Prototype Plate Bending

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Prototype Plate Bending Tool 1 mm Size in the Process of Making a Fence with an Anthropometric Approach in the Pasuruan Regency Welding Workshop

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Abstract. In the process of bending the plate making fence workers have difficulty because the process of bending the plate is still done in a conventional way as well as the absence of bending tools that correspond to the posture of the welding workshop bending in Pasuruan district area. The condition of the workers that occurred in welding workshop bending in Pasuruan district at the time of bending the plate is considered not ergonomic, because with the position of the dimensions of the body is not suitable. Among them the head bends, the back bends, the legs bend, the hands bend and the production results are less maximal. In the design of this bending tool uses an anthropometric approach in determining the design of ergonomic bending tools and providing worker comfort, samples used from 20 workers. Based on research conducted in welding workshop in Pasuruan Regency area, researchers proposed the idea of an ergonomic bending tool designed based on an anthropometric approach. With this bending tool, it is expected to be a solution to get comfort and security while working so as not to interfere with the work process. The presence of this product is expected to encourage innovation in the field of designing work systems and ergonomics.

1. Introduction

Work accidents often occur as a result of tools or machines, from less effective machines making it difficult for workers to process work.[1] In the process of bending the plate making fence welding workshop workers have difficulty because the process of bending the plate is still simple. The absence of bending equipment that corresponds to the posture of welding workshop workers in Pasuruan district. The risk of work accidents is common such as hands being scratched sharp objects, feet can be pinched and production results are not maximal. Therefore, the design of bending tool bending plate that is adapted to the body of welding workshop workers is highly blinded to suppress the number of work accidents and to produce maximum products.

Bending head, bending back, bending feet, bending hands and less maximum production are the conditions of welding workshop workers in various areas of Pasuruan district when bending plates. It is considered not ergonomic because of the inappropriate position of the body dimensions. These problems are against the backdrop of the need for ergonomic work tool repair, so researchers try to solve it by designing a bending tool bending bending plate that can help workers to produce quality products and suppress the number of work accidents in welding workshop in Pasuruan district area. The purpose of

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making this tool is to help reduce complaints of Musculeskeletal Disorders resulting from bending plate bending activity of 1mm size.

2. Methodology

This study uses experimental research design. The design of the experiment is an experimental design with every step of the action defined, so that information related to or necessary an issue to be examined can be collected in factual.[3] This research sample is a plate bending tool in the bending process. Methods of data collection by methods of literature, observation and experimentation. While the method of analysis uses anthropometric calculation and the design of worker tools.

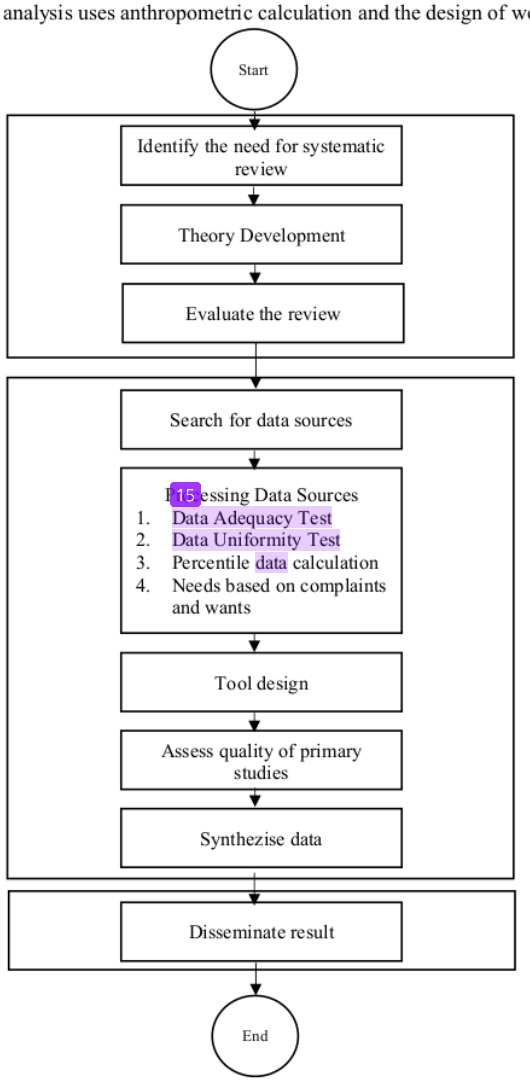

Figure 1. Systematic review diagram

Identification and Data Collection Stage

The initial stage of this research is to identify welding workshop workers in Pasuruan district to look for problems that are then used as the basic material of tool design. The research site was conducted in several welding workshop in Pasuruan district area in the bending tekuk plate process.

