Design of Work Facilities in Warehouses and Work Stations for SME Dwarr Leather Cutting Leather

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Abstract

This case study discusses a work facility design project in a leather bag craft business in Magetan. Magetan leather craft has great potential to become the largest leather producer in Indonesia. The leather craft production process in Magetan still uses the traditional method or what is known as handmade. The problems raised were obtained based on direct observations and interviews conducted at SME bags Magetan, namely Dwarr Leather. The existing condition regarding the management and storage of raw materials in SME Bags Leather Magetan has a lot of risk and waste. The purpose of this project is to design work facilities in the form of swivel racks and tables that can increase company productivity and reduce the risk of *musculoskeletal disorders* in operators. The design stage uses the NIDA (Need, Idea, Decision, Action) method. In the NIDA design stage, two alternative rack design solutions were obtained. To determine the chosen alternative decision, the selection is carried out using the Pugh selection method. The results obtained show the selected alternative design 2. The design analysis stated that the specifications made were declared safe and the raw materials for the tools were available in the market.

Keywords
Design, Design, Pugh selection, NIDA, Leather storage

1. Introduction

Magetan Regency is the center of the leather industry with many leather handicrafts such as shoes, sandals, and bags. Magetan leather craft has great potential to become the largest leather producer in Indonesia. Shopping tourism as an alternative tourism is expected to be a center for the development of creativity and innovation. The leather industry in Magetan Regency is a micro, small and medium enterprise (MSME). Data from the Department of Industry and Trade of Magetan recorded that there were 115 business units in the leather sector in 2017. Each manufacturer competes to be able to produce quality products and have low prices. This is because the resulting product has the same product/service characteristics (Suhartini, 2015). This intense competition will certainly have an impact on competitive prices as well. Therefore, the development of leather craft production is needed in order to obtain better quality and affordable prices.

The leather craft production process in Magetan still uses the traditional method or what is known as handmade. This makes it superior because in terms of product quality it can compete with other similar products (Hadinata, 2014). However, the traditional method also has various shortcomings such as the lack of conformity with the existing standard of production methods and others. The problems raised were obtained based on direct observations and interviews conducted at SME bags Magetan, namely Dwarr Leather. The existing condition regarding the management and storage of raw materials in SME Bags Leather Magetan has a lot of risk and waste. Dwarr Leather's raw material storage system does not have adequate facilities. The leather raw material is placed on the floor and mixed others. The operator has slouch postur and lifts heavy loads. The human posture and work facilities are not ergonomic cause muscoloskeletal disorder (Silviana et al., 2022) The bad raw material storage system causes many losses such as searching time, quality of raw materials and musculoskeletal injuries. This has an effect on poor business productivity.

The raw material storage at DWARR Leather is not well structure. The operator just stack leather in the floor because didn't have any facilities. The existing storage system causes operators to have difficulty when looking for raw materials to be used for the production process. It takes a long time to find the raw material because all types of raw materials are mixed together.Searching time is non value added which can eliminate the wastes (Srisuk & Tippayawong, 2020). This long time to find raw materials certainly hampers the production process and can reduce productivity. In addition, this condition also affects the operator's work posture. The operator's work posture tends to be unergonomic and bent so that it can pose a risk of injury to musculoskeletal disorders. If this is allowed to continue, it will increase the severity of the risk, moreover the operation is included in repetitive movements that are carried out repeatedly with high frequency.

The existing raw material storage system does not have adequate facilities. This requires additional facilities to improve the work environment. The good work environment can improve the efficiency of the company and reduce the risk of injury (Tambunan et al., 2020). Tools in the form of storage racks and tables can be a solution to existing problems. The design of raw material storage facilities is carried out because it can help operators more easily find and retrieve raw materials so that the search time can be shorter with minimal operator effort. This tool is expected to be able to help the storage system and pattern drawing more effectively, efficiently and safely. The operator has a safe and comfortable working posture so that musculoskeletal disorders can be avoided.

1.1 Objectives

The purpose of this project is to design work facilities in the form of swivel racks and tables that can increase company productivity and reduce the risk of musculoskeletal disorders in operators. This swivel rack will make it easier for the operator when taking raw materials, because the swivel rack can be adjusted in height. This will be able to make the operator comfortable and the body position right when taking leather raw materials. Making this rack will also maintain the quality of raw materials and keep them clean. And the use of this rack will make it easier for operators to find and take raw materials so it doesn't take a long time.

