Risk Assessment Of Working Posture And Implementation Of New Workstation To Increase Productivity

Risk Assessment Of Working Posture And Implementation Of New Workstation To Increase Productivity

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Abstract. In the production process of plastic spoons, workers who run the separation process are working in a less ergonomic condition. In consequence, the production process lacks productivity because the task requires relatively longer time than it should. Utilizing Nordic Body Map analysis method, this study found that there are physical complaints among workers. More specifically, using Quick Exposure Score method, the exposure score on the separation station is at 59.09% and at 67.90% on the packaging station. Using REBA method of analysis, this research obtains REBA score at 10 on the separation station and 9 on the packaging station. Using WERA method, the last score on the separation station is at 40 and the packaging station at 33. The standard time based on the current workstations is at 127.97 seconds. Improvement is manifested by designing working tools. The implementation of the new tool results in the decrease of biomechanical complaints and exposure level at 49.38%, REBA score at 3, and WERA score at 26 on the separation, arrangement, and counting process. This research also results in WERA score at 25 during the process of inserting packing output. The total of standard time is reduced up to 62.10%.

1. Introduction

Plastic spoon is one of several products made of plastic seeds that are shaped by injection molding machine. During early observation on August 2018, this study found that the output of the injection molding machine is handled through several phases. At first, plastic spoons are separated from the molding machine (Figure 1), putting the spoons inside a sack, then packing every 25 spoons inside a plastic bag. At last, the plastic bags are packed into a cardboard box. Each cardboard box holds up 3,000 spoons inside it. Based on observation and interview with several workers, this research found some problems regarding the working arrangement. First, workers are not working in ergonomic condition during the process of separating the spoons from the molding. Spoons are pulled off one by one as shown on Figure **2.** This condition is unproductive because the whole separating process takes relatively longer time than it should. The workstation is also not ergonomic. All activities occured while sitting down on a mattress laid on the floor without proper cushion (Figure 3). The spoons are gathered in a sack that results in a disorganized working space (Figure 4). As a consequence, the packaging process needs longer time because workers still need to arrange the disorganized spoons before putting them inside plastic bags. Improvement needs to be planned out in order to prevent a decrease in productivity and increase the ergonomic risk among its workers. Implementing the appropriate workstations will reduce workers' ergonomic risk.

Understanding the problems, it becomes crucial to improve the condition of the workstations. Designing the proper workstations can improve workers' productivity and time efficiency [2]. Enhancement is established by designing a working table and chair to improve

the standard time and standard output [3]. Improvement is also done by reorganizing the tasks of each operator. By reorganizing the operators and minimizing the moving distance, workers can work more productively [4]. Other than that, improvement in the workplace is also done by rearranging the position of the machine and other facilities. Rearrangement will result in shorter finishing time with higher amount of standard output [5].

Figure 1. Spoons on molding machine

Figure 2. Separating spoons from the molding

Figure 3. Disorganized spoons in a sack

Figure 4. Process of packing the spoons

2. Research Method

This research is executed in several stages. The data gathered in this research includes operators' working posture, workers' biomechanic complaints, time cycle per working element, and overview of the condition of the current workstations. This research utilizes questionnaire and interview, as well as camera video and stopwatch as the measuring tools. The data is analyzed using QEC, REBA, and WERA methods to get the risk value of workers' working posture.

Standard time is the sum of time cycle and adjustment factor based on the field condition as well as allowances. Based on weaknesses on workstations found, this research also implemented designs of new workstations. The last step is assessing the new workstation to investigate the reduction of biomechanical complaints, risk reduction of working posture, as well as the increase of operators' working speed.

3. Data and Analysis

The handling process of the plastic spoons include several steps. First, all plastic spoon output coming out from the injection molding machine is assessed. Next, spoons are separated from its mold then kept in a sack. The packaging process includes putting in the spoons inside plastic bags, starting from taking several spoons from the sack and arrange the spoons. The last step is keeping the plastic bags filled with spoons inside a cardboard box that holds 3,000 pieces of plastic spoons per box.

