Assembly Line Balancing with Method Ranking Positional Weight (case study: XYZ Company)

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Abstract. A company uses several methods to increase productivity in the company. One of the methods used in increasing productivity is balancing production lines on each work element. Balancing the work track can be done by allocating work elements. The allocation of work elements in the work station can be seen at the cycle time. Big difference in cycle time causes some work elements have bottlenecks. In achieving high productivity in a work station company must have a balanced workload. Effectiveness in the production floor aims to make the company achieve the desired production target of consumers. Companies failing to achieve production targets will have a negative impact on the company. The negative impact felt by the company in the form of losses. Ineffectiveness in production summary can be caused by differences between machine capacity and production capacity. Machine capsules that are smaller than the capacity of production cause the work elements must have accumulated. Effective production trajectories can be measured by producing high output with low resource utilization. The reason why companies often experience bottlenecks on a production floor is an imbalance of resources within a factory.

1. Introduction

The process of balancing production lines at a factory needs to be carried out by utilizing a series of plant resources including (machinery and equipment) [1]. Companies must be able to balance factory resources to achieve the desired production targets. Incorrect assembly planning results in efficiency in the production process and reduces the level of flexibility in the manufacturing process. Assembly allocation in each work center has an important role to increase the flexibility of the production process. Setting the right production line will cause the workload at each assembly to balance in the production process. Balance at each work station will cause a balanced workload so it will not cause congestion on the assembly. Production line is the process of balancing factory resources (machinery and equipment) that are designed to meet production capacity [2]. Line balancing is designed by the assembly line assembly at each station in the assembly process. Balance the production line can prevent idle time at each work station. Production lines can achieve effectiveness can be seen from the level of a slight delay in balance [3]. The research method uses Ranking Positional Weight (RPW) and Algorithm Ant RPW is the initial initials in the ant algorithm. Comparison of these two methods provides a solution in the assembly process [4].

The general purpose of this study is

- Allocate work elements at work stations using ant algorithm
• Analyze the state of the actual track in the production floor
• Analyze the performance measurement of the actual track

The time requirement in work stations II, III and VIII has less time than the time available causing bottlenecks and have work in process.

|       | Time Requirement | Time Available | Difference   |
|-------|------------------|----------------|--------------|
| II    | 201659250        | 96595200       | 105064050    |
| III   | 128709750        | 96595200       | 32114550     |
| VIII  | 126334000        | 96595200       | 29738800     |

2. Theoretical Background
Balance the production line is a series of work stations (machinery and equipment) used in the manufacture of products. The line balancing consists of several work areas called work stations provided by the operator or more and there is the possibility of handling using various tools. The steps in processing the path using the Helgeson Bernie method are:

• Make a precedence diagram and precedence matrix
• Calculate Positional Weight and rank based on the biggest weight
• Determine the cycle time
• Conduct grouping based on work stations
• Calculation of the efficiency of each line balancing

3. Research Methodology
Data can be obtained from two main sources namely primary sources and secondary sources. Data obtained from primary sources is called primary data, that is data obtained by searching / digging directly from the source by the relevant researcher. Secondary data is data that has been collected and processed by other parties so that it does not need to be explored / sought by the relevant researcher but only to quote or retrieve [3]. A variable is something that has a different or varied value. Variable essence values can be quantitative or qualitative. The variables contained in this study are:

Variables are very important in supporting the research process, research variables are supported by the theoretical basis as a reference. Independent variables are variables that explain and influence other variables. The dependent variable is the variable describing and influenced by the independent variable. The conceptual framework provides a design in support of systematic research. Conceptual framework can be explained the steps of the research to be made systematically [5]

![Research framework](image-url)
Research procedure
The research procedure can be shown in the following figure

![Diagram](image)

Figure 2. Research procedure

4. Rating Factor and Allowance
Time measurement is carried out using stopwatch aids. This measurement is carried out for 5 times on all work elements in the work station. Time data on each work element can be seen in table 1 [6].
Value Rating Factor and Allowance of operators in each element of PVC Pipe manufacturing work can be seen in Table 2

| Work Element | Rating Factor | Allowance (%) |
|--------------|---------------|---------------|
| 1            | 1.07          | 23.5          |
| 2            | 1.11          | 22            |
| 19           | 1.16          | 16            |
| 20           | 1.13          | 15            |
| 21           | 1.14          | 16            |

