Jurnal Sains dan Teknologi
Volume 12 Number 2, Tahun 2023, pp. 533-544
P-ISSN: 2303-3142 E-ISSN: 2548-8570
Open Access: https://doi.org/10.23887/jstundiksha.v12i2.52850

Care for Mechanics: Development of Motorcycle Workbench Based on ADDIE Model to Reduce Musculoskeletal Disorders

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ARTICLE INFO

Article history:
Received October 07, 2022
Revised October 11, 2022
Accepted May 20, 2023
Available online July 25, 2023

Kata Kunci:
Mekanik, Workbench *Sepeda Motor, Gangguan* Musculoskeletal *(MSDs)*

Keywords:
Mechanics, Motorcycle Workbench, Musculoskeletal Disorders (MSDs)

ABSTRAK

Di negara berkembang seperti Indonesia, yang mayoritas penduduknya bekerja di sektor informal, diperlukan intervensi alat yang ergonomis, berbiaya rendah, dan mudah diproduksi dengan bahan yang tersedia secara lokal. Pesatnya pertumbuhan penjualan sepeda motor di Indonesia mendorong tumbuhnya bengkel-bengkel sepeda motor. Namun, beberapa bengkel reparasi non-dealer mengabaikan keselamatan kerja para mekanik. Penelitian ini bertujuan untuk mengembangkan motorcycle workbench sebagai alat bantu pekerjaan perawatan dan perbaikan sepeda motor untuk mengurangi gangguan muskuloskeletal (MSDs). Metode penelitian yang digunakan adalah Research and Development (R & D) dengan model ADDIE. Subjek penelitian adalah 4 orang mekanik di sebuah bengkel swasta. Pengumpulan data dilakukan dengan teknik wawancara, observasi dan kuesioner. Data MSDs dianalisis menggunakan Nordic Musculoskeletal Questionnaire (NMQ). Faktor risiko ergonomis dianalisis menggunakan Rapid Upper Limb Assessment (RULA) dan Ovako Work Posture Analysis System (OWAS). Hasil penelitian menunjukkan adanya perbaikan pada postur kerja mekanik. Keluhan MSDs menurun berdasarkan NMQ Score. Selanjutnya, skor RULA dan skor OWAS juga mengalami penurunan. Dengan demikian, pengembangan workbench sepeda motor berhasil mengurangi keluhan MSDs dan meningkatkan keselamatan kerja mekanik.

ABSTRACT

In a developing country like Indonesia, where the majority of the population is working in the informal sectors, there is a need for ergonomic tool intervention, which is low cost, and easy in terms of manufacturability with locally available materials. The rapid growth of motorcycle sales in Indonesia has stimulated the growth of motorcycle repair workshops. However, some of the non-authorized repair workshops ignore the occupational safety of the mechanics. This study aims to develop a motorcycle workbench as a tool for maintenance work to reduce musculoskeletal disorders (MSDs). The present study used Research and Development (R&D) with the ADDIE model combined with an ergonomic approach. The research subjects were 4 mechanics from one private workshop. Data was collected using interview, observation, and questionnaire techniques. The MSDs data was analyzed using Nordic Musculoskeletal Questionnaire (NMQ). The ergonomic risk factors were analyzed using Rapid Upper Limb Assessment (RULA) and Ovako Work Posture Analysis System (OWAS). The result showed an improvement in the work posture of mechanics. The MSDs complaint decreased based on NMQ Score. Furthermore, the RULA score and OWAS score also decreased. Thus, the development of the motorcycle workbench succeeded in reducing the MSDs complaint and improving mechanics' occupational safety.

1. INTRODUCTION

In developed industrial countries, almost every work is done by machines. Mechanization and automation aims to increase productivity. On the other hand, in developing and underdeveloped countries, much of the work is still done manually with more exertion and physical strain. One of the consequences of this can be that increasingly laborers encounter lower back, waist, neck, and wrist pain, in fingers, and toes (Karuppiah et al., 2020; Kataria et al., 2022). OSHA (Occupational Safety and Health Administration) in the United States stated that ergonomic principles are very important to prevent the occurrence of Musculoskeletal Disorders (MSDs) or skeletal muscle system symptoms (Calvetti et al., 2020; Coombs et al., 2020; P.-C. Wang et al., 2022). The benefits that can be obtained from the application of ergonomic principles are not only the perceived comfort, health, and safety of workers, but also a decrease in occupational diseases and the risk of work accidents, even more important is an increase in work productivity. Various ergonomic solutions are offered to overcome human issues with their work (Joshi & Deshpande, 2019; Kee, 2021; Sun et al., 2019). The method used does not require a large cost to be applied

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but can improve working conditions to meet the criteria for applying ergonomic principles (Lowe et al., 2019; Santoso, 2022).

