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Analysis of productivity improvement using line balancing method (study case assembling line in PT XYZ)

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Abstract.To produce optimal production, it is necessary to adjust the placement of labor quantity, work line arrangement, facility layout and machine position, but to get accurate results as the initial calculation before production, it is necessary to schedule the right target with correct calculation , so there is no mistake in production, based on the results of previous research, the cause of cessation of production due to no production support materials, traffic jam between work stations, delay of order, and delay of delivery of goods. One of the factors that is quite influential in productivity is the production line and how many work stations. The efficiency of the production line between several related work stations is very influential in supporting the continuity of the company's production. This paper aims to analyze the cause of the delay in Line assembling so that the flow of raw materials and intermediate goods between work stations is better by using line balancing method. Delay, shortage of workers and the effectiveness of materials can be overcome. Based on the problems found in the assembling development section, it is known that there is congestion in the production process can be seen in station F because the cycle time is 6 minutes so the station G must wait for 4 minutes after the work. After the improvement cycle time reduced to 1554 seconds from the previous 1580 seconds, efficiency from 93.38% to 98.87%, with the method of line balancing obtained increased productivity and production efficiency.

1. Introduction

Currently Indonesia is a developing country in all respects, especially in the shoe industry. Competition of companies in improving product quality is a natural thing in the industry. Companies are required to improve the quality and quantity of products to gain maximum profit in maintaining the company's continuity. Companies that are not able to increase productivity will suffer losses and may be bankrupt, Productivity is the ratio between the output of goods and services divided by inputs of resources, such as labor and capital (Heizer & Render., 2006).

The productivity of a company is closely related to its employees either using machines or humans. PT XYZ uses a combination of humans and machines in the production process. To produce optimal production, arrangements are needed on the placement of labor quantities, work line arrangements, facility and facility layouts and machinery, and many things that support the productivity of the

production process. The production process can be defined as an activity involving human labor, materials and equipment to produce useful products (Zulian Yamit., 2003).
However, to obtain an accurate production result as an initial calculation before production, it is necessary to schedule the right target with correct calculation, so that there is no mistake in production, cessation of production due to unavailability of production support raw materials, traffic jam between work stations, and late delivery of goods.
The method used in the previous research is to simulate improvements with the displacement of existing jobs in the production area gradually (Ristumadin, 2015), robotic Algorithm approach (Gregory Levitin et al., 2006).
One of the factors that is quite influential in productivity is the production line and how many work stations. The efficiency of the production line between several related work stations is very influential in supporting the continuity of the company's production.
Objectives and efforts made from this research is to increase productivity and reduce the waiting time so that the percentage of efficiency becomes better in each lininya, the flow of raw materials and intermediate goods between work stations the better. And the delay (delay time), the shortage of the number of workers and the effectiveness of materials can be overcome. Below is a cycle time table in the assembling development section.

Table 1. Cycle time asembling development

Work station	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Time	1,5	1.8	1,9	1,8	2	6	2	2	2	2	2,1	2,2	1,9	2

Based on the problems found in the assembling development section, it is known that there is congestion in the production process can happen in station F because the cycle time is 6 minutes so the station G must wait for 4 minutes after the work is finished. In addition, there is also congestion between work stations, so the production is often late, exceeding the time limit should be, which resulted in delayed delivery of production goods. Due to inhibited production, the resulting product is not in accordance with the time of production that has been set, it causes the effectiveness of performance is disrupted so that the non-fulfillment of production targets and will hamper the continuity of production processes in the long term will reduce corporate profits.

2. Theory fundamental

2.1 Definition of factory facility layout

According to Wignjosoebroto (2000) quoted from AchmadRidwan (2010), that the layout of the factory can be defined as the procedure of arranging plant facilities to support the smoothness of the production process. Setting the layout of the facility is a problem that operational managers often encounter in large industrial firms as well as for smaller scopes. ZulianYamit (2003: 130) states that the arrangement of plant facility layout is a plan of arrangement of all production facilities in order to facilitate the efficient and effective production process.
According to ZulianYamit (2003), the main objective to be achieved in plant facility layout planning is to minimize costs or improve efficiency in the regulation of all production facilities and work areas.

