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Ergonomic Redesign in Scrap Area to Reduce the Risk of Cumulative Trauma Disorders and to Increase Capacity at Toy Manufacturing Company

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ABSTRACT

In the auto rooting area, rejected rooted heads undergo scrap process before being discarded. A solder is currently used, which only destroys both eyes and thus, may increase the risk of rework done by irresponsible parties. A new tool using a toggle is preferable as it is more effective in removing the entire face. However, the toggle has a smaller capacity compared to the solder, which prevents the full transition. Upon observation, it is found that there are many non-ergonomic and non-value-added activities. This resultingly increases the risk of Cumulative Trauma Disorders (CTDs), particularly carpal tunnel syndrome, and reduces toggle capacity. Anthropometry and Rapid Upper Limb Assessment (RULA) are used to analyze the current posture and dimension. The method used to redesign the scrap workstation is Quality Function Deployment (QFD). The results of this study are that using, the newly improved workstation reduces RULA score from 6 to 2. Based on Nordic Body Map, the operator only feels pain in one body part, compared to the five body parts before improvement. By changing the pinch grip to a power grip, risks associated with carpal tunnel syndrome are minimized. Toggle capacity also increases by 49% from 300 to 448 rooted heads.

Keywords: *Scrap, Workstation, Cumulative Trauma Disorders, Carpal Tunnel Syndrome, Capacity, Ergonomics, Anthropometry, Rapid Upper Limb Assessment (RULA), Flow Process Chart, Nordic Body Map, Quality Function Deployment (QFD)*

ABSTRAK

Di area *auto rooting*, *rooted heads* yang ditolak akan melalui proses *scrap* sebelum dibuang. Alat yang digunakan saat adalah solder, yang hanya merusak kedua mata sehingga dapat meningkatkan risiko *rework* yang dilakukan oleh pihak yang tidak bertanggung jawab. Alat baru yang menggunakan *toggle* dinilai lebih baik karena lebih efektif dalam merusak seluruh wajah. Namun, *toggle* tersebut memiliki kapasitas yang lebih kecil dibandingkan dengan solder, sehingga mencegah implementasi menyeluruh. Berdasarkan observasi, banyak ditemukan aktivitas yang tidak ergonomis dan tidak menambahkan nilai pada proses. Hal ini mengakibatkan peningkatan risiko *Cumulative Trauma Disorders* (CTDs), khususnya *carpal tunnel syndrome*, dan mengurangi kapasitas *toggle*. Antropometri dan *Rapid Upper Limb Assessment* (RULA) digunakan untuk menganalisis posture dan dimensi saat ini. Metode yang digunakan untuk mendesain ulang *scrap workstation* adalah *Quality Function Deployment* (QFD). Hasil dari penelitian ini adalah dengan menggunakan *workstation* yang baru diperbaiki tersebut menurunkan skor RULA dari 6 menjadi 2. Berdasarkan *Nordic Body Map*, operator hanya merasakan nyeri pada satu bagian tubuh, dibandingkan dengan lima bagian tubuh sebelum perbaikan. Dengan mengubah *pinch grip* menjadi *power grip*, risiko terkait dengan *carpal tunnel syndrome* dapat diminimalkan, Kapasitas *toggle* juga meningkat sebesar 49% dari 300 menjadi 400 *rooted heads*.

Kata kunci: *Scrap, Workstation, Cumulative Trauma Disorders, Carpal Tunnel Syndrome, Capacity, Ergonomics, Anthropometry, Rapid Upper Limb Assessment (RULA), Flow Process Chart, Nordic Body Map, Quality Function Deployment (QFD)*

1. Introduction

Work system design is crucial for manufacturers to improve efficiency, quality, safety, and employee satisfaction, and to remain competitive and profitable in the long run. Apart from that, a well-designed work system also encompasses lean manufacturing principles, namely flow improvement and waste elimination, so

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that productivity is improved and customer satisfaction is achieved (Santos et al., 2015). If a workplace is designed in poor manners, workers might assume working postures that are unnatural to the human body, potentially leading to a variety of health problems, which would reduce the productivity of workers and output levels of the product. However, poor ergonomics in the workplace and the impact it brings are often overlooked even though the repetitive nature of work in a poorly designed workplace can potentially result in a permanent damage to the health and well-being of the workers. In the industrial sector, cumulative trauma disorders (CTDs) pose a significant challenge as they can lead to various costs such as worker compensation, labor turnover, absenteeism, reduced productivity, and poor quality (Yusuff & Abdullah, 2016). Based on this, it is imperative that ergonomics be implemented in designing the work system of companies to minimize the risk of health issues and to improve productivity of workers.

Toy Manufacturing Company is a manufacturing company that produces various types of toys, which include fashion dolls. A solder was used for the scrap process in the auto rooting area but a new tool using a toggle is more preferred as it can destroy a larger part of the reject. However, there is a trade-off as the capacity of the toggle is less than the solder. Many non-value-added and non-ergonomic activities are found. The small size of the handle requires a pinch grip instead of a power grip. Because the pinch grip relies on the strength of the fingers and thumb, it can cause fatigue and strain in these muscles if used for extended periods, which should be avoided as the operator may risk from CTDs, particularly carpal tunnel syndrome (Kroemer, 1989). Additionally, the workstation itself does not have a proper design for discarding scrap rejects as they sometimes end up being pushed too far onto the floor. This extra movement would increase the time required for the scrap process, thus reducing capacity. Based on this, the capacity of the toggle needs to be increased so that it is at least equal to the solder to allow for the full implementation, which would minimize risks of rework and selling by irresponsible parties. Responding to the problems above, this study aims to improve the work system of the scrap process by redesigning the workstation that can minimize the risk of CTDs and to increase capacity of the toggle, which relates to product design using Quality Function Deployment (QFD). QFD is used in several studies to design a product based on the ergonomic analysis (Azwir, 2021; Andre, 2018).

