Workbench Design Based on the NIDA Method in The Finishing Stage of Leather Bag Production

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Abstract

The Leather Industry is one of the most important sectors in the Magetan region. However, there are certain problems encountered in the finishing stage of bag production, such as the operator's inapt working posture and the improper layout of accessories and equipment. This study aims to develop an alternative workbench design for improving the operator's working posture, providing a proper layout of accessories and production equipment, and accelerating the manufacture of leather bags. Based on the NIDA method, there were two alternative workbenches, of which the second was selected as the best choice to improve the operator's working posture and provide a proper layout of accessories and production equipment.

Keywords
Leather Industry, Finishing Line, NIDA, Ergonomic.

1. Introduction
The leather industry is one of the most important sectors in Magetan. However, there are many problems encountered in the production process, in various establishments, such as in Pak Ardhi's Leather Bag industry, which is one of the major commercial enterprises in Magetan, East Java. These problems were mostly encountered in the finishing stage of the production process, such as the operator's inapt working posture and the improper layout of accessories and equipment.

Work posture is the position adopted by workers while carrying out their job (Nurmianto, 2004). It is closely related to Ergonomics, the study of the ideal physical stance and mental well-being, to prevent the risk of ill health, accidents, or other occupational hazards. For a work pose to be considered good, research and evaluation should be conducted by experts in the scientific field of Ergonomics. People who constantly adopt wrong or non-ergonomic postures are prone to tiredness, lack of concentration, and decreased level of accuracy, which leads to work accidents, musculoskeletal disorders (MSDs), and other dysfunctions (Andrian, 2013). An operator installing accessories in a sitting position on the floor without a base, and with a bent neck is at risk of developing a musculoskeletal injury when this is practiced continuously.

The lack of organization and improper arrangement of accessories and equipment, used at the finishing stage is problematic, for instance, when it takes a longer period to find a particular instrument, therefore, leading to wastage of time. Hence, this study aims to develop an ergonomic workbench design and SOPs for operators at the finishing stage in the Magetan Leather Bag Industry. The result is expected to improve the operator's work posture and reduce the time wasted in searching for certain accessories and equipment, thereby, maximizing productivity.

2. Literature Review

2.1 Work Posture

Work posture, also known as work stance, is the pose adopted by workers while executing their jobs (Nurmianto, 2004). There are three types of work posture, which are; sitting, standing, and a combination of both. The normal posture at work is that the hands and wrists are in alignment with the middle finger, the neck is straight and does not twist to the sides, the shoulders are not raised, the elbows are close to the body, and the back is not allowed to bend beyond 20° or tilt to the sides. Poor posture is a major cause of back pain, stress, repetitive strain, and injuries, resulting in fatigue and MSDs (Musculoskeletal Disorders) (Birdger, 1995).

2.2 Musculoskeletal Disorders

The Musculoskeletal System is made up of bones, muscles, cartilage, ligaments, tendons, fascia, bursae, and joints (Ministry of Health, 1995). Subsequently, Musculoskeletal Disorders (MSDs) are injuries and disorders affecting the human body's mobility or musculoskeletal system. They are one of the most common and serious occupational health concerns in the workspace affecting the quality of life and posing a significant financial burden in terms of compensation and missed payment. They also reduce productivity due to the need for sick leave, absenteeism, early retirement, as well as being costly in terms of treatment (Erick and Smith, 2011).

2.3 Anthropometry

Anthropometry is the science of measuring the human body in terms of bone, muscle, and adipose (fat) tissue dimensions (National Health and Nutrition Examination Survey, 1988). Anthropometric data is utilized for a variety of purposes, including improving the user experience through designing workstations, facilities, and product design. It is employed as an ergonomic consideration in the design of human-useable products or work systems. All products, including consumer products, clothing, living and working environments, and so on, should be adapted to users' standards via the user-centered design method, to minimize negative health implications such as, musculoskeletal discomfort and injuries. Humans in general, have varying body forms and proportions, hence, the greater the number of persons measured, the more differences in body size (Wignjoseobroto, 2000; Fathallah et al, 2009 ; Hanson et al. , 2009).

