduction

Traffic jams are a long-standing problem in major cities in Indonesia. The worsening congestion is caused by the increasing volume of private vehicles and inadequate public transport. The large number of vehicles is directly proportional to using vehicle maintenance earlier so that the vehicle is in good

performance. Two-wheeled vehicle components will sooner or later experience damage or a decrease in ability, especially if maintenance is not carried out with a routine.

Indonesia's regulations on the length of use of two-wheeled vehicles are not implemented like neighbouring countries such as Singapore and Malaysia. So there are still many circulating two-wheeled vehicles that are old and can still be used. The absence of rejuvenation regulations makes vehicles still used starting from engine power, two-wheeled vehicle frames and vehicle shapes. There are many brands of two-wheeled vehicles, one of which is Honda. Honda was present in Indonesia on 11 June 1971 through PT Federal Motor which is currently known as PT Astra Honda Motor (AHM). Entering 1982 to 1984 Honda released the CB 100 and CB 125 with a more attractive appearance. The round frame shape and engine have increased performance which makes these two motorbikes a favourite of motorcycle users in Indonesia.

Every vehicle must have maintenance undertaken. In the maintenance of two-wheeled vehicles, there are sources of physical hazards that are most common and will appear in most workplaces at any given time. The workshop is a two-wheeler maintenance place that has the task of repairing vehicles. Workshop activities support the marketing of the product being sold (which in this case means two-wheelers). To fulfil the demands of work in the workshop, mechanics experience various types of movements such as moving, bending, turning and holding in a standing position. This is based on the fact that manual handling also has the advantage of being flexible in movement so as to facilitate the transfer of loads in limited spaces and irregular work (Nugroho et al., 2013).

Figure 1. Mechanical body posture

Moving goods with MMH can result in musculoskeletal (MSD) risks. MSD disorders are complaints that are in the skeletal muscles or skeletal muscles that are responded to by workers ranging from mild to severe complaints. Typical signs include chronic pain, discomfort during activity or static postures that lose mobility (Cooper 2015). If the muscles receive static loads repeatedly and for a long period of time, it will produce complaints in the form of damage to the joints. It can be seen in **Figure 1.** that mechanics perform activities by bending and without tools so that they can produce complaints of injury. In order to minimise the injuries that occur, a study was conducted to analyse work postures using the Workplace Ergonomic Risk Assessment (WERA) method to be a tool to analyse six physical risk factors in the workplace. WERA was developed by Rahman in 2009 and has physical movement identification factors that cause Musculoskeletal Disorders, namely posture, repetition, force, vibration, stress relationships and duration. The second method Novel Ergonomic Postural Assesment (NERPA) modifies some of the body part assessments observed from the RULA method. Therefore, this method is able to detect postures with ergonomic risks that are more sensitive to ergonomic improvement

detection than the RULA method. And finally, the Key Indicator Method (KIM) is used to assess a manual load handling risk in two stages. The first stage is an ordinal scaled description of the temporary work load section, the second stage is to evaluate the array of possible physical overloads. These three methods were chosen to identify all activities.

2. Methods

This research was conducted by direct observation of manual object workers in a work cycle, to determine the risk composition of lifting, lowering, carrying or grasping activities using the WERA, NERPA, and KIM MHO methods by direct observation related to the work process. Research related to the analysis of manual material handling was conducted on the activities of non-official workshop mechanics located in 33 districts/cities in Central Java province. This research was conducted on 5 workshop mechanics.

Musculoskeletal complaints felt by workshop mechanics during activities can be known through the Nordic Body Map (NBM) questionnaire. NBM complaint data was obtained from the results of asking directly to workshop mechanics. Workshop mechanics who filled out the questionnaire were asked to mark the presence or absence of disturbances in the body area. Workshop mechanics who were used as the object of research totalled 43 people.

The first processing uses the NERPA method by grouping the scores of body parts, load weight and muscle use in work activities, by selecting a score for each part of group A and group B. Then the score is entered in table A to obtain score A and table B to obtain score B. Then, scores A and B are allocated in table C to obtain the final score.

In the WERA method the risk assessment tool is measured by a combination of two items, e.g. a combination of postures with repetitions for the shoulder, wrist and back body regions and postures combined with task durations for the neck and foot body regions. A combination of force and wrist posture is also included in this assessment. To provide a high array sensitivity to vibration, a combination of force and wrist posture was performed. As in the case of vibration sensitivity, contact stress was also combined with wrist posture. Finally, a total score is calculated based on the sum of the nine risk factors that are combined with each other to obtain a final score and action risk array.