Data Processing Stage

The data processing in this study includes anthropometric data used to determine the size of the design:[5]

1. Test the adequacy of the data that serves to know if the data that has been obtained is sufficient

$$N' = \left[\frac{K}{s} \frac{\sqrt{N(\Sigma Xi^2) - (\Sigma Xi)^2}}{\Sigma Xi} \right]^2$$

2. Data uniformity test is performed to make the data within the control limit [6].

$$\sigma = \sqrt{\frac{n(\sum X^2) - (\sum X)^2}{n^2}}$$

3. Calculation of BKA and BKB to ensure the data is within the control limit.
4. Calculation of anthropometric data percentile data. In the concept of the existing population percentile is divided into 100 percentage categories, sorted from the smallest value to the largest value for a given body size.[7]
5. Determination of design solutions based on complaint and desire data.
6. Bending Plate Tool Design in Bending Process:
   a. Calculation of elbow length dimension data (X1)
   b. Calculation of forward hand range dimension data (X2)
   c. Calculation of high dimension Data of standing position feet (X3)

The method used in data collection is to retrieve work dimension data for workers bending bending plate and interview at the same time. The required data is the worker's complaint on the bending process of bending the plate and the anthropometric data of the dimensions of the worker's body in the process of bending the bending of the plate. Data processing is carried out based on the literature used. After data collection, data adequacy tests are carried out, data uniformity tests and percentile calculations to obtain the anthropometric size of the plate bending tool in the bending process.

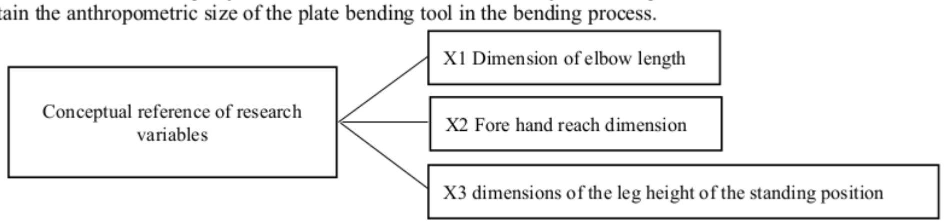

Figure 2. Mind map research

3. Result and Discussion

Welding workshop is a business in the field of welding and manufacturing metal products spread in various regions in Pasuruan district. Welding workshop is able to produce hundreds of products both individual and mass orders consisting of fences, metal doors, tralis, metal balconies, canopies, stainless gate, raling stairs and service.

In the process of designing bending tools bending plate size 1 mm required anthropometric data such as elbow length dimensions, bending head dimensions, foot height dimensions sampled by as many as 20 workers to ensure that the size of the designed tool can suit the needs of workers in the process of bending the plate appeal at a size of 1mm

Elbow Length Anthropometric Calculation

No	Name	Xi (Elbow length) cm	Xi^2 (Elbow length) cm	Xi (Hand reach) cm	Xi^2 (Hand reach) cm	Xi (Foot height) cm	Xi^2 (Foot height) cm
1.	Khoiri	31	961	58	3364	91	8281
2.	Minto	27	729	56	3136	85	7225
3.	Leo	32	1024	53	2809	95	9025
4.	Jainuri	31	961	52	2704	95	9025
5.	Hadi	32	1024	58	3364	95	9025
6.	Dedik	32	1024	58	3365	86	7396
7.	Antok	32	1024	58	3365	85	7225
8.	Japar	27	729	56	3136	85	7225
9.	Kholik	27	729	55	5025	95	9025
10.	Mandra	31	961	53	2809	95	9025
11.	Arip	28	784	56	3136	91	8281
12.	Rokim	28	784	58	3365	86	7396
13.	Khoirul	27	729	56	3136	86	7396
14.	Riyan	31	961	56	3136	85	7225
15.	Hari	27	729	56	3136	85	7225
16.	Hudi	31	961	52	2704	92	8464
17.	Yusril	32	1024	53	2809	91	8281
18.	Vicki	32	1024	53	2809	91	8281
19.	Khakim	32	1024	54	2916	95	9025
20.	Sule	31	961	56	3136	92	8464
	Total	601	18147	1107	63360	1801	162515

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Table 1. *Data Domensi Size Worker Process Bending Plate*

