PERBAIKAN FASILITAS KERJA PADA STASIUN PEMISAHAN DI USAHA KECIL MENENGAH ETA PURBA (UKM EP)

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ABSTRACT

Eta Purba Small and Medium Enterprises (UKM EP) is a business that produces tofu. UKM EP is a semi-traditional business, where human labor is still needed in the production process. Workers play a role in doing manual material handling from one machine to another. The transfer process includes a milling machine to a separation machine, adding water and pouring it into a boiling machine as well as a pouring or printing process. Repetitive work with non-ergonomic working conditions can cause injury or pain to certain body parts. To find out the existence of complaints and work methods that are not ergonomic, the Standard Nordic Questionnaire is distributed and performs biomechanics calculations using the Maximum Permissible Limit and Recommended Weight Limit and Lifting Index methods. From the results of the questionnaire, it was found that workers experienced pain in the shoulders, waist, back, and hands. The results of the calculation of biomechanics in MPL are 5499.27; 6443.51 ; 6948.63 ; 7196.23. This value is close to and exceeds the NIOSH standard value, which is > 6500 N, while the LI value is 3.77; 1.83 ; 1.79 ; 2.60. This value is above and between the NIOSH standard values, namely 3. These results are the basis for improving the work system by designing new work equipment which is expected to eliminate risks or complaints due to the work.

Keywords: SNQ, MPL, RWL, LI, work system, work facilities.

CHAPTER I

INTRODUCTION

1.1. The Background of the Study

Small and Medium Enterprises of Eta Purba (SMEs EP) is a business engaged in the production of tofu. In the production process, SMEs EP still use human labor in the process of moving and pouring processed materials. In total there are five work stations in this SMEs. Ranging from boiler stations, milling stations, separation stations, boiling stations, and printing stations. In SMEs EP, there are six workers occupying each work station except the separation station which has two workers. At the separation station, manual material handling activities are very dominant. The work activities carried out started from transferring soybean slurry from the milling station to the mixing container located at the separation station, adding water to the mixing container, pouring it into the separation machine from the mixing container, and pouring the separation product (soybean juice) into the boiling machine. .

Based on a preliminary study conducted through an observation and interview process using a nordic body map, workers experience complaints in several body parts such as the waist, buttocks, shoulders and neck. This is because the work activities are considered quite heavy. Like the distance of the material that must be moved or poured into the machine is quite far and high. The action of repetition also greatly affects the physical workers because the material that must be moved or poured into the machine is quite heavy. Therefore, it is necessary to calculate work biomechanics using the Recommended Weight Limit (RWL) and Maximum Premissible Limit (MPL) methods to determine whether these work activities are indeed risky and unsafe for workers.

By calculating work biomechanics using the Recommended Weight Limit and Maximum Premissible Limit methods, we know whether the work activity meets the NIOSH standards for the recommended force load or not. So that we can design and improve the proposed work

facility at the separation station which is expected to reduce the work risk experienced by workers.

1.2. The Problems of the Study

1. The existence of work activities that exceed the recommended limits that may cause injury to workers.
2. Ergonomic improvements are needed to reduce the risk of injury to workers.

1.3. The Objectives of Study

1. Design and improve proposed work facilities in order to minimize the occurrence of work risks caused by non-ergonomic work.
2. Calculate the economic value of the proposed work facility design in order to determine the comparison of the benefits obtained.

1.4. The Limitation of Study

1. The study was conducted in the separation station area in Eta Purba Small and Medium Enterprises (SMEs EP).
2. The research is only a suggestion for improving work facilities using ergonomics principles at the separation station.
3. Data collection is done by direct observation in the field, giving questionnaires and interviews with operators who work in that section.
4. The data taken is only the data needed in the research to design the required work facilities.

1.5. The Significance of the Study

1. For Students
   a. Efforts to gain experience in applying scientific concepts during the lecture process.
   b. Development of the concept of thinking in analyzing a problem with a scientific approach and looking for possible solutions.
2. For Companies
   a. The results of the research can be input to the company on the problems faced.
   b. The results of the design can be considered by the company to implement it.
3. For the University

   Research results can be an additional source of reference in the academic field.

CHAPTER II

LITERATURE REVIEW

2.1. Ergonomics

2.1.1. The Definition of Ergonomics

Ergonomics can be defined as a discipline that examines the limitations, strengths, and characteristics of humans, and utilizes this information in designing products, machines, facilities, environments, and even work systems, with the main goal of achieving the best quality of work without neglecting health, safety, and security aspects. as well as the convenience of human users. Referring to this definition, it can be said that almost all design objects that relate (interact) with humans require ergonomics. Some definitions and understandings of ergonomics can be seen in the following points.