2. Methods

2.1 Initial Observation

The first stage of the research involves observing the current scrap process specifically in the auto rooting area. The observations may include certain activities in the scrap process which do not add value to the overall process that leads to increased cycle time as well as awkward postures or unnecessary extra movements that would result in fatigue. Apart from that, interviews were also conducted to inquire operators about the problems they experienced during the scrap process. This stage is important as it aids in determining areas for improvement particularly in the scrap workstation that will be proposed in the next stages.

2.2 Problem Identification

This stage involves identifying and defining the problems or issues that must be addressed through research or other problem-solving methods. The problem statement serves as the base of the research in which the research assumption and scope are also determined. The problems in the study are related to the scrap process particularly in the auto rooting area. Despite being a more reliable tool compared to the solder, the new toggle introduces a new problem: increased cycle time and less capacity. There are several activities observed that do not add value to the overall process. Apart from that, there are also non-ergonomic activities that may cause the operator to experience fatigue. Additionally, the small handle requires the handle to do a pinch grip, which increases the risk of Cumulative Trauma Disorders, specifically carpal tunnel syndrome.

2.3 Literature Study

This stage involves reading and analyzing the selected works in depth to examine the techniques implemented in previous studies. The purpose of a literature study is to gain a deeper understanding of the ideas and themes present in the works being studied, as well as the context in which they were written. In this study, the literature study focuses on Lean Manufacturing, Ergonomics, Rapid Upper Limb Assessment (RULA), Time Study, Motion Study, Statistical Testing and Quality Function Deployment (QFD).
This study proposes an improvement to the scrap workstation through ergonomic redesign on the basis of lean manufacturing. Based on the principles of Toyota Production System (TPS), lean manufacturing was introduced by Toyota in the 1950s and is notable for its emphasis on seven waste elimination to increase customer satisfaction (Liker, 2004). The seven different types of waste in include wastes of overproduction, inventory, defects, transportation, motion, waiting, and overprocessing (Ohno, 1988). In this case, this study focuses on

reducing wastes of motion and overprocessing. According to Fernandez (1995), ergonomics in general aims to design tasks and workspaces that are suited to the physical, cognitive, and psychosocial characteristics of the individual performing them, rather than expecting the individual to adapt to the demands of the task or workspace. The principles of ergonomics center on achieving a balanced alignment between the physical, cognitive, and organizational aspects of work and the capabilities of the human body (Karwowski, 2012). Complaints might be detected when there is a disparity between the physical capabilities of the human body and the physical needs of the task (Korhan & Memon, 2019).

The existing scrap process and work condition is analyzed using several tools, namely flow process chart, Nordic Body Map, RULA, and anthropometry. Flow process charts are used in recording various types of activities, namely operations, inspections, movements, storages, and delays that an item encounters while going through the process in the plant (Freivalds & Niebels, 2014). While the Nordic Body Map is a tool that is used to assess the ergonomics by identifying and assessing the risk of musculoskeletal diseases (MSDs) in the workplace. This is achieved by its visualization of the body that helps employees in identifying any discomfort or pain in different body locations as shown on Table 1. Lastly, Rapid Upper Limb Assessment (RULA) is a tool that was developed to assess how much individual workers are exposed to risk factors related to upper limb problems at work (McAtamney & Corlett, 1993). Table 2 shows the RULA scores and their respective descriptions.

Table 1. Nordic Body Map score

Grade of complaints	Description	Score
A	No pain	1
B	Moderate pain	2
C	Pain	3
D	Very painful	4

Table 2. RULA score

Score	Description
1-2	Acceptable
3-4	Investigate further
5-6	Investigate further and change soon
7	Investigate and change immediately

The proposed improvement is developed using Quality Function Deployment (QFD), which is a methodology used for product development which aims to provide a systematic method of dealing with the various complexity and trade-offs inherent in all product design decisions (Hauser et al., 2010). Wolniak (2018) asserts that using QFD in the product development process can significantly impact the costs of a business. According to Cohen (1995), the four phases of QFD include Product Planning, Product Design, Process Planning, and Production Planning. The House of Quality (HOQ) is implemented in QFD, which is widely used to improve customer satisfaction as it helps to ensure that the product meets the customer demands (Shrivastava, 2013). After implementation, time study is conducted. Time study is beneficial for companies as it can help in optimizing processes, as well as minimizing waste by making a calculated estimation of the time required for each job element (Abraham-Igwemoh & Etebu, 2022). In time study, normal time is calculated, which refers to the average time taken by a qualified worker to accomplish a task under regular working circumstances, excluding any allowances or factors (Gusmon & Hutomo, 2019), which is calculated using Equation (1).

$$Normal\ Time = Average\ Observed\ Time \times Performance\ Rating \tag{1}$$

After obtaining normal time, standard time is computed using Equation (2).

$$Standard\ Time = Normal\ Time \times (1 + Allowance) \tag{2}$$

Statistical testing is also utilized to confirm the validity of data, which includes normality, homogeneity, and sufficiency tests. A normality test is used to evaluate whether the collected data follows to a normal distribution while a homogeneity test is conducted to verify the consistency of the data and that it is collected from the system (Zimmerman & Zumbo, 1992). Using the Equation(3), data is considered sufficient if $N' \leq N$.

$$N' = \left(\frac{\frac{k}{s}\sqrt{N \sum x^2 - (\sum x)^2}}{\sum x} \right)^2 \tag{3}$$

2.4 Data Collection

Data collection is the process of gathering information from a variety of sources and organizing it in a way that is useful for a specific purpose. In this case, the collected data includes the personnel specification, namely the operator. Additionally, the average cycle time of the scrap process is also obtained. Moreover, the process is further defined using the flow process chart. The Nordic Body Map questionnaires will also be distributed to find out the specific body part of the operator that is most affected.