Elbow Length Percentile Data

Biggest data = 32
The smallest data = 27
Range = 5

Many Interval Classes

K = 1 + 3,3 log n
K = 1 + 3,3 log 20
K = 5,2 = 5

Interval Class Length

$\frac{\text{range}}{\text{many classes}} = \frac{R}{K} = \frac{5}{5} = 1$

Percentile Frequency Distribution

No	Interval Class	Cumulative Frequency (f)	Cumulative Frequency (F)	Cumulative Frequency (%)
1.	27 – 28	7	7	35%
2.	28 – 29	0	7	0%
3.	29 – 30	0	7	0%
4.	30 – 31	6	13	30%
5.	31 - 32	7	20	35%

Table 2. *Percentile Frequency Distribution*

Percentile Location

Setting Pi = $\frac{i\,(n+1)}{100}$

P5 = $\frac{5(20+1)}{100}$ = 1,05

P50 = $\frac{50\,(20+1)}{100}$ = 10,5

P95 = $\frac{95(20+1)}{100}$ =19,5

Percentile Calculation (Elbow Length)

Pi = bi + p $\left[\frac{1.n/100-F}{f}\right]$

P5 = 27 + 1 $\left[\frac{20/100-7}{7}\right]$

P5 = 27,02

P50 = 30 + 1 $\left[\frac{20/100-7}{0}\right]$

P50 = 30,2

P95 = 32 + 1 $\left[\frac{20/100-20}{7}\right]$

P95 = 32,03

Worker's elbow length is 32,03

Hand reach Percentile Data

Biggest data = 58
The smallest data = 52
Range = 6

Many Interval Classes

K = 1 + 3,3 log n
K = 1 + 3,3 log 20
K = 5,2 = 5

Interval Class Length

$\frac{\text{range}}{\text{many classes}} = \frac{R}{K} = \frac{6}{5} = 1{,}2$

Percentile Frequency Distribution

No	Interval Class	Cumulative Frequency (f)	Cumulative Frequency (F)	Cumulative Frequency (%)
1.	52 – 53,2	6	6	30%
2.	53,2 – 54,4	1	7	5%
3.	54,4 – 55,6	8	15	40%
4.	55,6 – 56,8	0	15	0%
5.	56,8 – 58	5	20	25%

Table 3. *Percentile Frequency Distribution*

Percentile Location

Setting Pi = $\frac{i\,(n+1)}{100}$

P5 = $\frac{5(20+1)}{100}$ = 1,05

P50 = $\frac{50\,(20+1)}{100}$ = 10,5

P95 = $\frac{95(20+1)}{100}$ =19,5

Percentile Calculation (Hand reach)

Pi = bi + p $\left[\frac{1.n/100-F}{f}\right]$

P5 = 52 + 1,2 $\left[\frac{20/100-6}{6}\right]$

P5 = 52,036

P50 = 55,6 + 1,2 $\left[\frac{20/100-15}{8}\right]$

P50 = 56,63

P95 = 58 + 1,2 $\left[\frac{20/100-20}{5}\right]$

P95 = 58,06

The worker's hand reach length is 58,08

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Foot height Percentile Data

Data terbesar = 95
Data Terkecil = 85
Rentang = 10

Many Interval Classes

K = 1 + 3,3 log n
K = 1 + 3,3 log 20
K = 5,2 = 5

Interval Class Length

$$\frac{\text{range}}{\text{many classes}} = \frac{R}{K} = \frac{10}{5} = 2$$

Percentile Frequency Distribution

No	Interval Class	Cumulative Frequency (f)	Cumulative Frequency (F)	Cumulative Frequency (%)
1.	85 – 87	8	8	40%
2.	87 – 89	0	8	0%
3.	89 – 91	4	12	20%
4.	91 – 93	2	14	10%
5.	93 – 95	6	20	30%

Table 4. *Percentile Frequency Distribution*

Percentile Location

Setting $Pi = \frac{i\,(n+1)}{100}$

$P5 = \frac{5(20+1)}{100} = 1{,}05$

$P50 = \frac{50\,(20+1)}{100} = 10{,}5$

$P95 = \frac{95(20+1)}{100} = 19{,}5$

Percentile Calculation (Foot height)

$Pi = bi + p\left[\frac{1.n/100-F}{f}\right]$

$P5 = 85 + 2\left[\frac{20/100-8}{8}\right]$

P5 = 85,05

$P50 = 91 + 2\left[\frac{20/100-12}{4}\right]$

P50 = 91,1

$P95 = 95 + 2\left[\frac{20/100-20}{6}\right]$

P95 = 95,08

Worker Foot Height is 95,08

Figure 3 shows the average result of the calculation of elbow length with a percentile value of 32.3.