The use of the KIM method has three steps that are carried out, the first is determining the rating value of working time, in determining the rating value into other indicators where the indicator serves as a variable in the assessment such as activity indicators at work every day. The second step includes indicators of power transfer, indicators of hand movement position, indicators of working conditions, indicators of posture position, indicators of work organisation. The last step is assessment and evaluation, namely by adding or summing up the six variables and obtaining the final result and then analysing it according to the parameters.

3. Results and Discussion

This chapter lays out specific instructions for writing the full text, including the article section, the systematic chapter and its contents. These specific instructions will guide the entire editorial process of the article as shown in Figure 2.

3.1 NBM Assesment

Musculoskeletal complaints felt by workshop mechanics during activities can be known through the Nordic Body Map (NBM) questionnaire. NBM complaint data is obtained from the results of asking directly to workshop mechanics, this study explains the questions based on complaints felt at work and based on the contents of the NBM questionnaire.

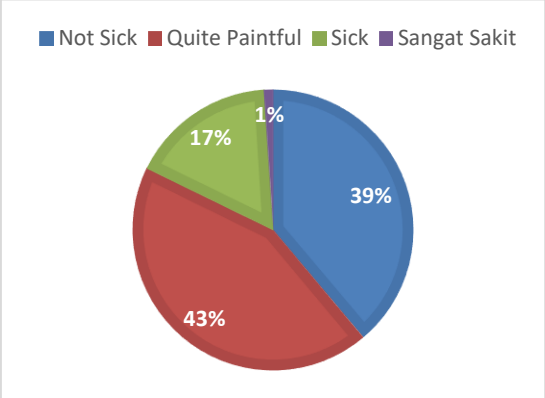

Figure 2. NBM Assesment

The results of the calculations in **Figure 2.** obtained Moderately Sick complaints with a value of 43% totalling 522 in each type of complaint investigated, for the assessment of complaints Not sick get a value of 39% totalling 468 in each type of complaint, on complaints Sick get a value of 17% totalling 202 in each type of complaint, and for complaints Very Sick get a value of 1% with a total of 12 in each type of complaint.
Whereas in the upper body there are complaints of no pain of 32% with a total of 252, for complaints Sick enough to get a value of 47% with a total of 357, complaints Sick get 20% with a total of 157, and Complaints Very Sick get a presentation of 1% with a total of 8. For the lower body part resulting from complaints Not Sick of 50% with a total of 430, for complaints Sick enough to get a value of 39% with a total of 216, while for complaints Sick get a value of 10% with a total of 157, and the type of complaint Very Sick Get Value 1% with a total of 4.

3.2 Assesment Methods

After calculating the NBM, it was found that there were musculoskeletal complaints experienced by mechanics in the mechanic workshop so that further assessment was carried out to assess the risks. Furthermore, calculations are carried out to assess how severe or high the activities carried out by workshop mechanics.

Table 1. Assessment of ergonomic risk levels

No	Activities	Value of Each Method		
		NERPA	WERA	KIM-MHO
1	Disassembling the Machine	7	47	58
	Raising the Engine	7	45	93
2	Disassembling the Machine	7	48	72
	Raising the Engine	6	52	105
3	Disassembling the Machine	7	47	74
	Raising the Engine	7	49	187
4	Disassembling the Machine	7	53	111
	Raising the Engine	7	47	62
5	Disassembling the Machine	7	53	62
	Raising the Engine	6	51	62

Mechanic 1 Activity of Disassembling the Machine obtained the results of calculating the risk level using the NERPA method on the activity of lowering the machine after the calculation obtained a final value of 7 which work requires further research and changes as soon as possible. The results obtained in the WERA method obtained a final value of 47 which can indicate that the activity is at a high level.

From the KIM-MHO method, the results obtained a total value for Disassembling the Machine of 58, which is a much-increased intensity. For Mechanic 1 in the activity of Raising the Machine, the risk level is obtained using the NERPA method in the activity of Disassembling the Machine after the calculation obtained a final value of 7, which requires further research and immediate changes. The results obtained in the WERA method obtained a final value of 45 which can indicate that the activity is at a high level. From the results obtained, the total value for Disassembling the Machine is 114, which is high intensity.

