JURNAL ILMIAH TEKNIK INDUSTRI
ISSN: 1412-6869 (Print), ISSN: 2460-4038 (Online)
Journal homepage: http://journals.ums.ac.id/index.php/jiti/index
doi:10.23917/jiti.v20i1.13222

Analysis of Work Posture Using the Muscle Fatigue Assessment (MFA) and Novel Ergonomic Postural Assessment (NERPA)

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Abstract. *A company needs to know each employee's ability to reduce accidents that happen to workers due to a lack of study on ergonomic principles. The research was conducted at a construction company producing paving blocks in Kediri. The paving production capacity at the company is 1000 paving/day. In 2017, three work accidents were caused by the fast pace of workers reaching the tired phase while working. Pulling, lifting, and putting down in carrying weighty loads and the repetition frequency of intense activities trigger stress on body parts that affect the worker's performance. The purpose of this study is to assess and provide recommendations for improvements in work activities that have a hazardous risk value based on the MFA and NERPA assessment methods. The research on the MFA method shows that activities with dangerous risk (high/very high) were in transportation activities. For the NERPA method, activities with dangerous risks were in 3 activities at the finishing work station with a final score of 7. Recommendations for improvement are work posture improvement, physical environment improvement, and work facilities.*

Keywords: *muscle fatigue assessment, NERPA, musculoskeletal disorders, ergonomic*

I. INTRODUCTION

The International Labor Organization (ILO) estimates that globally, there are 2.3 million occupational accidents and fatal diseases each year, 160 million occupational diseases, and 317 million work-related injuries (WHO, 2013). This means that four workers die due to accidents or illnesses at work every minute, 300 suffer from work-related diseases, and 600 suffer from work accidents (Fass et al., 2017). The worsening of workers' physical health and the loss of working days impact their welfare, quality of life, and economy. For example, in 2011, more than 400,000 people in the UK suffered from illnesses caused by their work, resulting in 7.5 million days lost (Valero et al., 2016). Musculoskeletal Disorders (MSDs) are injuries or pain that affect muscles, joints, and tendons. MSDs result from not neutral posture, such as using too much force in lifting or carrying weights, bending and turning the back or limbs, exposure to vibrations, or repetitive movements (including keyboard typing). Work-related musculoskeletal disorder (WMSD) is the most common reason workers miss workdays, increased costs, and work disruption in developing countries (Arsalani et al., 2014; Hoe et al., 2012; Parno et al., 2017; Saberipour et al., 2019). According to the Bureau of Labor Statistics in the United States, musculoskeletal disorders (MSDs) account for 29 percent of all workplace injuries. Lower back pain is the most common disorder, followed by neck pain or musculoskeletal disorders (Hoe et al., 2012). Studies show that workers suffering from MSDs range from 20 to 60%. (Heidarimoghadam et al., 2020).

In America, MSDs reach approximately 6 million cases per year or an average of 300-400 cases per 100 thousand workers. This problem results in lost days for rest which causes companies to lose money due to lost productivity. It is estimated that the costs incurred due to MSDs are an average of 14,726 dollars per year or more than 130 million rupiah (Dimi et al., 2014). Meanwhile, the results of a survey by the Ministry

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Submited: 14-01-2021 Revised: 20-05-2021
Accepted: 06-06-2021

of Health of the Republic of Indonesia on health problem profiles in 2015 showed that around 40.5% of diseases in workers are related to their work. According to the study conducted to 482 workers in 12 regencies/cities in Indonesia, the health problems in workers generally are MSDs (16.0%), cardiovascular disorder (8.0%), a neurological disorder (6.0%), respiratory disorder (3.0%) and ENT disorder (1.5%) (Hartono, 2005). According to Irvan et al. (2020), Occupational Health and Safety are highly needed in Small and Medium Enterprises (SMEs) because almost 70% of SMEs in Indonesia are uninformed about Occupational Health and Safety. This impacted the productivity competitiveness of SMEs.