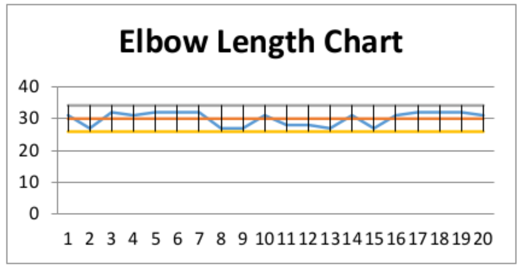

Figure 3. Elbow length in standing position

Figure 4 shows the mean result of the outreach calculation with the percentile value is 58.08

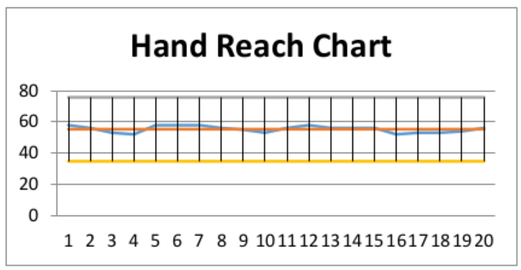

Figure 4. Reach Hand standing position

Figure 5 shows the mean of the calculated leg height in a standing position with a percentile value of 95.08

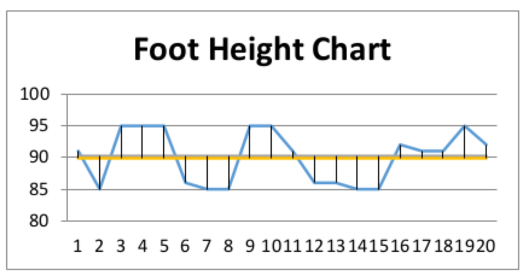

Figure 5. Standing Foot Height

After the data collection and processing results are obtained, the calculation of dimension size for the selected design based on anthropometric results is obtained namely: The length of the standing position elbow is 32.03 cm, the hand range of the standing position is 58.06 cm and the height of the standing position foot is 95.08 cm. The wide size design of the bending tool uses 95 percentiles of the population who are expected to use this bending tool using the results of the calculation of hand range and elbow length which is 58.06 and 32.03. Thus obtained the width value of the bending tool is 58.06 - 32.03 = 26.03 cm.

In the design of the length of the bending tool the population is expected to use this bending tool using the calculation results of hand range and elbow length which is 58.06 and 32.03. So obtained the length value of the bending tool is 58.06 + 32.03 = 90.09 cm. In the design of the high size of the bending tool the population is expected to use this bending tool using the calculation of the height of the standing position foot which is 95.08 cm.

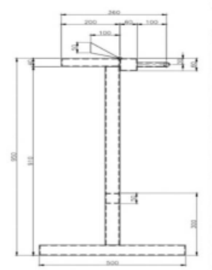

Figure 6. Side view

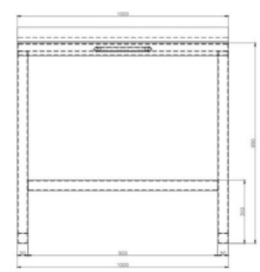

Figure 7. Front look

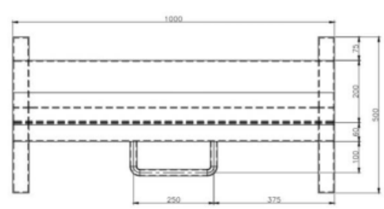

Figure 8. Top view

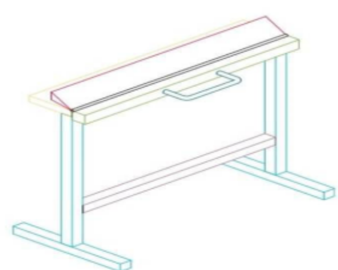

Figure 9. Prototype of 1 mm plate bending tool

4. Conclusion

Conclusions that can be drawn from the results of research on the design of bending tools bending welding workshop plates in Pasuruan regency area with this anthropometric approach, namely the result of Prototype bending tool bending plate on the manufacture of fence in accordance with the anthropometry of the body of the worker welding workshop Pasuruan district area. based on the results of the calculation of anthropometry namely the length of the elbow standing position 32.03 cm, hand length standing position 58.06 cm and foot height standing position 95.08 cm and result of body measurement dimensions workers bending bending plate with anthropometric approach in welding workshop in Pasuruan district area using 95th percentile result namely Bebding tool width 26 cm, bending tool length 100 cm and bending tool height 95,09 cm

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