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Implementation of Label Cutting Workstations Improvement in The Jago Jaya Shuttlecock Industry to Increase Productivity Based on Ergonomic Aspects

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Abstract: *Jago Jaya Shuttlecock Industry is an MSME in Jagalan, Surakarta, that produces shuttlecocks. Based on these conditions, a study was conducted in 2020 by Sherlinta Kaban, which produced a label cutting tool tested on a label cutting workstation. However, in the trial, there are several obstacles found in using the label cutting tool, so follow-up study to analyze and improve the label cutting tools in previous studies to produce a new design that can be re-implemented. Ergonomics aspects used in this study are analysis of work posture using REBA, measurement of standard time with Westinghouse adjustments, the study of left and right-hand map movements, and tool redesign using the Reverse Engineering method. The improvements include implementing a new label cutting tool that can improve the operator's work posture, reduce standard time, increase the number of standard outputs, and improve operator hand movements to increase productivity at label cutting work stations.*

Introduction

Micro, Small, and Medium Enterprises (MSMEs) in Indonesia have become the most critical pillar of the economic ecosystem[1]. One is the Jago Jaya Shuttlecock Industry in Surakarta, Central Java. Most of the production processes are still done manually, and simply one of them is on the label cutting workstation. Previously, the label cutting process at the Jago Jaya Shuttlecock Industry was still done manually using a simple cutting tool, a circular knife that was hit using a wooden block. Then Sherlinta Kaban

[1] Bambang Arianto, "Pengembangan UMKM Digital Di Masa Pandemi Covid-19," *ATRABIS: Jurnal Administrasi Bisnis (e-Journal)* 6, no. 2 (2020): 233–247.

designed a label cutting tool to improve the label cutting process in the industry. The tool uses the NIDA method, which consists of 4 stages: Need, Idea, Decision, and Action[2]. By combining a punching tool and a cutting tool, the tool can shorten the time of the label cutting process[3]. The tool consists of 4 main components, namely the base (coaster), cutter (cutter), handle (lever), and legs. The material used is stainless steel which is strong, durable, and not easy to rust. The working principle of the tool is to set up the label on the hole in the tool and then press the lever or handle on the tool to cut the label[4].

Who then tested the cutting tool designed by Sherlinta Kaban in the Jago Jaya Shuttlecock Industry, and several obstacles were found, including the cutter or cutter tool was not strong enough and sharp enough to carry out the cutting process. The lever or handle on the tool was also less elastic, making it difficult to move. In addition, the legs on this tool are not strong enough, so the cutting tool is easy to shake when used. This tool also relies too much on the accuracy of the operator's eyes when carrying out the process of setting up the label to the tool. These constraints affect the results of the label pieces becoming untidy. As a result, the label cutting process in the industry has returned to the traditional method of punching knives and wooden blocks because the cutting tools produced before cannot be used.

The target per day in the Jago Jaya Shuttlecock Industry is 100 slops, where one slop contains 12 shuttlecocks. So that the number of labels needed every day is around 1200 pieces. The Jago Jaya industry is struggling to meet many daily targets. This is because the cutting method using the manual tool currently used by the operator is inefficient. After all, it can only produce a neat number of label cuts with an average of 50% of the target set. Research of [5] mentions that efficiency uses inputs as sparingly as possible to produce outputs that match or exceed the target. This efficiency refers to how well resources are used to produce output.

Productivity is a behavior designated by individuals or groups that influence their performance[6]. The productivity of a job can be seen from several factors, one of which is the operator's work attitude. This is in line with [7] research, who states that work attitudes or postures are the determining points in analyzing the effectiveness of a job.

[2] E Nurmianto, "Ergonomi: Konsep Dasar Dan Aplikasinya. Kedua," *Surabaya: Guna Widya. Ratodi, M.(2015) Metode Perancangan Arsitektur. Surabaya* (2008).

[3] Sherlinta Immanuella Kaban, Rahmaniyah Dwi Astuti, and Eko Pujiyanto, "Perancangan Alat Pemotong Label Untuk Meminimasi Gerakan Repetitive Pekerja Di Industri Jago Jaya Shuttlecock Surakarta," *Matrik: Jurnal Manajemen dan Teknik Industri Produksi* 22, no. 1 (2021): 65–72.

[4] Sherlinta Immanuella Kaban, "Usulan Rancangan Alat Bantu Pemotongan Label Shuttlecock Untuk Mengurangi Gerakan Berulang Pekerja Di Industri Jago Jaya Shuttlecock" (2020).

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[6] Desi Rahmawati, "Pengaruh Motivasi Terhadap Produktivitas Kerja Karyawan PR Fajar Berlian Tulungagung," *Jurnal Bonorowo* 1, no. 1 (2013): 1–15.