4.1. Sufficiency Test
Data adequacy test is carried out to find out whether the data taken has met the amount that should or not. In this study a 95% confidence level and a 5% accuracy level were used. If a confidence level of 95% and a level of accuracy of 5% are used, then a multiplier variable of 40 is used [7]

\[
N' = \left[ 40 \sqrt{\frac{\sum xi^2 - (\sum xi)^2}{\sum xi}} \right]^2
\]  

(1)
Based on the calculation results obtained by the value of \( N > N'(5 > 1.71) \) which means that the cycle time data for work element 1 is sufficient. The results of the data adequacy test on the entire data have been declared sufficient [8].

4.2. Uniformity Test
Data uniformity test needs to be done first before using data so that it can be known whether the data is in a uniform condition to set a standard time. Examples of calculation of data uniformity test on work element 1 can be seen as follows [9]:

- Calculation of the average value of observation time
  \[
  \bar{x}_{\text{element 1}} = \frac{x_1 + x_2 + \ldots + x_n}{n}
  \]  
  (2)

- Calculate of standard deviation
  \[
  \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}
  \]
  (3)

- Calculate Upper Control Limit and Lower Control Limit
  Calculation of the Upper Control Limit and the Lower Control Limit for the 95% confidence level and the accuracy level of 5%, then the \( k \) value used is 1.96 [10].
  \[
  UCL = \bar{x} + k
  \]
  (4)

The uniformity test results for all data have been stated uniformly. The recapitulation of data uniformity test calculations for all work elements is shown. The normal time on work element 1 can be obtained as follows, namely

\[
T_n = T_s \times \text{Rating Factor}
\]
(5)

4.3. Standard Time
Standard time is the time to complete a cycle of work performed according to normal working methods and speed with consideration of adjustment factors plus time leeway for personal and other unexpected calculations for work element 1, namely

\[
\text{Standard Time} = \text{Time Normal} \times \frac{100\%}{100\% - \text{Allowance} (\%)}
\]
(6)

Determination of ranking order for each work element. From the precedence matrix we get the weight of each element from the sum of the working time for that element with elements that are +1 on each row. The following is an example of a calculation for obtaining a working element 6154.

PT XYZ has a production capacity of 43 batches / day. In one production (1 batch) the company is able to produce 416 PVC pipes. The company has 3 work shifts, each work shift is 8 hours. Then the cycle time can be calculated as follows:

\[
\text{Cycle time} = \frac{\text{Time Capacity Production}}{\text{Time Production}}
\]
(7)

Based on the data above, it appears that there are 8 work stations with a total of 37 work elements on the production floor of PT Sinar Utama Nusantara. In addition, PT. So, the actual condition can still calculate the amount of Idle Time obtained 1638

4.4. Precedence Diagram
The production line is in the initial condition with a cycle time of 2009 seconds and there are 8 work stations. The known value of balance delay is 59.50%, efficiency is 38.28%. In this situation, the production line is said to be unbalanced because the value of the efficiency of the production line is not yet close to 100%, so it needs to be improved.
5. Conclusion

The conclusions obtained are based on data processing and analysis. Troubleshooting is as follows: The actual Production Track on the production floor is obtained using Ranked Positional Weight method. This method uses weighting on each work element so that work elements can be formed work stations. The results obtained are the number of trajectories 8 work stations and the biggest cycle time of 1103 seconds. The results of performance calculations show that there is an increase in the efficiency of lateness, where the higher the percentage value, the trajectory production is getting better. Calculation of Balance Delay and Smoothing Index also decreased, which decreased the balance delay on the track shows a decrease in waiting time and a smaller value smoothing index of an assembly line, the more balanced the assembly line the. Based on the results obtained in this study, the trajectory gives better results compared to actual trajectory.

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