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Analysis of Work Posture and Risk of Musculoskeletal Complaints of Loading-Unloading Workers Using the REBA Method at PT. XYZ

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A B S T R A C T

PT XYZ is an airport manager in Indonesia engaged in the business of development, trade and services, and genuine estate. In the manual transportation of goods, extreme positions are still carried out. So that complaints of pain appear in several parts of the body, such as the neck, back, upper arms, and legs. The purpose of this study was to determine musculoskeletal complaints and analyze the work posture of workers. Risk assessment using the Rapid Entire Body Assessment (REBA) method because it can provide a more detailed evaluation of the level of risk of work posture as a whole. Based on the results of risk assessment research using the REBA method, workers in the Loading-Unloading Apron Area squatting position get a work posture risk value of 9, and the Apron Area standing position gets a work posture risk value of 8, where the value includes action level 4. For workers in the Loading-Unloading Makeup Area, the bending position gets a work posture risk value of 11, where the value consists of action level 4. Suggestions for improvement that can be proposed are making changes to the position of work postures and designing assistive devices.

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1. INTRODUCTION

Population growth in Indonesia is increasingly showing high numbers and is directly proportional to the need for land, sea and air transportation. The development of air transportation services shows a significant increase in time, and air transportation is much shorter, more efficient, and economical. As a result of these developments, every air company increases its productivity to compete and survive. Each airport must provide facilities that support and comply with established aviation safety and security standards to achieve aviation services and productive workers. According to Meliani et al., (2022), work posture is the various positions of the body members during their work activities. This non-ergonomic work posture is experienced by many workers who require excessive strength, which affects their part while working, one of which is workers who lift goods that use the spinal muscles as support. As a result, repetitive activities and inappropriate work postures can cause Musculoskeletal Disorders (MSDs). The creation of ergonomics of the work process on work postures will create safe and comfortable conditions for workers and can also increase efficiency in the physical, mental, and productivity conditions of these workers in carrying out their daily activities (Atuna & Safirin, 2023).

PT XYZ is an airport manager in Indonesia engaged in the business of development, trade and services, and genuine estate. PT XYZ Ground Handling serves services at Juanda Airport - Surabaya related to passengers, crew, cargo, and post services. Aviation and ground handling services are inseparable units where the implementation uses Loading-Unloading workers. Loading-Unloading workers are units whose activities include loading and unloading goods in the form of bags/luggage and cargo.

Figure 1. Material handling (illustration-1)
Source: personal document

Figure 2. Material handling (illustration-2)
Source: personal document

Figure 3. Material handling (illustration-3)
Source: personal document

While loading and unloading bags/suitcases and cargo, there are complaints about Loading-Unloading workers who have been observed and interviewed by the head of Loading-Unloading workers. In the Loading-Unloading, workers' activities are divided into two places, namely the makeup area and the airport apron area. In manually transporting goods, extreme positions are still carried out. So that complaints of pain appear in several parts of the body, such as the neck, back, upper arms, and legs. Thus, to solve these problems, research was conducted on analyzing musculoskeletal complaints of Loading-Unloading workers who transport goods in the form of bags/suitcases and cargo with the Nordic Body Map.

Then a risk assessment is carried out using the Rapid Entire Body Assessment (REBA) method because it can provide a more detailed assessment of the level of risk of work postures. This method assesses the upper and lower body's work posture, which will be given a score with its level and the importance of the action that needs to be taken.

2. LITERATURE REVIEW

A. Ergonomics

Ergonomics comes from the Greek words ergon (work) and nomos (rules); overall, ergonomics means work-related rules. Ergonomics is the science of humans to increase comfort in the work environment. Ergonomics is a science and its application that seeks to harmonize work and the environment against people or vice versa to achieve the highest productivity and efficiency through optimal human utilization. In short, ergonomics is the adjustment of work tasks to the condition of the human body to reduce the stress that will be faced. The efforts include adjusting the workplace's size to the body's dimensions so as not to tire and adjusting the temperature, light and humidity to suit the needs of the human body (Hutabarat, 2017). The scope of ergonomics is not only limited to organising a good working position but also includes engineering, anthropometry, and design. The Center for Occupational Health and Safety of the Indonesian Ministry of Health (2008) in (Andriani et al., 2017) states that the scope of ergonomics includes several scientific aspects, namely: (a) Engineering, (b) Physical, (c) Anatomy, (d) Anthropometry, and (e) Physiology.