Musculoskeletal disorders (MSDs) are currently one of the most prevalent disorders in the world. MSDs is a health problem involving the skeletal muscle system due to poor working posture, unorganized workstations, and lacking attention to ergonomic aspects (Theurel & Desbrosses, 2019; Zeverdegani et al., 2022; Zulkarnain et al., 2021). Work-related Musculoskeletal Disorders (WMsDs) is a term used to define MSDs, which are related or caused by work environment activities. This term is sometimes referred to as an 'ergonomic injury' or an 'ergonomic hazard', which is defined as a physical condition that poses a risk of injury to the musculoskeletal system. Ergonomists have developed various MSD risk assessment methods whose validity and reliability are guaranteed (Hossain et al., 2018; Macdonald & Oakman, 2022). Awkward posture is a contributing factor to MSDs. Assessment and identification of work postures is a very important field of study in ergonomics. Improvements and changes in certain work postures can efficiently reduce MSDs (Ezugwu et al., 2020; Jadhav et al., 2020).

MSD disorders often occur in small-scale industries that are not protected by occupational health and safety among both employees as well as employers (Brandt et al., 2021; Yovi & Yamad, 2019). The small-scale motorcycle repair industry is one of the foremost imperative businesses within the formal and informal segments and it were influence the economy in terms of work creation, source of government income, arrangement of fundamental administrations to the populace, and basics. Maju Jaya is a small workshop located in Makamhaji village, Indonesia. The working conditions made mechanics often complain about MSDs. Maintenance activities is considered a difficult work due to numerous factors such as work stations, high energy consumption, static work intensity, repeatedly bending, kneeling, twisting and standing in motorcycle workshop (Sing et al., 2022; Tanase et al., 2021). One of the factors that are often overlooked in small-scale industries is the factor of occupational safety and health (Mambwe et al., 2021; Manke & Mukhopadhyay, 2019). Awkward posture and repetitive work can be important factors in the development of MSDs among workers. Bending, twisting and sitting while peforming work is considered the main factor for musculoskeletal (Dagne et al., 2020; Tamene et al., 2020). This type of working posture affects the back, upper and lower limbs.

A preliminary study was conducted on 4 mechanics at a workshop at advanced jaya using a nordic musculoskeletal questionnaire (NMQ) and found that there were MSDs disorders (Ramdan et al., 2019). Observation results show pays less attention to ergonomics aspects, especially related to the design of work facilities. Poor work facilities result in a poor working position. By improving work facilities, it can reduce MSDs complaints and increase mechanics' productivity. Modifying an ergonomic tool requires some ergonomic evaluation related to MSDs disorders (Borz et al., 2021; Sa'Diyah et al., 2021; Tang, 2020). MSDs complaints from mechanics must be followed up immediately by improving posture and adding work tools in accordance with ergonomic principles. Creating ergonomic working conditions in motorcycle maintenance work requires a valid and accurate assessment (DesMarais & Wyatt, 2021; Enez & Nalbantoğlu, 2019). In this study, assessing and analyzing work postures and implementing the necessary improvements and methods is very important to contribute to improving performance and reducing MSD disorders.

Methodology in systematic macro ergonomics leads to the perspective of analysis, design and evaluation (Heidarimoghadam et al., 2022; Kalteh et al., 2020). The 3 main elements in the systematic mindset of macroergonomics must be complemented by the application and manufacturing process so that in the method there is an element of reciprocity that occurs repeatedly. Humans will continue to play an active role in the manufacturing process. Therefore, the ADDIE model will be used in this study to facilitate researchers in developing ergonomic tools in a structured and systematic manner. In the previous research, rarely or only a few researchers used the ADDIE model to create ergonomic products. This is also only used as a method in determining product size dimensions, not in terms of a thorough analysis using ergonomics assessment (Ismara & Prianto, 2020; Luwes et al., 2021; Puswadi & Sunyoto, 2021). The novelty and difference with previous research is in the ADDIE model which at each stage uses an ergonomics approach in analysis, design, development, implementation and evaluation. This concerns the use of focus group discussions in a macroergonomic perspective (Carayon, 2021; Kalteh et al., 2020; Reiman et al., 2021).