1. *"Ergonomics is the study of the interaction between humans and machines, and the factors that influence them. The goal is to improve overall system performance" (Bridger, 2009).*
2. B. W. Jastrzebowski, a Polish scientist, in 1857 pioneered the use of the word ergonomics, which in Greek ergos means "work" while nomos is "study (up)" or "laws" (Karwowski, 2006; Konz and Johnson, 2008). In late 1949, K.F.H. Murrell introduced the word ergonomics, which later became popular as a discipline.
3. *"Ergonomics is an interdisciplinary science, which examines the interaction between humans and the objects they use" (Pulat, 1997).*
4. "*Ergonomics is the application of scientific principles, methods, and data obtained from various disciplines aimed at developing an engineering system, where humans have a significant role" (Kroemer et al., 2004).*

5. *"Ergonomics is a multidisciplinary activity directed at gathering information about human capacities and abilities, and using it in designing jobs, products, workplaces, and work equipment" (Chengalur et al., 2004).*
6. *"Ergonomics (or human factors) is the scientific discipline concerned withthe understanding of interactions among humans and other elements of a system, and the profession that applies theory, other principles, data, and methods to design inorder to optimize human well-being and overall system performance"* (International Ergonomis Association).

2.1.2. The Purpose, Benefits, and Principles of Ergonomics

According to Tarwaka (2004), there are several goals to be achieved by applying ergonomics, including:

1. Physical and mental well-being is increased by preventing work-related injuries and illnesses, reducing physical and mental workloads, seeking promotion and job satisfaction.
2. Improving social welfare through improving the quality of social contacts, managing and coordinating work effectively and increasing social security both during the productive age and after being unproductive.
3. Creating a rational balance between various aspects, namely technical, economic, anthropological, and cultural aspects of each work unit carried out so as to create a high quality of work and quality of life.

Meanwhile, according to Santoso (2004) there are four main goals of ergonomics, namely:

1. Maximize employee efficiency
2. Improve occupational health and safety

3. Advise to work safely, comfortably, and enthusiastically
4. Maximizing a convincing form of work.

The benefits of ergonomics are for work to be completed quickly, with a smaller risk of accidents, time efficient, and so on. The various benefits derived from ergonomics are as follows:

1. Work productivity increases, for example speed, accuracy, and safety and reduces energy when working.
2. Time efficient means that time is reduced, as well as the cost of education and training.
3. Able to optimize Human Resources (SDA) by increasing the required skills.
4. Time efficiency so you don't waste it.
5. The comfort and safety of employees when working is increased.

The principle of ergonomics is a guide in the application of ergonomics in the workplace. According to Baiduri (Baiduri, 2008), the principles of ergonomics are as follows:

1. Reduce overload
2. Covers sparse space
3. Minimize static movement
4. Make displays and examples easy to understand
5. Work with normal position or posture
6. Equipment layout is within reach
7. Not a lot of repetitive and excessive movements
8. Creating a comfortable and safe work environment
9. Doing sports and stretching while working
10. Doing work in harmony with the height dimensions of the body.

2.1.3. Ergonomics Studies

The forerunner of ergonomics is the use of a number of basic sciences that study humans, such as anatomy, physiology, medicine, orthopedics, psychology, and sociology. Ergonomics then grows and changes rapidly. In addition, ergonomics is a design context that uses many engineering sciences. are some of the various sub-disciplines of ergonomics.

1. Anthropometry, which is a field that examines the physical dimensions of the human body, including age, standing height, weight, arm length, sitting height, and so on. Anthropometric data is widely used in the design of products, equipment, and workplaces.
2. Biomechanics of work, which is a field that focuses on mechanical processes (force, moment, speed, acceleration, and pressure) that occur in the human body, related to physical activities carried out by workers.
3. Work physiology, it is the field of ergonomics that examines the response of body functions (eg the cardiovascular system) that occur while working.
4. Human information processing and cognitive ergonomics, it is the field of ergonomics that studies how humans process information from their environment, starting from the stage of sensing the presence of a stimulus and perceiving it, to making decisions and taking the necessary actions.
5. Human-computer interaction (HCI), it is the field of ergonomics that examines and designs interactions between users and computer systems, with one of the objectives of which is to minimize errors, improve operating system performance, and increase user satisfaction.

6. Display and controls, it is the field of ergonomics that has a focus in the form of studies on display and control designs that match the characteristics of users.
7. Work environment, which is a field that tries to understand human response to the physical work environment, including noise, temperature, lighting, vibration, and so on.
8. Macro ergonomics, departing from the socio-technological concept, this field is a systems approach in assessing the suitability between individuals, organizations, technology, and the interaction processes that occur.