Mechanical Assessment 2 Activity Disassembling the Machine obtained a risk level calculation using the NERPA method on the activity of Disassembling the Machine after the calculation obtained a final value of 7 which work requires further research and immediate changes. The results obtained in the WERA method obtained a final value of 48 which can indicate that the activity is at a high level. From the results of the KIM-MHO method, the total value obtained for lowering the machine is 72, which is a much-increased intensity. In the activity of Raising the Machine, the resulting risk level calculation using the NERPA method on the activity of Disassembling the Machine after the calculation obtained a final value of 6 which means the work requires further research and immediate changes to the activity. The results obtained in the WERA method obtained a final value of 52 which can indicate that the activity is at a high level. From the results of the KIM-MHO method, the total value for lowering the machine is 105, which is at a high intensity.

Mechanical Assessment 3 on the activity of Disassembling the Machine gets the NERPA method calculation on the activity of Disassembling the Machine after the calculation obtained a final value of 7 which work requires further research and changes as soon as possible. The results obtained in the WERA method obtained a final value of 47 which can indicate that the activity is at a high level. From the results of the KIM-MHO method, the total value obtained for Disassembling the Machine is 74, which is a much-increased intensity. The NERPA method on the activity of lowering the machine after calculation obtained a final value of 7 which requires further research and immediate changes. In the results obtained in the WERA method, the final value is 49 which can indicate that the activity is at a high level. From the results obtained, the total value for lowering the machine is 87, which is an intensity that has increased a lot.

Mechanical Assessment 4 Activity of Disassembling the Machine NERPA method on the activity of Disassembling the Machine after calculation obtained a final value of 7 which work requires further research and immediate changes. In the results obtained in the WERA method, the final value is 53 which can indicate that the activity is at a high level. From the results obtained the total value for Disassembling the Machine as much as 111 is high intensity. While the Activity of Raising the Machine NERPA method on the activity of lowering the machine after calculation obtained a final value of 7 which work requires further research and changes as soon as possible. In the results obtained in the WERA method, the final value is 47 which can indicate that the activity is at a high level. From the results obtained, the total value for lowering the machine is 62, which is an intensity that has increased a lot.

Mechanical Assessment 5 on the activity of disassembling the machine NERPA method on the activity of lowering the machine after calculation obtained a final value of 7 which work requires further research and changes as soon as possible. In the results obtained in the WERA method, the final value is 53 which can indicate that the activity is at a high level. From the results obtained the total value for disassembling the machine as much as 62 is an intensity much increased. While the Activity of raising the machine NERPA method on the activity of raising the machine after calculation obtained a final value of 6 which work requires further research and immediate changes. In the results obtained in the WERA method, the final value is 62 which can indicate that the activity is at a high level. From the results obtained the total value for raising the machine as much as 51 is in the intensity of much increased.

3.3 Desain Concept

The description of needs is made to clarify the objectives in making design concepts and facilitate the stages of completion that must be carried out. Needs are obtained directly from interviews with mechanics directly or with workshop owners. There are several mechanical desires such as ease of operation, the absence of a work table in disassembling the machine, being able to move the machine to the workplace, the ease of starting the engine, and not taking up much space.