In this study, researchers will conduct a survey using NMQ, then choose a task based on the results of the questionnaire and assess work posture using ergonomics assessment methods. The methods referred to are Rapid Upper Limb Assessment (RULA) and OWAS (Ovako Working Analysis System). The design of work facilities uses the Focus Group Discussion method and an anthropometric approach so that the suitability between work facilities and the needs of workers can be achieved. After making the work tool, then the tool is implemented in the Maju Jaya workshop to evaluate the improvement posture. All concepts are summarized in an ADDIE method (Analyze, Design, Develop, Implement, Evaluate). A motorcycle repair tool in the form of a motorcycle workbench (MW) is expected to help mechanics overcome MSDs complaints at the Maju Jaya workshop.The current research is an attempt to reduce the MSD of mechanics who are poor and cannot manage advanced innovation and modern technology for improving their workstation. The reason for this consideration is to reduce the MSDs hazard in the Maju Jaya workshop by including simple tools with an ergonomic approach combined with the ADDIE Model.

2. METHOD

This study uses the Research and Development (R&D) method, with the ADDIE model combined with an ergonomic approach. This study was conducted from February 2022 to July 2020. ADDIE is an instructional design model most commonly used for training programs among instructors, software developers, and university principals. This study follows the phases of the ADDIE model to create and evaluate the ergonomic product because anyone can develop an ADDIE model to relate to any attribute or approach. The ADDIE model consists of Analysis, Design, Development, Implementation and Evaluation (Alsaleh, 2020; Saeidnia et al., 2022; Yu et al., 2021). The development of the ADDIE model with an ergonomic approach aims that the research conducted is structured in a directed model. The analysis phase aims to identify working problems using NMQ, RULA, and OWAS methods. The design phase is designing a tool with a forum group discussion and anthropometric approach. The development phase is to develop a tool into a finished product that can be used by mechanics. The implementation phase is applying the tool that will be used by mechanics. The last phase is evaluation. The research evaluation includes a comparison of the effects before and after the intervention of ergonomic tools. The effects of the intervention were measured through pre-post-differences in mean scores for the ergonomics training test, NMQ, and RULA and OWAS observation. The concept is show in Figure 1.

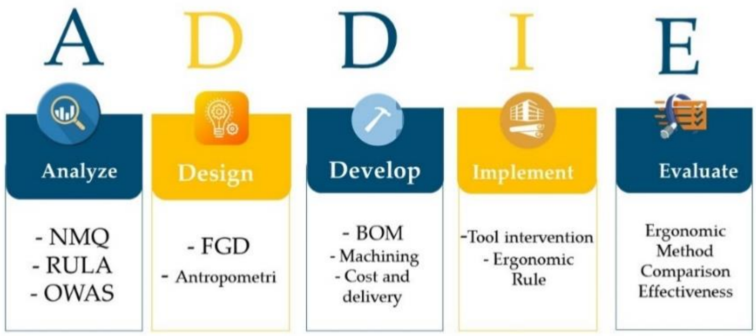

Figure 1. Ergonomic ADDIE Concept

NMQ is a method used to assess complaints of skeletal muscle system disorders or MSDs. This method has been widely used by ergonomics experts to assess the level of MSDs risk, has good validity and reliability, and has been applied in various fields of work (Mazloumi et al., 2021; Pulik et al., 2020). This questionnaire completely describes the body parts that mechanics complain about which are divided into nine parts, those are the neck, upper back, lower back, shoulders, elbows, thighs, knees, hands, and feet (Chairani, 2020; Hossain et al., 2018). This study uses a Nordic Map Questionnaire which has been further developed. To assess body parts in mechanics, it will be processed in the form of a percentage to find out which part of the body has a high percentage of pain. The RULA method is a quick ergonomics evaluation method that divides the human body into two groups. Group A, including the upper extremities (upper arms, forearms, and wrists), and Group B, including the neck, trunk, and legs (Mandal & Math, 2021; Ramdan et al., 2019).