The fields mentioned above are not a rigid division, but rather a way to understand the scope of ergonomics. Other areas that need to be understood also include the study of stress and workload, the use of robotic and automation technology, safety and human error, transportation safety, consumer product design, fiber aging aspects. The variety of systems that constitute ergonomics studies are relatively diverse, ranging from traditional ones to vital and sophisticated systems. lift. On the other hand, ergonomics is used in analyzing human errors that occur in accidents in the world of transportation and the military, evaluating automation technology, designing aircraft cockpits, and evaluating the control room used to monitor spacecraft. Thus, it can be clearly seen that ergonomics has a very broad spectrum of study, which is impossible to study through specificity in one field alone.

2.2. Work Biomechanics

2.2.1. The Definition of Biomechanics

Biomechanics is a science that studies humans in terms of their abilities such as strength, endurance, speed, and fatigue (Sutalaksana, 1979). Research using a biomechanics approach basically studies and analyzes the limits of strength, endurance,

speed and accuracy that humans have in carrying out their duties. Biomechanics is influenced by several factors, namely:

1. Self factors: age, gender, ethnicity, and others
2. Work attitude
3. Type of work

Work biomechanics is a sub-discipline of biomechanics that studies physical interactions between workers and equipment, machines, and materials to minimize the risk of disturbances to the musculoskeletal system related to work (Chaffin, 2006). - skeleton. The first disturbance is caused by a sudden load or pressure on the body or limb. The impact on the musculoskeletal system is in the form of fractures, joint damage, and others. Incidents like this are usually categorized as work accidents, which can occur in various parts of the body, such as the neck, shoulders, wrists, and lower back.

The second mechanism is related to continuous loading and is accumulative in the long term which results in abnormalities in the musculoskeletal system, such as: muscle function disorders, abnormalities in joint mobility, abnormalities in nerves, abnormalities in tendons (connecting muscles and bones), etc. Usually, in industry, disorders like this are categorized as occupational diseases. Furthermore, the impact of occupational diseases is only felt at old age when physical conditions also begin to weaken, so there is a bias in the analysis of whether a disease is due to work or due to age. The body parts that usually suffer from work-related disorders are the neck, shoulders, wrists, and lower back, which are often under excessive and continuous pressure at work.

2.2.2. Biomechanics Classification

Biomechanics is classified into two, namely:

1. General Biomechanics

   General Biomechanics is part of biomechanics regarding the laws and basic concepts that affect the human organic body both in a stationary position and in motion. General Biomechanics is divided into two, namely:

   a. Biostatics is a part of general biomechanics which only analyzes the body in a stationary position or moving in a straight line with a uniform velocity (uniform).
   b. Biodynamics is part of general biomechanics which is concerned with describing body movements without considering the forces that occur (kinematics) and movements caused by the forces acting on the body (kinetics). (Tayyari, 1997)

2. Occupational Biomechanics

   Occuptional Biomechanic is a material of applied biomechanics that studies the physical interaction between workers and machines, materials and hand tools with the aim of minimizing complaints on the muscular skeleton system so that work productivity can increase.

2.2.3. Material Transfer

Biomechanics basically studies and analyzes the limits of strength, endurance, speed and accuracy that humans have in doing a job. This factor is closely related to work that is material handling, such as lifting and moving manually or other jobs that predominantly use body muscles.

An agency that deals with occupational health and safety issues in the United States, the National Institute of Occupational Safety and Health (NIOSH) conducts an analysis of the human strength in lifting or moving loads and recommends a limit on the

load that can be lifted by humans without causing injury even though the work is done manually. repeatedly over a long period of time.

The formula for calculating the load based on the 1991 NIOSH recommendation there are 2 methods, namely the Recommended Weight Limit (RWL) method and the Maximum Permissible Limit (MPL) method.

2.3. Material Handling Manual

2.3.1. Recommended Weight Limit (RWL)

A research institute dealing with aspects of occupational health and safety in the United States, NIOSH (National Institute of Occupational Safety and Health), in 1991 issued a guideline regarding the maximum limit of objects that can be lifted by workers for various lifting conditions (Waters et al., 1993). The determination of the load limit is based on the results of research that combines biomechanics, physiology, and psychophysics approaches. The lifting limit is known as the RWL (Recommended Weight Limit).