2.5 Data Analysis

After all necessary data have been collected, analysis of the data will be conducted, which starts from analysing the current condition using several methods. Firstly, Rapid Upper Limb Assessment (RULA) is conducted, in which the final RULA score will indicate the ergonomic risk factors associated with the work. Additionally, anthropometry data will be used to determine the measurement for the workstation. Besides that, the activities in the scrap process that are considered to be non-value-added and non-ergonomic are identified as part of the opportunity identification. Customer needs and requirements are also reviewed based on interviews conducted. Based on that, QFD proposes improvements regarding the scrap workstation redesign. After the design process, the proposed scrap workstation is to be implemented based on the drawings of the selected concepts. Statistical testing is used to test the validity of the data before conducting time study to obtain standard time. Moreover, an analysis is conducted to compare the before and after improvements. The next step involves calculating the break-even point using the cost of improvement and cost savings. Lastly, assessment is done between the solder, toggle (before improvement), and toggle (after improvement) based on the QCDSM metrics.

2.6 Conclusion and Recommendation

As the final step, this section is used to summarize the findings of the study and the steps that have been taken to answer the problem statements. Apart from that, recommendations are also given for future research related to this topic.

3. Result and Discussion

3.1 Initial Observation

Toy Manufacturing Company has one operator to operate the toggle for the scrap process. In this case, the operator is a 35-year-old female with height 156 cm and weight 53 kg. Since the toggle is only currently used for processing products that have restricted access with lower quota or demand, the scrap process takes up two hours per day at the start of their shift. The average observed cycle time is obtained to be 11.13 s.

3.1.1 Flow Process Chart

Flow process chart is used to describe elements of a process from start until end. Necessary non-value-added activities are minimized while the non-value-added activities that produce pure waste should be eliminated. Figure 1 shows the flow process chart of the current scrap toggle.

FLOW PROCESS CHART								
○ : Operation □ : Inspection ▽ : Storage ⇨ : Transport D : Delay		Job: Rooted Head Scrap Component: Toggle Method: Present						
No.	Description	Time (s)	Symbol ○	Symbol □	Symbol ▽	Symbol ⇨	Symbol D	Remarks
1	Take rooted head from container	1.2	●					
2	Transfer rooted head to other hand	1					●	Eliminate
3	Place rooted head in between clamp	0.7	●					
4	Push handle	0.8	●					
5	Push down toggle	2.3	●					
6	Lift toggle	0.9	●					
7	Pull handle	0.7	●					
8	Pull rooted head from clamp	0.6	●					
9	Inspect	1		●				
10	Put rooted head into container	0.8	●					
11	Clean output that does not go into the hole	1.8					●	Eliminate
Total		11.8	8	1	0	0	2	

Figure 1. Flow process chart of current scrap toggle

Based on the flow process chart, it can be seen that there are several non-value-added activities, which are categorized as delays. These activities produce pure waste, that is time, and should be eliminated.

3.1.2 Nordic Body Map

Toy Manufacturing Company employs one operator to operate the toggle for the scrap process. Since the toggle is only currently used for processing products that have restricted access with lower quota or demand, the scrap process takes up two hours per day at the start of their shift. The operator fills the questionnaire before operating the toggle and after two hours (see Appendix). There are five out of twenty-one (23.8%) body parts in which the operator feel fatigue, particularly in the hand area. This is because the operator works in a sitting position and would move their hands frequently. The operator experiences fatigue in both of their left and right hands but the grade of complaints is higher in their left fingers and right upper arms. This is because the handle requires a pinch grip, which should be avoided to minimize the risk of carpal tunnel syndrome (Kroemer, 1989).

3.1.3 RULA

The assessment is divided into several parts to calculate the final RULA score. Figure 2 shows the current scrap work posture of the operator. Based on Table 3, the final RULA score is obtained to be 6, which signifies a need for further investigation and change.

Figure 2. Current scrap work posture

Table 3. RULA score

Table C		Neck, Trunk, Leg Score						
		1	2	3	4	**5**	6	7+
Wrist / Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	**6**	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

3.1.4 Anthropometry Measurement

Measurements in this study will refer to the Indonesian female anthropometry data based on Nurmianto (1989). Firstly, the table width follows the 50th percentile of the length between elbow and fingertips, which are 40.9 cm whereas the current table width is 45 cm. Thus, the table width needs to be reduced. Secondly, the table height is the combination of the 5th percentile of popliteal height, 95th percentile of sitting elbow rest height and an added 15% for room for shoes. Based on this, the calculation obtained is 77 cm whereas the current table height is also 71.3 cm. Thus, the table width should be reduced as well.

3.2 Proposed Improvement

In conducting the interview, several questions are prepared for the user, which is the operator. After collecting the raw data, the researcher interprets the data to a list of customer needs as shown on Table 4. These customer needs are prioritized using mudge diagram, which is shown on Table 5.