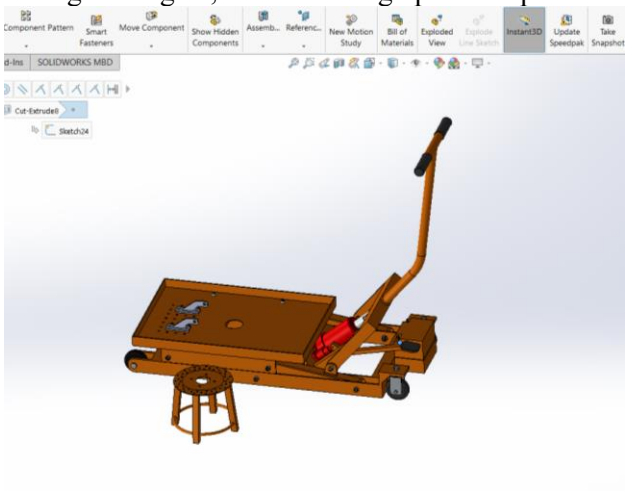

Figure 3. Design result

Figure 3. obtained the design of the mechanical input so as to simplify the operation. Dimension calculations are carried out to determine the dimensions and combined with the design data that has been prepared with the aim that the proposed improvements to the design of the tool design are made according to the objectives that have been made. Workplace height size. This calculation is adjusted to the height dimension between the ground and the machine while still on the motor. Made with additional hydraulics that can be adjusted from 0cm to a maximum of 35 cm. Anthropometric data needed to determine the diameter of the handle is the size of the diameter of the middle handle with the 50th percentile. The use of the 50th percentile is intended for the size of mechanical handles that have small palms and larger palms can use a diameter value of 5 cm. The size of the handle width is used Anthropometric data needed to determine the width of the handle is the width of the 50th percentile handle. The use of the 50th percentile is intended so that the width of the handle of the tool has a common size. So that mechanics with larger and smaller shoulder widths can hold the handle comfortably with a value of 36 cm. Width of the workbench board The calculation is adjusted to the dimensions of the width of the machine that will be transported by the mechanic when carrying out activities. Can also be used on other machines that have less width will also be used so that the size of 40 cm is made. The length of the machine table board used is adjusted to the dimensions of the distance between the front tyre of the vehicle to the middle standard point of the vehicle when carrying out mechanical activities with a length of 60 cm.

3.4 Calculations Using Design

After the design, the posture calculation is carried out using angles. Simulate this movement posture using CATIA software. From this software is used to reassess the results of the risk in the design of aids with the calculation of 3 methods can be seen in the following figure.

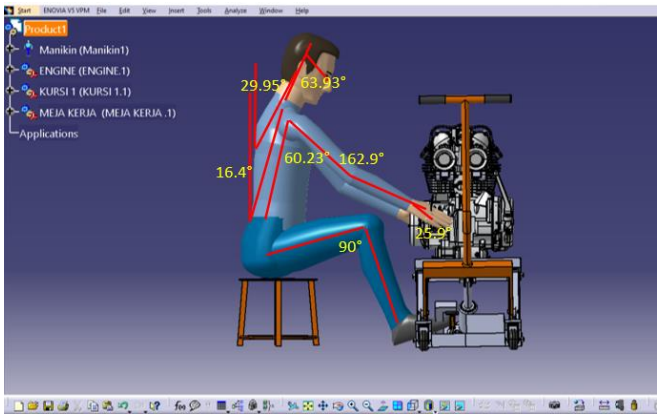

Figure 4. Posture assessment with tools

In calculations with tools such as **Figure 4** so that the calculation to disassembling the machine obtained results in the NERPA method of 4 which means the activity has a medium risk. In the WERA method assessment, the final risk value is 33 with a medium risk value. The third calculation using KIM obtained a final risk value of 40 at level 2, meaning that the intensity increased slightly. The calculation of raising the machine obtained a NERPA value of 4 with a medium risk. The WERA method obtained a value of 38 with medium risk. The third calculation using KIM obtained a value of 35 with a level 2 value.

4. Conclusion

It was found that musculoskeletal complaints in the moderately painful category were the highest at 43%, totalling 522 in each type of complaint investigated, for the assessment of complaints It doesn't hurt to get 39%, totalling 468 in each type of complaint, for complaints It hurts to get a value of 17%, totalling 202 in each type of complaint, and for complaints It hurts to get a value of 1% with a total of 12 in each type of complaint.

The results of the assessment of the level of risk of injury using the NERPA method can be seen from the 5 mechanics studied all activities have a medium to high risk so that activities need to be investigated further. While the results of research on the level of risk of injury using the WERA method can be seen that 5 work mechanics observed there are 10 activities that have a high level of risk of injury (high) which can indicate that the activity is at a high level which means that the work of mechanical activities needs further investigation and immediate changes to the activity. In the final assessment of the results of the risk of injury activity assessment using the KIM method, it can be seen that of the 8 activities carried out by 5 mechanics, the intensity has increased a lot, which means that redesign and maintenance measures should be taken with risks that fall into the level 3 category, while 2 activities are at High intensity, which means that redesign and maintenance measures should be taken with risks that fall into the level 4 category.

The improvement made is to add a work table by producing a risk reduction using the three methods with the results of the calculation to disassembling the machine obtained results in the NERPA method of 4 which means the activity has a medium risk. In the WERA method assessment, the final risk value is 33 with a medium risk value. The third calculation using KIM obtained a final risk value of 40 at level 2 with the meaning of slightly increased intensity. The calculation of raising the machine obtained a NERPA value of 4 with a medium risk. In the WERA method, a value of 38 was obtained with a medium risk. The third calculation using KIM obtained a value of 35 with a level 2 value.

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