There are six factors that determine the amount of RWL, namely four factors that are influenced by attitude when lifting, one factor related to the frequency of lifting, and another factor related to the condition of the handle of the object being lifted. These six factors are referred to as the multiplier factors that determine RWL with the following equation formula:

$$RWL = LC \times HM \times VM \times DM \times AM \times FM \times CM$$

Information :

RWL : Recommended weight limit

LC : Load constant = 23 kg

HM : Horizontal multiplier

VM : vertical multiplier

DM : Distance multiplier

AM : Asymmetric multiplier

FM : Frequency multiplier

CM : Coupling multiplier

It should be noted that each multiplier has a maximum value of 1. That is, if all the multipliers are 1 then the RWL will be equal to the LC, which is 23 kg. This is what is referred to as the optimal lifting conditions. The smaller the magnitude of the multiplier factors, the smaller the lifting load limit is also for the posture, lifting frequency and given load conditions. The safe and unsafe assessment of a lifting is done by comparing the lifting load limit with the actual weight of the load lifted.

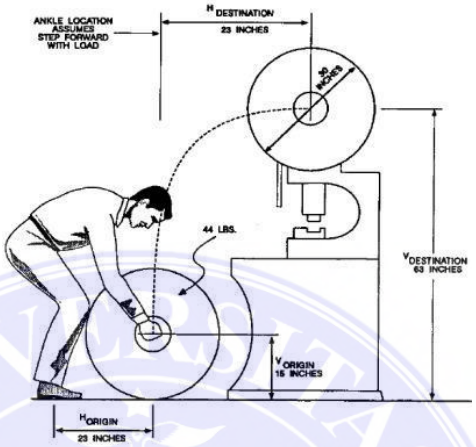
This RWL formula has been widely used in industry as a reference in evaluating manual lifting activities. The manual lifting load limit of 23 kg is also used as a reference. To get the lifting load limit, it is enough to calculate the six predefined multipliers.

a. Horizontal Multiplier (HM)

   The amount of HM is determined by the formula: HM = 25/H, where H is the horizontal distance defined as the distance between the midpoint of the two inner ankles to the projected point from the center of the load when lifting.

b. Vertical Multiplier (VM)

The amount of VM is determined by the formula: VM = 1 – (0.003|V – 75|), where V is defined as the distance from the floor to the position of both hands when lifting, which is usually assumed to be the midpoint of the object being carried.

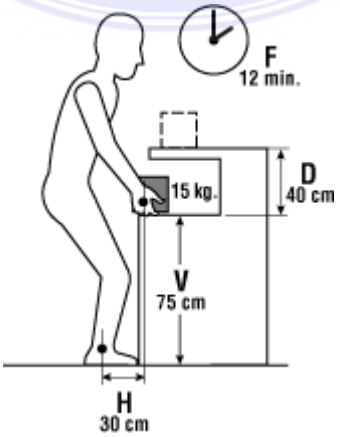


Source: NIOSH, 1994

Figure 2. 1 Horizontal and Vertical Distance

c. Distance Multiplier (DM)

The amount of DM is determined by the formula: DM = 0.82 + 4.5/D, where D is defined as the distance between the initial and final positions of the lift.

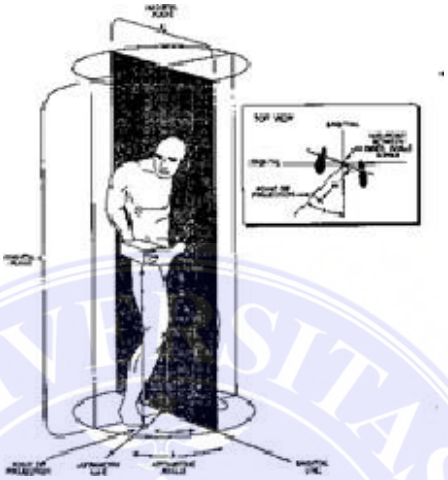


Source: NIOSH, 1994

Figure 2. 2 Horizontal, Vertical and Displacement Distance

d. Asymmetry Multiplier (AM)

AM is determined by the formula: AM = 1 – 0.0032 A (rad) where A is the asymmetric angle which is the angle formed between the mid-sagittal plane and the asymmetric line.



Source: NIOSH, 1994

Figure 2. 3 Representation of Asymmetric Angle

e. Frequency Multiplier (FM)

Unlike the multipliers that have been discussed previously, FM is not calculated by a mathematical formula, but can be determined based on a table.

