Line Balancing Analysis of Hollow Dakota 1730 Manufacturing Process in PT XYZ

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Abstract. The existence of operational balance in each production lines may decrease the idle time; it shows that the productivity is increasing therefore it increases the production rate. The issues existed in the production process of hollow Dakota 1730 in PT. XYZ were 3 departments, from the result of the first observation, there was a bottleneck from each department and each production did not achieve the required target. Therefore, this research would fix the production line. The method used was ranked /positional weight. Based on the data processing by the ranked positional weight method, gained the total of work station in the production process of hollow Dakota 1730 by the number of 2 work stations. From the result of efficiency balancing, gained 62.5% and balance delay value was 37.5%. it shows that the balance performance between each department increases significantly.

Keywords: *Productivity, Ranked positional weight, Efficiency balancing, Balance delay, Bottleneck*

1 Introduction

Most manufacturing companies pay close attention on how to increase productivity and minimize production costs [4];[5]. In addition, in the production process, bottlenecks often occur unavoidably. One of the ways to reduce bottlenecks and increase productivity that needs to be done is to balance the operation of work at each workstation. There have been many studies using various heuristic analytical methods, algorithms and computational simulations [11]-[15]. With the balance of operations in each production line can reduce idle time, this indicates that productivity is increasing so that it can increase the production rate [19];[20];[6].

At present, in the production process of hollow Dakota 1730 at PT. XYZ, there are 3 departments where initial observations indicate there is a bottleneck in each department and in each production did not reach the target specified by the company. Therefore, this research will improve the production line by using one of the line balancing methods, namely Ranked Positional Weight.

Ranked positional weight method is one of the heuristic methods to solve production line problems [7]-[10]. A research compared algorithmic methods and ranked positional weight in analyzing line balancing [1]. The result shows that the ranking positional weight method is a technique to find out how to synchronize the sorting of work station at a time of limited data availability and the ranking positional weight method is able to represent a more precise output than the algorithm method [1]. At present, in the production process of hollow Dakota 1730 at PT. XYZ, there are 3 departments where initial observations indicate there is a bottleneck in each department and in each production did not reach the target specified by the company. Therefore, this research will improve the production line by using one of the line balancing methods, namely Ranked Positional Weight.

2 Methods

The type of data used in this research is primary data. The data is a time-cycle data of the working element production process of the hollow Dakota 1730. Observations are carried out directly at the production process site with a total of 186 observations on each working element. The working element cycle time that will be completed by the ranked positional weight method is the data on the average time of the working element cycle of the hollow Dakota 1730 production process. There are 14 operating elements divided into three stations. The data are as follows: Product Manufacturing Process Stages.

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Table 1. Working Elements

No.	Product Manufacturing Process Stages	Operation	Department
1	Slitter setting	O-1	Department 1 (*Setting &Cutting)*
2	Coil picking	O-2	Department 1 (*Cutting)*
3	Opening the coil *packing*	O-3	Department 1 (*Cutting)*
4	Coil get into the machine	O-4	Department 1 (*Cutting)*
5	Coil preparation in the machine	O-5	Department 1 (*Cutting)*
6	Setting slitter machine (coil length and thickness)	O-6	Department 1 (*Cutting)*
7	Waiting for the production process 1 of slitter coil (material for hollow Dakota 1730)	O-7	Department 1 (*Cutting)*
8	Transferring the cut coil, which is the process of moving the cut coil into the Hollow Dakota 1730 machine	O-8	Department 2 (*Production)*
9	Cleaning and setting the Hollow Dakota 1730 machine	O-9	Department 2 (*Production)*
10	Material preparation get into the machine	O-10	Department 2 (*Production)*
11	*Setting* hollow Dakota 1730 machine	O-11	Department 2 (*Production)*
12	Checking the production result of the hollow Dakota 1730	O-12	Department 2 (*Production)*
13	Waiting for the production process 1 set of hollow Dakota 1730	O-13	Department 2 (*Inspection & Production*)
14	Packing Process	O-14	Department 3 (*Packing*)

The following is data on the average cycle time of each work element in the Dakota 1730 hollow production process:

