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Line Balancing Techniques for Efficiency Improvement in Construction Steel Company

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ABSTRACT

XYZ company is a company engaged in steel construction. This company produces steel construction with several classifications, namely Building Construction (structure) and Mining Construction (Conveyor and Tank). This problem is found in the production process area where the efficiency of the company is not optimal because of the bottleneck between workstations. To increase efficiency and reduce bottlenecks, companies use the Largest Candidate Rule (LCR); Killbridge and the Western Method (KWM); and the Ranked Positional Weights (RPW) Method. After comparing the three methods, LCR has the best results. Production line efficiency is 92.2%, balance delay is 7.8%, and the smoothness index is 14.6 with 11 operators.

Keywords: Line balancing, largest candidate rule, killbridge and western method, ranked positional weights.

Introduction

The production process is an activity that involves manpower of materials, as well as equipment to produce useful products (Assauri, 2016). Intense competition between the manufacturing industry and consumer demand that continues to increase every year requires companies to improve the performance of the production process carried out. The performance of the production process can be seen from the resulting efficiency. unbalanced production lines will lead to less than maximum company efficiency and increase bottlenecks, resulting in large waiting times and a buildup of semi-finished goods at several work stations. Track balance puts pressure on the assignment of individual work elements to the work station so that human resources have the same quantity of work (Yudha, 2017). PT. XYZ is a company engaged in the field of steel construction. This company produces steel construction with several classifications, namely construction of buildings (structures) and Mining Construction.

According to Nasution (2009), the problem of track balance mostly occurs in the assembly process than in the manufacturing process. This is as happened to PT.XYZ. Also, the problem that occurs is that the company's efficiency is not optimal, so there is a bottleneck and there needs to be a solution, one of which is by balancing the trajectory to improve company efficiency. From the problems that have been described, the purpose of this study is to improve efficiency and reduce bottlenecks on the production line to get the results of grouping tasks with balanced capacity. This research was conducted by carrying out the work measurement process by measuring the processing

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time of the operation. Data is collected using time studies and determine time standards. The alternative used to evaluate production line performance is to compare heuristic methods ((Hackman, et. al., 1989 in Kriengkorakot & Pianthong, 2015). The production line balancing method used is the Largest Candidate Rule (LCR), Killbridge, and Western Method (KWM), and Ranged Positional Weight (RPW) with the maximum results will be used as a suggestion for the existing problems. Line balancing is balancing the assignment of task elements from an assembly line to the work stations. Its main function is to minimize the number of work stations and minimize the total idle time price at all stations for a certain output level (Gaspersz, 2009; Henky, et al., 2016).

Research Method

In conducting research, problem-solving steps need to be done. Following the steps in solving this research problem.

1. Data collection
   Collecting research data The data includes production capacity data, available work station data, cycle time data for each work station, and precedence diagram data, raw material data.
2. Data Uniformity Test
   Test the uniformity of data to ensure that the data collected is from the same system, and separates data that has different characteristics. According to Syukron (2014) measurement of work, elements is done by using a stopwatch
3. Data Adequacy Test
   Testing the adequacy of the data to determine the number of samples taken is sufficient to be processed or not, and has been able to represent the existing system.
4. Data processing
   Line Balancing Calculations. By making an Assembly Chart (AC) then calculating the standard time for each process station. Draw a precedence diagram. calculate the performance of the proposed assembly line formed after the use of the line balancing method (Panchal, 2017).
5. Company Performance.
   Perform performance calculations that are running on the company today.
6. Largest Candidate Rule
   Perform calculations with the rules in the Largest Candidate Rule method
7. Killbridge and Wester Method
   Perform calculations with the rules in the Killbridge and Wester Method
8. Ranked Positional Weights
   Perform calculations with the rules in the Ranking Positional Weights method (Niaz & Kazi, 2014)
9. Selection of the Most Optimal Results Method

Result and Discussion

Data collection

In conducting this research, we need some data that will support solving the line balancing problem. Data obtained based on research and interviews at the company. To make one product, the company has 73 work elements. Among others: Cutting, Drilling, Testing, Welding, Cleaning, and Painting Process. The assembly chart shows in Table 1.