Table 2. 1 Frequency Multiplier

Frequency	Working Duration					
Force/minute	≤ 1 Hour		1 Hour ≤ t ≤ 2 hours		2 hours≤ t ≤8 hours	
(F)	V < 30	V ≥ 30	V < 30	V ≥ 30	V < 30	V ≥ 30
≤ 0,2	1,00	1,00	0,95	0,95	0,85	0,85
0,5	0,97	0,97	0,92	0,92	0,81	0,81
1	0,94	0,94	0,88	0,88	0,75	0,75
2	0,91	0,91	0,84	0,84	0,65	0,65
3	0,88	0,88	0,79	0,79	0,55	0,55
4	0,84	0,84	0,72	0,72	0,45	0,45
5	0,80	0,80	0,60	0,60	0,35	0,35
6	0,75	0,75	0,50	0,50	0,27	0,27
7	0,70	0,70	0,42	0,42	0,22	0,22
8	0,60	0,60	0,35	0,35	0,18	0,18
9	0,52	0,52	0,30	0,30	0,00	0,15

10	0,45	0,45	0,26	0,26	0,00	0,13
11	0,41	0,41	0,00	0,23	0,00	0,00
12	0,37	0,37	0,00	0,21	0,00	0,00
13	0,00	0,34	0,00	0,00	0,00	0,00
14	0,00	0,31	0,00	0,00	0,00	0,00
15	0,00	0,28	0,00	0,00	0,00	0,00
> 15	0,00	0,00	0,00	0,00	0,00	0,00

(Source: Waters et al, 1993)

f. Handle Multiplier (CM)

As with FM, the handle multiplier factor (CM) is determined from the table. CM is determined by the condition of the handle of the object being lifted and also the value of V.

Table 2. 2 Coupling Multiplier Table

Handle Condition	V < 75 cm	V ≥ 75 cm
Good	1,00	1,00
Enough	0,95	1,00
Bad	0,90	0,90

(Source: Waters et al, 1993)

The RWL formulation proposed by NIOSH is based on various studies conducted in the United States. Because there are physical differences, both anthropometrically and biomechanically, several studies have been conducted at ITB to revise the use of the RWL formula so that it is suitable for Indonesian workers. kg. Widyanti (1998) conducted a study of the vertical multiplier (VM) and proposed a new formula for VM that VM = 1 – (0.003|V – 69|) because the waist height for the average size of Indonesian workers is shorter. Salmiah (2001) conducted a study on the asymmetric multiplier factor (AM), and then proposed the following asymmetric multiplier equation.

AM = 1 – (0.005 A) for 0o≤ A 30o

AM = 1 – (0.0031 A) for 30o≤ A 60o

AM = 1 – (0.0025 A) for A > 60o

2.3.2. Lifting Index (LI)

In general, in every lifting there are two body positions, namely the initial lifting position and the final lifting position. Therefore, RWL must be calculated for both positions and named as RWLawal and RWLfinal. In both calculations, the magnitude of the DM multiplier will be the same. The magnitudes of the FM and CM multipliers in the two positions can be different or the same, depending on the value of V.

NIOSH proposes that a lifting activity is safe or not based on the Lifting Index (LI). LI is formulated as a comparison between the recommended load limit to be lifted against the load that should be lifted. The recommended load limit is selected from the smallest value between the initial RWL and final RWL. Therefore, the LI formulation is:

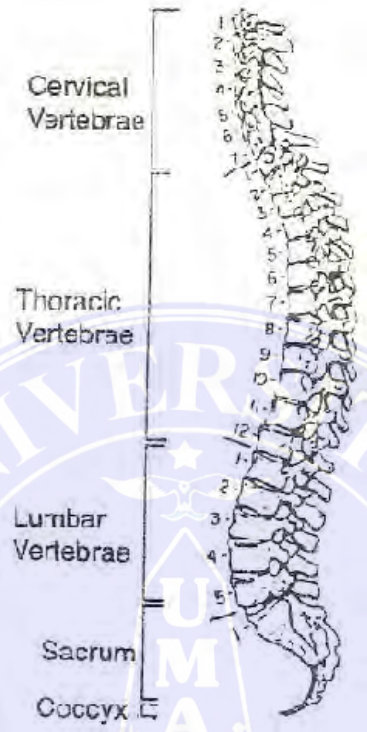
LI = Actual load weight / min {RWInitial , RWLend} The recommendations given are as follows.

1. If LI 1, then the job is safe
2. If 1 < LI 3, then the job may be risky
3. If LI > 3, then the job is risky.

3.3.3. *Maximum Permissible Limit* (MPL)

MPL or Maximum Permissible Limit is the limit of the compressive force in the L5/S1 segment of lifting activities in Newton units standardized by the NIOSH (National Institute of Occupational Safety and Health) in 1981. The magnitude of the compressive force is below 6500 N at L5/S1. While the normal force limit (the Action Limit) is 3500 at L5/S1. So, if Fc < AL (safe), AL < Fc < MPL (need to be careful) and if Fc > MPL

(dangerous). The maximum allowable lift limit recommended by NIOSH (1991) is based on a compressive force of 6500 N at L5/S1, but only 1% of women and 25% of men are estimated to be able to exceed this lifting limit.



