

Analysis Line Balance Sound Board Glue Production On Assembly Grand Piano Process Case Study PT Yamaha Indonesia

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Abstract

In the face of increasingly fierce competition every company must make the production process efficient and continuous improvement. One of the ways to make the process efficient production by production line balancing. PT Yamaha Indonesia is a company that performing continuous improvement. The problems that still exist in this company is the balance that is less than optimal production line. Line efficiency sound board glue working group on the actual condition of 47% and had a total time of 211.91 minutes idle by the number of work stations as many as 16 stations. The low value of efficiency and high idle time reflects the imbalance of production lines. To resolve these problems used two methods region approach and ranked position weight. Analysis of the balance using the region approach causes increased line efficiency by 76%, total idle time dropped to 60.86 minutes and the number of work stations was reduced to 10 stations. Meanwhile, the analysis of the balance of the position ranked weight method can improve line efficiency to 84%, lowering the idle time becomes 35.67 minutes and the number of work stations was reduced to 9 stations. It can be seen that the line balancing by using the ranked position weight can be applied to the company PT Yamaha Indonesia.

Keywords: line balance production, line efficiency, Idle time, Region approach, Ranked position weight.

Introduction

In the face of increasingly fierce competition, each company is required to always evolve for the benefit of all parties involved inside it. One of the ways that companies can evolve is to improve the performance and production. To achieve this is to improve the production process. Improvement of production processes need to be done continuously and constantly so that wastage of material and time can be minimized (Ashmore, 2001).

The company must still perform continuous improvement to maintain its competitive edge because the company has a variety of limited resources to perform each operation. In the midst of these limitations, companies are required to produce and submit products that are superior in terms of quality, flexibility, speed, and price (cost reduction) (Fernando, 2008).

To fulfill this, the required effective production process. Effectiveness of a production system not only seen on the working methods, but also from the production line balancing (Setyananda, 2013). Various ways have been done by some companies to balance the production line in order to smooth production

process running smoothly. Ranging from small companies and large, have improved the balance of production lines, including large companies such as Yamaha corporation.

Yamaha Corporation is a company name that is well known worldwide as a producer of motorcycles and musical instruments that have been stood since 1887. One branch of Yamaha corporation is PT Yamaha Indonesia engaged in world of music that produces piano with two types are Grand piano and Upright piano. In the production process of the piano, the main material in the form of wood need some group work station in accordance with the model and eventually became a qualified piano.

To maintain quality and increase production, until now PT Yamaha Indonesia is still working to implement continuous improvement and continuously at each work stations. Because the production process piano each work stations, has a dependency with other work stations, then each work stations, needs to make improvements. No exception to work stations, at the sound board glue. In the Sound board glue work station there are several stations and several operator working on different processes. However, any process related to each other between one and the other so that the smooth the production process is strongly

influenced by the balance line of work stations, and the number of work stations, . The efficiency of each station and high idle time is still a problem that often happens at this station so that the production process becomes less than the maximum. Therefore, this study aimed to do a sound board glue line balancing, improve the efficiency of the assembly line at the Piano GP at the sound board glue, and reduce the idle time on the sound board glue.

In research conducted by Kusumaningtyas (2012) entitled "Application of Line Balancing To Achieve Target Daily Production Rate And Simulation To Know Production Bottleneck On Dvd Player", also found similar problems as the low level of efficiency and a high level of bottleneck line. The delay in the production process at the beginning of the station will lead to the next station idle. This can occur due to several factors, one of which is the workload at the station late still higher compared to the next station. In addition, the number of work stations, also affect the speed of the production line due to the greater number of work stations, , the more time it takes to transport (handling) the material.

Literature review

The term balance of line or called balancing is a method of assignment of a job into work stations that are interrelated in a single production line so that each station has a time not exceeding the cycle time from the work stations, (Sinaga, 2014).

Measurement Working Time By Time Stop (Stopwatch)

In the context of work measurement, stopwatch time study methods is a work measurement technique using a stopwatch as a measure of time indicated in the completion of activity was observed (actual time). Time successfully measured and recorded and then be modified taking into account the tempo of the operator and add it to allowances.

There are three methods commonly used to measure the work elements by using a clock-stopping (stopwatch), the measurement of time continuously, repeatedly measuring time, and the measurement of time is a summation (Wignjosoebroto, 1995).

In this study, the measurement of working time with a stopwatch is used repeatedly (repetitive timing). The measurement of time of completion of a processing started since the first movement until the work was completed (called a cycle) and is repeated until sufficient statistical measurement.

From the measurement results obtained in this way will the standard time to complete a work cycle, then this time will be used as a standard completion of work for all workers who will carry out the same work.