RULA grand scores 1 and 2 have a negligible risk that indicates acceptable posture if it is not repeated for a longer period. Scores 3 and 4 have a low risk which indicates further investigation and change may be needed in the future. Scores 5 and 6 have a medium risk that indicates investigation required and changes needed soon. The final score of 7 has a high risk that indicates that investigation posture and change are needed immediate (Manzoor Hussain et al., 2019; Yazdanirad et al., 2018). The OWAS method is based on evaluating various posture positions while working. The results of the OWAS assessment are the result of a combination of coding body positions, especially the back (4 positions), arms (3 positions), legs (7 positions), and loading at 3 intervals (Ezugwu et al., 2020; Lins et al., 2021). This method uses a classification of 4 levels of risk contained in several codes. Score 1 means normal posture which does not need any special attention, except in some special cases. Score 2 means low risk which indicates corrective action is required in the near future. Score 3 means a medium risk that indicates corrective actions should be done as soon as possible. Score 4 means high risk which indicates postures need immediate (Enez & Nalbantoğlu, 2019; Mahachandra et al., 2018).

FGD is a group of individuals who share and interact in response to a problem. FGD can also assist in the design and implementation of proposed interventions or changes within a working group. FGD method was more appropriate than individual questionnaires interviews (Burgess-Limerick, 2018; O.Nyumba et al., 2018). In the FGD discussions were held with parties who are experts in their fields. In this forum, the parties involved are mechanics, researchers, tool design experts, and also ergonomics experts. Focus group is one of the ergonomic methods used to get valuable information in groups (Fusaro & Kang, 2021; Herdiman et al., 2020). To successfully apply the ergonomics participation method in developing countries such as Indonesia, in the design and implementation stages, FGDs are used so that the design of the tool is in accordance with the needs of workers and there is reciprocity between researchers and workers (Bernardes et al., 2021; Lawson et al., 2021).

3. RESULT AND DISCUSSION

Result

Analyze Stage

The analysis stage to find out the complaints experienced by workers is then described through a fishbone diagram. There are 4 factors behind the ergonomics problem. The first thing to do is identify the root cause of the problem through observation and interview techniques which are then compiled in the fishbone diagram method. There are four factors that trigger MSDs disorders, namely man, methods, machines and the environment. Complaints of pain from mechanics must be followed up immediately by improving posture and adding work tools according to ergonomic principles. If this is allowed, then the complaint will get worse and can cause morphological and functional abnormalities in the skeletal muscle system. A lot of work is done by mechanics in bending, squatting, twisting, and other positions. Therefore, the researcher conducted a skeletal muscle complaint survey (NMQ) to get direct feedback from mechanics about the complaints they felt.

Based on NMQ analysis, the percentage of complaints about the body parts of 4 mechanics. The graph shows the highest complaints were identified in the back (91.67%) before implementation MW. The different postures while repairing in motorcycle maintenance. The fishbone diagram is show in **Figure 2**.

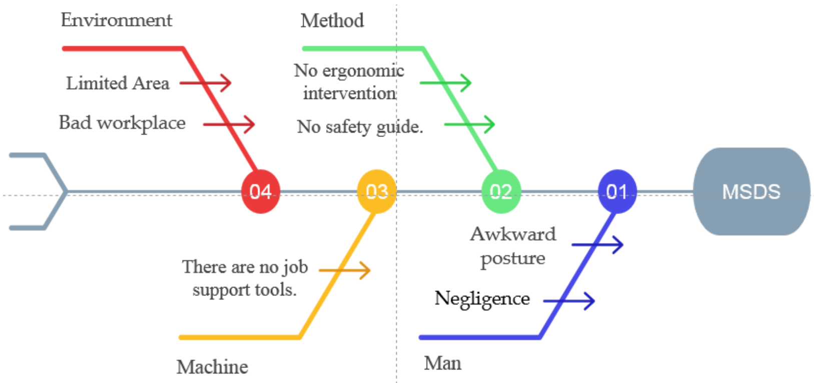

Figure 2. Fishbone Diagram

Mechanics provide different repairing services like cleaning parts, tire removing, repairing minor damages to vehicles etc. RULA and OWAS scores for 3 assessed postures. RULA score for Poster a and c is 7 which has a high risk. This indicates that investigating posture and change is needed immediately. The RULA analysis score for posture b is 6 with a medium risk that indicates investigation required and changes needed soon. OWAS score for posture b is 3 which means medium risk category that indicates corrective actions should be done as soon as possible. Postures a and b have a score of 4 in high risk category with an indication that corrective action is needed as soon as possible. The results of the RULA and OWAS analysis show that the three postures of unnatural work attitudes have a high risk and require changes in terms of work tools, body postures, and ergonomic interventions in Maju Jaya work stations. Work postures according to RULA and OWAS is show in Table 1.