Source: NIOSH, 1994

Figure 2. 4 Skeleton of Spine

It should be noted that the value of the biomechanical analysis is the range of postures or positions of work activities, the size of the load, and the size of the human being evaluated. Meanwhile, the safety criteria are based on the compression load on the internal disc between the fifth lumbar and number one sacrum (L5/S1). To find out more clearly L5/S1 can be seen in the picture above.

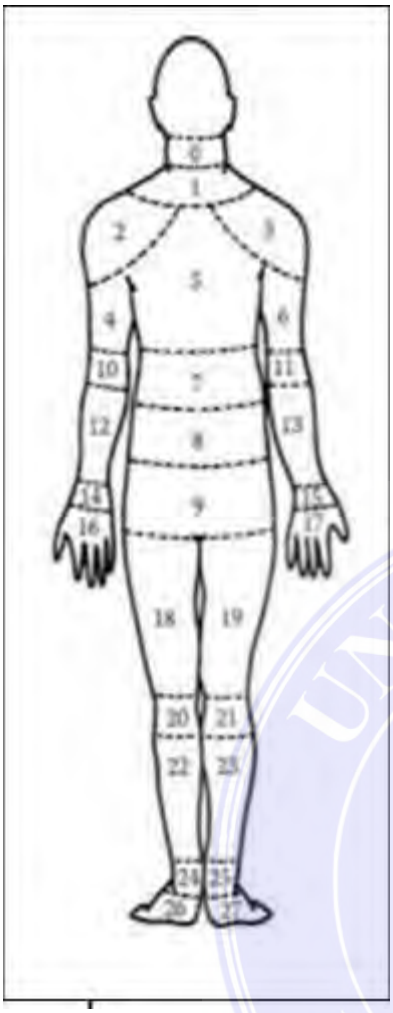
Chaffin and Park (1973) said that his analysis of various types of work showed that pain was closely related to the compression load that occurred in (L5/S1). It has also been found that 85-95% of herniated disks occur with relative frequency at L4/L5 and L5/S1.

Most spinal diseases are hernias of the intervertebral disks, namely the expulsion of the intervertebral nucleus (pulpy nucleus) caused by damage to the intervertebral disk covering layer.

Evan and Lissner (1962) and Sonoda (1962) conducted a study using a compression test on the spine. They found that a healthy spine is less prone to hernias, but is more prone to fracture if it is caused by the load borne by the spinal segments (spinal) and that occurs with the onset of damage to the upper/lower segments of the spine (the castilage end). -plates in the vertebrae). Small cracks that occur in the vertebral column will cause fluid to escape from the vertebrae into the intervertebral disc and subsequently result in disc degeneration (damage). From this incident it can be concluded that degeneration is a prerequisite for the occurrence of hernias in the intervertebral disc which in turn will be a common cause of low-back pain.

2.4. Standard Nordic Questionnaire (SNQ)

Standard Nordic Quetionnaire (SNQ) is a tool that can determine the parts of the muscles that are experiencing complaints with the level of complaints ranging from No Pain (NP), Somewhat Pain (SP), Pain (P), and Very Pain (VP). By viewing and analyzing the body map as shown in Figure 2.4.



Description	
No.	**Type of Complaint**
1.	Stiff pain in the lower neck
2.	Left shoulder pain
3.	Right shoulder pain
4.	Left upper arm pain
5.	Back pain
6.	Right upper arm pain
7.	Waist pain
8.	Butt pain
9.	Ass pain
10.	Left elbow pain
11.	Right elbow pain
12.	Left forearm pain
13.	Right forearm pain
14.	Left wrist pain
15.	Right wrist pain
16.	Left hand pain
17.	Right hand pain
18.	Left thigh pain
19.	Right thigh pain
20.	Left knee pain
21.	Right knee pain
22.	Left calf pain
23.	Right calf pain
24.	Left ankle pain
25.	Right ankle pain
26.	Left leg pain
27.	Righ leg pain

Source: An Introduction of Ergonomics

Figure 2. 5 Nordic Body Map

CHAPTER III
RESEARCH METHODOLOGY

3.1. Research Time and Place

This study was conducted at Small and Medium Enterprises of Eta Purba (SMEs EP), namely a tofu factory located on Jalan Sri Gunting, Sunggal Kanan Village, Kec. Sunggal, Kab. Deli Serdang. The time of this study was in February 2021.