To increase productivity and creative ideas in the world of work, we must first feel comfortable in the work environment. Many companies have started to pay attention to the work environment of their workers. They are making policies that raise the mood of their workers, for example, providing a comfortable restroom with a calm atmosphere. There are many ways to create a relaxed work environment, whether it's an initiative from the employee or, indeed, the policy of the business actor. There are many ways to make the work environment comfortable. One way that can be tried to create a healthy and comfortable work environment is to apply ergonomics in the workplace (Simanjuntak & Susetyo, 2022).

B. Manual Material Handling

Manual Material Handling (MMH) moves goods or objects in a production process that uses human labor. Manual handling can also be interpreted as transportation by workers, in which case workers carry out activities such as lifting, pushing, pulling, transporting, and moving goods. According to the American Material Handling Society, MMH is an art and science that includes handling, moving, packaging, storing and controlling supervision of materials in all forms. Manual moving, if not done ergonomically, will cause accidents. Work accidents occur due to damage to body tissue caused by overload lifting. Reality shows that humans have limits to their abilities, both regarding cognitive, physical, and psychological observation abilities. The human skeletal system has several vulnerable points, namely in the cervical vertebrae, vertebrae and groin (Purnomo, 2017).

This approach considers the average metabolic load from repetitive lifting activities and the amount of oxygen consumption. There is evidence that the greater the amount of material lifted and moved in a day by a person, the faster it will reduce the thickness of the intervertebral disc or the element between the spine segments. This phenomenon illustrates that accurate measurement of labour height can be used to evaluate workload (Ashary Aznam et al., 2017).

C. Anthropometry

The term anthropometry comes from two words: "anthro", which means human, and "metri", which means size. Anthropometry is definitively stated as a study measuring the human body's dimensions. Human anthropometric measurements can be divided into 2 types: static and dynamic/functional. The static dimension is measured when the human body has a static (fixed) attitude. The dynamic/functional dimension is measured when the human body moves in certain work position attitudes (Zetli et al., 2019). Anthropometry is a collection of numerical data related to the physical characteristics of the human body, size, shape and strength, and the application of these data to handle design/design problems. Anthropometry will be widely used as an ergonomic consideration in the design process of products and work systems requiring human interaction (Aras et al., 2019).

Anthropometric data that presents size data from various human limbs in specific percentiles will significantly benefit when a product design or work tool is made. For the creation of a product to be following the size of the human body that will operate it, the principles that must be taken in the application of anthropometric data must be determined first as follows (Montororing, 2021): (1) Design principles of products with extreme sizes. (2) Principles of product design between a specific size range. (3) Principles of product design with average size.

D. Musculoskeletal Disorders

Musculoskeletal Disorders (MSDs) or musculoskeletal disorders are a series of muscle, tendon, and nerve pain. Musculoskeletal Disorders can cause complaints in the skeletal muscles that cause discomfort to a person; this pain can cause various complaints, from mild complaints to severe complaints, caused by stretching muscles that are too heavy and the duration of loading is too long, can cause damage to joints, ligaments and tendons (Meliani et al., 2022). Complaints in the Musculoskeletal system are complaints on parts of the skeletal muscles felt by someone ranging from complaints on parts of skeletal muscles felt by someone ranging from very mild to very painful complaints. If the muscles receive static loads repeatedly and for a long time, it can cause complaints in the form of damage to joints, ligaments or tendons (Hutabarat, 2017).

