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DESIGNING THE PLACTICS WRAPPING TROLLEY IN THE PACKING PROCESS TO REDUCE THE RISK OF INJURY ON MUSCULOSKELETAL DISORDERS (MSDS)

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Abstract

PT. SMC is a filter trading company that involves business processes such as inventory, packing, and delivery. Manual material handling activities in the packing process are considered non-ergonomic and can lead to musculoskeletal disorders. One of the packing process activities is plastic wrapping on crates, in which workers carry 12 kg of plastic rolls around a 120×120×150 cm crate, starting from a bending position and lifting the plastic roll to a standing position. The goal of this study was to analyze and improve the wrapping process in terms of ergonomics and productivity. To assess the condition of activities, the Nordic Body Map and Rapid Entire Body Assessment (REBA) methods were used. In addition, a plastic wrapping tool is designed to help the worker in packing activities, and the Quality Function Deployment (QFD) method was used to develop the design process. According to the results of the nordic body map data, many workers have a complaint of pain in the waist and right hand. Using the REBA assessment for the existing condition was obtained the risk level of the lower position was very high, the risk level of the middle position and the upper position were high, while the output of the wrapping processes was 19 pallets per day. Three tool designs were developed, and the plastic wrapping trolley was selected as the best design. After using tools, the research shows that the plastic wrapping procedure in. PT. SMC is classified as non-ergonomic, causing a high risk of harm to the waist and right hand. By using the quality function deployment approach, a wrapping trolley is chosen to be manufactured, and the end REBA value is 3, indicating a low risk level. Another benefit shows that, there was an increase in manufacturing output specifically from 19 pallets/day to 37 pallets/day.

Keywords: Design, Musculoskeletal disorders, Packing, Trolley, Wrapping.

1. Introduction

Many workers perform manual tasks such as pulling, lifting, pushing, carrying, or moving an object. Every year, more than 250 million work accidents occur, and 160 workers are harmed and/or ill as a result of their jobs, according to the International Labor Organization (ILO) [1]. Approximately 32% of workers suffers from musculoskeletal disorders caused by excessive muscle activity. Musculoskeletal Disorders (MSDs), are caused by a variety of factors, including repetitive and long-term non-ergonomic work, pressure, vibration, and macrolides which are classified as the secondary causes [2]. The risk of developing MSDs can also be influenced by age, gender, physical strength, and anthropometry [3, 4]. PT. SMC is a filter distributor to power plants and oil companies. PT. SMC distributes their products to the customers which includes the process of inventory, packing, and delivery. The packing process is the primary focus of this study. The process requires the package to be wrapped in plastic by a warehouse operator. The plastic rolls itself have a length of 50 cm and a weight of 12 kg, with the largest package size being 120×120×150 cm. The wrapping process occurs almost every day, and because the operator's bends over for an extended period of time, it can cause fatigue or discomfort in body parts, both of which have a significant impact on work productivity.

In this research, we use REBA to develop the tool to help operators in packing process. A good work design can enhance productivity in working process [5, 6]. The plastic wrapping tool designed to be user-friendly, reliable, and as affordable as possible. The user-friendly tool is more likely to be use in every packing process by operators.

Based on the problem, it is necessary to conduct research into the operator's posture condition and the complaints received, so that a suitable process for improving work conditions can be implemented. Any product can be labeled as good if it meets the needs of the consumer. One of the most effective methods for analyzing consumer needs is to use QFD, which can translate consumer desires and needs into product designs with specific characteristics and technical specifications [7].

2. Research Methodology

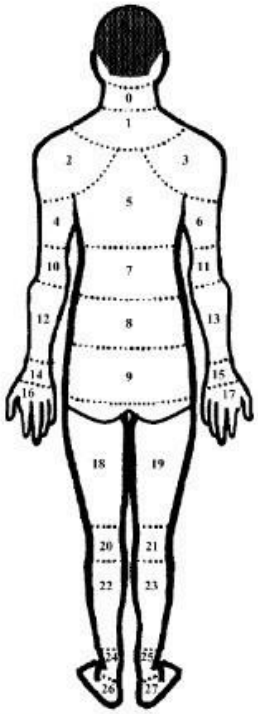
Ergonomics is a process of designing workplaces, tools, equipment, and work environments by considering human conditions and capabilities to optimize the effectiveness and productivity of a work system [5]. When ergonomics is applied correctly, it allows workers to produce better work results for the company. Good performance can also lead to increased productivity, as well as improved worker health and safety [8, 9]. Ergonomics can be used to analyse manual material handling process.