Table 4. Customer Needs

No	Customer Needs	Code
1	Can reduce cycle time	A
2	Large container	B
3	Easy to use	C
4	Ergonomic design	D
5	Safe to use	E
6	Space-efficient	F
7	Durable	G
8	Affordable manufacturing cost	H

Table 5. Mudge Diagram

	A	B	C	D	E	F	G	H	Total	%	Rank
A		A2	A1	A1	A1	A2	A3	A1	11	26.83	1
B			C1	D2	B1	B2	B2	B1	6	14.63	3
C				D2	E2	C1	C1	H2	3	7.32	6
D					D2	D1	D1	D1	9	21.95	2
E						F1	E2	E1	5	12.20	4
F							G1	H2	1	2.44	8
G								G1	2	4.88	7
H									4	9.76	5
Total Score									41	100	

All components or sections of HOQ which have been determined can now be combined. Figure 3 shows the HOQ for the scrap toggle. Following the HOQ, customer needs have been translated into technical response which have also been sorted from the highest to lowest priority, as follows:

1. Handle diameter
2. More inclined passageway
3. Handle material
4. Container size
5. Add output barrier
6. Transparent cover opening size
7. Output hole size
8. Manufacturing cost
9. Material availability at workshop
10. Workstation size
11. Container material

This will serve as a base on designing and proposing the improved workstation.

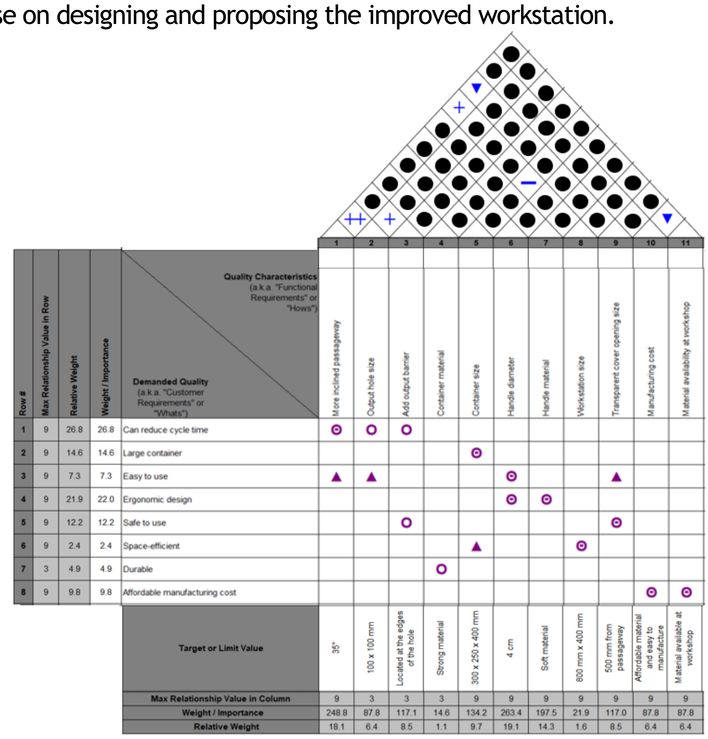

Figure 3. House of Quality (HOQ)

Based on the HOQ, there are four parts that need improvement, namely handle, face waste container, rooted head waste bag holder, and input container, which are then designed using Solidworks software (see Appendix).

After implementing the improvement of scrap workstation, observations are taken to calculate cycle time, which are determined to be 6.98 s. Normality test is conducted using Minitab 18 application as shown on Figure 4, where the p-value is obtained to be 0.284, which is greater than 0.05. This indicates the null hypothesis can be accepted. The results also pass homogeneity test because all data points are between UCL and LCL as shown on Figure 5.

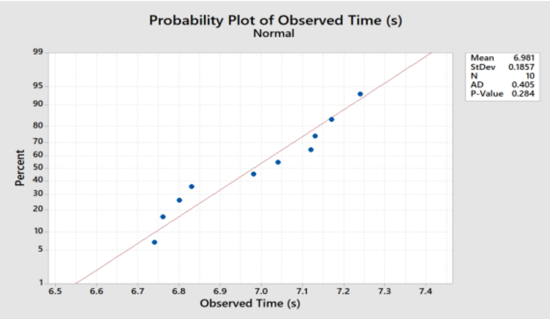

Figure 4. Normality test

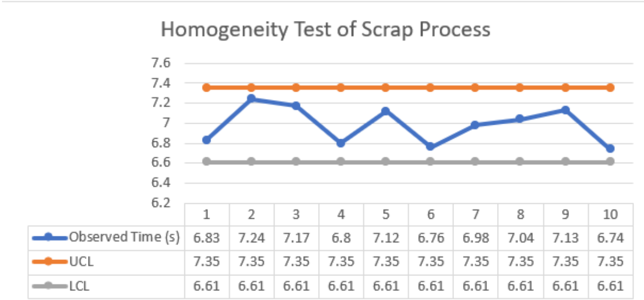

Figure 5. Homogeneity test

The calculation below shows that $N' \leq N$, thus the feasibility of the data is validated by the sufficiency test as it is considered to be sufficient.

$$N' = \left(\frac{\frac{2}{0.05}\sqrt{10(487.65) - (69.81)^2}}{69.81}\right)^2 = 1.019$$

As validity of data has been confirmed, time study is conducted using formulas explained previously. Normal time is obtained based on the performance rating set by production leader.

$$Normal\ Time = 6.981 \times 1.06 = 7.40\ s$$

Standard time is calculated using allowance that has been determined in advance. The allowance is 8.5% based on the standards set by Toy Manufacturing Company.

$$Standard\ Time = 7.40 \times (1 + 0.085) = 8.03\ s$$

3.3 Before-After Analysis

3.3.1 Flow Process Chart

The flow process chart after is made so that comparison between before and after improvement can be done. Figure 6 shows the flow process chart after improvement.

FLOW PROCESS CHART

○ : Operation □ : Inspection ▽ : Storage ⇨ : Transport D : Delay

Job: Rooted Head Scrap
Component: Toggle
Method: Proposed

No.	Description	Time (s)	○	□	▽	⇨	D	Remarks
1	Take rooted head from container	0.8	●					
3	Place rooted head in between clamp	0.9	●					
4	Push handle	0.6	●					
5	Push down toggle	1.4	●					
6	Lift toggle	0.9	●					
7	Pull handle	0.6	●					
8	Pull rooted head from clamp	0.6	●					
9	Inspect	0.9		●				
10	Put rooted head into container	0.4	●					
	Total	7.1	8	1	0	0	0	

Figure 6. Flow process chart after improvement

Based on the figure above, the non-value-added activities are eliminated. There are no delays anymore and cycle time consequently decreases.