Table 1. Work Postures According to RULA and OWAS

OWAS											
Postur a				Postur b				Postur c			
Back	Arm	Leg	Load	Back	Arm	Leg	Load	Back	Arm	Leg	Load
4	1	4	1	2	1	5	1	4	1	4	1
Final score = 4				Final score = 3				Final score = 4			
RULA											
Wrist Arm		Neck,Trunk and Leg		Wrist Arm		Neck,Trunk and Leg		Wrist Arm		Neck,Trunk and Leg	
5		8		6		5		5		8	
Final Score = 7				Final Score = 6				Final Score = 7			

Design Stage

The implementation of FGD is to obtain in-depth information about the perceptions, expectations, and complaints of mechanics, suggestions for improving ergonomics, and discussions the design of tools to improve working posture. The discussion is directed to explore ergonomic interventions that can be built to improve working conditions. This discussion involved participants to participate and find out the application of ergonomics in the design of work facilities. Mechanics know about how ergonomics work. Table 2 shows the results of the FGDs conducted 2 times.

Table 2. FGD Result

Mechanics	Result of discussion
Mechanics need tools that can help in doing the job	The tool is made of good quality material, safety, improves posture, and makes work easier
Mechanics have pain musculoskeletal disorders (MSDs) when servicing motorcycles	The dimensions of the tool are based on the anthropometric principle approach
Difficulty in servicing which made working awkward posture	A simple tool in maintenance and use
Mechanics have problems with the layout of the workstation	Change of workstation that is more comfortable, healthy, and safe for work

The next step is to design the tool. Based on the discussion FGD, a concept of motorcycle workbench (MW) was developed. MW was designed with the Indonesian anthropometric and uses 3 anthropometric dimensions. Popliteal height for chair height (47 cm), knee height for bench height (50 cm), and popliteal length for chair width (40 cm). The next step is to design the tool in the form of a drawing. The specifications used are the Supra X 125 type for the length (2100 mm) and width of MW (600 mm) because this type of motorcycle is the most frequently repaired at Maju Jaya workshops. Next step is to draw motorcycle workbench in 3D. The animation is show in Figure 3.

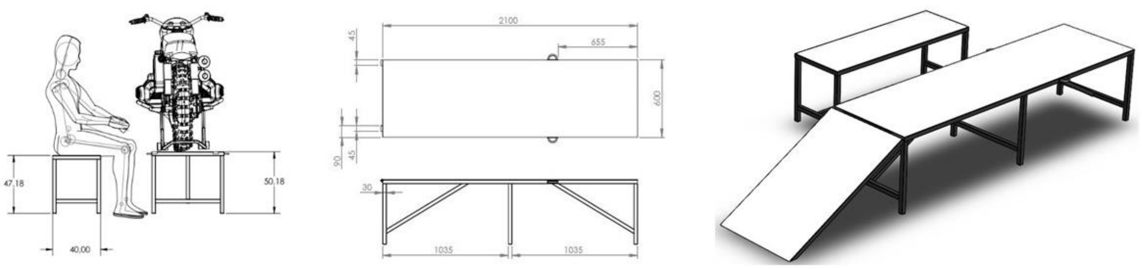

Figure 3. 2D and 3D Drawing Dimensions

Development Stage

Different methods are used in this phase to manufacture the motorcycle workbench. A Bill of Materials (BOM) is a product description consisting of items or materials needed to assemble or produce certain products. Material specifications are determined based on the components needed to build a motorcycle workbench. The selection of materials is based on the information of analysts conjointly interview with a design expert. The manufacturing techniques used are cutting, welding, assembling, and painting. Cost estimation is used to determine the cost required to make a motorcycle workbench based on the results of the design in FGD. This gets to be exceptionally vital because small-scale motor vehicle repair shops require tools with minimal costs. The materials used to make the tool include hollow iron for the table and chair frames, bordess plate for the table holder. The tools used are general workshop equipment such as welding tools, grinders, and others.

Implementation Stage

Researchers implement the tool directly so that the involvement of mechanics in the operation of using the tool can be re-evaluated. With a participatory ergonomics model approach, researchers can find out how mechanics work with the tools that have been provided. This shows that the designed work equipment can be applied optimally or not. This method is limited to small-scale industries because there is no organizational management such as in large companies but involves the active participation of Maju Jaya mechanics. This shows whether the designed work equipment can be applied optimally or not. At this phase, reassessment using the RULA, OWAS, and NMQ methods after applying MW at the Maju Jaya workshop. The improvement in work posture due to changes in the workstation that are more comfortable and ergonomic is show in Figure 4.