Manual material handling is a physical activity in the workplace to lift, lower, push, pull, carry, or move a load object [10]. A well-designed manual material handling can improve performance because it can reduce the accidents. Therefore, we use the nordic body map questionnaire is an assessment tool to measure pain in the musculoskeletal area. The questionnaire is widely used to identify musculoskeletal discomfort in operators. It is because the nordic body map questionnaire has been standardized and specialized [11, 12]. The musculoskeletal system itself provides shape, support, stability, and movement to the body. The

human skeleton consists of single or combined bones (such as skull) supported by other structures such as ligaments, tendons, muscles, and other organs. The nordic body map assessment generally uses a questionnaire with a list of body parts. The level of complaints given is generally based on a scale from "no pain" to "severe pain". The nordic map questionnaire which is shown in Fig. 1 used to undergo the rapid entire body assessment.

REBA is a method to analyse the attitude of workers who are sensitive to changes in work position and other hazards or accidents that occur [2, 13]. In the literature, REBA method has been applied for assessment the packaging worker's body [14-16]. The REBA method also has been used to assess the worker posture in the warehouse sectors [17, 18]. The REBA worksheet is used to conduct the assessment, which begins by assessing each part of the human body when performing manual handling activities [19, 20]. The REBA assessment divides the assessment of body parts into two parts, namely A and B. The assessment begins with measuring the scores of groups A and B, which are then used for further measurements to reach the final REBA score.

After the final REBA score is determined, the next step is to determine the level of risk from the manual material handling activity. Table 1 shows a range of 1 to 15 based on the final REBA score and a statement of the risk level and action plans required for the appropriate risk level.



No	Location	Grade of complaints			
0	Pain/stiff in the upper neck	A	B	C	D
1	Pain in the lower neck				
2	Pain in the left shoulder				
3	Pain in the right shoulder				
4	Pain in the left upper arm				
5	Pain in the back				
6	Pain in the right upper arm				
7	Pain in the waist				
8	Pain in the buttock				
9	Pain in the bottom				
10	Pain in the left elbow				
11	Pain in the right elbow				
12	Pain in the left lower arm				
13	Pain in the right lower arm				
14	Pain in the left wrist				
15	Pain in the right wrist				
16	Pain in the left hand				
17	Pain in the right hand				
18	Pain in the left thigh				
19	Pain in the right thigh				
20	Pain in the left knee				
21	Pain in the right knee				
22	Pain in the left calf				
23	Pain in the right calf				
24	Pain in the left ankle				
25	Pain in the right ankle				
26	Pain in the left foot				
27	Pain in the right foot				

Note :

A : No Pain B : Slight Pain C : Moderate Pain D : Severe Pain

Fig. 1. Nordic body map questionnaire.

Table 1. REBA risk level.

REBA Score	Risk Level	Action Plan
1	Negligible	None necessary
2-3	Low	Change may be needed
4-7	Medium	Further investigate, change soon
8-10	High	Investigate and implement change
11-15	Very High	Implement change

Previous researchers have carried out a number of developments [21, 22]. QFD is a method for matching customer requirements with a product's technical characteristics [7, 23]. The first step in satisfying customers is to convey and live their opinion. QFD, in the form of a visual linking process, assists the team in focusing on customer needs throughout the entire development cycle.

House of quality is a matrix that contains important points in the planning process in the deployment of the quality function. Problem targeting can be assisted by the house of quality to find out what is most important to customers and what technical methods can be done [7, 23]. The house of quality consists of six components, namely customer needs, planning matrix, relationship matrix, technical correlation matrix, and technical priority [24, 25].

(i) Customer needs identification. The process of recording customer needs can be done through questions and answers, questionnaires, or in direct activities. Then enter the voice of customer into the customer needs matrix chart.

(ii) Planning matrix. It is a matrix that serves as a tool to help prioritize customer needs. Usually, the planning matrix contains the level of importance to customer

(iii) Technical characteristics matrix. It is a matrix that contains technical characteristics that may be realized in an effort to meet customer needs.

(iv) Relationship matrix. This matrix contains the determination of the relationship of the voice of customer with the technical characteristics matrix and then translates it as a value that describes the strength of the relationship.

(v) Technical characteristic correlation matrix. This section describes the maps that are interconnected and interdependent on a matrix of technical characteristics.

There are three types of information in this matrix. The first type is the contribution of technical characteristics to the overall product or service performance.

(i) The level of this contribution is determined by ranking the technical characteristics based on the weight of the customer needs and interests in part b, as well as the relationship between customer needs and technical characteristics in part c.

(ii) Technical benchmarks describe information from knowledge about the superior characteristics of competitors. The trick is to compare each matrix of technical characteristics.

(iii) The target on the technical characteristic matrix is shown as a measure of the performance of the function against the technical characteristic matrix, which will then become the target of development activities.

There are two stages of concept selection method, the first stage is concept screening and the second stage is called concept scoring. In this second stage, there are six steps in the concept selection process [26], namely:

(i) Prepare the selection matrix. Create sub-criteria from existing criteria, then add weight to the criteria and sub-criteria.