2. Literature Review

Product design is the activity of designing a product creation involving a complete description of the specifications or description of a product according to the wishes of the customer or business actor (Sarkar & Sormaz, 2019). The design aims to analyze, assess, improve and compile a system, both physical and non-physical systems that are optimal for the future by utilizing existing information. The design procedure which is a general step that is commonly used is NIDA. NIDA is a design procedure technique, which stands for need, idea, decision and action. The stages for carrying out the design concept (Nurmianto, 2008: Pangesti, 2018).

The NIDA design technique is a design technique used to provide comfort and convenience for consumers. This technique consists of *Need, Idea, Decision,* and *Action* . *Need* is the first stage that the designer does in determining and identifying consumer needs for the product to be designed so that product development can be carried out. The description of customer needs is obtained from the results of complaints and wishes of the operator. The second stage is the idea of Generating Ideas in Design. The result of the requirement description is the generation of various alternative ideas to meet the operator's needs. The third stage is Decision in the form of Product Design Decision making. Then a product design decision is made based on the assessment and analysis of existing alternatives, so that the designer can decide on the best alternative. Then at the Action stage in the form of making a design, which is the application of the results of the decision. The results of the design made are required to provide convenience and comfort for users. This method will produce several alternatives which will then be made a decision (Sulaiman, 2017).

Pugh selection method

The Pugh method developed by Stuart Pugh can be used to assist in making decisions based on predetermined criteria. In this method the criteria and alternatives are arranged in the form of a matrix called the *decision matrix* .

The steps of the *pugh selection method* according to Sianturi (2011) include:

- Setting criteria
- Assign relative weights to each criterion
- Determine alternative solutions
- Making a decision matrix
- Choose one alternative solution as a reference

- Compare alternative solutions to references for each criterion by giving a score. For a certain criterion, the alternative can get better +1 points, equal 0, or worse -1 points
- Calculates the total score by adding up each score with the relative weight in each column. The highest value obtained is the best alternative solution.

The criteria used are derived from the needs for the design of work facilities.

3. Methods

The initial stages of this project are the exploration and interview stages. Exploration of the problem begins by looking at the working conditions at the DWARR Leather Bags. Interviews were conducted to deepen information about existing conditions and how operators work. After the exploration and interview stages, a brainstorming stage was carried out to discuss the existing problems and make plans for designing alternative designs for solutions to these problems. Then proceed to the design stage using the NIDA (Need, Idea, Decision, Action) method. In the NIDA design stage, two alternative rack design solutions were obtained. To determine the chosen alternative decision, the selection is carried out using the Pugh selection method. After that, the final stage is the analysis of the implementation plan of the design design.

4. Data Collection

The data comes from observations and interviews at the DWARR Leather IKM Bags production site as follows: (Figure 1)

Figure 1. Condition of leather storage facilities and cutting stations

1. The storage system for leather raw materials at SME Bags Leather DWARR Leather does not have a storage area for leather raw materials. Leather raw materials are stored on the floor and have no facilities storage. Leather raw materials are stacked mixed with each other. There is no arrangement that is adapted to the types of existing leather raw materials. The quality of raw materials can decrease due to environmental influences and animal attacks. Storage of leather raw materials like that causes the working environment to be untidy and seem dirty.
2. Operators have difficulty in finding leather raw materials to be used for the production process. Operators must look for leather raw materials because they cannot be seen directly if the leather is under. In addition, the operator must lift a number of piles of top leather if they want to pick them up. This results in a long time in the search and retrieval of raw materials. A long time can hamper the production process and reduce productivity.
3. Operators have poor working posture when picking up leather raw materials and doing leather cutting. This is due to the storage of raw materials on the floor and no storage space or shelves. So the operator has to bend down for a long time to find and pick up leather raw materials. In addition, when the operator cuts the leather

it is done in a squat position. This non-ergonomic work posture can pose a risk of injury or musculoskeletal disorders.

4. We received information about the complaints experienced by operators during production activities. Operators feel pain in the back when doing work due to bending and squatting work postures done repeatedly and continuously.

5. Results and Discussion

The process of designing a leather raw material storage facility uses the NIDA (need, idea, decision, analysis) method. The design uses an anthropometric approach and according to the needs of the raw material processing process. The decision uses the pugh selection concept method. The analysis is carried out to determine whether the design is in accordance with the needs and can be produced.