2.2 Basic principles of plant facility layout

In the preparation of a good plant facility layout, it is important to note several important things. According to Heizer and Render (2006: 450) that: In all cases, layout design should consider how to achieve utilization of space, equipment, and people higher, the flow of information movement, goods,

or people better, better employee morale, as well as safer working conditions, interactions with better customers, flexibility (regardless of the current layout condition, the layout will need to be changed.
The general procedures undertaken as the steps of the plant layout process planning process are as follows:

1. Analysis of product and production process required
2. Determination of the number of machines and the area required
3. Determination of the desired type of layout
4. Determination of work flow and materials
5. Determination of area for department
6. Plan in detail the selected layout

2.3 Line balance

Line balancing is the process of grouping work tasks in a production line into several work stations by observing the balance of time and load between each work station in order to create a smooth and smooth production process. Buffa and Sarin (1999: 241) in the book Modern Operations and Production Management mentions:
In the decision to design the line layout, the main problem is sifting through the work to produce a smooth flow. The process of sorting (subdivision) is called line balancing (line balancing).
In addition, Heizer and Render (2006: 472) mentions a balanced assembly line has the advantage of high employee utilization and high facilities and equal workload among employees. Some contracts from trade unions require that the workload be equal or almost equal among the same workers. The most commonly used term for describing this process is the assembly-line balancing. This continuous production layout is a type of layout based on the determination of work stations. The work station is a combination of machines, tools, and people.

3. Methodology

Types and sources of data used in this study, the authors use two types of data as research materials are:
1. Primary data
Is the data obtained directly from the object of research either through direct observation, interviews, or other methods. Primary data is a description of line production lines, production methods, production processes, and others.
2. Secondary data
Sourced from the data and records owned by the company research location. These secondary data can be production data per year or per day, map of plant layout location, production report, and others.
To get the data needed in this research, the data collecting conducted among others:

1. Field research
2. Direct observation of objects
3. Study documentation

The method of analysis in this research will be done that is, to analyze the layout and production system owned by the company, which is fundamental analysis to company condition. After that, the researcher will do the line balancing plan on the layout and assembling production workshop development system, then do the assessment of the application of the concept of line balancing. The analysis of Company's Production System is:
1. Number of production inputs and outputs
2. The amount of time required
3. Planning line balancing on production system
The results of the efficiency equation will show whether the efficiency by using the theoretical minimum number of new work stations has greater efficiency than the number of previous workstations. If efficiency decreases, then we can assume that the number of workstation

combinations that have been compiled beforehand is an optimal workstation grouping for the current condition

4. Result & discussion

4.1 Flow process development

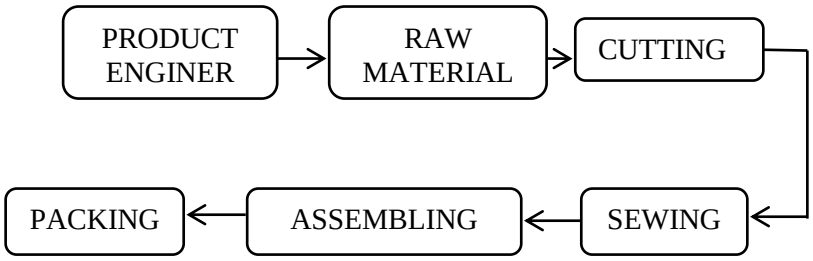

Figure 1. Flow process assembling development

Flow process Figure 1 above provides an overview of the process flow that occurs in the development process where in the shoe making will start from the product enginer in handling the product specifications will be in production, then enter the raw material area, cutting material, sewing, assembling and last packing.

4.2 Assembling development process

Section assembling is one of the parts in the development department, the assembling process itself consists of several processes including the following:

1. Checking is the checking process after the previous process (sewing) and ensure according to the specification that has been determined by NIKE.
2. Gathering tape is the process of tailoring the upper front (the top of the shoe before combined with outsole) shoes.
3. Bpm (Back pad molding) is the process of forming a counter (a material made of curved plastic contained in the back of the upper shoe).
4. Stroble is the process of merging upper with texon.
5. Sliplasting is the process of entering the last (component shaped like a replica of a human foot) into the upper.
6. Heel lasting is the process of leveling the heel (lower back bottom)
7. Gauge marking on the upper line for sticking outsole.
8. Grinding is the process gurinda on the part to be in the glue.
9. Primering is the process of giving fluids to the components before the glue.
10. Cementing is the process of gluing on the parts that have been determined (upper & outsole)
11. Attaching is the attachment between upper & outsole.
12. Automatic press is the process of penceprsan so that glue more glue.
13. Open last / de lasting is the final release process of finished shoes.
14. Put insole is insole mounting.
15. Press insole is a process of pressing insole so that glue is more glue.
16. Finishing (lacing, cleaning, packing) is the final process of the assembling process.

4.3. Condition before using line balancing method in assembling process

Productive working time at PT.XYZ is 8 hours (480 minutes) per day and in assembling one sift in a day, preparation time is 10 minutes, so the effective time is (480 - 10 = 470 minutes) or 7.83 hours, production rate of 300 pcs per day with 18 workers. Then the cycle time can be calculated:

Available production times per day = 470 minutes x 60 seconds = 28200 seconds. Daily production level of assembling section = 18 persons x 17 pcs = 306 pcs.

$$Cycle\ time\ = \frac{28200\ seconds}{300\ pcs} = 94 second. \quad (1)$$

From the above calculation obtained cycle time of 94 seconds will produce 300 pcs of shoes per day with 18 work stations.

