Decreasing of musculoskeletal complaints through redesigns handling arit and palu products

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Abstract. Arrester and hammer products are products that are often used by construction workers and agricultural workers. Arrester products are often used as the main tool for farmers who work in the fields every day, while hammer products are the main tools of construction workers when they will connect wood to one another using nails, or a hammer is used as a tool to destroy certain objects. Tool design that does not consider work comfort, has an impact on increasing musculoskeletal complaints felt by the user. The design of this study is treatment by subject design. The sample in this study amounted to 46 workers who were included in the inclusion criteria. The results showed that there was a decrease in musculoskeletal complaints of the workers after using the results of the design of the handle of sickle and hammer products. Arit products have an impact on the reduction of users' musculoskeletal complaints by 15.517%, the results of statistical calculations show a significant difference between the use of sickle products before and after the design. The Palu product has an impact on the reduction of the user's musculoskeletal complaints by 3.681%, the results of statistical calculations show no significant difference. The mean value of musculoskeletal complaints of conventional sickle products was 189,805 ± 5,569; mean musculoskeletal complaints using Arit products designed as much as 75.870 ± 9.985; mean musculoskeletal complaints using Conventional Hammer products 89,174 ± 6,775; mean musculoskeletal complaints using Palu products were 85.891 ± 7.388. This difference is influenced by the frequency level of product use.

1. Introduction

The community creative metal industry based on metal raw materials, such as the manufacture of agricultural equipment in the form of hoes, sickles, knives, and other household appliances up to now has grown rapidly. The capacity of the creative industry in this community is inseparable from the ability of the industry to provide raw materials or the ability to adopt technology. The creative industry of the community is actually able to compete in capturing the global market, but because it does not know the technology adoption map developed, it is difficult to determine short-term and long-term business development strategies.

Metal industrial waste still has the potential to be reprocessed into new products. Some processing products with raw materials for scrap are hoes, arrays, ovens, stoves. The processing itself is carried out by the creative industries of the household, so it can be possible that the technology used is very simple, relying on human hand power, not oriented to profit optimization, not oriented to the needs and desires...
of market share, quality or quality is not guaranteed. Based on the above problems, it is necessary to have a product innovation that is in accordance with the market including art products and hammer products from the creative industries in Indonesia.

Some scrap metal is generally only in accordance with the capabilities of an industry, there has been no attempt to categorize products that have a high selling value. Products with the category of results from small or micro industries or often known as the creative industries of the community tend to have minimal selling value because the adoption of technology is still low, while in certain industries that are still in the micro scale found in the field can make products that fall into the category middle market. During this time, industries that are in the middle category, still have not made efforts to provide opportunities for small industries to conduct backword and forward relations between micro and medium industries, both of these industry categories on business trips generally make their own efforts. The existence of a relatively simple industry, then the use of tools or tools also relies on its function alone does not think about the impact after using the tool, moreover the occupational health conditions.

Even though these various phenomena if not repaired immediately will have an impact on musculoskeletal complaints. Musculoskeletal complaints can occur due to the remaining activity in the previous day. Complaints that occur in the morning before work are accumulations of complaints that appeared before [1]. Static muscle contraction occurs because the emphasis on blood vessels from within the muscle tissue will inhibit blood circulation [2], musculoskeletal system disorders caused by inadequate workplaces [3], repetitive activities, unnatural work attitudes. Forced behavior at work and lasts a long time causes a burden on the musculoskeletal system [4], [5]. This condition occurs because there is no capability map related to technology adoption from each industry. There needs to be an effort to make products based on user needs, in line with improving work health and employee and company performance. One effort that can be done to improve the health and performance of workers is a decrease in musculoskeletal complaints. This complaint is often felt by workers who work in their daily hands with muscle power. The tendency of health deterioration conditions occurs because of designs that do not take into account user comfort. The new design is designed with emphasis on its functions, has not been designed to balance the comfort of the user, especially in the form of minimizing the risk of complaints when manually operating the tool.

2. Research methods
The correspondent of this study amounted to 46 male sexes, the type of work in each day is as farmers and construction workers who know and often use sickles and hoes. Questionnaires were randomly selected by random. The subjects met were asked to use conventional products and design products. After completing the activity within a certain time, the subject was given a Nordic Body Map questionnaire (NBM) to be filled in according to the complaint felt when using the product. The results of the questionnaire between the use of conventional products and the use of design products are processed, analyzed, discussed and compared.