5.1 Need

The first step in the design process is to identify product requirements for product development. Requirements derived from observation data and operator complaints have been obtained. The following is an identification of needs. (Table 1)

Table 1. Identification of Needs

No	Problem	Needs
1.	Operators feel pain in the back after doing work due to slouching working posture	Work facilities that when used do not cause pain in the operator's back
2.	The storage area for leather raw materials is messy so it takes a long time to find the materials to be used	Work facilities that make it easier for operators to find and take leather raw materials that will be used
3.	Storage of raw materials that does not pay attention to the condition of raw materials so that it can cause damage to raw materials	Work facilities that can maintain the quality of leather raw materials so that they are not easily damaged
4.	Operators find it difficult to draw patterns due to insufficient space and bent posture	Work facilities that can make it easier for operators to carry out the pattern drawing process

Observations and interviews with operators resulted in problems that had to be resolved. The problem is made into a need for resolve problem. At this stage the problems experienced will be identified as the need for improvement solutions. These needs must be fulfilled in the design of facility.

5.2 Ideas

The second stage is in the form of ideas, namely the generation of ideas in the design. After knowing the needs, then determine the features of the tool in order to meet the needs. The following is an idea development from needs to tool features that will be provided. (Table 2)

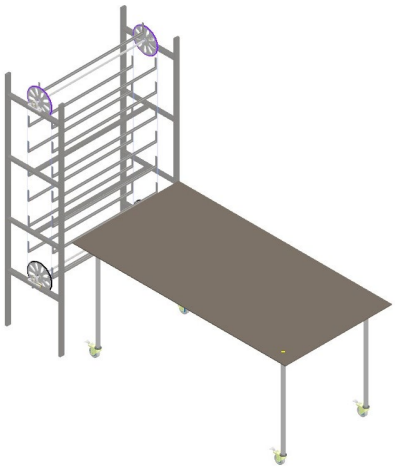
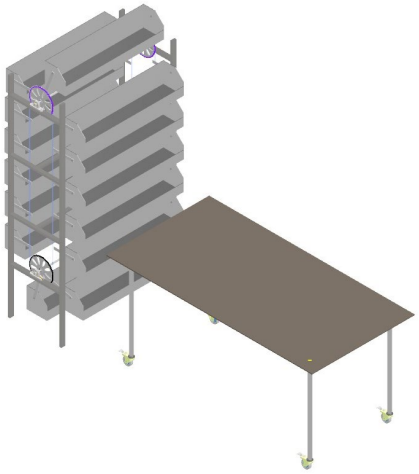
Table 2. Tool feature ideas

No	Needs	Idea
1.	Work facilities that when used do not cause pain in the operator's back	Work facilities in the form of a swivel rack equipped with pulleys and handles that can be adjusted to the operator's work (height) so as to minimize slouching work postures

2.	Work facilities that make it easier for operators to find and take leather raw materials that will be used	Work facilities in the form of swivel racks are designed by arranging leather raw materials according to certain criteria such as color, size, and so on so that it is easier for operators to find and take raw materials to be used.
3.	Work facilities that can maintain the quality of leather raw materials so that they are not easily damaged	Work facilities are designed by arranging leather raw materials in a neater and orderly roll form so that the quality is more maintained and not easily damaged
4.	Work facilities that can make it easier for operators to carry out the pattern drawing process	Work facilities in the form of a table connected to a swivel rack to facilitate the process of drawing patterns, then the size of the table is adjusted to the operator's anthropometry so as to minimize non-ergonomic work postures

Improvement needs are converted into improvement solution ideas. The creation of ideas comes from predetermined needs. The idea must be able to be a solution to an existing problem. After the ideas are collected, then a design is made that can accommodate the idea features. We produce 2 alternative designs which are as follows : (Table 3)