An industrial process is a working system that supports each other from each part in it. Company management often pays less attention to non-ergonomic work systems (Siska & Teza, 2012). It is important to consider the workstation component regarding the efforts to increase work productivity. Working conditions that do not consider work comfort, satisfaction, safety, and health will significantly affect the work productivity of workers. Improper work posture can cause losses and even accidents to employees (Bloom et al., 2013). It is essential to improve work posture to maintain workers' comfort in performing their work (Susihono, 2012). With a proper work posture, workers will need less rest, work faster and more efficiently.

On the other hand, long-term improper work posture will result in various health problems which can be fatal (Correia, 2016). One of the occupational complaints is Musculoskeletal Disorder (MSDs). MSDs are a group of pathological conditions which can affect the normal functions of the soft tissue of the musculoskeletal system, which includes the nervous system, tendons, muscles, and the supporting structures of body parts (Punnett et al., 2004). High risks postures include lifting, carrying, and putting postures. These postures can cause back and waist pain in workers. The research results on paving block workers showed no relationship between vibration intensity and MSDs complaints on paving block workers. It is also because not all workers are around the vibration source, which are tools or press machines. Workers work in the production section more than around the tools (Dimi et al., 2014). Bend over in the workplace should be kept to a minimum, even eliminated, because it can cause problems to the musculoskeletal system (Susihono, 2012). The increasing MSDs cases also increase the compensation costs incurred for workers (Jayanti et al., 2013).

The MFA (Muscle Fatigue Assessment) method is a technique in functional job evaluation developed by Rodgers, which characterizes the discomfort explained by workers in automobile assembly lines and fabrication tasks (Kalte, 2016). According to Moradpour et al. (2019), the MFA method is the most appropriate method to evaluate production tasks with less than 12 to 15 repetitions per minute with the same muscle group. It can also be used to study office work and services. This MFA method is excellent for a team evaluating its tasks and works. Then it can develop strategies to reduce risk exposure by defining occupational levels through the identification of postural and risk factors. The MFA method uses an MFA table as a reference to determine an assessment of the limb movement from toe to head on the work being performed, categorized based on the effort level, continuous effort duration, and effort frequency. The MFA method has been used in various industrial sectors such as Brick Production (Kalte, 2016), Assembly industry (Motamedzade et al., 2016), and maintenance operations (Ma et al., 2010). Rodgers suggested the Muscle Fatigue Analysis measure fatigue in muscles during different work patterns within the first 5 minutes of work. The theory was that muscle that is quickly fatiguing is more prone to injury and inflammation. Muscle injuries can be avoided if exhaustion can be reduced. MFA is best used to assess the risk of fatigue accumulation in activities that take an hour or more to complete and include uncomfortable postures or repeated exertions. Priority for change may be allocated to a role based on the possibility of exhaustion (Sharan et al., 2018).

The NERPA (Novel Ergonomic Postural Assessment) method is generally used in the manual assembly industry applied in automotive assembly process. It is a development or modified version of the RULA (Rapid Upper Limb Assessment) method. In his research (Sanchez-Lite et al., 2013) Novel Ergonomic Postural Assessment (NERPA) method is an ergonomic method used to analyze and assess the work posture of the upper body. The NERPA method modified some of the body part assessments observed in the RULA method. Therefore, this method can detect work postures with ergonomic risks and is more sensitive to ergonomic improvements detection than the RULA method. According to (Bloom et al., 2013), the NERPA method provides changes to the arm, neck, back, and wrists from the RULA method. The NERPA method still retains the original A, B, and C tables from the RULA method. It also established three score ranges on the upper arm following the ISO 11226:2000 standard. The NERPA method has been used in various industrial sectors such as pharmaceuticals, automotive, and assembly (Yazdanirad et al., 2018), manufacturing companies (Habibi et al., 2017), aeronautic and automotive industries (Sanchez-Lite et al., 2013). NERPA enables engineers to make informed decisions about workstation design and postural evaluation to reduce the risk of musculoskeletal injury during manual operations (Sanchez-Lite et al., 2013).

