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COMPARATIVE ANALYSIS OF WORK EFFICIENCY MEASUREMENTS IN THE WIRE HARNESS INDUSTRY

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ABSTRACT

PT XYZ is a company engaged in the wiring harness assembly industry that supplies products to automotive companies in Indonesia. The product of this company is a variant of the part number wiring harness, each of which has a different processing time and employee needs in the assembly process. In the production process for Part No 22-66779-00, PT XYZ divides the work line into three parts, namely the head assembly process (assembly of the product head), the body (assembly of the product body), and the end (assembly of the product tail). The work is conducted based on these parts by many manpower. The problem is that because social distancing is applied, work efficiency in each production line becomes less than optimal. Work productivity decreases and the finished product is past its delivery deadline. In this study, we analyze two scenarios of assembly work on wire harness products. The first scenario is to assemble the head, body, and end separately as PT XYZ has done in the field. While the second scenario is to assemble the heads separately and then carry out the assembly process with the assembly results from the body and end lines (mix body and end). It is resulting in a more efficient assembly process with a lack of time used. The transformation makes improved total time in all the activity processes faster in 2756.38 seconds. The productivity has an increase of 10% than using scenario 1.

Keywords: Wire Harnesses; Productivity; Efficiency

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1. INTRODUCTION

The Covid-19 pandemic is still a major obstacle in the economic aspect for several countries, including Indonesia. Referring to the data from the Central Statistics Agency, the Return On Assets (ROA) value during 2020 in all sectors was negative. This condition has even started in 2019 in the fourth quarter. The situation also causes the 2020 economy to be quite a bad year for companies in Indonesia (Badan Pusat Statistik, 2021). Meanwhile, the number of Covid cases in Indonesia as of February 1, 2022, is reach 4,353,370 confirmed cases (https://kawalcovid19.id/, 2022). This number continues to increase with the presence of a new variant of Covid-19 called Omicron. The World Health Organization (WHO) stated that variant B.1.1.529 or Omicron was first reported to WHO from South Africa on November 24, 2021. Based on many tests and existing evidence, WHO designated the Omicron variant as one of the Variants of Concern (VOCs). VOC is defined as a variant of the Coronavirus that causes an increase in transmission and death and can even affect the effectiveness of the vaccine (https://www.who.int/, 2021). Therefore, the current condition can still be said to be unstable with this new variant.

On the industrial side, the Covid-19 pandemic has changed the work system of industries and companies in many aspects. The Covid 19 health protocols that need to be enforced are wearing masks, washing hands and maintaining social distance. The implementation of social-distancing has resulted in the company such as reducing employe's working hours and the 'Work From Home' policy. These policies are known having impact on work efficiency. Based on Syaifuddin, (2018) work efficiency is the result of working by work procedures. An efficient way of working is a way that does not reduce the results to be achieved in the slightest.

Increasing efficiency in the production line is a way that the company can do in order to fulfill the consumer demand. To face the number of company competitors that produce the same product, companies need to increasing an efficient production process, namely how to use inputs as efficiently as possible to produce output that matches or exceeds the target demand that has been set (K.Dewi, 2015). Efficiency measurements are widely used in several analyzes, including research Karo-Karo and Hendra, (2015) to reduce differences in efficiency levels due to time differences between work cycle elements. The method applied is the line balancing method, the results can be seen in which stations often cause bottlenecks so that they can balance the load on each workstation.However, it is difficult for the industry to achieve work efficiency with the social-distancing policy. Especially for industries that using the assembly process requiring operators to work together to assemble product parts on the same line. The wire harness industry experiences this condition.

Wire harness is a collection of a series of cables that function to transmit electric currents and signals (Donatus Feriyanto Simamora, 2017).

Figure 1. Wire harness product

PT XYZ is a company engaged in the wiring harness assembly industry that supplies products to automotive companies in Indonesia. The product of this company is a variant of the part number wiring harness, each of which has a different processing time and employee needs in the assembly process. The types of part numbers ordered by customers have different process requirements, so each part number has different needs for employees with different assembly times. In carrying out the production process for Part No 22-66779-00 products, PT XYZ divides the work line into three parts, namely the head assembly process (assembly of the product head), the body (assembly of the product body) and the end (assembly of the product tail). The work is carried out based on these parts by a number of man power. The problem is that because social distancing is applied, work efficiency in each line becomes less than optimal. Productivity decreases and the finished product is past its delivery deadline. One of the research (Olbrich and Lackinger, 2022) suggests that increasing efficiency and productivity in the manufacturing process of the wire harness industry is necessary to support performance. Because the wire harness industry is a fundamental supporter of the automotive and heavy equipment industry.