3. Methods

The research methodology used for this study was in the form of data collection and processing using 2 methods, and selecting the best design alternative. The flow of the research methodology can be seen in Figure 1. below.

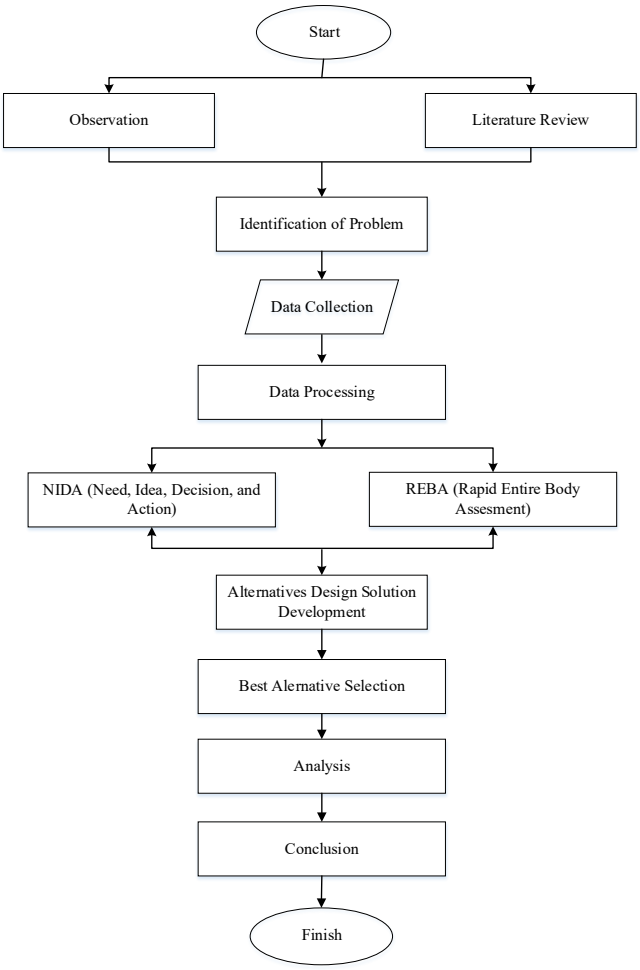

Figure 1. Research Methodology Flowchart

3.1 NIDA (Need, Idea, Decision, and Action)

NIDA is a basic step in the technique that is part of the design process. According to Nurmianto (2008), the designer should complete four stages, which are;

1. NEED: Customer needs are identified based on the desire factor and the challenges they are experiencing.
2. IDEA: At this stage, ideas are being developed to produce a variety of alternatives that suit the needs identified in the first stage.
3. DECISION: At this point, a decision is made about which alternative is most suitable as a design concept.
4. ACTION: The final step is to turn the design concept into an actual product.

3.2 REBA (Rapid Entire Body Assessment)

REBA (Rapid Entire Body Assessment) is a tool that is used to assess work posture. It was developed by Dr. Sue Hignett and Dr. Lynn Mc Atamney; Ergonomists from the *University of Nottingham's Institute of Occupational Ergonomics*. It was developed primarily to investigate dynamic activities that lead to musculoskeletal disorders at work and to examine the tasks that RULA is not capable of carrying out. REBA is based on the RULA posture scoring criteria, and is being developed to track risks linked with knee postures, loads or forces exerted, coupling, and whole-body activities (McAtamney and Hignett, 1995).

According to Wisanggeni (2010), the measurement process for the Rapid Entire Body Assessment (REBA) is broken down into six steps:

a. Observing the activities that are being carried out.
b. Choosing the work attitude that will be evaluated.

c. Assigning a score on the chosen work attitude.
d. Processing the scores that have been obtained.
e. Compiling REBA score.
f. Level determination.

Measurements using REBA are grouped into two to make the assessment easier: Group A, consists of neck, trunk, legs, and force/load, while Group B, consists of the upper arm, lower arm, wrist, activity, and coupling.