Table 2. Average Time Of Working Element

Working elements (Operation)	Average Time of Each Operation (Second)	Department
Operation 1	2004.909	Department 1 (*Setting &Cutting)*
Operation 2	106.161	Department 1 (*Cutting)*
Operation 3	167.333	Department 1 (*Cutting)*
Operation 4	52.849	Department 1 (*Cutting)*
Operation 5	135.629	Department 1 (*Cutting)*
Operation 6	20.112	Department 1 (*Cutting)*
Operation 7	1407.630	Department 1 (*Cutting)*
Operation 8	177.994	Department 2 (*Production)*
Operation 9	658.107	Department 2 (*Production)*
Operation 10	168.247	Department 2 (*Production)*
Operation 11	17.408	Department 2 (*Production)*
Operation 12	12.795	Department 2 (*Production)*
Operation 13	19.801	Department 2 (*Inspection & Production*)

Solution using the Ranked Positional Weight (RPW) method [16];[17]:

- Determine work elements based on positional weight for each work element of an operation that has the longest completion time from the beginning of the work to the end of the work element with the lowest completion time.
- Sort the work elements by positional weight in the second step above. The work elements that have the highest positional weight are sorted first.
- Continue by placing work elements that have the highest positional weight to the lowest to each work station.
- If at each work station there is an excess of time, in this case the station time exceeds the cycle time, change or replace the work elements in the work station to the next work station as long as it does not violate the precedence diagram.
- Repeat steps 4 and 5 above until all work elements have been placed into the work station.

In determining the cycle time by taking the longest cycle time [18];[19];[21]. In determining this work station or work station, the following formula can be used [22]:

$$K \min = \frac{\sum_{i=1}^{k} ti}{C} \quad (1)$$

Index :
$\sum ti$ = Sum of all operating time

ti = Operating time
C = Cycle Time
K min = Minimum number of working stations

After measuring using the RPW method, it is followed by measuring line performance with the following parameters:
Efficiency Balancing is used to find out the balance of the department. To calculate efficiency balancing, you can use the following formula [23] ;[24] :

$$E_b = \frac{\text{Sum of all operating time}}{Total\ Departemen\ x\ biggest\ \text{Cycle Time}} \quad (2)$$

This ballanced delay is used to identify the amount of time lost due to an imperfect balancing process. To find the balanced delay value can be searched with [25] :

$$d = 1\text{-}Eb \quad (3)$$

3 Results

3.1 Precedence diagram

Here's a precedent diagram of the initial production conditions of the hollow Dakota 1730:

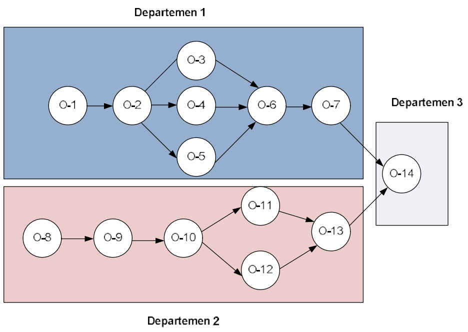

Fig. 1 Precedence diagram

picture x. describes that there are three work station as the starting condition of hollow Dakota 1730 production.

3.2 Starting Condition Analysis

The following table shows the starting condition analysis of the hollow Dakota 1730 production in the cycle time determination:

Table 3. Cycle Time Determination

Department	**Work Element (Operation)**	Total of Work Station Cycle Time	Biggest CT
1	1st operation	3894.623	3894.623
	2nd operation		
	3rd operation		
	4th operation		
	5th operation		
	6th operation		
	7th operation		
2	8th operation	1054.352	
	9th operation		
	10th operation		
	11th operation		
	12th operation		
	13th operation		
3	14th operation	330.382	

From the table, the biggest cycle time in the starting condition analysis is 3894.623 seconds.

3.3 The Determination of Efficiency Balancing

The calculation result of efficiency balancing stated below:

$$E_b = \frac{5279.357}{3\ x\ 3894.623} = 0.45 = 45\% \quad (4)$$

Based on the efficiency balancing calculation result, it can be known that the production line balancing hollow Dakota 1730 is 45%.