Among workers who work on the separating station and packaging station, this research noted several physical complaints as shown on Picture 5 and Picture 6. The shaded part shows the area where physical discomforts occurred. Using the Nordic Body Map, this study identified the total of complaints in workers' body [6].

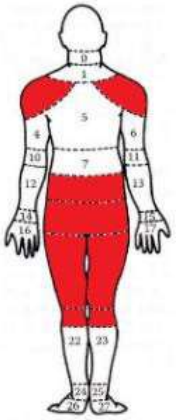

Figure 5. Physical complaints during the process of separating spoons from molding

Figure 6. Physical complaints during spoons arranging process

Complaints on skeletal muscle is also measured using Quick Exposure Checklist (QEC). QEC is one of the methods utilized to understand the risk of injury on workers' skeletal muscle or musculoskeletal disorder that emphasizes more on the upper body, such as back, neck, shoulder, and wrist. Table 1 shows the QEC score on the separating station where spoons are separated and the spoons packaging.

Table 1. Quick Exposure Check data on the workstations that separates and packs spoons

Observed Body Parts	Exposure Score in Workstations	
	Separating	Packaging
Back	30	26
Shoulder/Arms	34	34
Wrist	26	34
Neck	14	16
Total Exposure Score	104	110
Exposure Level	59,09%	67,90%
Action	Need further research for further steps	Need further research for further steps

Ergonomic risk is also measured using REBA (Rapid Entire Body Assessment). REBA analysis is implemented in the separating process, arrangement and counting process, as well as the packing process. Figure 7 shows workers' working posture based on REBA assessment.

Figure 7. Separating spoons

Figure 8. Arranging spoons

Figure 9. Packaging spoons

Ergonomic risk is also measured using Workplace Ergonomic Risk Assessment (WERA) method. This method is used to evaluate the workers' working posture and the repetitive movements while they work. The posture being evaluated includes the separating process of the spoons and the mold, the arrangement, and the calculation of plastic spoon, as well as the process of packing the plastic bags filled with spoons inside the cardboard boxes. Table 2 shows the summary of ergonomic risk using 4 types of measurement tools.

Table 2. Recapitulation of NBM, QEC, REBA, and WERA at present time

Work stations	Body Parts with Physical Complaints on NBM Assessment	QEC Level	REBA Score	WERA Score
Separating spoons	Lower back, left shoulder, right shoulder, bottom, left thigh, right thigh, left knee, right knee	59,09% (Needs further research for further action)	10 (High, need immediate action)	40 (medium)
Packaging spoons	Lower back, left shoulder, right shoulder, bottom, left thigh, right thigh, left knee, right knee	67,90% (Needs further research for further action	9 and 8 (High, needs immediate action)	40 and 33 (medium)

Productivity measurement is manifested by taking 30 samples during the separation process, arrangement process, calculation process, and the packing process. Based on the measurement, this research obtained enough unified data. The time cycle of the process of separating spoons from the molding is at 14.54 seconds, the process of arranging and counting the spoons takes up to 78.48 seconds, while the process of putting in the products inside the cardboard box takes 3.84 seconds. The normal time of the separating process is at 17.98 seconds, the arranging and counting process at 74.56 seconds, and packing process at 4.26 seconds. The standard time of the separating process is at 24.27 seconds, the counting process is at 98.42 seconds, and the packing process at 5.28 seconds.

Based on the assessment of ergonomic risk factor, the workstation that processes the separation of spoons and the workstation that processes packaging needs improvement in a form of helper tools. Workstation that is not ergonomic enough causes longer finishing time than it should. Enhancing productivity can be implemented by improving the working method and the workstation to make them more ergonomic [7]. Picture 10 shows the helper tools being used to help with the process of separating the spoons and packing the products in the cardboard box. Meanwhile, Table 3 shows the specification of the helper tool and the packing

tool. The main dimension of the helper tool already considers the anthropometry of the users and the product dimension being handled.