Table 3. alternative designs

Alternative Design 1	Alternative Design 2
	
Alternative 1 is designed to consist of a swivel rack with a roll concept and a table for leather patterning.	Alternative 2 is designed to consist of a swivel rack with a storage box concept and a table for leather patterning.
The roll swivel rack design has 3 parts, namely the rack frame, storage roll and pulley. The table design consists of 3 parts, namely the work area, table legs, and table wheels.	The box swivel rack design has 3 parts, namely the rack frame, storage box and pulley. The table design consists of 3 parts, namely the work area, table legs, and table wheels.
The use of a roll swivel rack is very helpful for operators in storing raw materials, the search for materials will not take long, and material retrieval is done easily because the rack can be	The use of a box swivel rack greatly assists the operator in storing raw materials, the search for materials will not take long, and material retrieval is done easily because the rack can be

rotated. The use of a table can reduce the position that is not ergonomic when drawing patterns.	rotated. The use of a table can reduce the position that is not ergonomic when drawing patterns.
The length of the roll in the rack is 1.3 m so that it can store rolls of leather raw material with a width of up to 1.3 m.	The length of the box in the rack is 1.2 m so that it can store rolls of leather raw material with a width of up to 1.2 m.
The roll swivel rack is designed using iron material and for the table using wood.	The box swivel rack is designed using iron for the rack frame and aluminum for the rack box and for the table using wood.
The disadvantage of this roll swivel rack is that it requires additional time for laying the roll of leather raw material into the roll.	The advantage of this box swivel rack is that the rolls of leather raw materials just need to be placed in the box so there is no need for more time for storage.

We produce two alternative designs that can be selected as improvement solutions. The creation of these two designs is used to produce the best alternative designs. Both of these designs have been able to accommodate all needs. The difference between these two designs lies in the leather storage area which is a box or roll storage system. Both have advantages and disadvantages of each.

5.3 Decision

The third stage is in the form of a decision, namely making decisions on alternative product designs. We make decisions based on assessment and analysis of existing alternatives using the Pugh selection method. We also make a BOM (bills of materials) to find out the product design in terms of costs for assessment. (Tables 4 & 5)

Table 4. BOM Alternative 1

No.	Name part	Quantity	Material	Total price
1	Steel rack frame	11 meters	Steel	IDR 125,000.00
2	Chain	2 Units	Steel	IDR 200,000.00
3	Round hollow steel	14 Units	Stainless Steel	IDR 420,000.00
4	wooden board	1 Unit	Wood	IDR 80.000,00
5	Gear	4 Units	Steel	IDR 80.000,00
6	Steel table frame	4 Units	Steel	IDR 100,000.00
7	Wheel caster	4 Units	Plastic	IDR 60,000.00
8	hanger plate	22 Units	Steel	IDR 110,000.00
9	Bolt	44 Units	Steel	IDR 52,800,000
10	Nut	44 Units	Steel	IDR 35.200.00
Total				IDR 1,227,800,000

Table 5. BOM Alternative 2

No.	Name part	Quantity	Material	Total price
1	Steel rack frame	11 meters	Steel	IDR 125,000.00
2	Chain	2 Units	Steel	IDR 200,000.00
3	Rack	14 Units	aluminum	IDR 840,000.00
4	wooden board	1 Unit	Wood	IDR 80.000,00

5	Gear	4 Units	Steel	IDR 80.000,00
6	Steel table frame	4 Units	Steel	IDR 100,000.00
7	Wheel caster	4 Units	Steel, Nylon	IDR 60,000.00
8	hanger plate	22 Units	Steel	IDR 110,000.00
9	Bolt	44 Units	Steel	IDR 52,800,000
10	Nut	44 Units	Steel	IDR 35.200.00
Total				IDR 1,647,800,000

The criteria are made in accordance with the objectives to be achieved. Alternative 1 becomes an alternative reference reference. We value alternative 2 by comparing it with the reference alternative based on predetermined criteria. After that, calculate the total score by adding up each score with the relative weight in each column. The highest value obtained is the best alternative solution. Based on the assessment of the pugh selection method, alternative design 2 was chosen. (Table 6)

Table 6. Pugh selection

Criteria	Alternative 1	Alternative 2
Good work posture	0	0
easy to use	0	1
Affordable price	0	-1
Time effectiveness	0	0
Maximum capacity	0	1
Security	0	0
Low energy use	0	1
Total	0	2
Decision	**Alternative 2**	

Based on the selection using the pugh selection method, alternative 2 becomes the result of the decision. Alternative 2 has advantages in ease of use, capacity, and energy use. Alternative 2 win in that the box design does not require the operator to roll up the leather for store. However, alternative 2 has the disadvantage of a more expensive cost factor.