[7] Agustin Dwi Arfiasari et al., "Hubungan Postur Kerja Dengan Keluhan Muskuloskeletal Dan Produktivitas Kerja Pada Pekerja Bagian Pengepakan Di PT. DJITOE INDONESIA TOBAKO" (Universitas Muhammadiyah Surakarta, 2014).

Musculoskeletal Disorders (MSDs) are complaints that are felt as a result of a collection of minor impacts that then accumulate continuously over a long period, causing pain and discomfort in muscles, bones, and joints[8].

This research is expected to produce improvements to label-cutting workstations in the Jago Jaya Shuttlecock Industry by finding weaknesses in the previous tool design and producing a new design based on evaluations that have been carried out to be implemented again in the Jago Jaya Shuttlecock Industry. By paying attention to several aspects of ergonomics that aim so that the results of the tool design can be used by humans effectively[9]. Therefore, the new tool design can make it easier for operators to do work so that the primary goal of tool procurement can be achieved, namely increasing the productivity of the shuttlecock industry, especially at label-cutting workstations.

Method

There are several stages carried out in this study, including:

First, Assessment of the operator's work posture in the label cutting process using the REBA (Rapid Entire Body Assessment) method. REBA is a method used to analyze and assess a work posture. REBA is a method of analyzing and assessing work posture to determine the risk level of musculoskeletal injury by conducting a comprehensive analysis of body parts. The REBA method is widely used to conduct assessments because it can be done quickly (rapidly) with assessment costs that are not so significant when compared to other assessment methods. The final result of the REBA assessment is the final REBA score, which is a single score used to represent the risk level of musculoskeletal disorder for the job task being evaluated. The minimum REBA score is 1, while the maximum REBA score is 15[10].

Second, The redesign of the cutting tool is carried out using the Reverse engineering method. Reverse Engineering is a tool method by observing the advantages and disadvantages of tool yang already existing[11].

The methodology of the study, in general, is shown in figure 1.

[8] Annisa Fitri, "GAMBARAN TINGKAT RESIKO TERJADINYA GANGGUAN MUSKULOSKELETAL PADA PERAWAT SAAT MEMANDIKAN PASIEN DI RUANG ICU DR M. DJAMIL PADANG BERDASARKAN METODE RAPID ENTIRE BODY ASESSMENT (REBA) TAHUN 2020" (Universitas Andalas, 2020).

[9] Fitria Susanti, "Analisis Postur Kerja Sebagai Upaya Mengurangi Risiko Musculoskeletal Disorders Pada Karyawan Bagian Gudang Non Medis Rumah Sakit Kasih Ibu Surakarta" (2015).

[10] Ergoplus, "Step by Step Guides to Recommended Ergonomic Assessment Tools."

[11] Tuwuh Wahyu Prasojo, S T Ratnanto Fitriadi, and others, "Perancangan Ulang Mesin Pencacah Rumput Dengan Menggunakan Metode Reverse Engineering" (Universitas Muhammadiyah Surakarta, 2016).

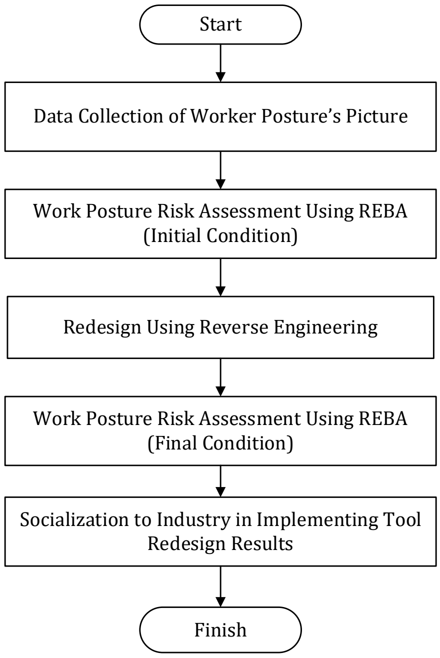


Figure 1. Research methodology flowchart

Result

At this stage, data collection and data processing is carried out by the research methodology that has been carried out. The assessment of the operator's work posture in the process of cutting labels before and after the tool implementation is carried out through corner pulling using Angulus Measurement software. Then data processing is carried out using the method REBA. What obtained a score of 9 with a high category in the conditions before the tool implementation. In contrast, in the condition after the tool implementation, what obtained a score of 4 with a moderate category.