This research used the Muscle Fatigue Assessment (MFA) method to analyze three physical risk factors in the workplace: effort level, work duration, and work frequency. Meanwhile, the Novel Ergonomic Postural Assessment (NERPA) method was used to identify the upper body movement. The MFA method was chosen because the assessment variables used were more comprehensive and suitable for analysis which provides an assessment related to ergonomic risk problems in the workplace and accuracy in assessing the duration and frequency of the efforts. Meanwhile, the NERPA method was used to analyze more detailed/specific work postures and involve workers' upper bodies. The NERPA method does not use modifications to assess the legs but presents changes for the arms, neck, trunk, and wrists. Following this logic, the output of each body part with changed scores is shown. The NERPA method differs significantly from the RULA method in that it modifies the assessment of specific joint ranges while retaining the same assessment framework. This method can identify postures of ergonomic danger and is more sensitive to identifying an ergonomic change than the RULA method for the work environments under which it was used(Sanchez-Lite et al., 2013).

Based on the interview results with production staff engaged in paving block construction in 2020, there were 3 cases of occupational accidents caused by worker fatigue in the finishing department and hampered the production process for quite a long time. Direct observations of the construction workers showed that they quickly got tired (Ramadhan, 2017) and complained about musculoskeletal muscle pain. Improper posture factors such as turning, bending over, and carrying loads that exceed the maximum limit cause musculoskeletal complaints. Workers generally experience it with repetitive movements (Bagas and Ertansyah, 2015). Some examples include the working posture in the finishing process, the transfer of molded paving products manually by bending over and lifting the wet mold from the hydraulic paving block press machine and arranging it by bending over and back to the standing position. The distance from the drying area to the press machine is 5 meters in open room conditions. The awkward postures of workers repeatedly and continuously can cause injury to workers/operators (Febriyanti, 2008), starting from taking 8 molded paving per tray, weighing 2.46 kg per paving, or in a total of 19.68 kilograms while bending over. Next, workers lift it in an upright position and transfer it to the drying area by walking for 5 meters, then bending over again and placing the wet pacing for the drying process. On average, workers bending over 300 times, lifting 240 times, putting 240 times, and standing upright 280 times within 1 hour. This movement is repeated for 8 hours a day.

This research uses the Muscle Fatigue Assessment (MFA) and Novel Ergonomic Postural Assessment (NERPA) method in analyzing improper work postures that affect operator performance at work station in mixing and finishing stages on the paving block production floor. This research results obtained that from the 2 process stages, namely mixing and finishing, the assessment value using the MFA method resulted in High and Very High values, which means that there is a need for improvement/change of work environment at the finishing work station.

The assessment results using the NERPA method showed a final score of 7 at the finishing workstation, which means that there is a need for further research and immediate improvement in the work activity at the said workstation. This research proposes improving the finishing work station by improving the workers' posture in transporting the molded products, increasing the height of the paving block press machine, and adding other supporting facilities in the arranging activity to reduce the unrecommended bending position (Purwaningsih et al., 2017).

II. Research Method

This research was conducted in the construction area of the paving block production in Kediri in the mixing and finishing section. The selection of mixing and finishing production lines was based on the previous research literatures and based on direct survey results observation in production lines of paving block construction. The determination of this type of work is the initial stage in the assessment using the MFA method. The research object was carried out manually and repeatedly. Therefore, risk analysis was necessary with 4 workers divided into 2 people at the mixing section and another 2 at the finishing section. The types of data needed in this research were primary and secondary data. Data collection was based on direct surveys and interviews with the management and company operators.

Primary data was obtained based on the observation sheets, photos/videos of survey results, and direct interviews with workers and management. Different parts were video recorded, and photographs were taken to capture various movements and postures of the workers during that specific mission, such as Material Dredging, Material Pouring, Molding Results Lifting, Molding Results Transporting, and Molding Results Laying. The assessment methods for posture, muscle exhaustion, and at-risk body parts were chosen based on the tasks to be assessed. The researcher evaluated each assignment individually, and the findings were analyzed to develop the final recommendations. The data required in this research include (a) analysis of photos/videos of survey results, (b) observation results, and direct interviews. Secondary data were obtained from archives and documents related to occupational risks, assessments of work activities related to paving production construction companies, and previous kinds of literature. In taking primary data, the results are taken from direct observation and photo analysis of workers during the paving process on the production floor. Such as the position and posture of workers when doing paving production and repetitive movements that workers often do. The researchers took a sample of 4 workers/operators and 5 work postures when the production process activities were carried out from this analysis. There are 2 activities and finishing, and there are 3 work activities observed in the mixing process. When the results have been obtained, the image is then processed using software to determine the angles formed from the activities carried out, processed using the MFA and NERPA methods.