E. Nordic Body Map

Nordic Body Map is a body map questionnaire containing data on body parts complained of by workers. The Nordic Body Map questionnaire is the most commonly used questionnaire to determine discomfort in workers, and this questionnaire is most often used because it is standardized and neatly arranged (Restuputri, 2017). Nordic Body Map (NBM) is a measurement method for identifying skeletal muscle complaints that uses a worksheet or worksheet in the form of a body map or body map that is easy to understand, simple, and requires a short time to implement (Tamala, 2020). Here is Figure 4, body map on the Nordic Body Map questionnaire, which consists of 28 body parts or muscle points. In its assessment, this Nordic Body Map questionnaire uses a "4 Likert scale" with a scale of 1 to 4. Respondents are asked to evaluate the parts of their body that feel Pain during work activities according to the predetermined Likert scale.

Four (4) Likert scales on the Nordic Body Map questionnaire represent indicators of no pain (N), quiet pain (Q), pain (P), and extremely pain (E), which are subjective to each respondent who gives an assessment. When respondents do work, there will be data which is then analyzed to determine or understand the ergonomics of a work process (Atmojo, 2020).

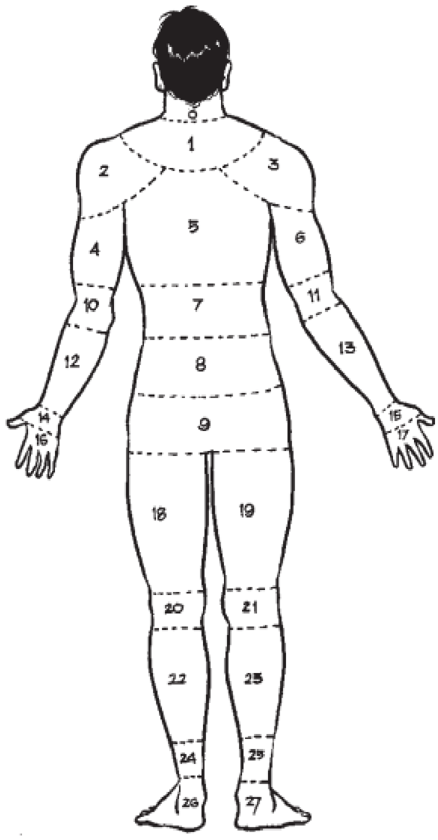

Figure 4. Body map
Source: Tarwaka et al., (2004)

According to Fikri et al., 2022, the Nordic Body Map questionnaire assessment classified the complaints felt by workers while working as follows: (a) Normal or No pain value 0, If you do not feel complaints about the worker's body parts. (b) Feel a little pain value 1 if you feel occasional pain or tingling. (c) Feeling pain score 2, if you often feel pain in the worker's body parts. (d) Feeling very sick score 3, if you feel aches and pains on the worker's body parts for a long time.

F. Rapid Entire Body Assessment

According to Hignett and Mc Atemney, Rapid Entire Body Assessment (REBA) is a method developed in ergonomics. It can be used quickly to assess the work position or posture of a worker's neck, back, arms, wrists and feet. In this REBA method, the analysis of the overall posture of the worker is grouped into two parts. The first part, or Group A, consists of the neck, trunk, legs, and force/arm parts, while the second part or Group B, consists of upper arms, lower arms, wrists, activity, and coupling (Anthony, 2020). According to Mc Atamney (2000) in Alifiana, et al., (2021) the results of REBA Analysis are in the form of risk level levels and suggested changes, where level 1 means that the risk does not need to be considered and there are no suggestions for improvement. Level 2-3 means the risk is low, and action may be required. Levels 4-7 mean that the risk is moderate and action is required. Levels 8-10 mean the risk is high and immediate action is required. Levels 11-15 mean the risk is very high and emergency repairs are needed.