Table 2. Cycle time assembling process before improvement

NO	Process name	Operator	Cycle time
1	Checking	Sri R	90
2	Gathering tape	Ramdan	60
3	Stroble	Seno A	82
4	Slip last	Asnawi	98
5	Heel last	Rendi WK	83
6	Gauge marking	Awaludin	300
7	Grinding	Edi S	99
8	Primering	Suamah	90
9	Cementing 1	Intan S	96
10	Cementing 2	Yoyom	95
11	Attaching	Husnul	96
12	Automatic press	Racmat p	90
13	Open last	Sigit S	94
14	Put insole	Mashuri	31
15	Press insole	Heri S	21
16	Lacing	Ruliyana	45
17	Cleaning	Iismawati	60
18	Packing	Suharsih	50
Total cycle time			1580

The above table describes the sequence of processes that occur in the assembling process from station 1 to station 18 based on cycle time and the operator performing the process activity, the total cycle time before the repair is 1580 seconds. So, efficiency = 93.38 %, idle time = 6.62 %, Man hour / unit = 0.468

In the above calculation shows that the efficiency in the assembling section is less effective and too long to wait with idle time 6.62% and man power is too much and not effective so that waste occurs. Here is the lay out line assembling plan using 18 man power man before using Line balancing method Figure 4

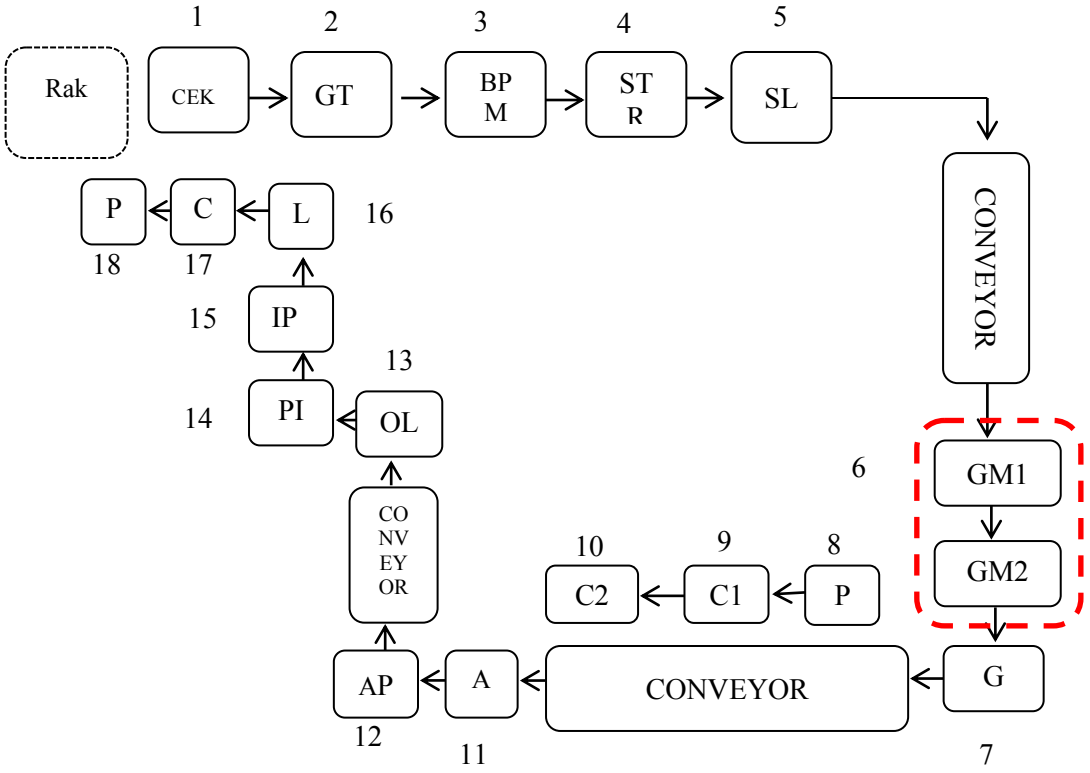

Figure 2 Layout Before Improvement

Explanation of figure 2 is assembling process before the repair where position of GM1 and GM2 parallel with 1 operator, so that happened accumulation in GM1 and GM2 area.