Figure 10. Helper tool to separate and pack spoons

Table 3. Specification of helper tool

Dimension	Size (mm)
Length	1600
Width	600
Height (Level 1)	850
Height (Level 2)	550
Length (Level 1)	400
Length (Level 2)	500
Length of Helper Tool	690
Width of Helper Tool	500
Height of Helper Tool	130
Diameter of Helper Tool	Ø450
Length of the Handle	100

Simulation is established to understand the body posture while using the helper tool. Based on Picture 11, REBA score is 2 in the process of separating, arranging, and counting the products, which means that the whole process is categorized as low risk. The next step is directly implementing the helper tool to understand the difference of its ergonomic aspect. The helper tool is designed so that it can help improving comfortability, increasing effectiveness, and reducing biomechanic complaints [8]. The measuring tools being used includes NBM, QEC, REBA, and WERA. Table 4 contains the data recapitulation after the implementation of helper tool.

Based on analysis using Nordic Body Map, Quick Exposure Check, Rapid Entire Body Assessment, and Workplace Ergonomic Risk Assessment methods, the results show that the workstation on the process of separating and packaging reached the highest QEC score at 67.90%, highest REBA score at 10, and WERA score on its peak at 40. After the implementation of working table, the QEC becomes 49.38%, REBA score at 3, and WERA score at 26. In other words, the helper tool can effectively reduce the ergonomic risks after the use of several methods. Analyzing body posture is also one of the best ways to assess working activities [9].

Time measurement is implemented by looking into the working time reduction after utilizing helper tools. Time measurement during this procedure is established by using a stopwatch. Time measurement is implemented during the process of separating the spoons, arranging the spoons, and counting the spoons, as well as the packing process. Table 5 shows the time comparison before and after the implementation of helper tools.

Picture 11. Separating,

arranging, and counting process

Table 4. Recapitulation of NBM, QEC, and WERA after implementing helper tool

Work stations	Body Parts with Physical Complaints on NBM Assessment	QEC Score		REBA Score	WERA Score
		Exposure Score	Exposure Level		
Separating, Arranging, Counting	Waist, left calf, right calf	Back: 20 (Medium) Shoulder/Arms: 26 (Medium)	49,38% (needs further research)	3 (Low, may need action)	26 (Low)
Putting in Packing Output	Waist, left calf, right calf	Hand: 22 (Medium) Neck: 12 (High)		3 (Low, may need action)	25 (Low)

Table 5. Comparison of standard time before and after implementation of helper tool

	Process	Time cycle	Normal time	Standard Time	Total of Standard Time
Before Implementation	Separating	14,54	17,98	24,27	127,97
	Arranging and Counting	78,48	74,56	98,42	
	Putting in Packing Output	3,48	4,26	5,28	
After Implementation	Separating, Arranging, Counting	35,44	36,15	44,83	48,5
	Putting in Packing Output	2,66	3,01	3,67	

The total of standard time in every process before the implementation of helper tool is at 127.97 seconds/pack, with one pack contains 25 pieces of spoon. The total of standard time in

every process after implementation is at 48.5 seconds/pack. In conclusion, the use of helper tool has helped in reducing the standard time of the production by 62.10%.

4. Conclusion

Nordic Body Map establishes the tangible problems during the production process of plastic spoons, namely workers' physical complaints. Quick Exposure Check, Rapid Entire Body Assessment, and Workplace Ergonomic Risk Assessment methods show that the separating station and packaging station have the biggest QEC number at 67.90% with REBA score at 10, and WERA score at 40. After implementing the new helper tool and working table, the QEC score becomes 49.38%, REBA score at 3, and WERA score at 26. The scores proved that the newly designed helper tool successfully reduces ergonomic risks. The standard time of spoons handling before the implementation of new design was at 127.97 seconds, but after using the tool, the standard time has significantly reduced by 62.10% at 48.5 seconds.

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