Table 1. Assembly chart of the steel column production process

No	Type of work/pieces	Pre.	Time	No	Type of work/pieces	Pre	Time
1	Cutting H 400 * 200 * 8 * 13 (part A) 1p	-	1,2	38	Component dimension Test E	5,24	1.9
2	Cutting plate 12 * 300 (part B) 4p	-	0.6	39	Component dimension test F	6	2.6
3	Cutting Plate 28 * 290 (Part C) 1p	-	0.8	40	Component dimension Test G	7	2,9
4	Plate Cutting 9 * 45 (part D) 4p	-	0.3	41	Test the dimensions of Component H	8.25	1.6
5	Plate Cutting 10 * 180 (part E) 1p	-	0.5	42	Test for Component I dimensions	9.26	1.8
6	Cutting Plate 9 * 96 (part F) 6p	-	0.3	43	Component dimension Test J	10	2.8
7	Cutting plate 12 * 96 (part G) 4p	-	0.4	44	Dimension Test Component K	11.27	1.6
8	Cutting plate 16 * 230 (part H) 1p	-	0.7	45	Test for Component L dimensions	12.28	1.7
9	Cutting plate 12 * 186 (part I) 1p	-	0.5	46	Test the dimensions of Component M	13	2.7
10	Cutting plate 9 * 96 (part J) 4p	-	0.3	47	Component dimension Test N	14.29	1.9
11	Cutting plate 9 * 186 (part K) 1p	-	0.4	48	Component O Test dimensions	15.30	1.6
12	Cutting plate 12 * 180 (part L) 1p	-	0.5	49	Test the dimensions of Component P	10,49	1.7
13	Cutting plate 9 * 96 (part M) 4p	-	0.3	50	Test component dimensions Q	17.31	1.6
14	Cutting plate 9 * 186 (part N) 1p	-	0.4	51	Test for Component R dimensions	18.32	1.8
15	Cutting plate 12 * 180 (part O) 1p	-	0.5	52	Component Dimension Test S	19	1.7
16	Cutting plate 9 * 96 (part P) 2p	-	0.3	53	Test the dimensions of the Component T	20	1.6
17	Cutting plate 12 * 180 (part Q) 1p	-	0.5	54	Test the U Component dimensions	21	1.8
18	Cutting plate 9 * 186 (part R) 1p	-	0.4	55	Test for Component V dimensions	22.33	1.7
19	Cutting plate 9 * 96 (part S) 2p	-	0.3	56	Welding A, B, C, D (Part 1)	34,35, 36,37	17.3
20	Cutting plate 12 * 180 (part T) 1p	-	0.5	57	Welding Test (1)	56	11.2
21	Cutting plate 6 * 96 (part U) 2p	-	0.2	58	Welding E, F ex 1 (Part 2)	38.39	13.7
22	Cutting plate 16 * 347 (part V) 1p	-	0.9	59	Welding Test (2)	58	11.3
23	Drilling A 42 Holes	1	5.6	60	Welding G, H, I (part 3)	40,41, 42	11.8
24	Drilling E 10 Holes diameter 25	5	0.5	61	Welding Test (3)	60	9.2
25	Drilling H 8 hole diameter 25	8	0.8	62	Welding J, K, L (part 4)	43,44, 45	11.7
26	Drilling I 5 hole diameter 25	9	0.4	63	Welding Test (4)	62	8.9

To be continued..