Determination of methods was conducted after analyzing the observation results and previous literature to determine the method used. This research uses the MFA (Muscle Fatigue Assessment) method to analyze three physical risk factors in the workplace, which include effort level, continuous effort duration, and effort frequency; and the Novel Ergonomic Postural Assessment (NERPA) method to identify the upper body movements that include body postures, muscles activities, and load weight.

The assessment was carried out for work posture, especially on the material dredging and material pouring at the mixing stage and lifting, transporting, laying the paving mold results at the finishing stage. Assessment using both methods resulted in scores and analysis on manual work performed by the operator in occupational risks

Table 1. Recapitulation of Work Activity Data at the Mixing and Finishing Stage

No	Work Station	Activity	Identification
1	Mixing	Material Dredging	The operator performs the material dredging activity with a body position that bent too much and bent legs. The operator is in a standing position, hands are bent holding the shovel and hoe with lifting load that weighs (± 3 kg). The wrist reaches forward. The back, shoulders, and neck area in a bent position. This posture is done repeatedly.
2	Mixing	Material Pouring	In this material pouring activity, the operator is standing. Back, shoulders, and neck bent forward. Hands are holding the material container, and the wrist reaches forward. This posture is done repeatedly. The loads lifted weighs (± 3 kg).
3	Finishing	Molding Results Lifting	This activity is carried out repeatedly in a bending position to pick up the mold, and the right hand rests on the molding machine while the left hand pulls the molding pan. Then, the operator standing not in a proper position when lifting the molding results. The hands are bent, and the wrists support the molding pan that weighs (± 19.68 kg). Legs, shoulders, and waist are in a bent position.
4	Finishing	Molding Results Transporting	This activity is carried out repeatedly in an upright body position. The hands are bent, and the wrists support the molding pan that weighs (± 19.68 kg). The back, neck, shoulders, and waist turn > 180° after the pan is lifted. The operator walks to move the molding pan as far as 5 meters from the press machine. Legs, waist, shoulders, back, and neck are in a straight position.
5	Finishing	Molding Results Laying	This activity is carried out repeatedly with a body position that turns 90° and bends. The wrists support the molding pan that weighs (± 19.68 kg). The hands are reaching down, while the legs, waist, and neck are bent.

assessment in the paving block production line. In the MFA method (*Rodgers Muscle Fatigue Analysis*, 2018), Low and Moderate scores in the assessment results mean acceptable postures. However, High and Very High scores tell improvement is necessary on the workstation to support workers' posture in doing their activities. Then, using the NERPA method, a final score of 1-2 (level 1 category) means work posture is still acceptable, 3-4 (level 2 category) means further research is needed, 5-6 (level 3 category) means further research and action soon is required, and 7 (level 4 category) means further research and immediate action is needed (Setiyowati & Pratiwi, 2017)

After obtaining the final score analysis results and the action level in the above method, this research proposed improvement in the physical environment, operator's work posture, and supporting facilities (Pramestari, 2017). Based on the results of occupational risk assessment, the determination of improvement proposals was based on previous research. Therefore, the improvement determination both in postures or facilities has been considered based on previous research results. After gave the proposed improvement, researchers drew conclusions and suggestions based on the assessment results obtained.

III. RESULT AND DISCUSSION

Identification of Each Work Station

The initial stage was performing the observation process at the facilities and workers' postures in each activity at both work stations by direct observations and identification based on photos/videos taken at the location during the production process. This was conducted to find and determine the parts that tend to become the factor causing fatigue when workers perform such activities. Researchers also used this stage to describe the load and posture positions during the production process in identification descriptions.