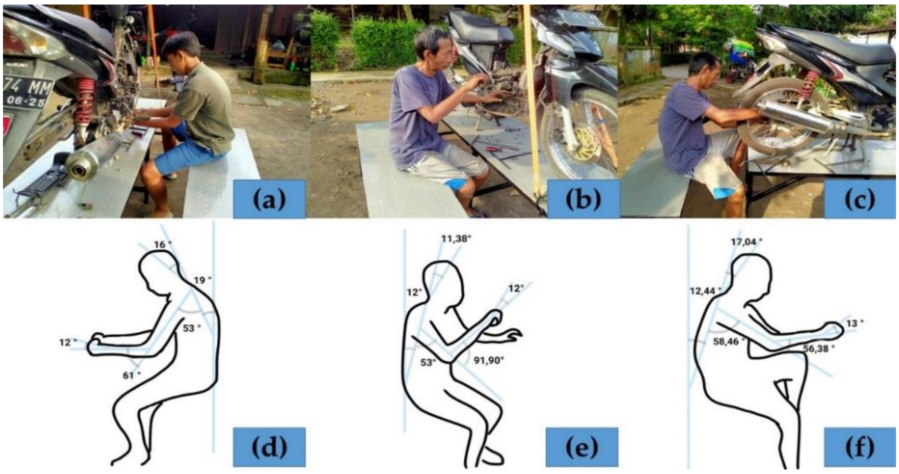

Figure 4. Work Postures Analysis: (a) Posture a, (b) Posture b, (c) Posture c, (d) Sketch Posture a, (e) Sketch Posture b, (f) Sketch Posture c

Then the RULA score for postures a, b, and c is 4 which means change may be needed in the future. For the OWAS analysis, all scores changed to 1 which means do not need any special attention is show in **Error! Not a valid bookmark self-reference.**.

Table 3. RULA and OWAS after Ergonomic Tool Intervention

OWAS											
Postur a				Postur b				Postur c			
Back	Arm	Leg	Load	Back	Arm	Leg	Load	Back	Arm	Leg	Load
1	1	1	1	1	1	1	1	1	1	1	1
Final score = 1				Final score = 1				Final score = 1			
RULA											
Wrist Arm		Neck,Trunk and Leg		Wrist Arm		Neck,Trunk and Leg		Wrist Arm		Neck,Trunk and Leg	
5		3		5		3		5		3	
Final Score = 4				Final Score = 4				Final Score = 4			

Evaluation Stage

At this phase, an evaluation is carried out to compare work postures before and after the application of MW to measure how effective the tool is in improving posture while working. A comparison of NMQ percentage aims to determine whether there is a decrease in MSD complaints or not in mechanics. The comparison of NMQ percentage before and after the implementation of the motorcycle workbench in the Maju Jaya workshop is show in Figure .