This study was included in an experimental study with the design of treatment by subject design [6], [7], [8], [9], [10]. Schematic picture of research design which can be seen in Figure. 1 as follows:

Figure 1. Research Design Chart

Explanation :
P : Affordable population (workers who enter the inclusion criteria)
Rs : Random Sampling (using a simple random method)
S : Samples (workers selected as samples in the study)
P0 : Conventional conditions
P1 : Conditions using design products
O1 : Observe samples before working with old products
O2 : Observe the sample after finishing working using the old product
WOP : Washing Out Period
O3 : Observe the sample before working, after using a new product
O4 : Observe the sample after work, after using a new product

3. Results and Discussion
Product assembly is inseparable from the need for anthropometric data. Anthropometric data is used as part of basic data to provide size according to the user. Anthropometric data in this study are needed to provide a design size that is in accordance with the actual dimensions of user size [11]. Another study which states that anthropometric data is the basis for product design or product design. Static anthropometric data as the basis for designing tools in the industry [12], anthropometric data can be used for ergonomic tool design [13], anthropometric data can be used for equipment design [14], anthropometric data provide competitive advantages and improve user health [15]. The design of the sickle and the design hammer provides more user-friendly comfort as in Fig. 2 and Fig. 3, respectively.

![Figure 2. Arit](image)
Description: A. Conventional sickle; B Modification sickle

![Figure 3. Hammer](image)
Description: Hit. Conventional Hammer; b. Modification Hammeri

Improvements are made by adding foam to the handle, this condition is an attempt to provide comfort when the handle holds. It should be noted in this case that the height of the foam is given as part of the thickness. Avoiding the maximum limit of the hand holding, so that the strength of the hand becomes a part that must be considered. Improvements can be made to continue to reduce musculoskeletal
complaints through ergonomic interventions such as designing anthropometric-based tools. Ergonomics intervention as an effort to reduce musculoskeletal complaints [16], requires improvement by applying ergonomic concepts to reduce complaints of body posture and biomechanical load [17].

Musculoskeletal complaints can occur in some parts of the body. Symptoms of musculoskeletal complaints include neck 50.5%, shoulder 50.2% and 65% complaints of pain due to discomfort working for 6 months [18], musculoskeletal complaints found 52.9% back pain, pain in the legs 14.8%, upper arm 8.9%, neck 3.0%, wrist 2.3%, and arm 2.1% [19]. The occurrence of dominant complaints is pain in the hands, wrists and shoulders [20], the prevalence of musculoskeletal complaints in the head, neck, arms of the subject under study [21].

**Skeletal Muscle Complaints**

Skeletal Muscle Complaints of workers or often known as musculoskeletal complaints of subjects were measured using Nordic Body Map questionnaire (NBM) before planning and after designing.

**Table 1.** Output of SPSS results from the test of the Normality of workers' musculoskeletal complaints

| Periode                                      | Kolmogorov-Smirnov* | Shapiro-Wilk       |
|----------------------------------------------|----------------------|--------------------|
| Musculoskeletal Complaints (Conventional Sickle) | 0.094 46 .200' .972 46 .324 |                |
| Musculoskeletal Complaints (Modification Sickle) | 0.238 46 .000 .825 46 .000 |                |

**Table 2.** Hasil iji Normalitas produk (Kolmogorov-Smirnov)

| No | Variabel           | N   | rerata | SB   | z     | Nilai p* |
|----|--------------------|-----|--------|------|-------|----------|
| 1  | Conventional Sickle| 46  | 89,804 | 5,569| 0.094 | 0.200    |
| 2  | Sickle design results| 46  | 75,870| 9,985| 0.238 | 0.000    |
| 3  | Conventional Hammer| 46  | 89,174| 6,775| 0.099 | 0.200    |
| 4  | Hammer design results| 46  | 85,891| 7,388| 0.142 | 0.021    |

SB: standard deviation; data is normally distributed if P> 0.05

Based on Table 2 shows that musculoskeletal complaints using conventional arrhythm obtained z = 0.094 and p = 0.200 means that the data is normally distributed (p> 0.05), while the use of arit design z = 0.238 and p = 0.000 means that the data is not normally distributed (p <0.05).

While the results of the normality data test on conventional hammer use musculoskeletal complaints z = 0.099 and p = 0.200 means that the data is normally distributed (p> 0.05), while the use of the hammer design is z = 0.142 and the value of p = 0.021 means that the data is not distributed normal (p
<0.05). Because there is no normal distribution of data, the mean test uses the nonparametric test of the Wilcoxon sign ranks test.