4. Data Collection

Data were collected by directly observing the finishing process of leather bags and working posture in conditions before and after using a work desk. The bag accessories installation operator carries out the task in a sitting position on the floor without a base and parts the neck down. This requires a high degree of concentration and accuracy. Workers who carry out the finishing process continuously in a bent position, experience neck fatigue which reduces their level of focus.

Figure 2. below is a demonstration that was done by the researcher according to the operator's working posture before using the workbench, during the installation of leather bag accessories:

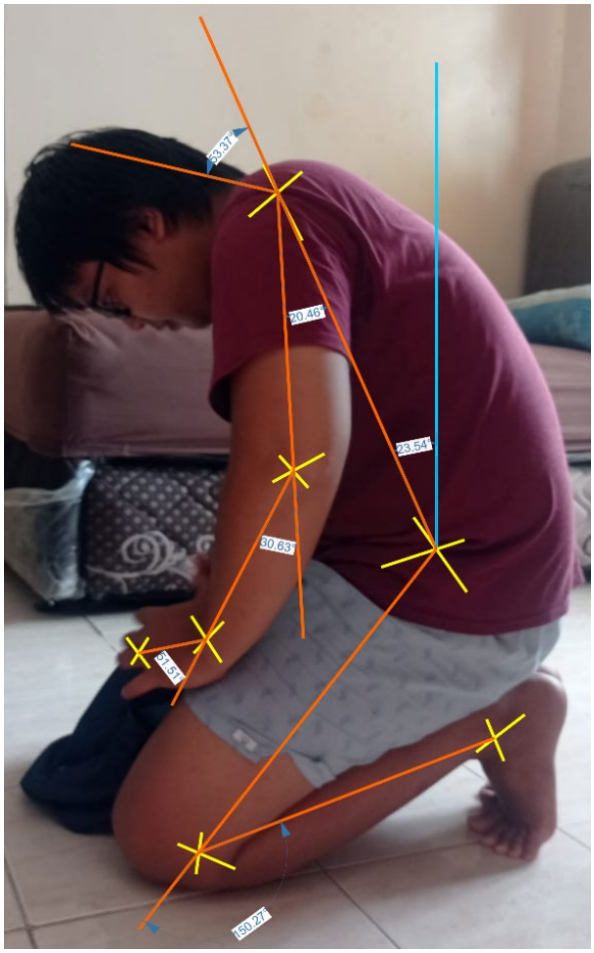

Figure 2. Position Before Using Finishing Workbench

Angle drawing is carried out on the trunk, neck, upper arm, lower arm, wrist, and leg. An analysis of the working posture angle is shown in the Table 1. below

Table 1. Analysis of Working Posture Angle Before Workbench Implementation

Parts of Body	Angle(°)
Trunk	23.54
Neck	53.37
Upper Arm	20.46
Lower Arm	30.63
Wrist	51.51
Leg	150.27

The risk assessment of the operator's working posture before using the workbench is carried out using the REBA method with the results as can be seen in Figure 3. below:

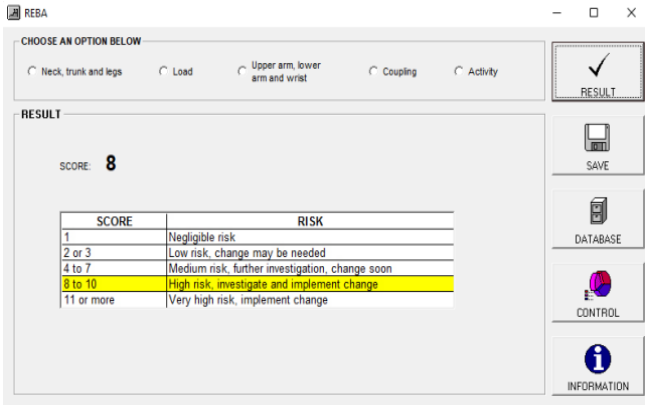

Figure 3. Posture Score Before Using Finishing Workbench

The result of the operator's working posture in conditions before the implementation of the workbench is 8. This suggests that the work posture has a high risk and requires investigation and prompt improvements.