3.3.2 Nordic Body Map

Based on the Nordic Body Map questionnaire, the operator only feels pain slightly on their right upper arm (see Appendix). Previously, the operator feels pain in five body parts and after the improvement, the number reduces to only one body part (4.8%). This is because the improved workstation allows the operator to operate the toggle without having to move their hands frequently. In addition to this, the larger handle also helps the operator as they feel it is more comfortable operating the handle.

3.3.3 RULA

RULA is also done after improvement, as shown by Figure 7 which shows the work posture of the operator while doing the scrap process. Table 7 shows the RULA score after improvement.

Figure 7. Scrap work posture after improvement

Table 7. RULA score after improvement

Table C		Neck, Trunk, Leg Score						
		1	2	3	4	5	6	7+
Wrist / Arm Score	1	1	2	3	3	4	5	5
	2	2	2	3	4	4	5	5
	3	3	3	3	4	4	5	6
	4	3	3	3	4	5	6	6
	5	4	4	4	5	6	7	7
	6	4	4	5	6	6	7	7
	7	5	5	6	6	7	7	7
	8+	5	5	6	7	7	7	7

Referring to the table above, the final RULA score is determined to be 3. Based on this, the RULA score decreases from 6 to 3 after improvement.

3.3.4 Toggle Capacity

Toggle capacity increases as a result of improving scrap workstation as seen on Figure 8. The number of toggle capacity using the toggle and the improved workstation, which is 448 rooted heads, is greater than the number of toggle capacity using the solder, which is 420 rooted heads. This indicates that the scrap process can transition fully to the toggle using the improved workstation.

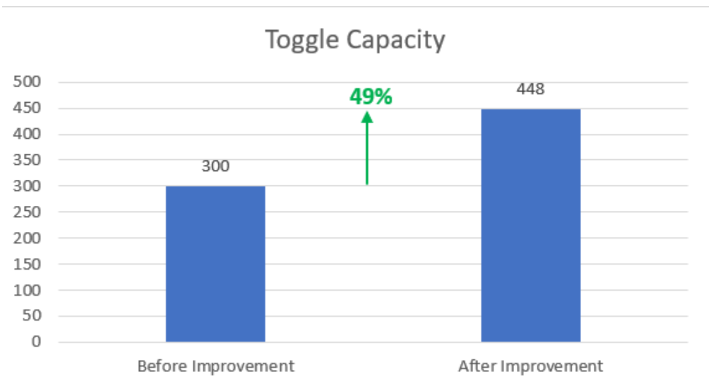

Figure 8. Toggle capacity comparison

3.3.5 QCDSM

Evaluation is done using QCDSM metrics, which offers a comprehensive structure for assessing and enhancing an organization's performance. Table 8 shows the comparison of the tools for the scrap process based on QCDSM.

Table 8. QCDSM comparison of scrap

Parameter	Solder	Toggle (Before Improvement)	Toggle (After Improvement)
Quality	Output is not completely destroyed and is still recognizable	The entire face is cut through which gives better results	The entire face is cut through which gives better results
Cost	Electricity cost = IDR 688,946.69 per year	No electricity cost	No electricity cost
	Labor cost = IDR 45,871,209.29 per year	Labor cost = IDR 64,219,693 per year	Labor cost = IDR 42,973,677.90 per year
Delivery	Flow of scrap process is maintained and less inventory buildup	Buildup of scrap inventory	Better flow of scrap process and less inventory buildup
Safety	There is a risk of workplace accidents due to heat generated by the solder	Reduced risk of workplace accidents as no heat is generated and operator is not in contact with sharp part	Reduced risk of workplace accidents as no heat is generated and operator is not in contact with sharp part
Morale	Morale is maintained but ergonomics was not considered in designing workstation	Reduced morale due to low productivity and non-ergonomic activities, which increases risk of CTDs	Improved morale and ergonomics

The improvement is able to reduce RULA score from 6 to 2 and based on Nordic Body Map, the percentage of uncomfortable body parts decrease from 23.8% to 4.8%. Consequently, capacity also increases from 300 to 448 rooted heads. Apart from that, based on the table above, the improvement also brings positive impact as it outweighs both solder and toggle before improvement. On account of that, the toggle can be implemented and a full transition from the solder to the toggle can also be conducted. Using the newly improved workstation, it receives a positive response from the operator as it is able to meet their demands as identified in QFD.

4. Conclusion

To reduce the risk of CTDs, particularly carpal tunnel syndrome, the handle is improved so that it requires a power grip instead of a pinch grip. Unnecessary activities that cause additional movements are also eliminated. Based on RULA, the score is reduced from 6 to 3 and based on Nordic Body Map, the operator only feels pain in one body part compared to the previous workstation where the operator feels pain in five body parts. Activities that are considered do not add any value to the overall process are either minimized or eliminated. Increasing the capacity of container minimizes the frequency of refills whereas adding a barrier and increasing the inclination of the passageway would eliminate the possibility of the rooted head being stuck or thrown too far away. Along with the improved ergonomics, the cycle time using the improved workstation consequently decreases, increasing capacity by 49% from 300 rooted heads per hour to 448 rooted heads per hour. Comparing the QCDSM metrics, the toggle after improvement outperforms the solder, allowing the full transition to take place and giving way for the toggle to be fully implemented for the scrap process.