The data processing methods used in this study are the Nordic Body Map questionnaire and the Rapid Entire Body Assessment (REBA) method. The identification process itself is done in several ways, as follows: (1) Explain the Nordic Body Map questionnaire and the Rapid Entire Body Assessment (REBA) method to the research subjects. Then the respondent is asked to fill out a sheet of paper Nordic Body Map questionnaire can recognize the parts of the body that experience complaints and those that do not experience complaints to workers when doing risky work. (2) Determine workstations that require improvement based on the Nordic Body Map questionnaire results. (3) Taking data on the posture of workers while working. Data collection is carried out using photo or video assistance. Taking photos and recording videos is done to get a detailed picture of workers' posture from the neck, back, arms, wrists to feet. This step is done so that researchers get detailed (valid) posture data so that accurate data can be obtained from the results of photos and recordings for the next stage of calculation and analysis. (4) Determination of the angles of the worker's body parts based on the provisions of the Rapid Entire Body Assessment (REBA) method. (5) Calculating work posture data using the Rapid Entire Body Assessment (REBA) method. REBA analysis is carried out by dividing the body posture into two groups. The first part, or Group A, consists of the neck, trunk, legs, and force/load, while the second part or Group B, consists of upper arms, lower arms, wrist, activity, and coupling. (6) The REBA value is obtained from the sum of the Group C value (a combination of Group A and Group B values) with the worker's activity value. The REBA value determines the risk level and actions that need to be taken to reduce the risk of injury and work improvement. (7) Determine the action level of the Loading-Unloading worker's work position. (8) Obtain the final score value, namely the REBA value. (9) Proposed work posture improvements to reduce the risk of work postures by performing good and correct work postures.

3. RESEARCH METHOD

The worker data used is the Loading-Unloading section workers at PT XYZ. The number of workers successfully collected in the Loading-Unloading section is 21 in the Apron Area section and 21 in the Makeup Area section. The following is data on the number of workers who have been collected. The variables associated with this study are: (a) The dependent variable in this study is the risk value of the work posture of Loading-Unloading workers. (b) The independent variables in this study are the data from the Nordic Body Map questionnaire, consisting of 28 complaints and the work postures of Loading-Unloading workers, such as: bending, standing, and squatting.

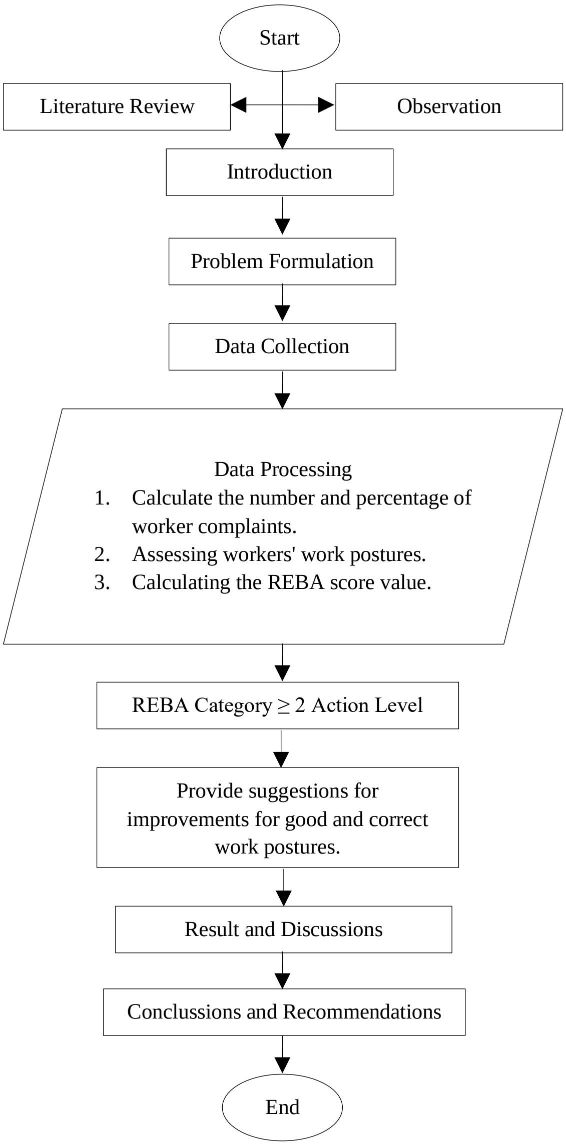

Figure 5. Research flowchart

4. RESULT AND DISCUSSION

A. Nordic Body Map

Data was taken based on questionnaires submitted by researchers for respondents. Samples were taken from the population of PT XYZ Loading-Unloading workers, with the following formula