Figure 2. Label cutting before tool implementation

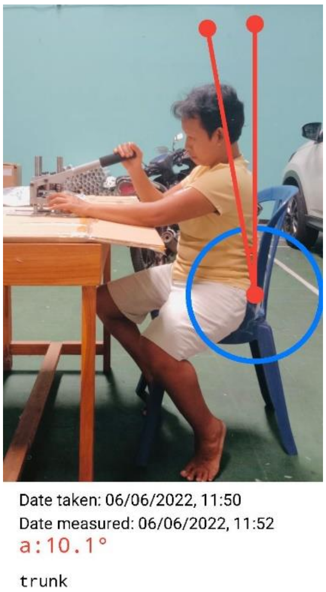


Figure 3. Label cutting after the implementation of the tool

The process of socialization to encourage industrial workers to adopt the new assistive tool involves several key steps. Firstly, the research findings, which identify weaknesses in the current label-cutting workstations at the Jago Jaya Shuttlecock Industry, need to be effectively communicated to the workforce. This communication can take the form of presentations, workshops, or informational sessions, where the operators and relevant personnel are made aware of the shortcomings in the existing tool design.

Following this awareness phase, the proposed improvements and the new design generated from the research evaluations should be clearly presented. This includes highlighting how the new design addresses the identified weaknesses, emphasizing its potential benefits in terms of ergonomic enhancements, increased efficiency, and overall improvements in the working conditions of the label-cutting process.

To ensure a successful socialization process, it is crucial to actively engage with the workers, addressing any concerns or questions they may have about the new assistive tool. Providing demonstrations and practical examples of how the new design operates can significantly contribute to their understanding and acceptance. Additionally, obtaining feedback and insights from the workers during this stage can foster a sense of involvement and ownership in the decision-making process.

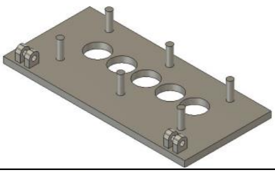
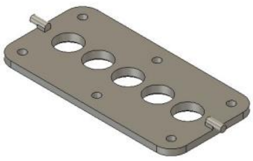
Discussion

The redesign of the tool begins with an interview of the operator regarding the operator's complaints and needs for the cutting tool. The operator was asked to provide information regarding the label cutting tool designed by Sherlinta Kaban. What will consider the evaluation results in redesigning the new label cutting tool using Reverse Engineering. Reverse engineering consists of 5 stages: disassembly, assembly, benchmarking, redesign, and prototyping[12].

Demolition

At this stage, a more profound observation of the previous cutting tool product was carried out to obtain data related to the size of the tool, the components used in the tool, and how the tool works. Table 1 shows disassembly of Sherlinta Kaban cutting tools

Table 1. Disassembly of Sherlinta Kaban Cutting Tools

Component	Design Drawings	Size	Information
Base/outer cutter		• Tool size 150 mm x 71.5 mm x 5mm • Hole diameter 18 mm	• Material stainless steel • Used as a cutter
Cutter/inner cutter		• Cutting tool size 118 mm x 58.5 mm x 4 mm • Hole diameter 18 mm	• Material stainless steel ST-90 • Used as a cutter
Foot		• Leg height of 49 mm • Diameter by 10 mm	• Material pipa stainless steel • Used as a machine support holder
Handle/Tuas		• Handle size 126 mm x 94 mm	• Hollow iron material and stainless steel plate • Used as a handle that relieves the operator in using cutting tools

Assembly

This stage is the process of combining the cutting tool's components, which will then be*nchmark* (comparison) with the components of the cutting tool designed by

[12] Rizaldi Wiranda, "PERANCANGAN ULANG ALAT PEMOTONG KERUPUK LOMANG MENGGUNAKAN METODE REVERSE ENGINEERING (RE)(STUDI KASUS: IKM KERUPUK LOMANG UBI WATI)" (Universitas Islam Sultan Syarif Kasim Riau, 2020).

Sherlinta Kaban.

Benchmarking

This stage is a process of comparing existing cutting tools designed by Sherlinta Kaban to find out the disadvantages and advantages of the tool that can be used as repair data for the cutting tool being designed. The tool comparison is in the following Table 3.

Table 3. Benchmarking

Product Name	Component	Sherlinta Kaban Cutting Tool	Current Snipping Tools
		Deficiency	Excess
Label Snipping Tool	Handle	Dimensions are too small, so they cannot withstand the load when the tool is used	Dimensions are extended to withstand loads when tools are used
		Less comfortable grip	Equipped with foam or sponge at the end of the handle for added operator comfort
		The handle is less elastic so that when it is climbed down, it falters	The addition of a spring or pear to the handle to make it more elastic and easy to move down
	Cutter	Less sharp so that the cut is untidy and cannot be used	Repair of cutter material using unique cutting material so that it is sharp enough to make cuts
	Foot	It is only a pipe and is too small and not equipped with a lock, so the tool is easy to shake when used.	Use two types of legs, namely long and short legs, for the front and back of the cutting tool. And equipped with a lock, so the tool does not shake quickly when used.
	Stopper		A stopper on the tool makes it easier for the operator to set up the label

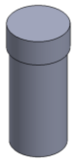
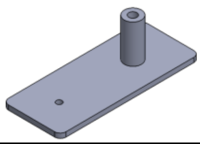
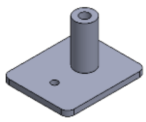
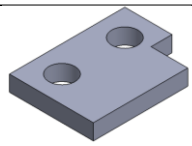
Tool designing

After *benchmarking* on the previous cutting tool, data was obtained that was used as a reference in the design of the label cutting tool either from raw materials or materials, how the tool works, and the design used.