3.4 The Determination of Balance Delay Value

The result of balance delay value calculation stated below:
$d = 1 - E_b = 1 - 0.45 = 0.55 = 55\%$

based on the balance delay calculation, the total of time loss due to the imbalance line between each department of hollow Dakota production process is 55%.

3.5 The Solution of RPW Method

3.5.1 Determination of positional weight value :

The evaluation table of positional weight of each work operation element stated below

Table 4. Determination of positional weight value

Work Element	***Positional Weight***	**Total (seconds)**	Rank
1st Operation	2004.909 + 106.161 + 167.333 + 52.849 + 135.629 + 20.112 + 1407.630 + 330.382	4225.005	1
2nd Operation	106.161 + 167.333 + 52,849 + 135.629 + 20.112 + 1407.63 + 330.382	2220.096	2

3rd Operation	167.333 + 135.629 + 20.112 + 1407.630 + 330.382	1925.457	3
4th Operation	135.629 + 20.112 + 1407,630 + 330,382	1893.753	4
5th Operation	20.112+1407.630 + 330,382	1758.124	5
6th Operation	1407.630 + 330.382	1738.012	6
7th Operation	177.994 +658.107+ 168.247+ 17.408 + 12.795 + 19.801 + 330.382	1384.734	7
8th Operation	658.107+ 168.247+ 17.408 + 12.795 + 19.801 + 330.382	1206.740	8
9th Operation	52.849 + 20.112 + 177.994 +330.382	581.337	9
10th Operation	+168.247+ 17.408 + 12.795 + 19.801 + 330.382	548.633	10
11th Operation	17.408 + 12.795 + 19.801 + 330.382	367.591	11
12th Operation	12.795 + 19.801 + 330.382	362.9784	12
13th Operation	19.801 + 330.382	350.183	13
14th Operation	330,3817	330.382	14

From the table above, the positional weight value gained obtained from the connected work operation element. For instance, the 1st work operation element connected with the 1,2,3,4,5,6,7,14 element therefore the positional weight value obtained is 4225.05 seconds.

3.5.2 Determination of cycle time

The determination of cycle time uses the biggest cycle time. The result shows:

Table 5. Determination of biggest CT

Department	**Work Element (Operation)**	Total of Cycle Time Work Station	Biggest CT
1	1st Operation	3894.623	3894.623
	2nd Operation		
	3rd Operation		
	4th Operation		
	5th Operation		
	6th Operation		
	7th Operation		
2	8th Operation	1384.734	
	9th Operation		
	10th Operation		
	11th Operation		
	12th Operation		
	13th Operation		
	14th Operation		

From the table, the biggest cycle time is 3894.62 seconds in the 1st work station.

3.5.3 Determination of Efficiency balancing

The result of efficiency balancing calculation stated below:

$E_b = \frac{5279.357}{2\,x\,3894.623} = 0.625 = 62.5\%$

From the result of efficiency balancing calculation, the production line balancing of hollow Dakota 1730 is 62.5%.

3.5.4 Determination of balance delay value

The result of balance delay value calculation stated below:

d = 1- Eb = 1-0.625 = 0.375 = 37.5%.

from the result of balance delay calculation, the total of time loss due to the imbalance line between each department of hollow Dakota 1730 production process is 37.5%

based on the result, there could be comparison between line performance hollow Dakota 1730 production process as follows:

Table 6. Comparison line performance

Indicators	Starting condition	RPW
Work station total	3	2
Efficiency balancing	45%	62.5%
Balance delay	55%	37.5%

Based on the comparison above, the idea of fixed-line balancing between each work department by RPW method obtained a better result than the previous condition. It was measured by the parameter value which increase significantly.

4 Conclusion

Based on the data processing, the total of work station by RPW method obtained 2 work stations. The parameter result increase significantly from the previous condition, which the efficiency balancing of RPW method is 62.5% bigger than the previous one. Total of time loss also decreases, which affect positively into the balance between each department. The further research is expected to continue the comparison by the other line balancing method. Furthermore, it is possible to measure the cost to obtain the significant cost for each work operation element.

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