$$n = \frac{\mathrm{N}}{1 + \mathrm{N.e}^2}$$

Where
n = Number of Samples
N = Total Population
e = Error Tolerance (error tolerance limit)
Then the sample calculation is as follows:

$$n \quad = \frac{70}{1 + 70.(0,1)^2}$$

$$n \quad = 41,17 \approx 42 \text{ respondents}$$

Therefore, this research data was taken from PT XYZ loading and unloading workers who complained of pain. So direct observation and interviews were conducted with 21 workers in the Apron Unloading Area and 21 in the Makeup Unloading Area for follow-up.

Table 1. Results of the nordic body map questionnaire

No	Locations	Morbidity Rates					
		F		Q		E	
		T	%	T	%	T	%
0	Pain in the upperneck	10	24%	9	22%	-	-
1	Pain in the lower neck	15	37%	15	37%	-	-
2	Pain in the left shoulder	13	32%	1	2%	-	-
3	Pain in the right shoulder	12	29%	1	2%	-	-
4	Pain in the left upper arm	-	-	-	-	-	-
5	Pain in the back	-	-	6	15%	38	93%
6	Pain in the right upper arm	-	-	-	-	-	-
7	Pain in the waist	9	22%	13	32%	20	-
8	Pain in the buttock	1	2%	9	22%	-	49%
9	Pain in the bottom	-	-	-	-	-	-
10	Pain in the left elbow	-	-	-	-	-	-
11	Pain in the right elbow	-	-	-	-	-	-
12	Pain in the left lower arm	-	-	-	-	-	-
13	Pain in the right lower arm	-	-	-	-	-	-
14	Pain in the left wrist	-	-	-	-	-	-
15	Pain in the right wrist	-	-	-	-	-	-
16	Pain in the left hand	2	5%	-	-	-	-
17	Pain in the right hand	2	5%	-	-	-	-
18	Pain in the left thigh	3	7%	15	37%	-	-
19	Pain in the right thigh	3	7%	15	37%	9	-
20	Pain in the left knee	2	5%	2	5%	9	22%
21	Pain in the right knee	2	5%	2	5%	-	22%
22	Pain in the left calf	2	5%	12	29%	-	-
23	Pain in the right calf	2	5%	12	29%	-	-

24	Pain in the left ankle	2	5%	8	20%	-	-
25	Pain in the right ankle	2	5%	8	20%	-	-
26	Pain in the left foot	27	66%	15	37%	-	-
27	Pain in the right foot	27	66%	15	37%	-	-

Source: processed data

Based on the results of the questionnaire data processing that has been carried out, the percentage of questionnaires collected from 42 workers (**W**) in the loading and unloading section is 19 body parts complaining of silent pain (**Q**), pain (**P**), and severe pain (**E**). The most common complaint felt by loading and unloading workers is when 38 workers, with a percentage of 98%, experience severe pain in the back. No pain (**N**) complaints are not included because the respondents do not exist. Meanwhile, 15 workers, with a percentage of 37%, experienced complaints of pain under the neck, left thigh, right thigh, left leg, and right leg. Then as many as 27 workers, with a percentage of 66%, experienced moderate complaints of pain in the left leg and right leg. Unnatural work postures can cause this.

B. Rappid Entire Body Assesment

Collecting work posture data using photos of Loading-Unloading workers to determine the angles in the posture of the work attitude performed by Loading-Unloading workers. The following photos of work postures while performing Loading-Unloading worker activities (Squatting) can be seen in Figure 4. For Loading-Unloading workers (Standing) Figure 5. and Loading-Unloading workers (bending) Figure 6.