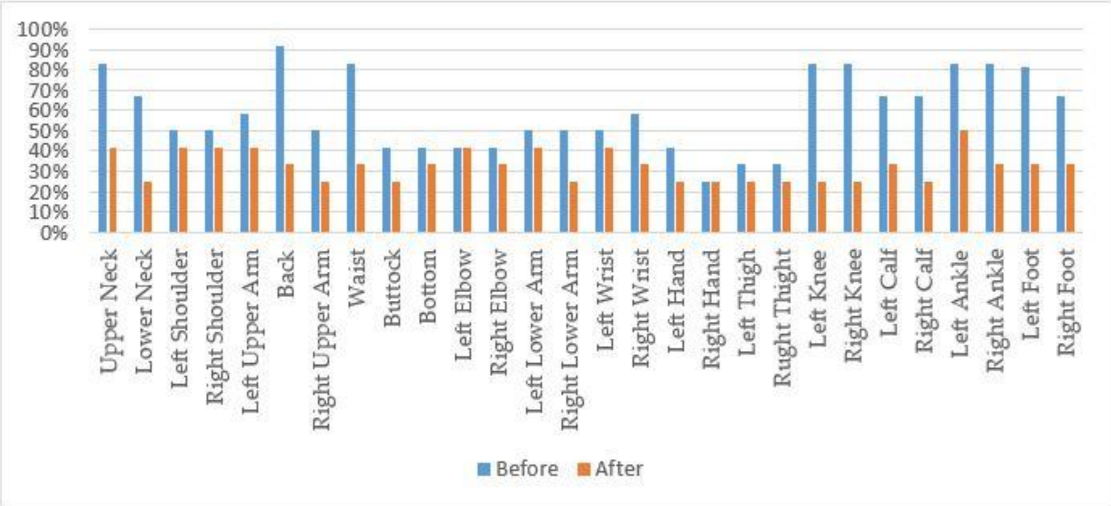

Figure 5. Comparison of NMQ

The comparison between RULA and OWAS is show in Figure . The greatest decrease in MSDs complaints was in the back, waist, left knee, and right knee. Whereas the parts that did not involve changes in MSD complaints were the left elbow and right hand. RULA decreased from a score of 7 or 6 to 4, while OWAS from the score of 4 or 3 to 1. The application of MW can reduce MSDs based on the NMQ questionnaire and improve work posture based on OWAS and RULA evaluations. This is caused by the suitability of work equipment used to affect the posture of mechanics which then also affect MSDs complaints among the mechanics. The tool is simple but makes the work easier to be done so MSDs risk can be reduced.

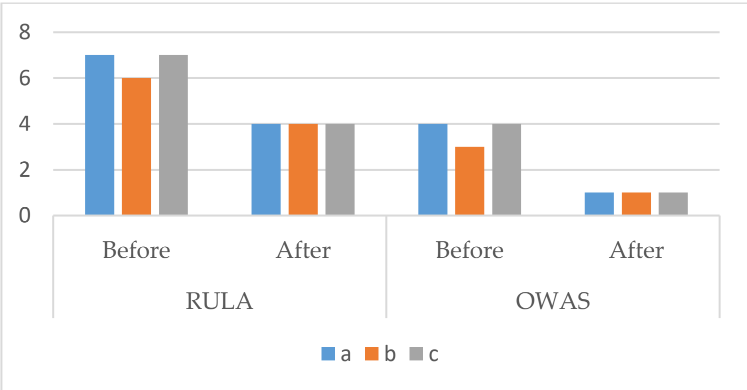

Figure 6. Comparison of RULA and OWAS

Discussion

A preliminary study was conducted to analyze ergonomic problems in the Maju Jaya workshop. There are 4 factors behind the work station that is not ergonomic. Machine factors include not having motor vehicle service support equipment. Environmental factors include limited area and poor workplace layout. Mechanics do most of their work in work stations that are not ergonomically designed, thus placing themselves in unhealthy conditions that can pose a risk of stress and pain. Designing an ergonomic work design is an important part of the strategy to increase mechanical motivation at work because it makes work more interesting (Lööw, 2020; Suresh et al., 2020). Method factors include not having health and safety management in the workshop. In small-scale workshops, occupational health control is not given much attentionm (Jain et al., 2020; Manke & Mukhopadhyay, 2019). The human factor includes working with awkward postures that make it uncomfortable when doing work. Work station design that is not ergonomic forces mechanics to do work with poor posture. The negligence factor is often experienced by mechanics when working so they are not careful in carrying out work. With the addition of a Motorcycle Workbench, a new work layout will be created, a new work posture, a more attractive and unsaturated appearance.

Researchers, mechanics, design experts and ergonomics held discussions to design a tool that can be used to service motor vehicles. Tool design is based on ergonomic principles with an anthropometric approach to consider the suitability of work tools, user limitations and improve worker posture when performing services. The dimensions of the length and width of the MW are adjusted to the size of the motorcycle for the purpose of safety considerations so that the motor body is within the MW area. Anthropometry uses the population size of Indonesians to represent the dimensions of Indonesians (Cahyadi & Soeprapto, 2021; Mahachandra et al., 2018). The WM height is based on the 50th percentile of the knee height of the Indonesian people to meet the needs of mechanics in order to position the motorcycle to be serviced. MW chair height is based on the 95th percentile of Indonesian popliteal height. The 95th percentile was used because people with the smallest size could use the chair comfortably. The width of the MW chair uses the 5th percentile size of the popliteal length of the Indonesian people in order that people can use them comfortably.

After making the tool, the next step is to implement it for a month. After the motorcycle workbench was tested at the maju jaya workshop, there were several postures that had changed due to the addition of the MW equipment. Changes in posture are also caused by the use of the MW chair. The OWAS score which previously indicated high (3 and 4) became a score of 1 in the category of no need for improvement. This happens because the back and legs have a change in position due to the MW. The addition of chair assistance greatly affects the OWAS score (Ramadhani et al., 2018; Suhardi et al., 2018). The decrease in the RULA score from 7 to 4 was due to significant changes in body position, especially the back and neck. The previous position of the body bent to form an angle of more than 60^{o} changed to 0^{o} – 10^{o}. Changing the position of squatting, bending with the knees as support when working becomes more comfortable with the motorcycle workbench. This improves work posture and increases RULA scores (Aminuddin et al., 2018; Aziz et al., 2019; Das, 2021).

