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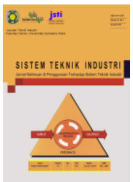

Analysis of Production Line Balance with Helgeson Birnie Approach on Plastic Chopping Machine

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Abstract. The purpose of track balance is to find out the constraints that cause the work station to be unbalanced. Research on plastic chopping tool products, where the production of plastic chopping tools takes too long in the process of making one product. line balancing is the process of balancing the production line, especially in the assembly production process. The balance of this path is intended to reduce excessive workload on one work station and strive so that each work station on each path has the same load. It is intended that each work station has a more efficient work cycle time and can avoid operator errors in assembly. to minimize the number of stations for a given cycle time. The problem of unbalanced production lines and differences in large station times causes an imbalance in the production floor. Balancing the lines on the production floor will affect the achievement of predetermined production targets. The Helgeson-Birnie method is one of the track balance methods that can solve problems in track balance. In the Ranked Position Weight results there are 6 work stations, the efficiency value is 90.02%, the balance delay is 9.97% and the Smoothing Index is 628,204

Keyword: Line Balancing, Plastic Chopping Machine, Bottleneck, Helgeson - Birnie

Abstrak. *Tujuan keseimbangan lintasan untuk mengetahui kendala-kendala yang mengakibatkan stasiun kerja tidak setimbang. Penelitian pada produk alat pencacah plastik, dimana pada produksi alat pencacah plastik membutuhkan waktu yang terlalu lama dalam proses pembuatan satu produknya. line balancing adalah proses penyeimbangan lintasan produksi terutama dalam proses produksi perakitan. Keseimbangan lintasan ini dimaksudkan untuk mengurangi beban kerja yang berlebihan pada salah satu stasiun kerja dan diusahakan agar setiap stasiun kerja pada setiap lintasan mempunyai beban yang sama. Hal ini bertujuan agar setiap stasiun kerja memiliki waktu siklus pengerjaan lebih efisien dan dapat menghindari timbulnya kesalahan pada operator dalam perakitan. untuk meminimalkan jumlah stasiun untuk waktu siklus tertentu. Permasalahan ketidakseimbangan lintasan produksi dan perbedaan waktu stasiun besar menyebabkan terjadinya ketidakseimbangan dalam lantai produksi. Penyeimbangan lintasan pada lantai produksi akan mempengaruhi pencapaian target produksi telah ditetapkan. Metode Helgeson-Birnie adalah salah satu metode keseimbangan lintasan yang mampu memecahkan permasalahan pada keseimbangan lintasan. Pada hasil Ranked Position Weight terdapat 6 stasiun kerja, nilai effisiensi sebesar 90,02 %, balance delay 9,97 % dan Smoothing Index 628.204*

Kata Kunci: Lintasan Produksi, Mesin Pencacah Plastik, Bottleneck, Helgeson Birnie

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1. Introduction

Before balancing the production line, first perform work measurements or measurement of time, namely an activity in determining the time needed by a person operator with trained capabilities in carrying out work activities in conditions and tempo everyday work [1]. Line balancing is a production line balancing process, especially in the assembly production process. This track balance is intended to reduce the excessive workload on one workstation and to ensure that each workstation on each track has the same load [2].

To solve the optimal SALBP-E, the researcher proposes a combination of a linear programming model and an iterative procedure [3]. The application of line balancing is a consideration of the heterogeneity of workers on an assembly line, maximizing their integration while maintaining a high level of productivity [4]. The Japanese manufacturing system approach known as Just-in-Time is in line with the concept of Line Balancing. One part of the JIT philosophy is that production lines must produce at a rate that matches market demand, thereby minimizing inventory of the final product. In order to maintain production levels according to market demand, line balancing is carried out once a month to adjust to actual sales levels in the last period. Line balancing can include adding or reducing capacity [5].

Time measurement is intended to obtain the standard time for work completion, namely the time normally required by a normal worker to complete a job in the best work system [6]. Time measurement is used to determine the time required for specially trained and qualified workers working in the normal course of business to perform a specific task or job. Time measurement is used to measure work, where the result of time measurement is the time when someone does a job and is trained for that job with a normal or standard tempo [7].

The Helgeson-Birnie method is one of the path balance methods that can solve the problem of path balance. It’s more commonly known as the Ranking Positional Weighting System or the RPW system. The Helgeson-Birnie method is considered capable of solving track balance problems and finding solutions quickly and precisely [8]. The criteria for balancing the production line are as follows: Balance Delay, Line Efficiency, and Smoothing Index [9].

2. Methodology

2.1. Ranked Positional Weight

Determine the position weights for each work element about the operating time for the longest working time from the start of the operation to the remainder of the operation after that [10].

2.2. Research Steps

The stages contained in the methodology will be used as a guide for researchers to conduct research in a systematic and directed manner so that they can answer the formulation of the problem.