The formula used to determine the number of measurements to be performed in this study are:

$$N' = \frac{\frac{Z}{a} \sqrt{N(\sum Xi^2) - (\sum Xi)^2}}{(\sum Xi)}$$

Where:

N '= number of measurements / observations that should be implemented.

N = the number of preliminary measurements have been done.

Xi = the turnaround time measured at the i-th observation.

Z α = α : 5% $\rightarrow$ Z α = 1.96

a = level of precision or accuracy.

Calculation Standard Time

The standard time is the length of time required by a skilled worker to complete one cycle of work in normal speed is adjusted by an adjustment factor and factor allowances given to finish the job (Satriyanto, 2008). If the data have been sufficient condition N1 < N, then phase calculation to derive the value of the standard time job is as follows:

1. Calculate the cycle time by:

$$Ws = \frac{\sum Xi}{N}$$

2. Calculate the normal time by:

$$NT = Ws (1 + Rating Factors)$$

3. Calculate the standard time by:

$$ST = NT (1 + Allowance)$$

To determine the value of rating factors, can be done by providing value adjustment factor for factor that working, the factors assessed are as follows:

1. Skill
2. Effort
3. Consistency
4. Condition

and for values of the allowances is done by providing value factor allowances for workers based on factors that affect the operators work. Allowance factors afforded views of the following things:

1. Personal Needs
2. Environmental conditions
3. Labour Issued
4. Work Attitude
5. Work Movement

6. Eye Fatigue

7. Temperature Workplace

Ranked Position Weight Method

Ranked Positional Weight (RPW) method is the earliest heuristic developed. This method was developed by Helgeson and Birnie. How to determine the weight of precedence diagram starting from the end of the process. $RPW = \text{Weight of the operation processing time} + \text{time processing operations that follow}$. Grouping operations into a work station on the basis of the order of RPW (from the largest) and also noticed a barrier of cycle time and work stations predecessor.

Steps to resolve by using Ranked Positional Weight (RPW) are as follows (Santosh T. Ghutukade1, 2013):

1. Calculate the desired cycle time. The actual cycle time is the desired cycle time or the operating time greatest if the largest operating time was larger than the desired cycle time.
2. Create a precursor matrix based networks docking.
3. Calculate the weight of the position of each operation is calculated based on the amount of time the operation and the operations that followed.
4. Ordering operations start from the position of greatest weight to the weight of the smallest position.
5. Perform the workload of operations at the work station operating with weights from the largest position until the weight of the smallest position, with the criteria of total operating time is smaller than the cycle time.
6. Calculate the average efficiency of the work stations are formed.
7. Use the procedure of trial and error to find the workload that will produce an average efficiency is greater than the average efficiency in step 6 above.
8. Repeat steps 6 and 7 until no longer found work station that does not have an average efficiency higher.

Region Approach Method

This approach involves a tradeoff between job after the initial balance is obtained. This approach is not feasible for large networks and a combination of work that can be exchanged can be stiff. OPC is essentially transformed into a precedence diagram with the steps - steps as follows (Saptanti, 2008):

- a. Make precedence diagram.
- b. Dividing operations in precedence diagram in some regions / areas from left to right with the requirements in the plan should not be operating interdependent. Accumulate all the

work to the precedence of the last region. This will ensure that job with little dependence on at least considered for the final job in the schedule.

- c. In each of the region a sequence precedence from the maximum job time to the minimum. This will assure the greatest work will be considered first, provided an opportunity to obtain a better combination with the jobs that smaller.
- d. Accumulate jobs in the following order:
 1. At first, leftmost region.
 2. In an region initially performed the greatest job.
- e. Classify operation in work stations, based on the terms which may not exceed the specified cycle time. At the end each of the work station, decide whether the use of time is acceptable, if not, check all job that has precedence relationships. Determine whether the use will increase when the exchange with the work being considered. If yes, do the exchange.
- f. Continue until all the elements of the work are placed on all work stations.
- g. Compose pattern of the production flow.

Research methodology

Object of research

This research was conducted in the sound board glue PT Yamaha Indonesia is located in the Industrial Area Pulogadung Jln. Rawagelam I / 5 Jakarta 13930

Data source

The data used in this study are primary data and secondary data, both qualitative and quantitative. The primary data obtained through observation and interviews with the company mainly to the head of sound board glue section. Data retrieval starts from the beginning of November until the beginning of December 2015. Primary data were obtained, include:

- a. Production process cycle time of each work station.
- b. number of operators
- c. The number of work stations
- d. Production process flow
- e. Balance the current line condition

Secondary data is data that the company itself along with the literature data, research results, articles and journals. The data required are:

- a. A brief history and organizational structure of the company.
- b. Production capacity data.
- c. Production planning data.
- d. Effective working hours.