(ii) Rate the concepts. Use a 1-5 interval scale.

(iii) Rank the concepts. Multiply the weights by the provided scale, then sum the results to rank each product concept.

(iv) Combine and improve the concepts. Examine and try to merge the inadequacies of many conceptions to create a superior notion.

(v) Select one or more concepts. Select the most promising concepts for further developed.

(vi) Reflect on the results and the process. Reflect on the selected concepts and the selection process.

3. Results and Discussion

3.1. Nordic body map questionnaire analysis

The nordic body map is one of the subjective measurement methods used to assess workers' muscle pain [27]. The results of the nordic body map questionnaire are then analysed to obtain a value or score; there are four levels of pain used in the questionnaire, with the lowest being one for no pain, two for slight pain, three for moderate pain, and four for severe pain. The values for each body part number in the questionnaire are then averaged and is shown in Fig. 2.

3.2. Rapid entire body assessment

Samples were taken in three positions for the REBA of the plastic wrapping process: 1) lower wrapping position; 2) middle wrapping position; and 3) top wrapping position. The spine, neck, legs, upper arms, forearms, and wrists were all measured, as well as workload, clutch, and work activity values. Work attitudes are assigned to each member of the body [4].

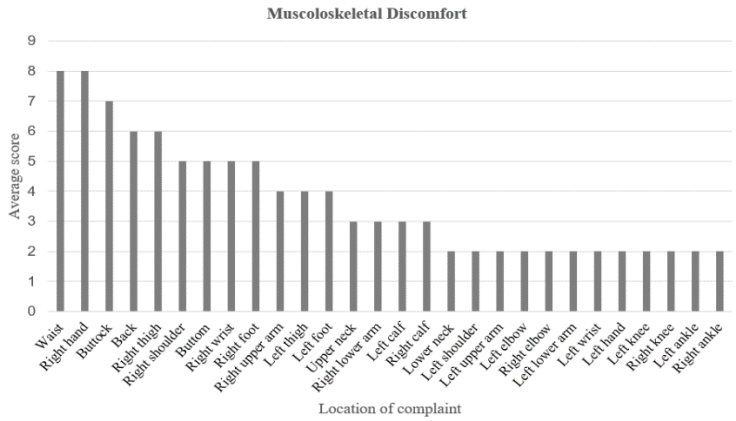


Fig. 2. Complaint graph on plastic wrapping process.

3.3. REBA assessment of lower wrapping position

Figure 2 depicts an operator's posture when wrapping the lower part of packaging is a significant deviation from the normal position that increases the workload of

the muscles, resulting in more energy consumption [28]. Figure 3 also depicts the operator lifting a 12 kg plastic roll. When a person bends over to lift a load, the force of the load being lifted is ten times greater felt on the spine [29, 30]. The result of the REBA is shown in Fig. 4.

Fig. 3. Lower wrapping position.

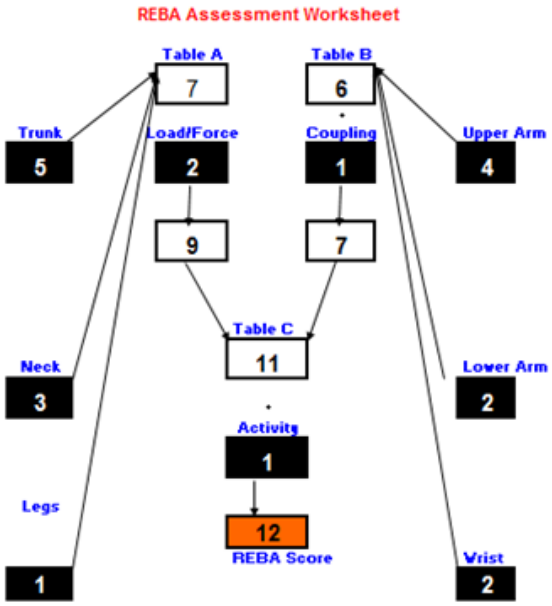


Fig. 4. REBA assessment of lower wrapping position.

3.4. REBA assessment of middle wrapping position

Figure 5 depicts the operator's posture when wrapping the middle part. The worker's posture shows that his back is slightly bent, and his legs are bent when he is lifting heavy plastic rolls. Irritation, inflammation, muscle fatigue, and damage to muscle tendons and surrounding tissues are all possible with heavy loads [28]. The results of measurements using the REBA method are shown in Fig. 6.

Fig. 5. Middle wrapping position.