Figure 6. Material handling (illustration-4)
Source: personal document

Table 3. Work posture angle withdrawal

Locations	Description	Score
Neck	0°	2
Trunk	20°-60°	3
Legs	>60°	3
Force	-	0
Upper Arms	45°-90°	4
Lower Arms	>100°	2
Wrists	>15°	2
Coupling	Good	0

Source: processed data

Figure 7. Material handling (illustration-5)
Source: personal document

Table 4. Work posture angle withdrawal

Locations	Description	Score
Neck	>20°	3
Trunk	20°-60°	3
Legs	<30°	1
Force	>10kg	2
Upper Arms	>20°	2
Lower Arms	60°-100°	1
Wrists	>15°	2
Coupling	Good	0

Source: Processed Data

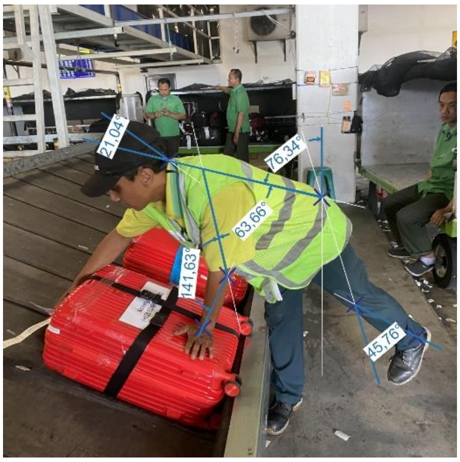

Figure 8. Material handling (illustration-6)
Source: Personal Document

Table 5. Work posture angle withdrawal

Locations	Description	Score
Neck	>20°	2
Trunk	>60°	4
Legs	30°-60°	3
Force	>10kg	2
Upper Arms	45°-90°	3
Lower Arms	>100°	2
Wrists	>15°	2
Coupling	Fair	1

Source: processed data

Based on the results of REBA scores that have been carried out manually and using Ergofellow 3.0 software, the following value comparison is obtained:

Table 6. Results Of REBA scores

Work Process	Scores
Loading-Unloading Apron Area (Squatting)	9
Loading-Unloading Apron Area (Standing)	8
Loading-Unloading Apron Area (Bending)	11

Source: processed data

C. Proposed Improvements

Based on the observations and results of the analysis that has been carried out on the posture of the Loading-Unloading workers, an improvement proposal is obtained to reduce the risk value of work postures by doing the correct work position.

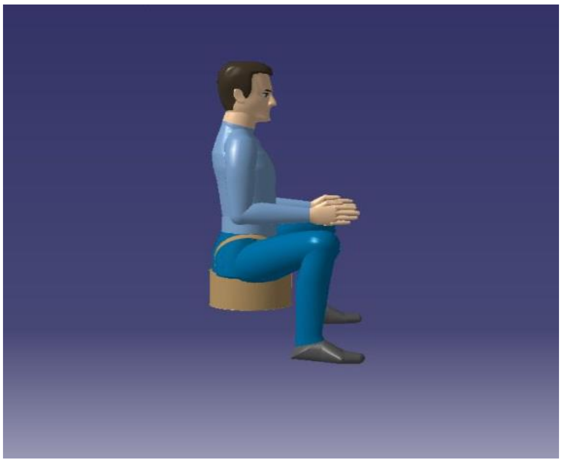

Figure 9. Material handling (illustration-7)
Source: processed data

The proposed work posture improvements are as follows: (1) The back position forms an angle between 20°-60° so that, given the proposed improvement of the back position forms an angle between 0°-20° so that the REBA score becomes 2. (2) The position of the two feet still holds the weight of the body like sitting, which has a score of 1, and the knee position forms an angle of >60° so, given the proposed improvement of the knee position forms an angle between 30°-60° so that the REBA score becomes 1 (+1) equal to 2. (3) The position of the upper arm forms an angle between 45°-90° so, given the proposed improvement, the position of the upper arm forms an angle between 20°-45° so that the REBA score becomes 2. (4) The position of the forearm forms an angle between >100°, so the proposed improvements to the position of the forearm form an angle between 60°-100° so that the REBA score becomes 1. (5) The position of the wrist forms an angle of >15 °, so, given the proposed improvements to the position of the wrist, it forms an angle between 0 °-15 ° so that the REBA score becomes 1. From the proposed work posture improvements above, the REBA score is 4, where this value is lower than the initial work posture of 9, so the proposed improvements can reduce the risk assessment of the initial work posture.