3.2. The Source of Data and Research Instruments

3.2.1. Source of Data

1. Primary Data

   Primary data is data obtained from observations and measurements of the research object in the field. The primary data in this study are:

   a. Data of Standard Nordic Questionnaire (SNQ)

      This data is obtained by giving questionnaires to workers to be filled directly based on the conditions experienced by the workers' bodies at work.

   b. Data of Recommended Weight Limit (RWL)

      This data is data on the weight of the load, the vertical and horizontal distance of the worker to the load, the distance of the load transfer, and data on the number of repetitions and the condition of the handle.

   c. Data of Maximum Premissible Limit (MPL)

      This data is data on the angle of inclination formed by the body when working and the length of the worker's body part.

2. Secondary Data

Secondary data is data obtained from the research object and is not a direct measurement of the research object. The secondary data obtained is about the general description of the company and the production process in the company.

3.2.2. The Research Instruments

The study used several instruments to assist in data collection, the instruments used were:

1. Digital Camera, which is a tool used to take pictures of workers' posture when moving materials.
2. Roll Meter is a tool used to measure the distance or position of workers when carrying out material transfer activities and to measure the dimensions of the worker's body.
3. Weight Scales is a tool used to determine the average load of the workforce.
4. An arc is a tool used to determine the angle formed by the worker's body.
5. Questionnaire is a question sheet that will be filled out by workers.

3.3. Research Variables

The variables that will be used in this study are as follows:

1. Independent Variable

   The independent variable is a variable that influences and causes the dependent variable to arise. The independent variables in this study are:

   a. Force load
   b. Body dimensions
   c. Working method

2. Dependent variable

   The dependent variable is a variable that is influenced by the independent variable. In this study, the dependent variable is work facilities.

3.4. The Technique for Collecting Data

Data collection is carried out directly on workers on the production floor. The steps taken include:

1. Conduct direct observations and interviews with workers using a questionnaire sheet to obtain initial information in order to determine a problem.
2. The load transfer distance data and the distance of the worker's position are measured by a roll meter as the data of the multiplier factor.
3. Work frequency data to find out the repetition of work carried out within a certain period of time by using data from the table.
4. Data for the load handle to determine the value of the feasibility of the handle using data from the table.
5. Data on the weight of the worker's load to determine the average weight of the load being lifted.
6. Inclination angle data to determine the angle formed from the worker's body when lifting.
7. Worker's body length data to determine the body length of the hands, upper and lower arms, and back.

3.5. The Technique for Analyzing Data

1. The techniques for analyzing data used in manual material handling for this research are:

a. Calculation of the Recommended Weight Limit (RWL) value

b. Calculation of Lifting Index (LI) value

c. Calculation of Maximum Premissible Limit (MPL) value

2. The techniques for anlyzing data used to design the study are:

a. Calculation of manufacturing costs

b. Calculation of economic value.

3.6. Thinking Framework

The framework for thinking in this research are:

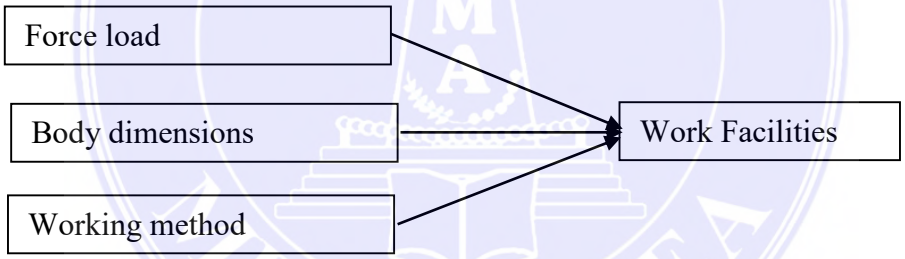


Figure 3. 1 Thinking Framework

3.7. Research Methodology

The research methodology is all stages of the research process carried out.