Based on the results of the study on improving the scrap workstation, recommendation for future study is also necessary. Future research could examine the toggle tool itself to determine the toggle properties (i.e., length) and the necessary force exerted by the operator. It could also further redesign and improve the workstation to reduce the RULA score to 1 or 2 so that the operator does not have to extend their hand much.

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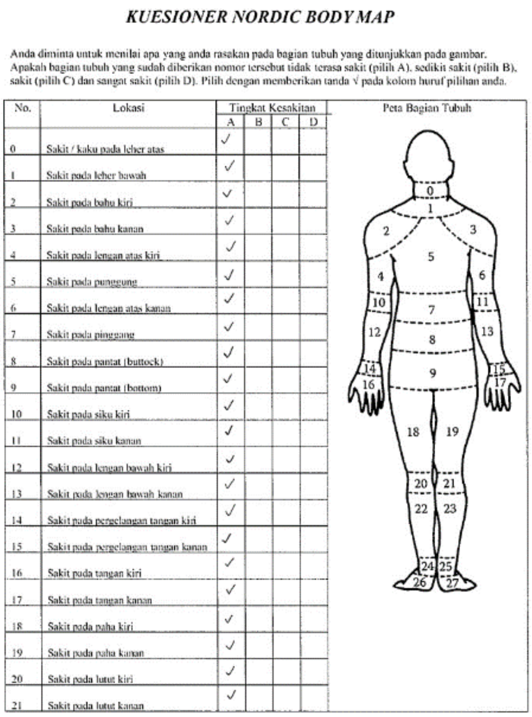
Appendix

Current (before process starts)

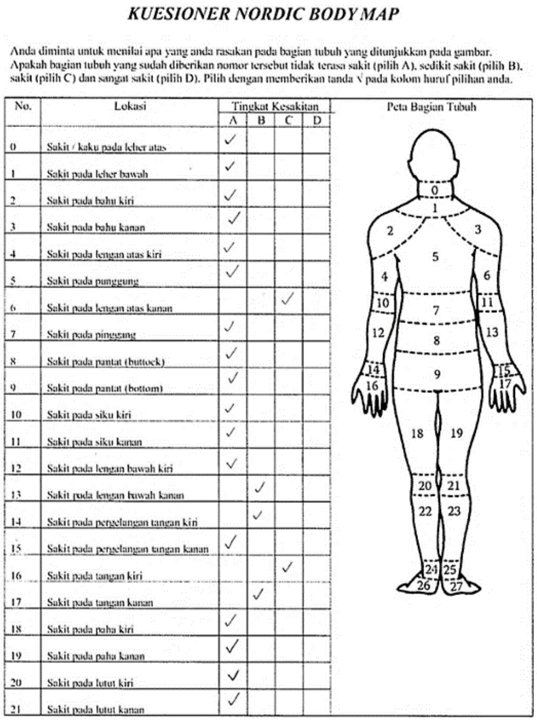


KUESIONER NORDIC BODY MAP

Anda diminta untuk menilai apa yang anda rasakan pada bagian tubuh yang ditunjukkan pada gambar. Apakah bagian tubuh yang sudah diberikan nomor tersebut tidak terasa sakit (pilih A), sedikit sakit (pilih B), sakit (pilih C) dan sangat sakit (pilih D). Pilih dengan memberikan tanda √ pada kolom huruf pilihan anda.

No.	Lokasi	Tingkat Kesakitan				Peta Bagian Tubuh
		A	B	C	D	
0	Sakit / kaku pada leher atas	√				
1	Sakit pada leher bawah	√				
2	Sakit pada bahu kiri	√				
3	Sakit pada bahu kanan	√				
4	Sakit pada lengan atas kiri	√				
5	Sakit pada punggung	√				
6	Sakit pada lengan atas kanan	√				
7	Sakit pada pinggang	√				
8	Sakit pada pantat (buttock)	√				
9	Sakit pada pantat (bottom)	√				
10	Sakit pada siku kiri	√				
11	Sakit pada siku kanan	√				
12	Sakit pada lengan bawah kiri	√				
13	Sakit pada lengan bawah kanan	√				
14	Sakit pada pergelangan tangan kiri	√				
15	Sakit pada pergelangan tangan kanan	√				
16	Sakit pada tangan kiri	√				
17	Sakit pada tangan kanan	√				
18	Sakit pada paha kiri	√				
19	Sakit pada paha kanan	√				
20	Sakit pada lutut kiri	√				
21	Sakit pada lutut kanan	√				

Current (after 2 hours)

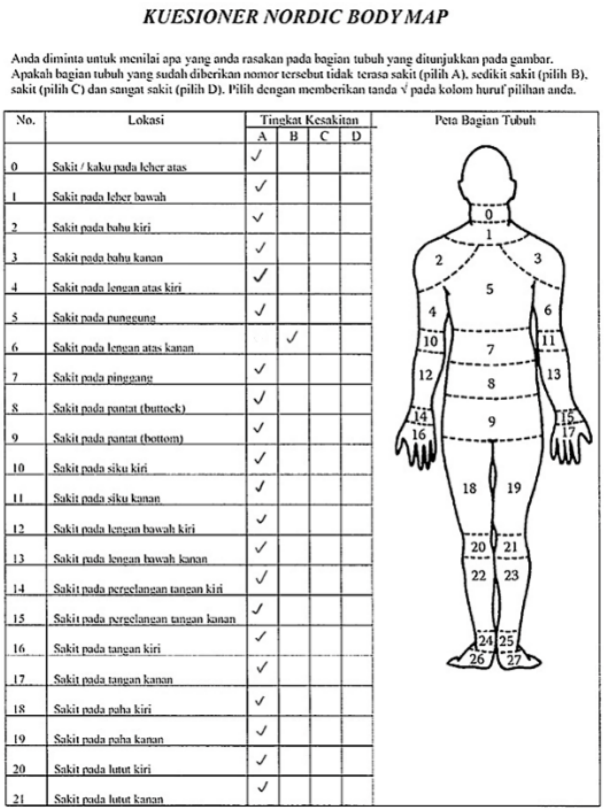


KUESIONER NORDIC BODY MAP

Anda diminta untuk menilai apa yang anda rasakan pada bagian tubuh yang ditunjukkan pada gambar. Apakah bagian tubuh yang sudah diberikan nomor tersebut tidak terasa sakit (pilih A), sedikit sakit (pilih B), sakit (pilih C) dan sangat sakit (pilih D). Pilih dengan memberikan tanda √ pada kolom huruf pilihan anda.