3. Result and Discussion

3.1. Ranked Position Weight

The process flow on the production floor is as follows:

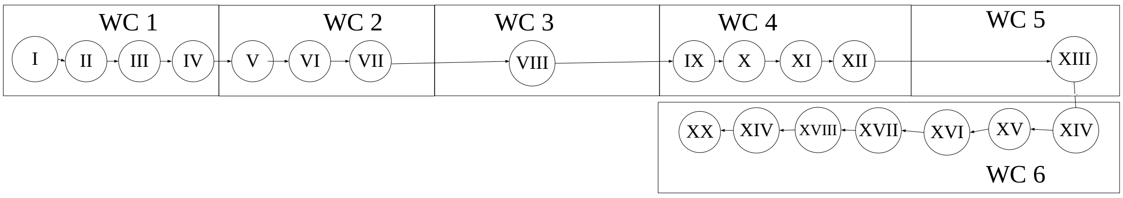

Figure 1 Actual precedence diagram

Zoning constraints limit the allocation of work elements at workstations that prevent or require the grouping of certain work elements at certain stations [11]. The Precedence matrix is a matrix made from the relationship between each of the existing work elements.

Table 1 Precedence matrix

EK	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2	-1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
3	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
4	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
5	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
6	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1	1	1
7	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1	1
8	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1	1
9	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1	1
10	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1	1
11	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1	1
12	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1	1
13	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1	1
14	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1	1
15	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1	1
16	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1	1
17	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1	1
18	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1	1
19	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1		1
20	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	

The results of ranking each work element that has been sorted. The precedence matrix obtains the weight of each element from the sum of the processing time for that element with elements with a value of +1 in each row. The weighting of each work element can be seen in Table 2.

Table 2 The weighting of each work element

Work Element	WS (second)	Weight	Rank
1	304	123548	1
2	1506	123244	2
3	2407	121738	3
4	25210	119331	4
5	14415	94121	5
6	2415	79706	6
7	3611	77291	7
8	25209	73680	8
9	1816	48471	9
10	1204	46655	10
11	2713	45451	11
12	2421	42738	12
13	28825	40317	13
14	1519	11492	14
15	1204	9973	15
16	1808	8769	16
17	2129	6961	17
18	1506	4832	18
19	1825	3326	19
20	1501	1501	20

CV. XY has a production capacity of 4 units/month. The company has 1 work shift, working hours are 8 hours. Then the cycle time can be calculated as follows:

$$\text{Cycle Time} = \frac{\text{Time}}{\text{production capacity}} \quad (1)$$

$$\text{Total Time for Each Work Station} = EK_1 + EK_2 + \ldots + EK_n \quad (2)$$

$$\text{Idle Time} = \text{Cycle Time} - \text{Total Time for Each Work Station I} \quad (3)$$

The cycle time obtained from the calculation formula above equals 276.923 seconds/month. Using the calculation formula above, the total Time for Each Work Station I equals 29.427 Seconds. The idle time calculation results obtained from the above formula equal 247,496 seconds. The total time at each actual workstation is in Table 3.

Table 3 Total time at each actual workstation

Work Station	Work Element	Standard Time (Second)	Total (Second)	Idle (Second)
I	1	304	29.427	247.496
	2	1506		
	3	2407		
	4	25210		
II	5	14415	20.441	256.482
	6	2415		
	7	3611		
III	8	25209	25.209	251.714
IV	9	1816	8.154	268.769

	10	1204		
	11	2713		
	12	2421		
V	13	28825	28.825	248.098
	14	1519		
	15	1204		
	16	1808		
VI	17	2129	11.492	265.431
	18	1506		
	19	1825		
	20	1501		

The balance delay value, track efficiency, and smoothing index are based on actual conditions.

$$\text{Balance delay} = \frac{n.Sm - \sum Si}{n.\,Sm} \times 100\% \qquad (4)$$

$$\text{Eficiency} = \frac{\sum_{i=1}^{n} Si}{n.Sm} x100\% \qquad (5)$$

$$\text{Smoothing Index (SI)} = \sqrt{\sum_{i=1}^{n} (C - Si)^2} \qquad (6)$$

The processing results obtained at six workstations have a cycle time of 276.923 seconds, a balance delay of 9.97%, an efficiency of 90.02%, and a smoothing index of 628.204. So, it needs to be repaired because the production line is not close to 100 %.

4. Conclusion and Future Research

The processing results obtained at six workstations have a cycle time of 276,923 seconds, a balance delay of 9.97%, an efficiency of 90.02%, and a smoothing index of 628,204. The method used in balancing the production line has several methods; one of the methods used is the Helgeson and Birnie method. The production line balancing method is used to balance the cycle time in the manufacturing industry. The result of balancing this production line can result in a higher level of productivity than before.

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