Table 1 describes that the average activity performed by workers tends to form a bend-over posture which was done repeatedly in each activity (Al-Otaibi, 2001). Based on Table 1, researchers are focused on assessing the 5 activities using the MFA and NERPA methods in assessing occupational risk, physical environment, and workers' posture in performing their actions on the paving block production floor. The 5 activities include material dredging (mixing), material pouring (mixing), molding results lifting (finishing), molding results transporting (finishing), and molding results laying (finishing). The assessment results will provide an overview of proposed improvements that can be carried out immediately to improve workers' discomfort in body posture and work environment. Table 2 shows the Workers Data at Production Department.

Work Posture Assessment of Mixing Work Station

The following is an assessment using the MFA and NERPA methods at the mixing workstation.

Based on Figure 1., the assessment results obtained with MFA and NERPA methods are presented in Table 2. MFA covered 3 assessment factors, while NERPA covered upper body movement, which includes body posture, muscle activities, and load weight (Sanchez-Lite*et al.*, 2013). The MFA method resulted in the highest risk score of M (moderate). In contrast, the NERPA

Table 2. Workers Data at Production Departement

No	Worker	Age	Activity	Experience (year)
1	Worker 1	28	Lifting, Transporting, Laying	1
2	Worker 2	40	Dredging, Pouring	4
3	Worker 3	38	Dredging, Pouring	3
4	Worker 4	36	Lifting, Transporting, Laying	3
5	Worker 5	32	Lifting, Transporting, Laying	2

Table 3. Recapitulation of MFA and NERPA Assessment Methods on Work Posture at Mixing Station

MFA (Muscle Fatigue Assessment) Method												
Activity	Neck	Shoulders		Back	Arms/ Elbows		Wrists/Hands/ Fingers		Legs/ Knees		Ankles/ Feet/Toes	
		R	L		R	L	R	L	R	L	R	L
Material Dredging	L	M	M	M	M	M	M	M	L	L	L	L
Material Pouring	L	M	M	L	L	L	M	M	L	L	L	L

NERPA (Novel Ergonomic Assessment) Method				
Activity	Table A Score	Table B Score	Table C Score / Final Score	Risk Level
Material Dredging	4	4	**6**	3 (Further research and action in the near future is needed)
Material Pouring	4	1	**6**	3 (Further research and action in the near future is needed)

Note: VH (Very High); H (High); M (Moderate); L (Low) method resulted in a final score of 6, which provides a recommendation of risk level 3 (further research and action soon are needed).

The above assessment was carried out by (Hendra 2011), which results in a cumulative analysis categorized as high on the back, neck, shoulders, and elbows. Therefore, improvements are focused on processes that involve these body parts. Based on the cumulative results, there are 5 high risks work activities that mostly involve the back, neck, shoulders, and elbows. From the assessment conducted (Bagas and Ertansyah, 2015), three postures out of five work postures observed have the most significant risk of injury, which can affect the production process.

From the two assessment results above, work risk is still acceptable because it does not have a high-risk score. However, it still needs further investigations. This can be taken into consideration in the company to make decisions to improve the work environment in the paving block production line. The assessment recapitulation results in the material dredging and material pouring activities in the mixing process are presented in Table 3.

Work Posture Assessment of Finishing Work Station

The assessment results on 3 activities at the finishing workstation were obtained using the MFA and NERPA methods. The MFA method covered 3 assessment factors (*Rodgers Muscle Fatigue Analysis*, 2018), while NERPA covered upper body movement, which includes body posture, muscle activities, and load weight presented in Table 3. and Figure 2. It showed that the activity at the finishing work station has a Very High (VH) score in the MFA assessment method and scored H (High) in several other body parts. Meanwhile, the NERPA method assessment showed a final score of 7 in all activities at the finishing workstation. Therefore, these results provide a recommendation at risk level 4, which means that further research and immediate action are needed.