No.	Lokasi	Tingkat Kesakitan				Peta Bagian Tubuh
		A	B	C	D	
0	Sakit / kaku pada leher atas	√				
1	Sakit pada leher bawah	√				
2	Sakit pada bahu kiri	√				
3	Sakit pada bahu kanan	√				
4	Sakit pada lengan atas kiri	√				
5	Sakit pada punggung	√				
6	Sakit pada lengan atas kanan			√		
7	Sakit pada pinggang	√				
8	Sakit pada pantat (buttock)	√				
9	Sakit pada pantat (bottom)	√				
10	Sakit pada siku kiri	√				
11	Sakit pada siku kanan	√				
12	Sakit pada lengan bawah kiri	√				
13	Sakit pada lengan bawah kanan		√			
14	Sakit pada pergelangan tangan kiri		√			
15	Sakit pada pergelangan tangan kanan	√				
16	Sakit pada tangan kiri			√		
17	Sakit pada tangan kanan		√			
18	Sakit pada paha kiri	√				
19	Sakit pada paha kanan	√				
20	Sakit pada lutut kiri	√				
21	Sakit pada lutut kanan	√				

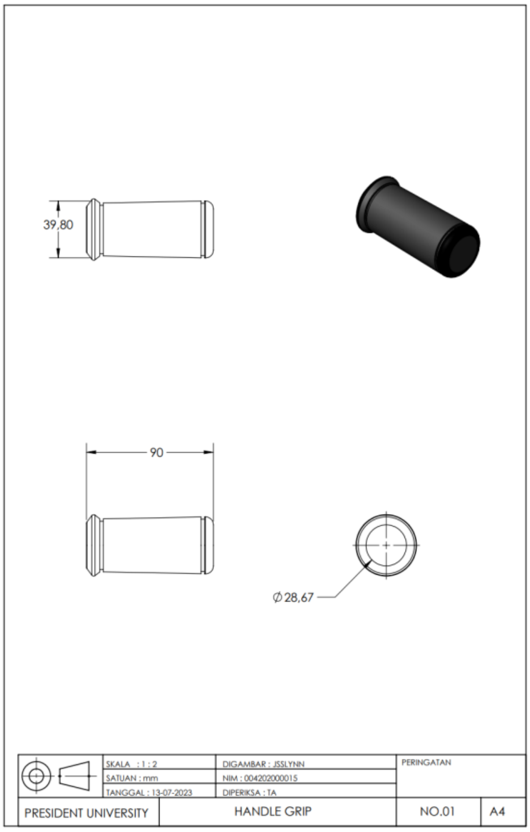
Proposed

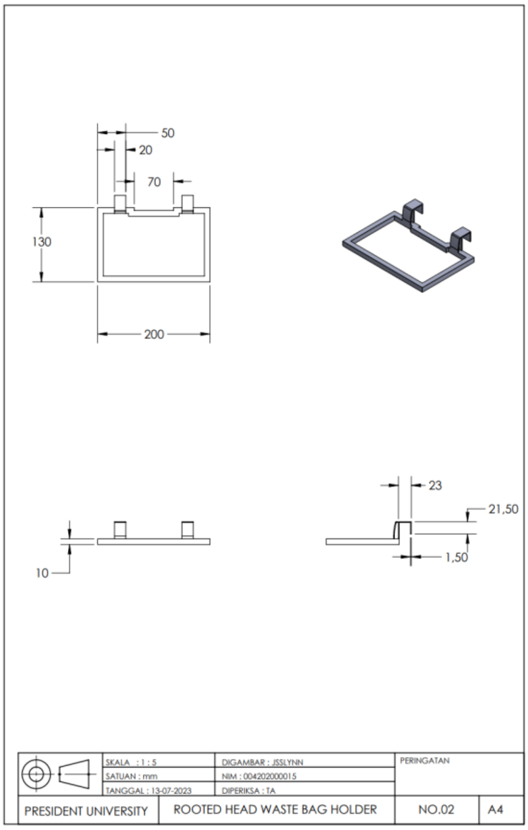


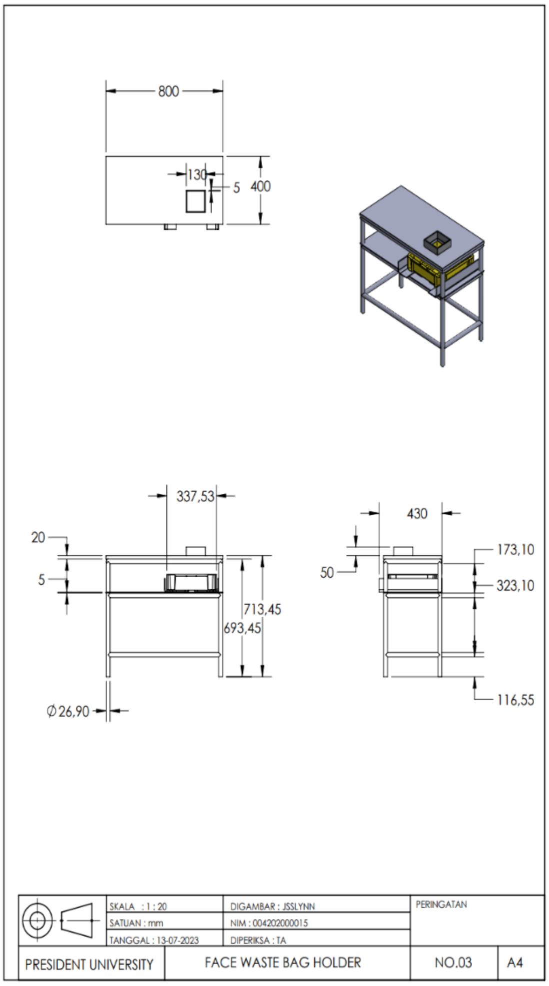
KUESIONER NORDIC BODY MAP

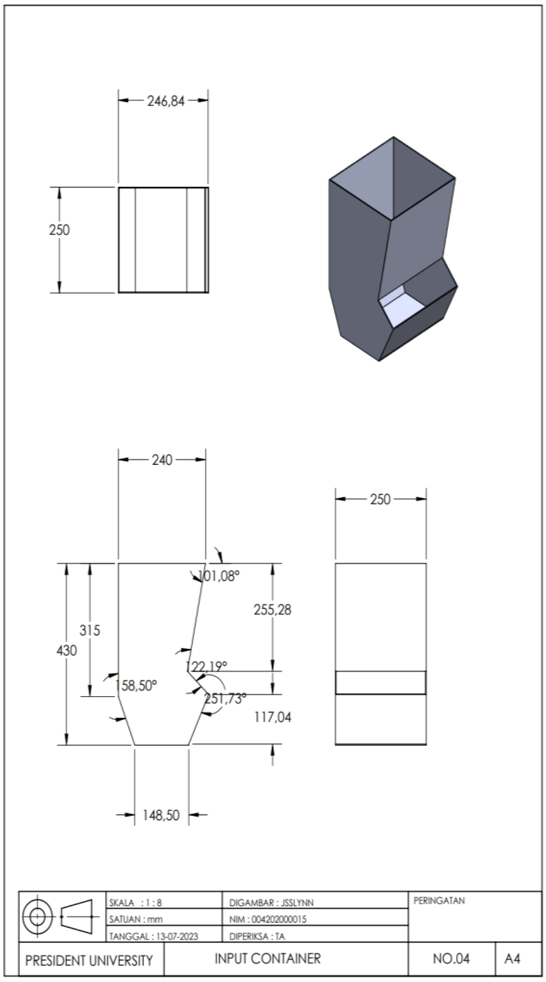
Anda diminta untuk menilai apa yang anda rasakan pada bagian tubuh yang ditunjukkan pada gambar. Apakah bagian tubuh yang sudah diberikan nomor tersebut tidak terasa sakit (pilih A), sedikit sakit (pilih B), sakit (pilih C) dan sangat sakit (pilih D). Pilih dengan memberikan tanda √ pada kolom huruf pilihan anda.

No.	Lokasi	Tingkat Kesakitan				Peta Bagian Tubuh
		A	B	C	D	
0	Sakit / kaku pada leher atas	√				
1	Sakit pada leher bawah	√				
2	Sakit pada bahu kiri	√				
3	Sakit pada bahu kanan	√				