5. Results and Discussions

To curtail the problems encountered at the finishing stage of the Magetan Leather Bag, enhanced tool aids were developed to reduce the risk of operator fatigue due to unnatural work postures and improper placement of accessories. They also feature compartments for the organized arrangement of production accessories and equipment. The workbench is designed in two alternatives. Both have some differences in certain features as shown in Figure 4. below:

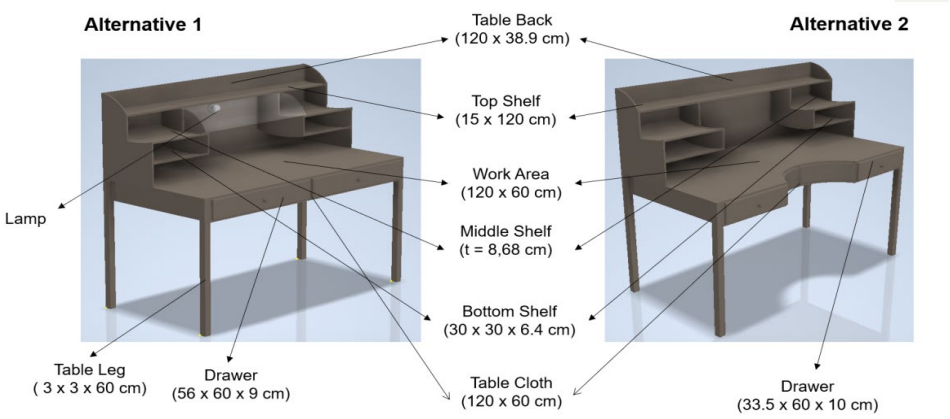

Figure 4. Table Features of Alternative 1 and 2

The workbench in addition to a chair adjustable to its height is used by the operator. The design of the chair and workbench that is to be implemented by the operator can be seen in Figure 5. below.

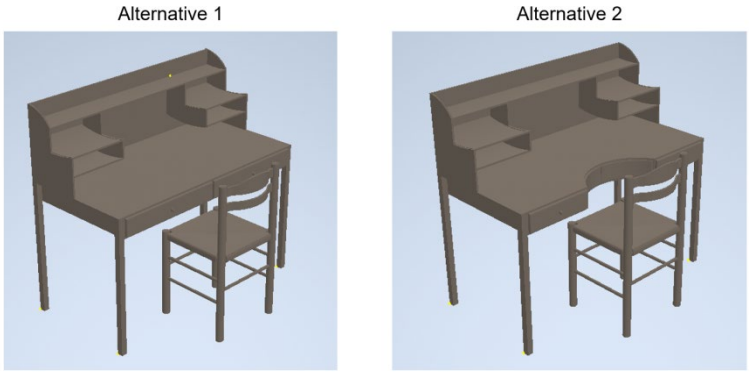

Figure 5. Design of Alternative 1 and Alternative 2

The workbench design with a budget of around IDR 1,009,800, and several wood materials are used in the production. Table 2. below lists the estimated prices for making the operator's workbench for the Magetan Leather Bag Finishing Stage.

Table 2. Design Cost of Finishing Workbench

No	Part	Material	Dimension (cm)	Need (Unit)	Total Need (cm)	Unit Price (IDR)	Total (Unit)	Total Price (IDR)
1.	Work Area	Multiplex 12 mm	120 x 60	1	122 x 244	175,000	1	175,000
2.	Table Cloth		120 x 60	1				
3.	Tabel Back		120 x 38.9	1				
4.	Top Shelf	Multiplex 9 mm	30 x 15 x 8.68	2	122 x 244	138,900	2	277,800
5.	Middle Shelf		30 x 30 x 6.4	2				
6.	Bottom Shelf		15 x 120	1				
7.	Drawer	Multiplex 6 mm	56 x 60 x 9	2	122 x 244	70,000	1	70,000
8.	Table Leg	Wood Beam	3 x 3 x 60	4	3 x 3 x 120	15,000	4	60,000
9.	Lamp	Plastic	15 x 60	1	60 x 100 x 0.5	27,000	1	27,000
Total Material Cost								609,800
Labor Costs								400,000
Total Design Cost								1,009,800

Figure 6. below demonstrate the operator's working posture after using the workbench for the installation of leather bag accessories. This demonstration was done by the researcher.