5.4 Action and Analysis

Stage 4 in the form of action, namely making the design is the implementation of the results of the decision. The swivel rack design has 14 shelves arranged vertically in 1 swivel rack. The vertical arrangement of the shelves aims to maximize space. The number of racks that will be required can be adjusted by the relevant industry. The rotating rack is intended to allow the rack position to adjust to the operator's ergonomic position so that the operator does not have to bend over. The proposed facility is equipped with 1 table. The addition of a table is intended for the operator to be able to carry out the process of patterning the design and cutting the leather in an ergonomic position. The table has lockable wheels. The purpose of giving the table wheels is that the table can be moved according to the rack used. So for example, there are 3 storage swivel shelves, the table that is used remains only one. This is because in the leather industry, Dwarr Leather bags only have one operator and space is limited.

The design dimensions are made based on the circumstances and environment of the Dwarr Leather leather industry. The storage space as well as the pattern drawing workspace has an area of about 45 m2. The dimensions of the rack are 3 x 0.8 x 2.5 meters. The length of the rack comes from the width of the leather, which is 1.2 meters. This is so that the leather can be stored on the rack properly. The height of the rack comes from the height of the storage room ceiling, which is 2.7 meters. This is so that the room can be used as much as possible. The dimensions of the table are 2.5 x 1.25 x 1.2 meters. The length of the table is obtained from the length of the leather which has a length of 2.1 meters. The length of the table is made 2.5 meters so that all the leather can be placed on the table and has more length for a rack for cutting results. The width of the table comes from the width of the leather. The height of the table is

obtained from the human anthropometric elbow height plus an allowance of 16 cm because this type of work requires high accuracy. (Figure 2)

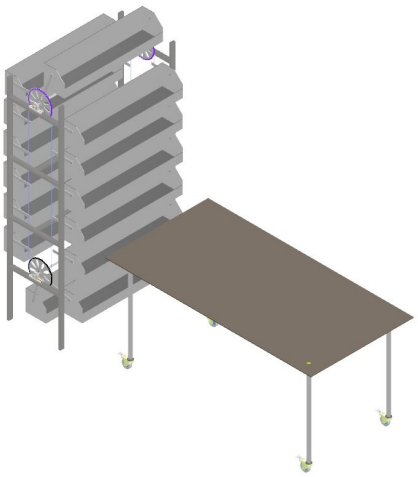


Figure 2. Selected Design

The storage rack has several components, namely:

1. Rack frame

   The rack frame is designed to be made of iron. This is because the iron material is considered strong and strong so that it can support heavy objects. The size of the rack frame is 2550 mm x 1300 mm x 600 mm. In the picture below, a 2D image of the rack frame is shown as follows: (Figure 3)

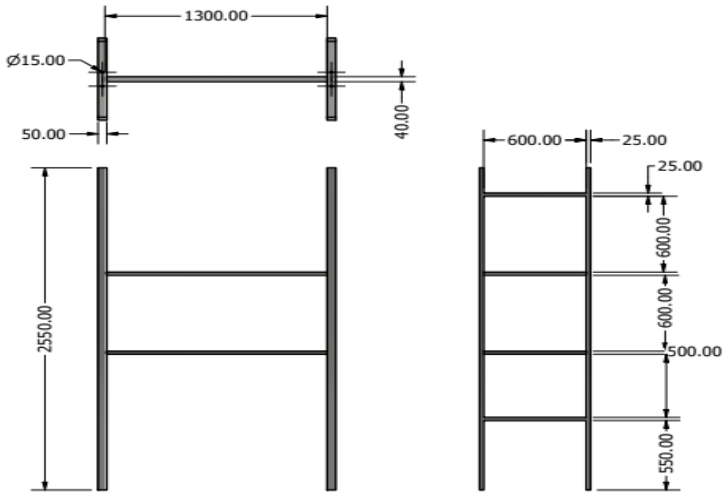


Figure 3. 2D Rack Frame

2. Leather Storage Rack

   Leather storage rack designed made of aluminum. This is because the aluminum material anti-rust, lighter and stronger. The size of the rack storage box is 1200 mm x 250 mm x 250 mm. In the image below, a 2D image of the rack storage box is shown as follows (Figure 4)

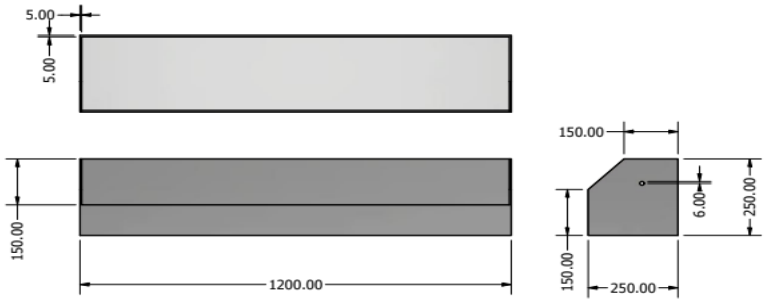


Figure 4. 2D Leather Storage Rack

3. Gears and chains

   Gear as the axis where the chain rotates. There are 4 gears and 2 chains in the design. The chain becomes a place to attach the storage rack.