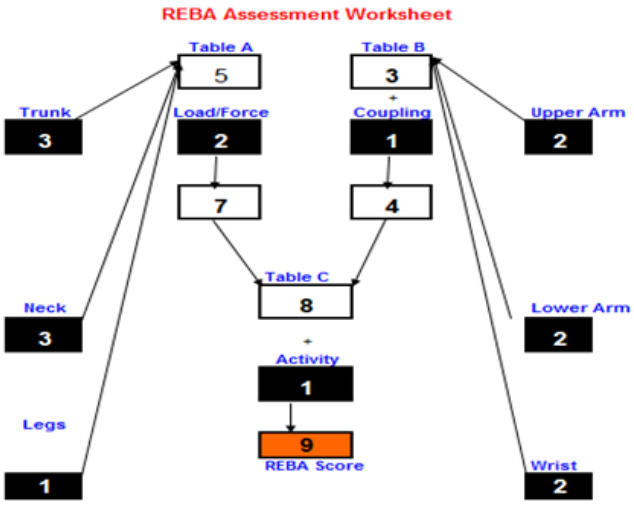


Fig. 6. REBA assessment of middle wrapping position.

3.5. REBA assessment of top wrapping position

Figure 7 depicts an operator's posture during the upper wrapping process. The angle is calculated based on this posture. Figure 7 also depicts the legs resting on both straight legs. This foot position provides stability at work, preventing the worker's body from slipping. The result of the REBA measurement is shown in Fig. 8.

Fig. 7. Top wrapping position.

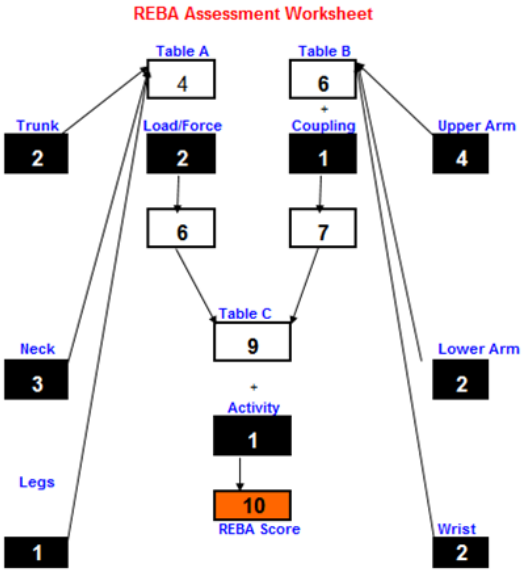


Fig. 8. REBA assessment of top wrapping position.

3.6. Prototype development based on quality function deployment method

3.6.1. Voice of customer data analysis

We have gathered seven important points of customer needs and then proceeded to determine the importance level for each customer needs. Determining the customer importance level helps to determine the most important needs or expectations of consumers [31, 32]. The assessment starts from the level of importance 1 to 5. Level 1 indicates very unimportant, and level 5 indicates very important. Table 2 displays the final result derived from the average value of the two responders who handle the plastic wrapping procedure.

Table 2 explains the level of importance in determining the response of the three main techniques, namely equipment that can hold plastic rolls, can be adjusted easily in height, and can be operated easily.

Table 2. Customer needs/voice of customer.

No.	Customer Need	Respondent		Importance
		1	2	
1	**The wrapping tool can grip the plastic roll**	5	5	5
2	**The wrapping tool is height adjustable**	5	5	5
3	**The wrapping tool is able to withstand the weight of the plastic roll of 10-12 kg**	3	5	4
4	**The wrapping tool has a simple and lightweight shape**	5	3	4
5	**The wrapping tool is in the form of a machine or a working tool**	4	5	4;5
6	**The working tool is easy to operate**	5	5	5
7	**The wrapping tool's price is affordable**	5	4	4;5

3.6.2. Determining customer specifications

Metrics are determined as the initial stage in defining customer specifications. Metrics are used to define product features that can meet consumer expectations. Each metric is assigned a unit description to make determining product specifications easier [26]. The list of metrics is shown in Table 3.

Table 3. Product specification.

No. Metric	No. Need	Metric	Importance	Units
1	**1**	**Plastic roll mounting**	5	Binary
2	**2**	**Adjuster feature on the plastic roll's gripper**	5	Binary
3	**3**	**Maximum load**	4	kg
4	**4;5**	**Number of tool's variant for maintenance**	4	List
5	**4;5**	**Product size (L × W × H)**	4	mm
6	**4**	**Product weight**	4	kg
7	**5;6**	**Wrapping process time**	4	minute
8	**4;5;6**	**Time to install the plastic roll**	4	minute
9	**7**	**Manufacturing cost**	4	Rp

Customer needs and metrics are related. Table 3 shows that attribute number 1 is related with plastic roll mounting metrics. Then, attribute number 2 has a relationship with the adjuster feature on the plastic roll clamp. Meanwhile, attribute number 3 has a relationship with the load that can be held, and attribute number 4 has a relationship with the number of variants of tools for maintenance, product dimension, weight of tools, as well as the time to install plastic rolls. Attribute number 5 has a relationship with the number of variants of tools for maintenance, product dimension, wrapping process time, and plastic roll installation time. Meanwhile, attribute number 6 has a relationship with the time of the wrapping process and the time of installing the plastic roll. In addition, attribute number 7 has a relationship with manufacturing costs.