From several postures, the parts that have a high score are the angles of the body (back), neck, upper arms, and wrists. Postures a and c have a RULA score of 7 with a body position that exceeds an angle of 60^{o}. The back has the highest pain. This pain is due to the body position being too bent with a flexion angle exceeding 60 degrees. If the flexion angle between the back and the vertical line of the body exceeds 45 degrees, it will feel symptoms of low back pain (Koopman et al., 2020; Omura et al., 2022). This will get worse if the position of the body twists or bends even a little. Changing body part inclination is necessary to reduce the health problems faced by mechanics (Jain et al., 2020; J. Wang et al., 2019). The back had the biggest decline from 91.67% to 33.3%. Waist and neck also decreased. This can be seen clearly especially the back which has changed when adding work facilities. The average body position changes from 0^{o} - 20^{o} in the new posture. In repairing the upper part of the motor vehicle such as the neck bending downwards, the position is not too bent inward to form an angle > 20^{o}. The position of the motorcycle workbench height is the same as the knee height of the advanced workshop mechanic so that the mechanic can repair the upper part while standing without bending or twsiting with a body position < 20^{o}. Significant changes that occur in the right knee, left knee, right and left wrist, right and left leg.

The decrease in MSD complaints was supported by evaluation of NMQ, RULA, OWAS, improvement of body posture through changes in the angle of inclination of body parts such as legs, back, arms, waist and neck. Complaints of MSDs also decreased in the right knee, left knee, right and left wrist, and right and left leg. The application of a work chair provides comfort to the legs because it does not become the body's support (Irawan et al., 2019; Mandal & Math, 2021; Zeverdegani et al., 2022). This study has analyzed the prevalence of work-related musculoskeletal symptoms among mechanics working in small-scale workshops using several subjective ergonomic assessment techniques such as NMQ, anthropometric surveys, and posture analysis based on RULA and OWAS. However, some limitations associated with this study have been identified. In this study, there were several limitations experienced in the study, such as the minimal number of samples. The small number of samples is because the research focuses on only one place, so the sample depends on the workers in that place. For further similar research, it is expected to use a larger sample so that the research results become more accurate because the research subjects are more diverse in terms of age, size, length of work, and others. The second limitation is the cost of the research. Research area. The design of research tools depends on discussions with respondents. Researchers adjust the design of the tool to the environment at the research site such as soil conditions, area, workshop conditions and others.

The methodology in this research can be used and applied in industry or other fields related to work ergonomics. Simple analysis with ADDIE ergonomics allows everyone or ergonomics to more easily check the design of security, safety, and health at work stations. Communities with low economics need tools that are easy to produce, use, operate without requiring large costs. The addition of ergonomic tools in the Maju Jaya workshop can improve work posture based on the OWAS and RULA methods. MSDs complaints have also decreased based on the NMQ complaints survey. This proves that using ergonomic tools that are simpler and more economical can help mechanics work more efficiently and effectively. Other small-scale industries can use this simple design for use especially in motorcycle repair shops, or it can be modified according to the desired needs. Future research is expected to examine more reference sources so that it can complement the shortcomings and limitations that exist in this study so that the reduction of MSDs complaints in motorcycle repair and maintenance workshops can achieve more accurate results. The design of the motorcycle workbench can be developed by the industry or researchers, such as more emphasis on manufacturing costs so that small-scale industries can use ergonomic tools at a lower cost, the use of a folding system on the motorcycle workbench so that it is more practical in storage, or replacement of tool components that are lighter but have stronger strength.

4. CONCLUSION

In a developing country like Indonesia, where the majority of the population is working in the informal sectors, there is a need for ergonomic tool intervention, which is low cost, and easy in terms of manufacturability with locally available materials. Motorcycle workshop repairing is one such sector where there was a need for such intervention. Assessment of work posture using the RULA and OWAS methods which were carried out after the implementation of the tool showed a decrease in the risk level. Improved work posture in reducing MSD complaints based on the NMQ questionnaire. It can be concluded that the motorcycle workbench can be used as an alternative solution to reduce MSD risk in the Maju Jaya workshop, especially in the sector of motorcycle maintenance and repair.

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