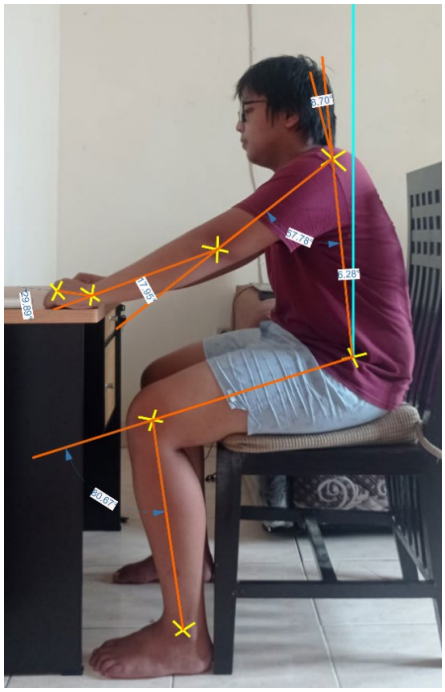

Figure 6. Position After Using Finishing Workbench

An analysis of the working posture angle is shown in the Table 3. below:

Table 3. Analysis of Working Posture Angle After Workbench Implementation

Parts of Body	**Angle (°)**
Trunk	6.28
Neck	8.70
Upper Arm	57.78
Lower Arm	17.95
Wrist	29.89
Leg	80.67

The risk assessment of the operator's work posture after using the workbench is carried out using the REBA method with the result as can be seen in Figure 7. below.

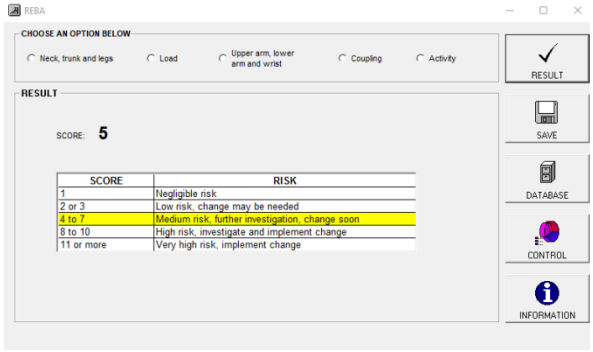

Figure 7. Posture Score After Using Finishing Workbench

Based on the operator's posture angle after using the workbench, it is observed that the application of the desk reduced the risk of working pose. The risk level of work posture plummeted to 5 (from 8). Therefore, decreasing from high risk to medium, because the operator is working on the finishing process of installing accessories with a more ergonomic posture. The improved finishing stage coupled with the application of SOPs for the Magetan Leather industry, increases operators' productivity.

Based on the evaluation of the Magetan Leather Bag industry, the improvement lies in familiarizing the operators with the intricacies of the newly developed workbench, by integrating the use of SOP (Standard Operating Procedure) into the desk application.

Therefore, the proposed solution plans were:

1. Implementation and Confirmation of SOP (Standard Operating Procedure), for an orderly work process to be achieved.
2. Operators should understand how each feature of the workbench functions to facilitate work familiarization. The SOP is in the form of procedures for placing tools and bag accessories in the appropriate positions, and has been determined as follows:
   a. Long shelf: put a zipper bag.
   b. Racks: put tools, such as hammers and pliers.
   c. Drawer: a place to set aside for accessories, separated by a drawer divider.

Familiarization with the workbench help to reduce the risk of occupational health hazards and improve safety (K3), abate Musculoskeletal Disorders (MSDs), maintains standard working rules, and good postures.

6. Conclusion

The application of the REBA method shows that workbench is an important facility that enables a good operator's working posture, reducing the risk of musculoskeletal disorders, and maximizing productivity. It also helps in the time optimization as accessories are neatly arranged to be easily accessed. However, it is necessary to be familiarized and comfortable using the workbench, to assuage unprofessionalism and unnecessary stress as a new user.

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Biographies

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