3.6.3. Screening process

The product design is created during the screening process. The design concept developed at this stage is the interpretation and development of the product planning process's characteristics [33, 34]. Figures 9-11 show three concept concepts that have been designed.

Fig. 9. U-shape wrapping holder.

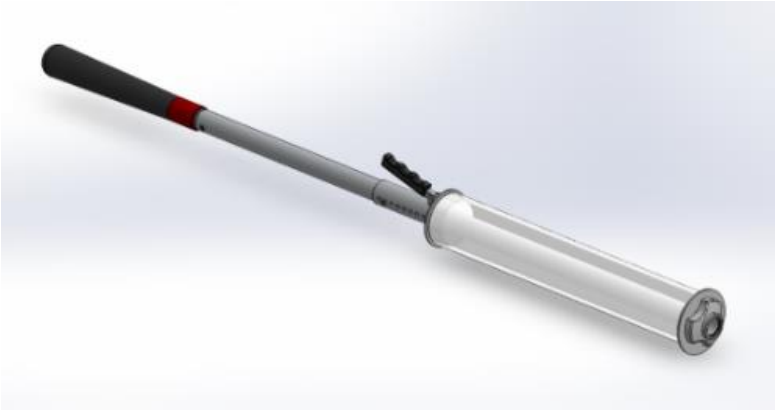


Fig. 10. Stick wrapping holder.

Fig. 11. Wrapping trolley.

After making product concept ideas, the following step is to evaluate the product concept. The purpose of the screening scoring step is to assign a score to each product concept based on customer needs, by giving a plus or minus value. The plus value means that the product concept has strength against its criteria. While the minus value means that the product concept has a weakness in its criteria and a value of zero means that the product concept has a neutral value in its criteria. After the screening process, the results show that wrapping trolley and wrapping holders are the two highest rankings. The two selected concepts then be subjected to a scoring process to obtain the weight criteria for each concept (see Table 4). Importance weight shows the total level of interest of respondents to a product design attribute. Meanwhile, relative weight shows the value of the relative importance of the weight of other product design attributes [35].

According to Table 4, the concept chosen is wrapping trolly, which has a total score of 352. The following step is production planning, which is the process of developing relationships and aligning the features of the process with the characteristics of the production department's wishes [33, 34].

3.6.4. House of quality for wrapping troller

The house of quality which was developed in making trolley wrapping is presented in Fig. 12, explaining the demanded quality (customer requirements), quality characteristics (functional requirements), direction of the improvement and competitive analysis.

3.6.5. Concept development

At this stage, product development, testing, and evaluation involves various constructions of various versions using the initial production method of the product to be developed [26]. Several factors must be addressed in the production of the wrapping trolley. The main pole must be adjusted to the average height of the container, so it is 155cm in length. The trolley's strength must be good enough to hold a plastic roll weighing 12 kg, which is the trolley's mass. Although the wrapping trolley must be strong, it must also be small. So that the wrapping trolley's weight does not exceed 15 kg. Figure 13 shows the finished product of the wrapping trolley.

Table 4. Concept assessment with scoring.

	Importance	Weight	U-shape Wrapping Holder		Stick Wrapping Holder		Trolley Wrapping	
			Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Function	5	22						
The wrapping tool can grip the plastic roll	5	11	3	33	3	33	3	33
The wrapping tool is height adjustable	5	11	1	11	2	22	3	33
Maximum load	4	18						
The wrapping tool is able to withstand the load of the plastic roll of 10-12 kg	4	18	3	54	3	54	3	54
Characteristic	4.5	20						
The wrapping tool is in the form of a machine or a working tool	4	20	1	20	1	20	3	60
Portability	4.5	20						
The wrapping tool has a simple and lightweight shape	4.5	8	4	32	4	32	4	32
The working tool is easy to operate	5	12	4	48	4	48	5	60
Price	4.5	20						
The wrapping tool's price is affordable	4.5	20	5	100	5	100	4	80
Total Score	22.5			298		309		352
Rank				3		2		1

Fig. 12. Final design of wrapping trolley.