The above assessment was also conducted by (Hendra 2011), which showed that the cumulative analysis was categorized as high on the back neck, shoulders, and elbows. Therefore, improvements that are focused on the processes that involve these parts are necessary. Based on the cumulation results, 5 work activities possess high risks, which tend to occur at the back, neck, shoulders, and elbows. Then, (Dimi *et al.*, 2014) stated that the cause of MSDs in paving block workers is work or body position during the work activities. Additionally, there are also repeated loads on the muscles in awkward situations that

Table 4. Recapitulation of MFA and NERPA Assessment Methods on Work Posture at Finishing Station

MFA (Muscle Fatigue Assessment) Method												
Activity	**Neck**	**Shoulders**		**Back**	**Arms/ Elbows**		**Wrists/Hands / Fingers**		**Legs/ Knees**		**Ankles/ Feet/Toes**	
		R	**L**		**R**	**L**	**R**	**L**	**R**	**L**	**R**	**L**
Paving Lifting	VH	M	M	H	L	H	L	H	M	M	M	M
Paving Transporting	L	M	M	L	M	M	M	M	L	L	L	L

Note: VH (Very High); H (High); M (Moderate); L (Low)

NERPA (Novel Ergonomic Assessment) Method				
Activity	**Table A Score**	**Table B Score**	**Table C Score / *Final Score***	***Risk Level***
Paving Lifting	4	7	7	4 (Further research and immediate action are needed).
Paving Transporting	4	2	7	4 (Further research and immediate action are needed).
Paving Laying	4	3	7	4 (Further research and immediate action are needed).

causing injury or trauma to the soft tissue and nervous system. The NERPA method assessment conducted (Setiyowati & Indah Pratiwi, 2017) showed that 11 activities are at risk level 4. This indicates that such activities need further research and immediate action.

From the two assessment results above, the risk scores are very high and high, which are not recommended for workers. Therefore, further investigation and immediate actions are needed. The company can consider this assessment to improve the work environment in the paving block production line. The assessment recapitulation results in lifting, transporting, and laying the molding results of the paving block in the finishing process are presented in Table 4.

Improvement Recommendation

The proposed improvements made based on the highest level of action were then analyzed to find the causes for variables of each method. The following are activities that require immediate improvement in both the work environment and work posture:

Lifting Activity

The assessment and calculation results using the MFA and NERPA methods on these activities are high, with a final score of 7. This indicates that the activities carried out by workers are work posture hazards. This high score is caused by the position of the back that bends 48.5° forward with pressure on the neck and wrists that pulls the paving pan from the machine. This causes the body in a lower position, and the hands to reach too far straight forward-down, and the legs bend and pressing when transporting paving from the paving block press machine. Therefore, the proposed recommendations are improving the work posture and increasing the press machine height. By doing this, the workers will be in a neutral standing position so that when they pull the paving pan, their back is not bent too far, the legs are not bent while holding the position, the neck is not pressured too much, and the arms are not reaching forward too far.

The height improvement of the hydraulic paving press machine is shown in Figure 3. The original height of this machine measure from the ground level to the lower molding vibro section is 35.7 cm. Therefore, an additional value of 79.3 cm was added to level the machine height during pressing with the conveyor roll height that has been adjusted to the assessment of the operators' proposed work posture. The final size of the hydraulic paving press machine from the ground level to the bottom molding vibro section is 115 cm or as high as the operators' waist when lifting the paving block mold. Then, the width of the media to increase the height is following the width of the hydraulic paving block press machine of approximately 80 cm. And for media used as the basis for a press paving block machine in the form of cast concrete or in the form of a steel plate that has been adjusted to the weight capability of the paving block press machine and size that has been determined.

Figure 4 shows the activity of paving block transporting in which the initial posture is standing with bent knees. This posture is

Figure 2. The activity of Lifting, Transporting and Laying of Molding Results.

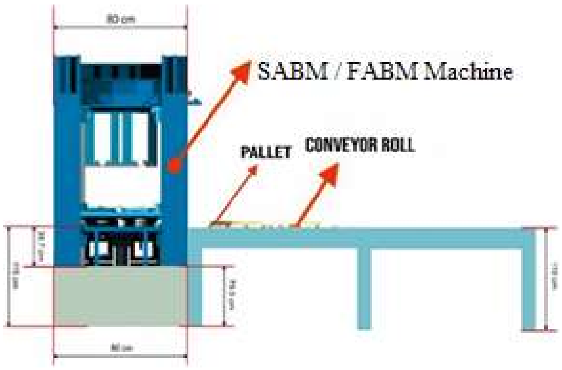

Figure 3. Improvement in the Height Position of Paving Block Press Machine.