4. Leather Cutting Table

   The table for pattern drawing and leather cutting has 3 parts, namely the workboard, table legs, and table wheels. The table board is designed to be made of wood and the leg frame is made of iron. For boards made of wood, they are quite strong and affordable. The table size is 2500 mm x 1250 mm x 1159.5 mm. In the picture below shows a table image in 2 dimensions as follows: (Figure 5)

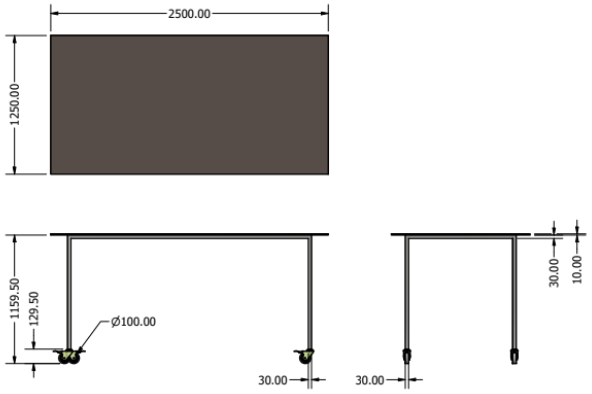


Figure 5. 2D Leather cutting table

Storage rack material selection

Storage racks for leather have criteria that are strong, lightweight and safe for leather storage. For this reason, the selection of the most appropriate material for leather storage is carried out.

Table 7. Rack material selection

Material	Strength	Lightness	Hygienic
Steel	V	X	X
stainless steel	V	X	V
Aluminum	V	V	V

Based on the Table 7, aluminum is the material of choice for storage shelves. Furthermore, calculations are carried out to calculate the strength of the rack material and rack frame.

Rack length = 1.2 m

Rack width = 25 cm

aluminum = 95 MPa

Processed leather mass: 10 kg

Calculation of needs:

F = mxa

= 10 kg x 10 m/s ^{2}
= 100 N
σ = F / A $_{\text{cross section}}$
A = F / σ
= 100 / 95
= 1.05 mm ^{2}

Calculation of materials used
The aluminum specifications to be used are 2 mm thick (available in the market)
A = l x w
= 250 x 2 mm
= 500 mm ^{2}
The cross-sectional area is more than required so that aluminum with a thickness of 2 mm is safe to use
Rack Frame
Frame specifications:
Material: Square hollow steel
Dimensions: 40 x 20 x 2 mm
$_{\text{iron}}$ = 250 Mpa
Rack capacity = 14 unit
Leather mass = 10 kg
Mass of iron plate = 280 grams
Chain mass = 600 grams
Calculation of needs
Total mass = (10kg x 14) + (0.280 kg x 28) + (0.6 kg x 2)
= 140 + 7.84 + 1.2 kg
= 149.04 kg
F = 149kg x 10 m/s ^{2}
= 1490 N
σ = F / A $_{\text{cross section}}$
A = F / σ
= 1490 / 250
= 5.96 mm ^{2}
Calculation of materials used
A = (40x20) – (38x18)
= 800x x 684 mm
= 116 mm ^{2}
The cross-sectional area is more than required so that the square hollow steel is 40x20x2 mm, so it is safe to use.

6. Conclusion

Dwarr Leather does not have adequate facilities for storing leather raw materials. This causes operators to experience difficulties and fatigue in storing and processing leather raw materials for production. In addition, there are other effects such as musculoskeltal injury, inhibition of production and decreased leather quality. The design of the raw material storage facility is carried out to improve the facility in its existing condition. By using the NIDA design method, the results obtained are designs that meet the needs and overcome the problems faced by SME Dwar leather. The design has a swivel rack system and a table so that the operator has a good working posture. The quality of the leather is maintained because it uses a hygienic aluminum material suitable for leather processing. The design analysis stated that the specifications made were declared safe and the raw materials for the tools were available in the market.

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Biography

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