Prototyping

This stage is the last stage, which is to make a *prototype* of the product to be designed with the following description in Table 4.

Table 4. Prototyping

Component	Design Drawings	Description
Handle		• Dimensions Lever length 215 mm and diameter 23 mm • Material Pipa MS
		A sponge or foam is used at the end of the handle
Cutter		• Dimensions of 50 mm height and 20 mm diameter according to label size • Material AS HSS
Foot		• Dimensions Leg Length 121 mm x 50 mm • Short Leg Dimensions 60 mm x 50 mm • Material Plat MS
		
Stopper		• Dimensions 22 mm x 16 mm • Material Striplat MS

Here is a picture of the realization of the new label cutting tool that has been produced in this study:



Figure 4. Top View Cutting Tool, Front-Facing Cutting Tools, and Side-View Cutting Tools

At the label cutting work station, the operator carries out the label cutting process before implementation by sitting cross-legged on the floor or using a small stool. This working posture is less comfortable and ergonomic because it causes the operator to have to bend over for quite a long time. Based on the results of the Nordic Body Map (NBM) questionnaire, it is known that operators complain of pain in several parts of the body, including the waist at 75%, the hip at 68.75%, the right wrist at 56.25%, and the right shoulder at 56.25%. This complaint arises as a result of the operator's bent work attitude and involves a lot of the right side of the body. In the assessment using the REBA method, the final score resulting from the label cutting work posture before implementation was 9, which indicates that this posture is at a high risk level where improvements must be made to this activity immediately.

The process of cutting labels in conditions after implementing the tool is carried out by the operator sitting on a chair and using a table. Changes in working attitude after applying this tool are carried out to reduce bending and operator discomfort during the label cutting process. The final value resulting from the label cutting work posture after implementation is 4, which indicates that this posture is included in the moderate risk level where improvements need to be made to this activity.

From this description, it can be seen that there is an improvement in the operator's working posture during the label cutting process. The working posture after implementing the tool produces a lower risk value, namely 4 compared to before implementing the tool which had a value of 9. This is because the angle formed by the operator's working posture after implementing the tool is smaller than before, apart from that there is also an improvement in the operator's clutch or grip. from the previous value of 2, which was in the poor category, it changed to the good category with a value of 0. Meanwhile, the load value and activity score in both conditions were still the same. Where the operator load is less than 5 kg with a value of 0, while the Activity Score means repetition of movement in a short time with a value of 1.

Conclusion

In conclusion, the label cutting work station initially presented ergonomic challenges, with operators experiencing discomfort and musculoskeletal pain due to prolonged bending during the cutting process. The Nordic Body Map (NBM) questionnaire highlighted significant complaints, particularly in the waist (75%), hip (68.75%), right wrist (56.25%), and right shoulder (56.25%). The REBA method assessment indicated a high-risk level with a score of 9 before the implementation of the ergonomic tool. However, positive changes were observed after the tool was introduced, as operators transitioned to a chair and table setup. This adjustment resulted in a reduced risk level, with a final score of 4, indicating a moderate risk level. Notably, the improved working posture was attributed to a smaller angle, leading to a lower risk value. Additionally, enhancements in grip strength were evident, shifting from a poor category (2) to a good category (0). Although the load and activity score remained constant, the overall findings underscore the effectiveness of the ergonomic tool in mitigating risks and improving the operator's working conditions during the label cutting process.

Collaboration with the management and decision-makers within the Jago Jaya Shuttlecock Industry is essential to gain their support for the implementation of the new tool. This may involve discussing the potential positive impacts on productivity, employee well-being, and long-term cost savings. Continuous communication and feedback loops should be established throughout the implementation phase to address any challenges or adjustments needed. Training sessions on the proper use of the new tool should be conducted, ensuring that operators are comfortable and proficient in incorporating it into their daily work routines. By fostering a transparent and collaborative approach to socialization, this research aims to create a positive environment for the adoption of the new assistive tool, ultimately leading to improved label-cutting workstations in the Jago Jaya Shuttlecock Industry.

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