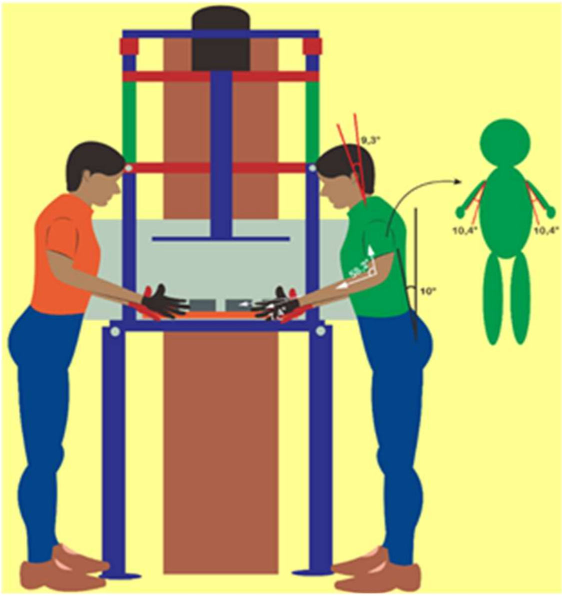

Figure 4. Improvement the height of Press Machine

categorized as high level due to the back, wrist, neck, and arms positions. The initial position is 48,5° for the back, 43,3° for arm, 25,5° for neck, and 168° for the arm. Then (Purwaningsih *et al.*, 2017), the proposed posture is a straight body position. The head is parallel to the object subjected to the work, and workers are recommended not to work while bending and twisting. The results of these improvements are work posture score of 9,3° for the neck, 10° for the back, 58,2° for the arm, and 7,4° for wrists.

Transporting Activities

The assessment and calculation results using the MFA and NERPA method in the paving block transporting activities are at a moderate and final

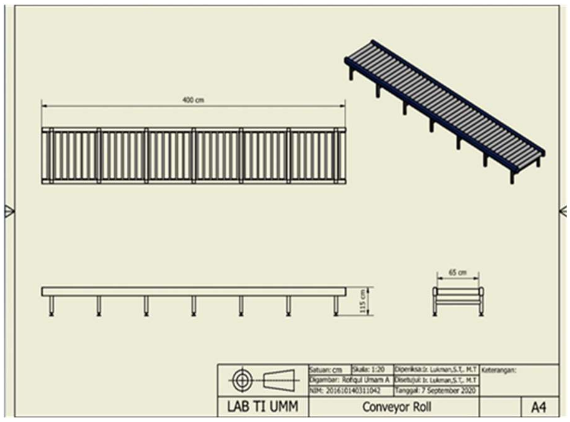

Figure 5. Conveyor Roll

score of 7. This indicates that the activities carried out by workers are work posture hazards. This high score is caused by the activity performed during paving block transportation while carrying the molding results that weighs ± 19.68 kg with turning back position. Shoulders are lifted so that the arms reach forward straight while holding the heavyweight that they carry. The wrist is in a bent position while holding the heavy load. These positions are carried out > 4 times/minute, which poses a risk to workers.

The proposed improvement is to add work facilities for the paving block transporting activities in conveyor roll, as shown in Figure 5. With this improvement, workers do not need to hold a very heavyweight of ± 19.68 kg to the drying area, and workers only pull the molding results on a pan assisted by the conveyor manually. This improvement is carried out to improve the not recommended position in work postures during the work activities.