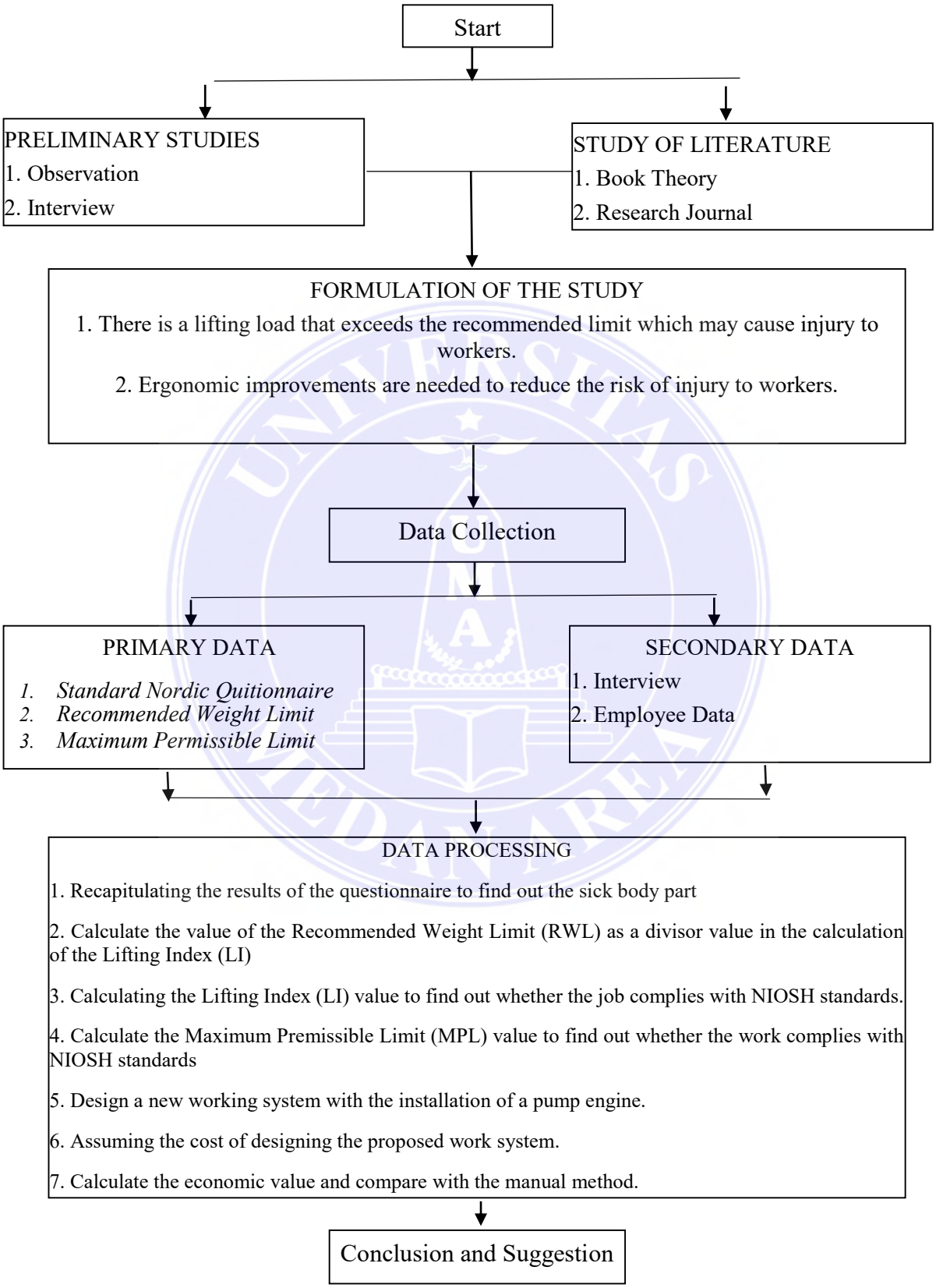


Figure 3.2 Reserarch methodology

CHAPTER V
CONCLUSIONS AND SUGGESTIONS

5.1. Conclusion

1. Based on the calculation of work biomechanics, the MPL value for each activity is 5499.27; 6443.51 ; 6948.63 ; 7196.23. From these results it is found that activities 1 and 2 may be risky and activities 3 and 4 are very risky. Meanwhile, the LI value obtained is 3.77; 1.83 ; 1.79 ; 2.60. From these results it is known that the first activity is very risky and activities 2,3, and 4 may be risky. From the results of MPL and LI, it is known that there are no jobs that are categorized as safe for workers.
2. Based on the proposed design in the form of pump installation, the total design cost is 4,700,000 rupiah. With a comparison of monthly expenses between pumps of 1,359,816 rupiahs and two workers of 4,800,000 rupiahs, then by reducing one worker at the separation station, a profit of 1,040,184 Rupiah/Month is obtained with a payback of capital within 3.5 months.

5.2. Suggestion

1. It is hoped that SMEs EP consider the proposed design because based on the calculation the design is feasible to be applied so that the risks of work biomechanics can be avoided.
2. It is hope that SMEs EP pay more attention to the physical condition of workers, due to the production process at night. This will affect the health of workers because of irregular sleep patterns, it is necessary to provide pudding.