- e. Schedule weekdays.
- f. Table rating factors.
- g. Journals, articles, and research results on the theme line balancing

Data Processing Method

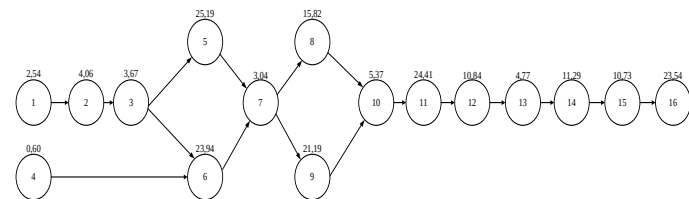
Once the data is obtained then performed data processing. The stages of data processing is carried out as follows:

- a. Calculating the cycle time.
After getting the cycle time, the first thing to do is to calculate the total time and average cycle time - average each work station.
- b. Sufficiency test data.
Test the adequacy of the data was conducted to prove that the data collected is sufficient. By searching for values N 'provided that the data is already sufficient if $N > N'$ '.
- c. Uniformity test data.
Data uniformity test was conducted in order to identify their data far away from the average is actually due to the data that is too large or too small. From the data obtained control limits will be tested, so that data can be said to be uniform if it is between the control limits. The control limits are divided into two, namely the Upper Control Limit (UCL) and Lower Control Limit (LCL).
- d. Calculation of normal time.
Normal time calculation is a calculation of time when operators start to finish the job without any interference, so penyelesaian job in a normal pace.
- e. Calculation of standard time
Calculation of standard time is a computation of time in which the normal time job multiplied by a factor predetermined allowances.
- f. Balancing the production line.
Balancing the production line is done in several stages:
 1. Perform the assembly line balance calculations initial conditions.
 2. Once you know the condition of the initial state assembly lines, line balancing will be performed by two methods: the method ranked position weight (RPW) method and the approach area (region approach).

Research result

Table 1 Normal Time and Standard Time

NO	Proses	ws	wn	wb
1	Planner <i>Back post</i>	2.2	2.31	2.54
2	Pengolesan kilsta	3.52	3.69	4.06
3	Press <i>Back post</i> Block	3.18	3.34	3.67
4	Cat Frame Support	0.53	0.54	0.6
5	Proses Pertama Arimizo 1	22.45	22.9	25.19
6	Proses Pertama Arimizo 2	20.53	21.76	23.94
7	Moulder	2.71	2.77	3.04
8	Proses Kedua Arimizo 1	14.1	14.38	15.82
9	Proses Kedua Arimizo 2	18.18	19.27	21.19
10	Planner Barbelt	4.65	4.88	5.37
11	Cukur dan Coak <i>Back post</i>	21.14	22.19	24.41
12	Proses Pasang Middle Beam	9.39	9.86	10.84
13	Proses pengecatan bagian dalam <i>back post</i>	4.05	4.33	4.77
14	Proses Crown	9.59	10.26	11.29
15	Proses Bokaki	9.11	9.75	10.73
16	Proses Press dan Buka Press	20.78	21.4	23.54
total		166.1	173.63	191



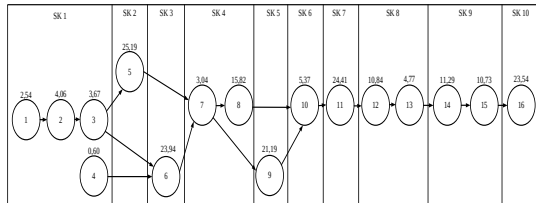
Picture 1 Precedence Diagram Initial Condition

Initial conditions

At the initial conditions are 16 work stations and a cycle time of 25.23 minutes. From the calculations have been done the results obtained, namely the efficiency of the work station 1 by 10%, which means at Station 1 only using 10% (2.54 minutes) of the total available time (25.23 minutes) for one-time production process and so Similarly to the next station. At the work station 2 by 16%, work station 3 by 15%, work station 4 at 2%, the work station 5 by 100%, work station 6 by 95%, work station 7 by 12%, work station 8 by 63%, work station 9 by 84%, work stations 10 to 21%, work station 11 amounted to 97%, work station 12 by 43%, work station 13 by 19%, work station 14 by 45%, work station 15 by 43%, and 16 work stations by 93%. Total idle time of 211.97 minutes meaning of the entire work station, there are still idle time of 211.97 minutes or 3.53 hours occurs because division of labor is still uneven. The efficiency of production lines by 47%, which means the level of efficiency -

average of the overall work station that is only 47%. Balance delay by 53%, which means the entire work station are idle 53% of the total time available. Smoothness index of 63.58, which means the waiting time rate relative who happens to all stations at 63.58 while balancing to achieve a perfect (perfect balanceing) level relative waiting time is 0.