27	Drilling K 3 hole diameter 22	11	0.2	64	Welding M, N, O (part 5)	46,47, 48	11.6
28	Drilling L 8 hole diameter 25	12	0.6	65	Welding Test (5)	64	9.3
29	Drilling N 3 hole diameter 22	14	0.2	66	Welding P, Q, R	49,50, 51	9.8
30	Drilling O 8 hole diameter 25	15	0.6	67	Welding Test (6)	66	4.7
31	Drilling Q 8 Holes diameter 25	17	0.6	68	Welding S, T, U, V (part 7)	52,53, 54,55	11.6
32	Drilling R 3 holes in diameter 25	18	0.2	69	Welding Test (7)	68	5.9
33	Drilling V 5 hole diameter 25	22	0.5	70	*Cleaning*	69	25
34	Component dimension Test A	1.2 3	7.2	71	Painting	70	30
35	Component dimension Test B	2	2.8	72	Cutting of wooden blocks	71	16.7
36	Component dimension Test C	3	1.8	73	Packaging	71.72	29.8
37	Component Dimension Test D	4	2.7				

Steel column production process at PT. XYZ has 73 work elements. Namely the cutting process, the drilling process, the dimensional test process, the welding process, the cleaning process, the painting process, and the packaging process. The steel column production process has 320 minutes, a production speed of 1.8 units per hour, a cycle time per station of 31.55 minutes, a minimum of 11 workers, and a service time of 31.6 minutes. The most effective and efficient improvement of track balance is using the Largest Candidate Rule Method. This method can produce 11 workstations with a line efficiency of 92.2%, a balance delay of 7.8%, and a smoothness index of 14.6 seconds. Figure 1 representative the comparing result of the effective method to calculate line balancing.

Table 2. Comparing Between three methods

No	Line Balancing	Number of Workstation	Line efficiency	Balance delay	Smoothness index
1.	Initial Condition	14	72.4%	27.6%	65.1 second
2.	Largest Candidate Rule	11	92.2%	7.8%	14.6second
3.	Killbridge and Wester Method	12	84.5%	15.5%	35.1 second
4.	Ranked Positional Weight	14	72.4%	27.6%	54.1 second

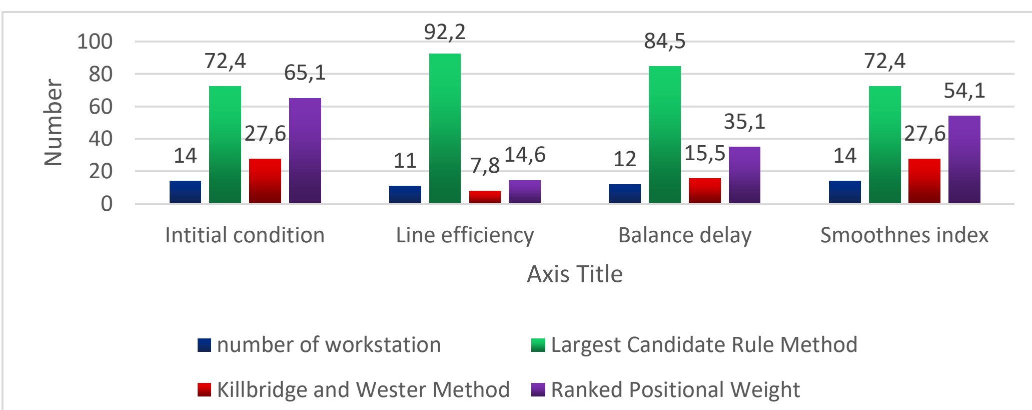

Figure 1. Line balancing result comparing

Conclusion

Based on the balance improvement calculation, the most effective and efficient way to increase efficiency and reduce drag is to use the LCR Method. At the initial trajectory, the efficiency is 72.4%; the smoothness index is 65.11 or the smoothness of production is very high. Meanwhile, the number of work stations is 14. After using the LCR Method in the production area, the company only has 11 workstations, it means the company can reduce 3 workstations. On the other hand, line efficiency is 92.2%, balance delay is 7.8%, and the smoothness index is 14.6. It means that with a smoothness index reach14.6 seconds, companies can reduce the congestion bottleneck to 50.51%.

There are several outputs of this research for the environment. I.e with decreasing the number of bottlenecks and increasing production efficiency causes a decreasing number of gas emissions. the value of high production efficiency causes the use of virgin material for more optimal product manufacturing. While the remaining products in the form of waste are also decreasing too.

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