### Table 3. Output SPSS Wilcoxon Signed Ranks Test Ranks

| Musculoskeletal complaints | N   | Mean Rank | Sum of Ranks |
|----------------------------|-----|-----------|--------------|
| Modivication sickle) -     |     |           |              |
| Musculoskeletal complaints | 40  | 23.51     | 940.50       |
| (Conventional sickle)      |     |           |              |
| Positive Ranks             | 4   | 12.38     | 49.50        |
| Ties                       | 2   |           |              |
| Total                      | 46  |           |              |
| Musculoskeletal complaints |     |           |              |
| (Modified Hammer) -         |     |           |              |
| Musculoskeletal complaints | 23  | 28.39     | 653.00       |
| (Conventional Hammer)      |     |           |              |
| Negative Ranks             | 22  | 17.36     | 382.00       |
| Positive Ranks             | 1   |           |              |
| Ties                       | 46  |           |              |

The mean score of musculoskeletal complaints using conventional arrhythms was 89,804 ± 5,469 and the use of arit design was 75,870 ± 9,985. Meaningful analysis with the nonparametric test Wilcoxon sign ranks test showed that the value of z = -5,200 and p = 0.000 so that H0 was rejected, meaning that the mean score of musculoskeletal complaints in the two periods was significantly different (p <0.05), the conditions using conventional sickle were different significantly compared to using design arrays. While the analysis of the treatment effect test on the mean score of musculoskeletal complaints using a conventional hammer is 89,174 ± 6,775 and the use of a hammer design is 85,891 ± 6,775.

Meaning analysis using nonparametric test Wilcoxon sign ranks test showed that the value of z = -1.531 and p = 0,126 so that H0 was accepted, meaning that the mean score of musculoskeletal complaints in both periods was not significantly different (p <0.05), the condition using conventional hammer not significantly different compared to using a design hammer. Percentage of changes caused by the modification of the handle on the arrhythmic and hammer products is presented in Table 5.

### Table 4. Differences and Percent changes in Musculoskeletal Complaints using the nonparametric test Wilcoxon sign ranks test

| No | Uraian            | Mean  | SD   | Value of z | Value of P | Percentage of Change |
|----|-------------------|-------|------|------------|------------|----------------------|
| 1  | Conventional Sickle | 89,904 | 5,569 | -5.200     | 0.000      | 15.517               |
| 2  | Sickle design results | 75,870 | 9,985 | -5.200     | 0.000      | 15.517               |
| 3  | Conventional Hammer | 89,174 | 6,775 | -1.531     | 0.126      | 3.681                |
| 4  | Hammer design results | 85,891 | 7,388 | -1.531     | 0.126      | 3.681                |

Based on Table 4, shows that the percentage of changes caused by the modification of the product handle, shows that the change between conventional arrhythmic products and designed arit products is 15.517% which is stated in a statistically different test. These changes have an impact on the more comfortable and safe use of sickles by users, so that complaints of skeletal muscles or musculoskeletal complaints can be significantly reduced.

While the changes that occur in the use of conventional Palu products with Palu products are designed as much as 3.681%, this change does not cause improvements in skeletal muscles, because the statistical results show changes are very small, so it does not have an impact on improving musculoskeletal complaints. This condition is possible because the use of a hammer in the same research subject has a different frequency where farmers and construction workers use the sickle more frequently each day than using a hammer (the results of a separate interview). Other similar studies reported to have different percentage changes compared to the results in this study namely musculoskeletal complaints of 22.48%
[22], musculoskeletal complaints of 15.10% [23]. Worker's musculoskeletal complaints were 87.8% [24], musculoskeletal complaints were 43.1% [25]. The difference in percentage changes is due to differences in the characteristics of the task, work organization and work environment, as well as the choice of treatment given to the subject which is a characteristic of the intervention of each research conducted.

4. Conclusion
The design results provide changes to the user's musculoskeletal complaints.

1. Arit products have a reduced impact on users' musculoskeletal complaints by 15.517%, the results of statistical calculations show a significant difference.
2. Hammer products have a reduced impact on users' musculoskeletal complaints by 3.681%, the results of statistical calculations show no significant difference.
3. The mean value of musculoskeletal complaints in conventional sickle products was 189,805 ± 5,569 while the designed Arit mean was 75,870 ± 9,985
4. Conventional Palu average value 89,174 ± 6,775; The mean of Palu was 85.891 ± 7.388.
5. The difference in mean values is influenced by the frequency of use of the product and redesign of the handle of sickle products and hammer considering the comfort of work, especially the muscles in the hands of workers.

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