4	Sakit pada lengan atas kiri	√				
5	Sakit pada punggung	√				
6	Sakit pada lengan atas kanan		√			
7	Sakit pada pinggang	√				
8	Sakit pada pantat (buttock)	√				
9	Sakit pada pantat (bottom)	√				
10	Sakit pada siku kiri	√				
11	Sakit pada siku kanan	√				
12	Sakit pada lengan bawah kiri	√				
13	Sakit pada lengan bawah kanan	√				
14	Sakit pada pergelangan tangan kiri	√				
15	Sakit pada pergelangan tangan kanan	√				
16	Sakit pada tangan kiri	√				
17	Sakit pada tangan kanan	√				
18	Sakit pada paha kiri	√				
19	Sakit pada paha kanan	√				
20	Sakit pada lutut kiri	√				
21	Sakit pada lutut kanan	√				


39,80
90
Ø 28,67
SKALA : 1 : 2
SATUAN : mm
TANGGAL : 13-07-2023
DIGAMBAR : JSSLYNN
NIM : 004202000015
DIPERIKSA : TA
PERINGATAN
PRESIDENT UNIVERSITY
HANDLE GRIP
NO.01
A4


50
20
70
130
200
10
23
21,50
1,50
SKALA : 1 : 5
SATUAN : mm
TANGGAL : 13-07-2023
DIGAMBAR : JSSLYNN
NIM : 004202000015
DIPERIKSA : TA
PERINGATAN
PRESIDENT UNIVERSITY
ROOTED HEAD WASTE BAG HOLDER
NO.02
A4


800
130
5
400
337,53
20
5
713,45
693,45
Ø 26,90
430
50
173,10
323,10
116,55
SKALA : 1 : 20
SATUAN : mm
TANGGAL : 13-07-2023
DIGAMBAR : JSSLYNN
NIM : 004202000015
DIPERIKSA : TA
PERINGATAN
PRESIDENT UNIVERSITY
FACE WASTE BAG HOLDER
NO.03
A4


246,84
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240
250
101,08°
255,28
315
430
122,19°
158,50°
251,73°
117,04
148,50
SKALA : 1 : 8
SATUAN : mm
TANGGAL : 13-07-2023
DIGAMBAR : JSSLYNN
NIM : 004202000015
DIPERIKSA : TA
PERINGATAN
PRESIDENT UNIVERSITY
INPUT CONTAINER
NO.04
A4