In this research, desires to analyze two scenarios of manufacturing work on wire harness products. The first scenario is to assemble the head, body, and end separately as PT XYZ has done. The second scenario is to assemble the heads separately and then execute the assembly process with the assembly results from the body and end lines (mix body and end). In both assembly processes, efficiency measurements and analysis of the resulting outputs are carried out. So it can be known which assembly process is better to apply. Through this comparative analysis, it is also expected to be able to provide recommendations for better assembly alternatives to PT XYZ.

2. METHODS

2.1 Work Measurements

The process of working time documentation in this study was conducted using the calculation of processing time. Process time calculation aims to calculate cycle time, normal time and standard time for each operator in the assembly process of wire harness products. Cycle time is the completion time of one production unit starting from the beginning of the product being processed (Muqimuddin, Ilmi and Abdallah, 2021). The cycle time can be calculated using the following Equation:

$$Cycle\ time = \frac{Amount\ of\ time}{Number\ of\ Products\ Produced} \quad (1)$$

Normal time is the time for the completion of work completed by workers in reasonable conditions and of average ability (Soh, Ong and Nee, 2014). To determine the normal time can be calculated by the following equation:

$$Normal\ time = Cycle\ Time\ x\ Performance\ Rating \quad (2)$$

The performance rating is obtained from Westing House System's Rating Method which based on yang 4 criteria including skill, effort, condition, and consistency. Thus, the standard time can be obtained by equation:

$$Standard\ Time = Normal\ Time\ x \frac{100\%}{100\% - \%Allowance}$$

2.2 Scenario Determination

This research was conducted with two scenarios to compare the efficiency and productivity level of the two assembly models.

1) Scenario 1, assemble the head, body and end separately as PT XYZ has actually done in the field.
2) Second 2, assemble the heads separately and then carry out the assembly process with the assembly results from the body and end lines (mix body and end part).

Then the analysis of the two scenarios carried out by taking experimental data directly in the company in the assembly process. In this observation activity, measurements were made using a stopwatch and the cycle time of each scenario was measured.

3. FINDINGS AND DISCUSSION

3.1. Findings

The wire harness industry must withstand the high quality requirements of fast acceleration and deceleration, tension, compression stress and torque, and millions of bending cycles. At the same time, the wire harness industry has high requirements regarding the quality of the cables due to the high current involved and the high current. The cable designed must be in accordance with the needs of the customer, both in the design and manufacturing process. The manufacturing process is a simple assembly process that demands precision because it needs to be adapted to the geometric and electrical requirements of the manufacturing components. PT. XYZ is one of the wire harness industries that is required to meet customer demands amid changing working conditions due to the covid pandemic. The production process that has been running is considered unable to meet the production target that has been running. The flow of the production process is obtained from the results of discussions with the engineering department in order to be able to determine the time requirements of each process.

Based on the cycle time measurements, are known 3 non-value added activities in the assembly process. In addition, there are also 18 necessary non-value added activities for inspection and transportation activities. For non-vaue added activities, it also takes quite a lot of time, which is 681.24 seconds. Using fishbone diagrams, identification of problems where waste occurs during the production process is carried out. There are a number of wastes that occur such as:

1) Lack of supervision during the production process causes employees to work as they please without paying attention to the production targets that have been set.
2) The available equipment is not used according to its function, making the WIP longer
3) The distance between work stations that are far apart makes the cable transfer process to be processed takes quite a long time. Equipment is not placed in place making it difficult for workers to find equipment to use.
4) Assembly process is the process that takes the longest, causing the process time (cycle time) to be longer. The absence of an standart operating procedure (SOP) that guides employees to work on making cables is not effective.

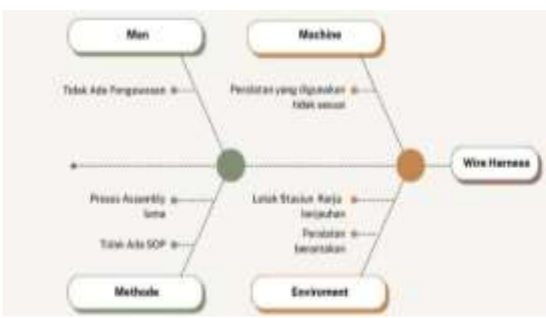

Figure 2. Fishbone Diagram Wire Harness Industry

After knowing several problems that occur in the production process using a fishbone diagram then several solutions are formulated that can be used to eliminate the waste that occurs. That is to analyze two different scenarios by taking experimental data directly in the company in the assembly process. In this observation, measurements were made using a stopwatch and the cycle time of each alternative was measured to obtain data as shown in the table below:

Table 1. Cycle Time Measurement of Scenario 1

Observations	Scenario 1			Total cycle time (s)
	head	body	end	
Operator 1	275.4	200.6	147.6	623.6
Operator 2	208.5	180.9	140.4	529.8
Operator 3	226.0	269.4	124.2	619.6
Average	236.6	217.0	137.4	**591.0**

Table 1. Cycle Time Measurement of Scenario 2

Observations	Scenario 2		Total cycle time (s)
	Head	Body-end	
Operator 1	165.2	261.2	426.4
Operator 2	125.1	241.0	366.1
Operator 3	135.6	295.2	430.8
Average	142.0	265.8	**407.8**

Table 3. Activity Peocess in Wire Harness

No	Station	Dis (m)	Time (s)
1	Print Cable		70
2	Cable move to cutting cable process	5	68
3	Cutting Cable		40
4	Cable move cutting tube	2	40
5	Cutting Tube		33
6	Cable move to crimping	3	55
7	Crimping 735685		12
8	Crimping 12089040		10
9	Crimping 12103881		36
10	Crimping 12089290		10
11	Crimping 12103881		64
12	Crimping C10-700527-000		17
13	Crimping C10-613361-016		50
14	Crimping 350536-1 (4)		44
15	Crimping AO00000100000G (6)		72
16	Crimping 926823-2 (2)		26
17	Visual Crimping (79)		106
18	Splice Handtool 31818 (12)		80
19	Visual Handtool (12)		92
20	Hotgun Cable Thermistor		55.32

21	Hotgun Cable VPS1,VPS2, KD4		10.95
22	Hotgun Cable ICFABDE		29.72
23	Hotgun ECL 3 (HS)		8.56
24	Insert Keying Connector EC LY- EC LK		69.9
25	Visual Check PR1234 ICF ICR		21.64
26	Cable move to tapping dan testing		10
27	Tapping & Testing KE (SUB-37A)		36.51
28	Tapping Cable Thermistor		46.81
29	Cable move to molding	3	55
30	Molding		40.62
31	Cooling		6.4
32	Visual Molding & Insert Courgatte		36.71
33	Joint Cable With Grommet		45.68
34	Preparations cable ECJ1, ECJ2, VPS2 & HS CONNECTOR		30.01
35	Preparations Thermistor		60.33
36	Insert Cable EC Connector (20 Pin)		44.6
37	Insert Cable EC Con. No corget (24 Pin)		38.56
38	Visual Marking After Insert EC Conector		44.99
39	Stripping Crimpping After Insert EC Connector 12089290		75.88
40	Visual EC Connector After Stripping & Crimping (48 Pin)		23.12
41	Pull Cable EPT/SPT/DPT		35.19
42	Pull of EC Connector After Crimpping (48 Pin) 2 operator 2 station		68.04
43	Cable move to assembly	5	68
44	Assembly		407.8
45	Assembly wire to jig hotmelt -->		76.8
46	Hotmelt		22
47	Cable tie & open holmelt		46.02
48	Moulding		51.4
49	Thesting Termistor		24.84
50	Testing Full Assembly		44.9
51	Cable Tie & Forgated		31.4
52	Additonal Transducer		28.6
53	Visual FG		39.68
54	Cablemove to packing	2	30
55	Packaging		65.4
Sum			2756.38

The existing assembly time at the Company takes 681.24 seconds out of a total time of 3029.82 seconds. Then a comparison is made to the two scenario where the average time required for scenario 1 is 591.0 seconds and scenario 2 is 407.8 seconds. Seeing this condition, alternative two was chosen as a solution for the assembly process so that there was an improvement in the form of decreasing the cable assembly process time to 2756.38 seconds.

3.2. Discussion

PT. XYZ is one of the wire harness industries that is required to meet customer demands amid changing working conditions due to the covid pandemic. The production process that has been running is considered unable to meet the production target that has been running. The flow of the production process is obtained from the results of discussions with the engineering department in order to be able to determine the time requirements of each process. All processes have been measured for cycle time and categorized as whether the activity is a value-added activity or a non-value-added activity. The result is known that the largest non value added activity is in the assembly process. The three assembly process is assembly 1 in 318.6 seconds, assembly 2 in 206.52 seconds, and assembly 3 in 156.12 seconds. So that this assembly process needs to be improved by trying alternatives using scenario 2 which has been proposed.

4.CONCLUSION

In this study, shows comparison of two scenarios in wire's assembly process. The scenario 1 that assemble the head, body and end separately, does not efficient because having non value added activity and wasted time. To solve the problem, we purpose the scenario 2 that assemble the heads separately and then continue the assembly process with the assembly results from the body and end lines (mix of body and end parts). It is resulting more efficient assembly process with lack of time used. The transformation make improved of total time in all the activity process faster in 2756,38 seconds. The productivity have increase 10% than use the scenario 1.

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