Region Approach Method



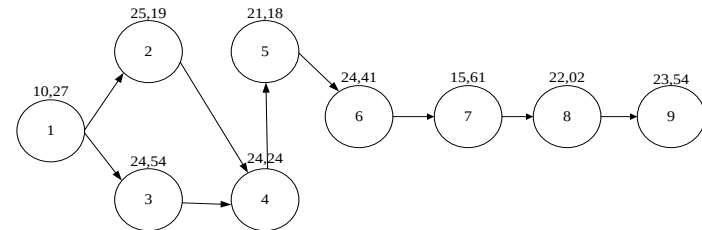
Picture 2 Precedence Diagram Region Approach

With this method the work stations will be combined in accordance with the respective regions - each with terms not exceeding cycle time and cycle time that is used together with the initial condition that is 25.23 minutes. From the result of the merger the number of work stations obtained work station is 10 stations. With details of the merger are the work station 1 consists of SK 1,2, 3, and 4, at the work station 2 consists of SK 5. At work stations 3 consisting of SK 6, at the work station 4 consists of SK 7 and 8, at station working 5 consists of SK 9, at the work station 6 consists of SK 9, at the work station 7 consists of SK 11 at the work station 8 consists of SK 12 and 13 at the work station 9 consists of SK 14 and 15 at the work station 10 consists of SK 16.

The result of the calculation of the efficiency of each station is a work station 1 by 43%, which means at the work station 1 using 43% (10.87 minutes) of the total available time (25.23 minutes) for one-time production process and so is the next station , work station 2 at 100%, work stations 3, 95%, work station 4 by 75%, work station 5 by 84%, work station 6 by 21%, work station 7 at 97%, work station 8 by 62%, the station 9 employment by 87%, 10 work stations by 93%. Total idle time amounted to 60.86 meaning of the whole work stations there are still idle time of 60.86 minutes, or 1.02 hours occurs because the division of labor is still uneven. Line efficiency by 76%, which means the level of efficiency - average of the overall work stations there by 76%. Balance delay by 24%, which means the entire work station there are 24% idle time of the total time available. Smoothness index of 27.52, which means the waiting time rate relative who happens to all

stations at 27.52 while balancing to achieve a perfect (perfect balancing) the relative level of the waiting time is 0.

Ranked Position Weight Method



Picture 3 Precedence Diagram Ranked Position Weight

With this method the work stations will be combined in accordance with the weight of each position - each work station provided this does not exceed the time cycle time and cycle time that is used together with the initial condition that is 25.23 minutes. From the results obtained merging work station work station number is 9 station. With details of the merger are the work station 1 consists of SK 1,2, and 3, at the work station 2 consists of SK 5. At work stations 3 consisting of SK 4 and 6, at the work station 4 consists of SK 7 and 9, at station 5 work consists of SK 8 and 10 at the work station 6 consists of SK 11 at the work station 7 consists of SK 12 and, at the work station 8 consists of SK 14 and 15 at the work station 9 consists of SK 16.

The result of the calculation of the efficiency of each station is a work station 1 by 41%, which means at the work station 1 using 41% (10.27 minutes) of the total available time (25.23 minutes) for one-time production process and so is the next station , work station 2 at 100%, work station 3 at 97%, work station 4 is 96%, work station 5 by 84%, work station 6 by 97%, work station 7 by 62%, work station 8 by 87%, and work station 9 by 93%. Total idle time amounted to 35.67 meaning of the whole work stations there are still idle time of 35.67 minutes, or 0.6 hours occurred because the division of labor is still uneven. Line efficiency by 84%, which means the level of efficiency - average of the overall work stations there by 84%. Balance delay by 16%, which means the entire work station, there are 16% idle time of the total time available. Smoothness index of 18.57, which means the waiting time rate relative who happens to all stations at 18.57 while balancing to achieve a perfect (perfect balanceing) level relative waiting time is 0.

Conclusion

From the research that has been done it can be concluded as follows:

1. By performing balancing of sound board glue production line then found the number of work stations on the initial conditions as many as 16 stations. After the line balancing, it is known that the number of work stations minimum of 8 stations. By using the method of region approach balancing the number of work stations to 10 stations and the balancing weight using the ranked position into a number of work stations 9 stations. Both methods can be seen that the method of weight is more optimal position ranked as the number of work stations closer to the minimal number of stations.
2. From the calculation of initial conditions, the calculation region approach, and ranked position calculation weight, the percentage of line efficiencies gained by 47%, 76% and 84%. So it can be seen that by using the method of region approach line efficiency increased by 29%. While the method of weight ranked position line efficiency increased by 37%.
3. With line balancing has been done can reduce the idle time and the reduced amount of idle time is as follows:
 - a. Total decrease in idle time by region approach, which amounted to 151.11 minutes of the initial conditions.
 - b. Total decrease in idle time with the ranked position weight of 176.30 minutes of the initial conditions.

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