4.4. Application of line balancing method in assembling process in development section

- Total cycle time sectionassembling = 1580 second
- Number of work stations assigned = 17 station
- Tack time set = 94 second
- Efficiency = 98.87%
- Idle time =1.13%
- Man hour / unit = 0.442

So the minimum station number is 17 work stations is 17.

Table 3. Cycle time process assembling after improvement

NO	Process name	Operator	Cycle time
1	Cheking	Sri repiyanti	90
2	Gathering tape	Ramdan	60
3	Stroble	Ahmatseno	82

Table 3. Cycle time process assembling after improvement

NO	Process name	Operator	Cycle time
4	Slip last	Asnawi	98
5	Heel last	Rendi WK	83
6	Gauge marking 1	Awal P	150
7	Gauge marking 2	Heri S	150
8	Grinding	Edysuanda	99
9	Primering	Suamah	90
10	Cementing 1	Intan SU	96
11	Cementing 2	Yoyom	95
12	Attaching	Husnul	96
13	Automatic press	Rachmat P	90
14	Open last	Sigit S	120
15	Lacing	Ruliyana	45
16	Cleaning	Iismawati	60
17	Packing	Suharsih	50
TOTAL CYCLE TIME			1554

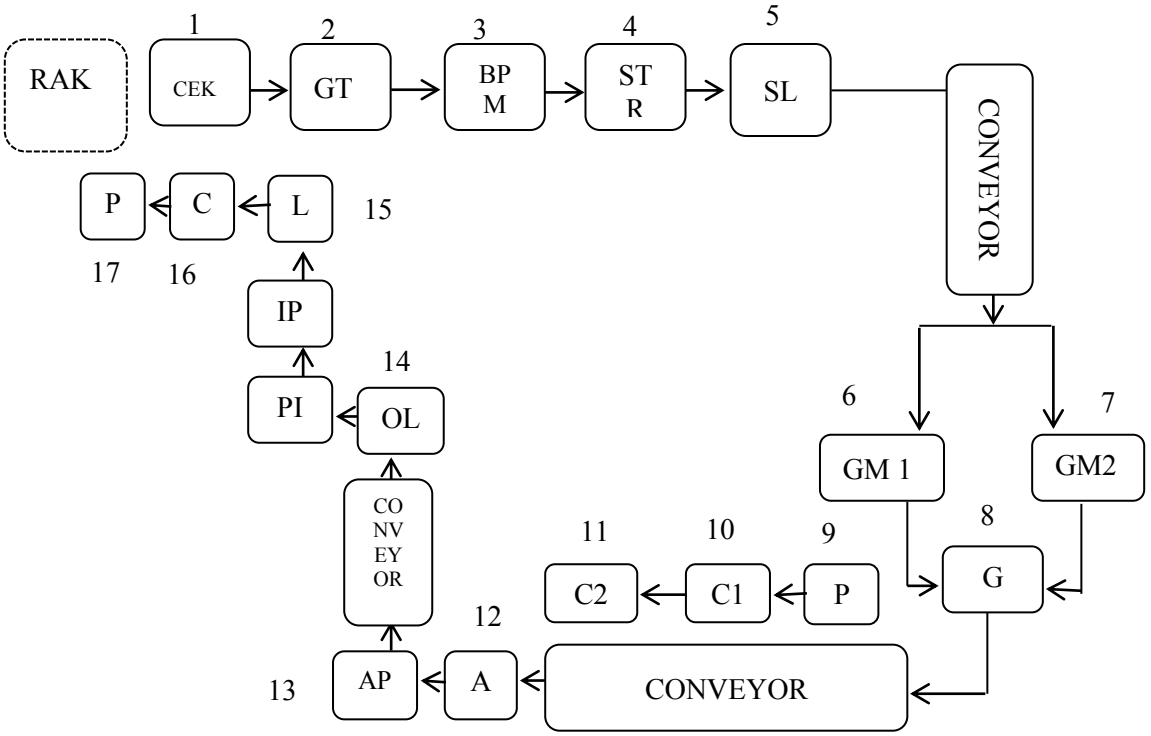

Figure 3. Layout after improvement

5. Conclusion

Before using line balancing method in unbalanced assembling production process and causing low line efficiency and high idle time with total line efficiency 93.38% and idle time 6.62%, and man hour / unit 0.468, then after applying line method balancing there is a total efficiency of 98.87% and idle time 1.13% and man hour / unit to 0.442. With a productive time of 28200 seconds / day, producing 300 pcs / day of shoe with 18 man power operational, with a cycle time of 94 seconds and total cycle time of 1580 seconds, resulting in uneven production output with the number of man power. So after using the method of balancing and recalculating the cycle time in every work station, calculating the capability of each man power, combining the work of each man power and changing the layout of the machine equipment placed closely together, then in assembling production with target 300 pcs / day enough with 17 man power.

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