Figure 10. Material handling (illustration-8**)**
Source: processed data

The proposed work posture improvements are as follows: (1) The neck position forms an angle between >20 °, so, given the proposed improvement of the neck position to form an angle between 0 °-20 ° the REBA score becomes 1. (2) The back position forms an angle between 20°-60° so that, given the proposed improvements to the back position forms an angle between 0°-20° so that the REBA score becomes 2. (3) The position of the wrist forms an angle between >15 °, so, given the proposed improvements in the position of the wrist, it forms an angle between 0 °-15 ° so that the REBA score becomes 1. From the proposed work posture improvements above, the REBA score is 4, where this value is lower than the initial work posture of 8, so the proposed improvements can reduce the risk assessment of the initial work posture.

Figure 11. Material handling (illustration-9)
Source: processed data

The proposed work posture improvements are as follows: (1) The neck position forms an angle between >20° so that, given the proposed improvement of the neck position forms an angle between 0°-20° so that the REBA score becomes 1. REBA score becomes 1. (2) The back position forms an angle between 20°-60° so that, given the proposed improvements to the back position forms an angle between 0°-20° so that the REBA score becomes 2. (3) The position of the two feet still holds the weight of the body like sitting, which has a score of 1, and the knee position forms an angle of> 60 ° so, given the proposed improvement of the knee position forms an angle between 30 °-60 ° so that the REBA score becomes 1 (+1) equal to 2. (4) The position of the upper arm forms an angle between 45°-90° so that the proposed improvement of the position of the upper arm forms an angle between 20°-45° so that the REBA score becomes 2. (5) The position of the forearm forms an angle between >100° so that, given the proposed improvement, the position of the forearm forms an angle between 60°-100° so that the REBA score becomes 1. (6) The position of the wrist forms an angle between >15 °, so, given the proposed improvements to the position of the wrist, forming an angle between 0 °-15 ° so that the REBA score becomes 1. From the proposed work posture improvements above, the REBA score is 5, where this value is lower than the initial work posture of 11, so the proposed improvements can reduce the risk assessment of the initial work posture.

D. Proposed Worker Aids

The proposed improvements also utilize tools designed to help workers in the Loading-Unloading section of PT XYZ, and the following are tools designed to improve the proposed work posture.

1. Seat Cushion

Figure 12. Seat cushion design
Source: processed data

PT XYZ loading and unloading workers use the proposed seat cushion aids with a squatting position in the aircraft or a squatting place in the Apron Area. This seat cushion aid has a diameter of 30cm and a height of 15cm. It is made of synthetic leather, dacron, and rubber straps. This seat cushion aid is used by inserting both legs into the rubber holes. The purpose of using this tool is to help ease the burden on workers so that the suggested improvements work optimally and follow the score results obtained.

2. Stick

Figure 13. Stick design
Source: processed data

PT XYZ loading and unloading workers in the Makeup Area use the proposed stick assistive device. This stick aid has a length of 60cm. This tool is made of stainless steel. The way to use this stick has two different ends, which are adjusted to the position of the suitcase to be carried younger. The purpose of using this tool is to help ease the burden on workers so that the proposed improvements work optimally and follow the score results obtained.

5. CONCLUSION

Based on questionnaire data processing, the percentage of questionnaires collected from Loading-Unloading workers where as many as 38 workers, with a percentage of 98%, experienced complaints of severe pain in the back could be caused by an unnatural work posture. Based on the processing of posture observation data of Loading-Unloading workers using the REBA method of manual and software calculations, workers in the Loading-Unloading Apron Area squatting position get a work posture risk value of 9, and the Apron Area standing position get a work posture risk value of 8, where the value includes action level 4. For workers in the Loading-Unloading Makeup Area, the bending position gets a work posture risk value of 11, where the value includes action level 4.

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