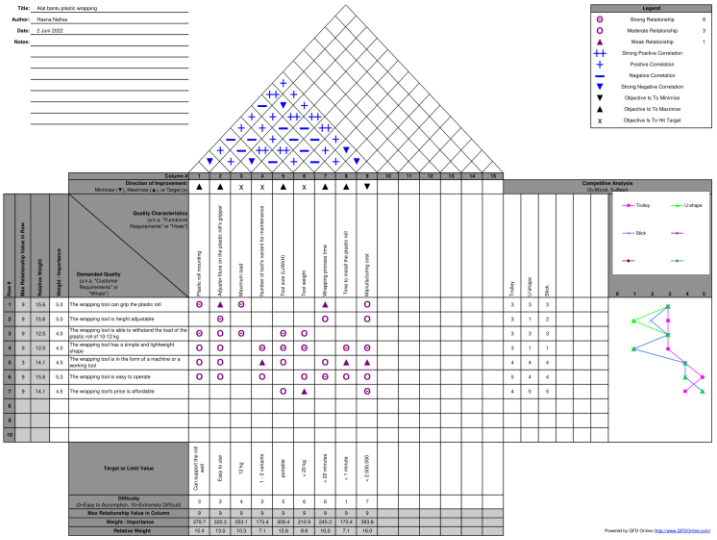


Fig. 13. House of quality.

4. Results and Discussion

4.1. Nordic body map results

The nordic body map questionnaire employs a Likert scale, which must be operationally defined and easily understood by respondents [13]. Wrapping trolley aids that had been used for one month were re-evaluated using a nordic body map questionnaire to determine complaints of musculoskeletal disorders. Figure 14 shows a graph of the results of the nordic body map questionnaire, which shows a decrease in the level of complaints at the waist, but it is still quite high for complaints around the hands, especially the wrists, because the operator still has to control and push the wrapping trolley while surrounding the pallet.

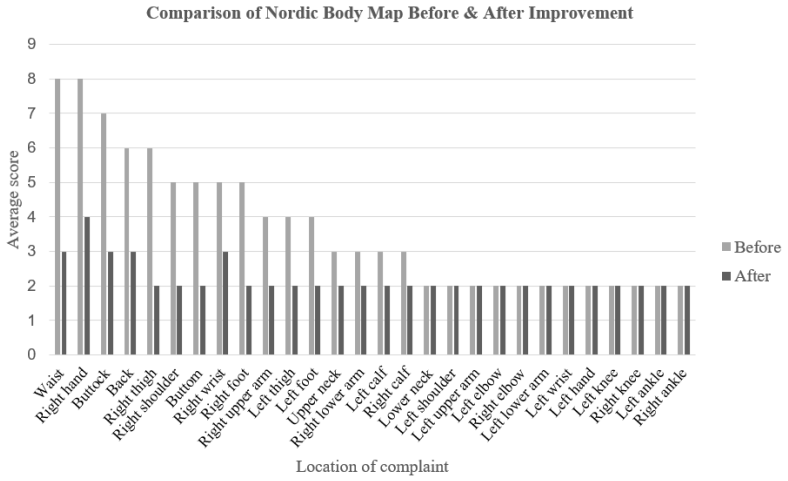


Fig. 14. Comparison graph of nordic body map.

4.2. REBA score improvements

Following the implementation of the wrapping trolley, the REBA score decreased to 3, indicating a low-risk activity and an action plan was not urgently required. Figures 15 and 16, depicts the operator's position standing upright on both feet. There are benefits to this position, such as the ability to use body weight to exert strength, legs working more effectively in dampening vibrations, and also reducing muscle activity.

Fig. 15. Usage of wrapping trolley.

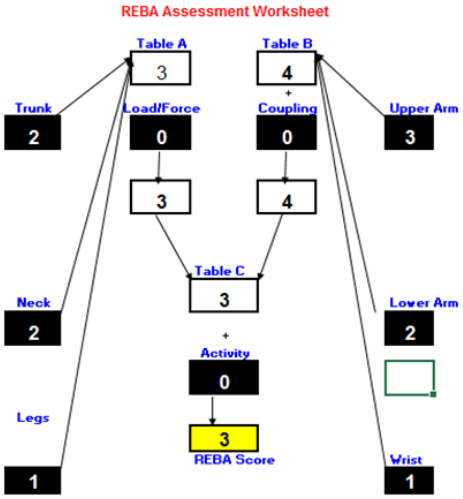


Fig. 16. REBA assessment after implementation.

4.3. Productivity improvement

Work productivity is defined as the ratio of output to input. Knowing the value of productivity also reveals how effectively the input sources have been saved. To see the details of the productivity output calculation, the following calculation compares the quantity of production output produced before and after using the tool.