Laying Activities

The assessment and calculation results using the MFA and NERPA method in the paving block laying activities are at a moderate and final score of 7. This indicates that the activities carried out by workers are dangerous due to the improper posture by the workers themselves. The question is laying the paving, which makes the workers bend their back forward with heavy loads. Since the floor distance is too low, it forces the workers to bend and bend their knees while carrying heavy loads. This position results in a high

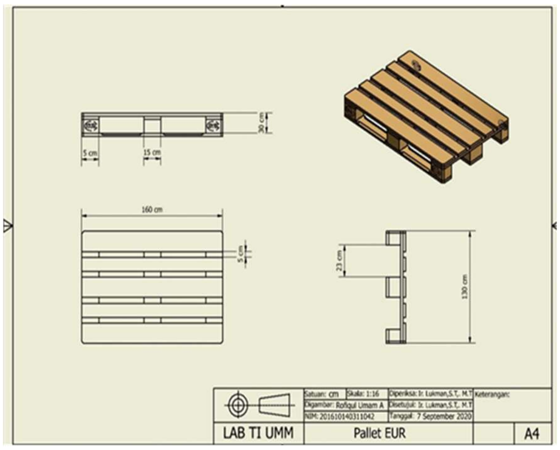

Figure 6. Pallet/Skid design.

assessment score. The proposed improvement is adding work facilities such as pallets/skids higher than the ground level to make the paving block laying activities easier without making the body bend too much or forcing the arms and wrists to hold heavy loads. (Nugroho, 2020) stated that the pallet designed can improve the operators' work posture in carrying out their activities.

According to (Riskha 2017), the lifting activity when passing the solid raw materials requires the body to bend in her research. The work postures of the two workers are formed because of the low lift platform of only 1 pallet. To reduce the posture score of the two workers, it is necessary to add a pile of pallets as a lifting platform at the raw materials lifting stage. The position should be parallel to the knees or as high as 60.5 cm above the ground.

This facility also aims to reduce the risk level and improve work posture on the upper arms, forearms, neck, back, and legs to achieve a good work posture score or a low-level score. Figure 6 shows the detailed improvement proposal for the paving block lying activity by adding work facilities in pallets/skids.

After doing repairs on a posture and production facilities in the working environment of paving blocks, it will get the final results are acceptable assessment score and have lower risk with simulation tools and posture that has been redesigned in the work environment production of paving blocks. For Lifting activity from score 7 could reduce to 2 scores for NERPA, which means acceptable and MFA low risk. For paving block transporting activities are at a moderate level and final score of 7 after improvement it could get 2 scores for NERPA which mean acceptable and for MFA low risk. The MFA and NERPA method in the paving block laying activities are at a moderate level and final score of 7, and after improvement, it can reduce score 1 for NERPA, which mean acceptable and Low Risk for MFA.

According to the findings of a study conducted by Habibi et al. (2017), the NERPA has a strong ability to identify low risks. The NERPA approach has limited predictive ability for high and very high risks. The NERPA method was created solely to correct the RULA angles. Nonetheless, the results showed that this angle correction was not very successful. While angle correction, the elevation of the classification number of angles, and consideration of more comprehensive angular ranges for higher risks improved the predictability of low risks, it hampered the ability to identify high risks. Rodger's Muscle Fatigue Assessment scale is used to compare a task's physiological demands to published requirements for appropriate levels of oxygen consumption for whole-body or upper-body function. The neck, shoulder, side, wrist, arm, back, thighs, elbow, and knee are all included in this scale. This scale is suitable for jobs that require frequent and long periods of standing, as well as uncomfortable postures. Work-related musculoskeletal disorders of the lower back, spine, and shoulders are strongly linked to both of these biomechanical risk factors. The worker was at a moderate to high risk of developing WRMSD, with certain postures posing a very high risk. Environmental and workstation modifications, preparation, role redesign, ergonomic principles implementation, and organizational improvements are all recommended as ways to minimize risk (Sharan et al., 2018).

IV. CONCLUSION

Based on the observation results at the production site and the assessment using both MFA and NERPA methods, it was found that the finishing work station has the highest score for risk factors and requires immediate action. The MFA method assessment for molding results lifting activity obtained Very High and High scores in several body parts. In contrast, the NERPA method assessment showed a final score of 7 on the three activities, suggesting that further investigations are needed. The company is advised to make improvements as soon as possible, either by improving work posture or work environment by increasing the paving block press machine heights or adding work facilities to support the workers' needs to carry out their activities at the work station. Future research can focus on creating a tool for workers to minimize the risk of injury to workers.

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