- **Before using the trolley**

Wrapping time = 25 minutes per palette

Total working hours = 480 minutes (8 hours × 60 minutes), hence,

Total output = total working hours : wrapping time

Total output = 480 : 25

Total output = 19.2 $\approx$ 19 palettes per day

- **After using the trolley**

Wrapping time = 13 minutes per palette

Total working hours = 480 minutes (8 hours x 60 minutes), hence,

Total output = total working hours : wrapping time

Total output = 480 : 13

Total output = 36.9 $\approx$ 37 palettes per day

5. Conclusion

Based on the results, it is concluded that according to the results of the final REBA evaluation of the three occupations, the plastic wrapping procedure in PT. SMC is classified as non-ergonomic, causing a high risk of harm to the waist and right hand. By using the quality function deployment approach, a wrapping trolley is chosen to be manufactured, and the end REBA value is 3, indicating a low risk level. In addition, there was an increase in manufacturing output after utilizing the trolley, specifically from 19 pallets/day to 37 pallets/day.

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References

1. Salguero-Caparrós, F.; Pardo-Ferreira, M.D.C.; Martínez-Rojas, M.; and Rubio-Romero, J.C. (2020). Management of legal compliance in occupational health and safety: A literature review. *Safety Science*, 121, 111-118.
2. Micheletti Cremasco, M.; Giustetto, A.; Caffaro, F.; Colantoni, A.; Cavallo, E.; and Grigolato, S. (2019). Risk assessment for musculoskeletal disorders in forestry: A comparison between RULA and REBA in the manual feeding

of a wood-chipper. *International Journal of Environmental Research and Public Health*, 16(5), 793.

3. Astuti, R.D.; and Suhardi, B. (2009). Analisis postur kerja manual material handling menggunakan metode OWAS (ovako work postur analysis system). *GEMA TEKNIK Majalah Ilmiah Teknik*, 10(1), 67-75.
4. Beheshti, M.H.; Firoozi Chahak, A.; Alinaghi Langari, A.A.; and Poursadeghiyan, M. (2015). Risk assessment of musculoskeletal disorders by ovako working posture analysis system OWAS and evaluate the effect of ergonomic training on posture of farmers. *Journal of Occupational Health and Epidemiology*, 4(3), 131-138.
5. Faber, M.; Przybysz, P.; Latos, B.A.; Mertens, A.; Brandl, C.; Finsterbusch, T.; and Nitsch, V. (2019). Empirical validation of the time accuracy of the novel process language human work design (MTM-HWD®). *Production and Manufacturing Research*, 7(1), 350-363.
6. Greig, M.A.; Village, J.; Salustri, F.A.; Zolfaghari, S.; and Neumann, W.P. (2018). A tool to predict physical workload and task times from workstation layout design data. *International Journal of Production Research*, 56(16), 5306-5323.
7. Suryadjaja, P.; Hutagalung, M.; and Sutarto, H. (2020). Modeling traffic flows with fluid flow model. *International Journal of Informatics, Information System and Computer Engineering (INJIISCOM)*, 1(1), 1-12.
8. Goonjur, M.; Sumitra, I.; and Supatmi, S. (2020). Enhanced the weighted centroid localization algorithm based on received strength signal in indoor wireless sensor network. *International Journal of Informatics, Information System and Computer Engineering (INJIISCOM)*, 1(1), 13-22
9. Nishanth, R.; Muthukumar, M.V.; and Arivanantham, A. (2015). Ergonomic workplace evaluation for assessing occupational risks in multistage pump assembly. *International Journal of Computer Applications*, 113(9), 9-13.
10. Mohammadi, H.; Motamedzade, M.; Faghih, M.A.; Bayat, H.; Mohraz, M.H.; and Musavi, S. (2013). Manual material handling assessment among workers of Iranian casting workshops. *International Journal of Occupational Safety and Ergonomics*, 19(4), 675-681.
11. Du, B.; Boileau, M.; Wierts, K.; Hignett, S.; Fischer, S.; and Yazdani, A. (2019). Existing science on human factors and ergonomics in the design of ambulances and EMS equipment. *Prehospital Emergency Care*, 23(5), 631-646.
12. Joshi, S. (2016). To study the relationship between ergonomics and efficiency of the housekeeping employees at workplace. *Atithya: Journal of Hospitality*, 2(1), 37-42.
13. Muhammad, I.; and Susilowati, I.H. (2021). Analisa manajemen risiko K3 dalam industri manufaktur di Indonesia: Literature review. *Prepotif Jurnal Kesehatan. Masyarakat*, 5(1), 335-343.
14. Lasota, A.M. (2014). A REBA-based analysis of packers workload: A case study. *LogForum*, 10(1), 87-95.
15. Ahfriliandre, J.E.; Pratama, I.; Nafia, I.; Sekartaji, P.; and Fauzi, M. (2021). The work posture analysis of packaging workers at PT. X using the REBA method. *Turkish Journal of Physiotherapy and Rehabilitation*, 6259-6268.

16. Haekal, J.; Hanum, B.; and Adi Prasetio, D.E. (2020). Analysis of operator body posture packaging using rapid entire body assessment (REBA) method: A case study of pharmaceutical company in Bogor, Indonesia. *International Journal of Engineering Research and Advanced Technology-IJERAT*, 6(7), 27-36.
17. KIRCI, B.; ENSARİ, M.; and Rüştü, U.Ç.A.N. (2020). A case study in ergonomics by using REBA, RULA and NIOSH methods: Logistics warehouse sector in Turkey. *Hittite Journal of Science and Engineering*, 7(4), 257-264.
18. Torres, Y.; and Viña, S. (2012). Evaluation and redesign of manual material handling in a vaccine production centre's warehouse. *Work*, 41(Supplement 1), 2487-2491.
19. Singgih, I. (2020). Air quality prediction in smart city's information system. *International Journal of Informatics, Information System and Computer Engineering (INJIISCOM)*, 1(1), 35-46.
20. Achmadi, R.T.; and Lestari, M.S. (2022). Analisis postur kerja menggunakan metode rapid entire body assesment (REBA) proses pembuatan buis beton. *Journal of Applied Mechanical Engineering and Renewable Energy*, 2(1), 30-35.
21. Iida, H.; and Khalid, M. (2020). A paradigm shift from optimal play to mental comfort: A perspective from the game refinement theory. *International Journal of Informatics, Information System and Computer Engineering (INJIISCOM)*, 1(1), 47-78.
22. Kelesbayev, D.; Kalykulov, K.; Yertayev, Y.; Turlybekova, A.; and Kamalov, A. (2016). A case study for using the quality function deployment method as a quality improvement tool in the universities. *International Review of Management and Marketing*, 6(3), 569-576.
23. Jaiswal, E.S. (2012). A case study on quality function deployment (QFD). *Journal of Mechanical and Civil Engineering*, 3(6), 27-35.
24. Rizaldi, A.; Margareta, F.; Simehate, K.; Hikmah, S.N.; Albar, C.N.; and Rafdhi, A.A. (2021). Digital marketing as a marketing communication strategy. *International Journal of Research and Applied Technology (INJURATECH)*, 1(1), 61-69.
25. Desai, Y.; Kartikeyan, B.; and Panchal, N. (2016). "Hows" of quality for remote sensing data user-a house of quality approach. *International Journal of Geomatics and Geosciences*, 6(3), 1708-1723.
26. Handayani, T.; Widianingsih, I.; Julianti, S.; and Pebriani, D.N. (2021). Web-based micro small and medium enterprises product brand development. *International Journal of Entrepreneurship & Technopreneur (INJETECH)*, 1, 11-16.
27. Santy, R.D.; Habibillah, M.I.; Dimyati, Y.R.; Nofia, V.S.; Luckyardi, S.; Gaol, T.V.; and Oktafiani, D. (2021). Artificial intelligence as human behavior detection for auto personalization function in social media marketing. *International Journal of Research and Applied Technology (INJURATECH)*, 1(1), 25-34.
28. Wulantika, L.; Ragatodi, A.; Sya'bani, M.A.; and Nugraha, R. (2021). Website analysis as a media for healthy living digital campaign. *International Journal of Research and Applied Technology (INJURATECH)*, 1(1), 43-48.

29. Khusaini, A.; Pradana, M.A.R.; and Kusmayandi, D. (2022). The importance of building design and its contribution to human health. *International Journal of Research and Applied Technology (INJURATECH)*, 2(1), 210-217.
30. Polat, O.; Mutlu, Ö.; and Özgormus, E. (2018). A mathematical model for assembly line balancing problem type 2 under ergonomic workload constraint. *The Ergonomics Open Journal*, 11(1), 1-10.
31. Astuti, W.; and Augustine, Y. (2022). The effect of digital technology and agility on company performance with management accounting system as mediation. *International Journal of Research and Applied Technology (INJURATECH)*, 2(1), 11-29.
32. Erdil, N.O.; and Arani, O.M. (2019). Quality function deployment: More than a design tool. *International Journal of Quality and Service Sciences*, 11(2), 142-166.
33. Moran, J.J. (1997). Customer integration: The quality function deployment (QFD) leader's guide for decision-making. *The Journal of Product Innovation Management*, 2(14), 148-149.
34. Sundareswaran, G.; Kamaraj, H.; Sanjay, S.; Devi, A.; Elangovan, P.; and Kruthikkha, P. (2022). Consumer behavior analysis. *International Journal of Research and Applied Technology (INJURATECH)*, 2(1), 82-90.
35. Al-Hinai, N.; Al-Kindi, M.; and Shamsuzzoha, A. (2018). An ergonomic student chair design and engineering for classroom environment. *International Journal of Mechanical Engineering and Robotics Research*, 7(5), 534-543.