

Layout Efficiency Analysis of Production Facilities at Suyadi Tofu Factory Jember

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Abstract:

Background: Free trade and investment in each country has exceeded the limit so that companies are required to be able to face intense business competition both at home and abroad. The most feasible way for the company to take is by structuring production facilities. This research was conducted at the Suyadi Jember Tofu Factory which is engaged in the home industry with the resulting product, namely tofu. The factory is located in Karanganyar Village, Ambulu District, Jember Regency. This factory strives to improve the quality of production for the sake of customer satisfaction. Good quality can be obtained from raw materials and production processes, namely by structuring the facilities used, so that production can run efficiently.

Materials and Methods: The research method used in this research is Line Balancing by balancing the assignment of task elements from an assembly line to a work station to minimize the number of work stations and minimize total idle time at all stations for a certain output level.

Results: The results of this study indicate that the type of layout used at the Suyadi Tofu Factory is product layout because the production process is sequential and the placement of machines or production facilities is arranged according to the sequence of the production process from raw materials to final products. By using the line balancing method, an adequate capacity of 8,57 and a cycle time of 32,14 minutes. The number of work stations that must be made on the production line is 3 work stations. This calculation is in accordance with the current number of work stations. Idle time at the Suyadi Tofu Factory is -8,58 which indicates the maximum time for workers at the work station. Meanwhile, the balancing delay at the Suyadi Tofu Factory was 8,89%

Conclusion: By using the line balancing method, the efficiency level of the tofu production process at the Suyadi Tofu Factory is fairly high, namely 91,10%.

Key Word: Tofu Factory; Layout Efficiency Analysis; Production Facilities; Line Balancing Method; Cycle Time; Idle Time; Balancing Delay.

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I. Introduction

Currently companies are required to be able to face competition from both local companies and foreign companies. This is because free trade and investment in each country are unlimited. The competition that is happening is getting tougher and cannot be avoided, so that entrepreneurs inevitably have to deal with business actors engaged in the same industry both domestically and abroad.

In addition, the manufacturing industry is always in tough competition. To deal with this condition, where product variety is high, product life cycle is short, demand is always changing, and there are demands in terms of timely completion, the company needs a strategy to improve efficiency in using facilities. A manufacturing system must be able to produce products at low cost and high quality, and can be completed on time. A system must also be able to adapt to the changes that occur, both in process design and product demand. One of the most possible ways that companies can take is to increase efficiency in all factors. One of these factors is planning the arrangement of existing production facilities in the company.

Layout or often referred to as the arrangement of the layout of production facilities within a company really needs to be planned and arranged properly and in accordance with the implementation of existing production within the factory. Selection of the type of layout used by a company depends on the type of operation of a company's production process. This is intended to optimize the management of production factors, and also to achieve a smooth flow of production within the company in order to support production efficiency carried out by the company in question.

The problem that is often encountered in layout planning is the problem of balancing the flow of the production process. If this balance is not maintained, it will result in the accumulation of goods in process in a particular section. This will result in high costs of storing goods in process. Conversely, if there is output from a part that is smaller than the capacity to receive it. Then there will be capacity from an idle part. So that it results in idle working time which can also result in unemployment of the existing workforce.

Suyadi Tofu Factory is a factory engaged in the home industry with the product it produces is tofu. This factory is trying to improve the quality of production for the sake of consumer satisfaction. Good quality can be obtained from raw materials and production processes, namely by arranging the facilities used, so that production can run efficiently.

As with other factories in general, this factory is also not free from pressure and intense competition. To survive, the Suyadi Tofu Factory must make improvements in its internal environment, one of the efforts being made is to review the arrangement of production facilities. This is intended to determine how much the level of efficiency of the layout of production facilities at the factory.

II. Material And Methods

Research Design

This research uses descriptive quantitative research, where this study analyzes the level of efficiency of production facilities at the Suyadi Jember Factory using the Line Balancing Method. This research was conducted in several stages consisting of problem identification, data collection, data processing and analysis, and improvement design.

Research Object

This research was conducted at the Suyadi Tofu Factory located in Karanganyar Village, Ambulu District, Jember Regency, East Java Province. This factory was founded in 2004.

Data Source

This study used data obtained directly from observations and data collection using the interview method which was carried out by holding question and answer verbally to related parties and observations were made by collecting data and direct observation and observation of the object of research.

Data Analysis Method

To solve the first problem, which type of production facility system layout is used in the production process at the Suyadi Tofu Factory in Jember, the authors made direct observations in the production section and collected data from the company. The data obtained will be adjusted to the characteristics of each type of layout to then determine the type of layout applied by the Suyadi Tofu Factory in Jember.

To solve the second problem, namely how much efficiency is the layout of the production facilities at the Suyadi Tofu Factory in Jember after an analysis is carried out by applying the Line Balancing method. Determination of line balance can be done in the following way:

1) Determine the cycle time

Cycle time can be interpreted as the longest time of a task or job to complete one unit of product

2) Determine the minimum number of duty cycles

Allocation of work elements to work stations using the following rules:

a) Allocate the first time the work element that has the largest number compared to the next / other elements.

b) Allocate the first element of work that has the longest processing time.

3) Calculating the level of efficiency by determining the Level of Delay (Balancing Delay)

Delay is used as a measure of the allocation of work element assignments to work stations, which is an indicator of efficiency. This will show the amount of idle time caused by imperfect assignment of the work elements between existing work stations.

III. Result

Arranging the sequence of work elements with the completion time of each work carried out in the production process of the Suyadi Tofu Factory by using the symbols of each job to compile a network. The order can be seen in the following table:

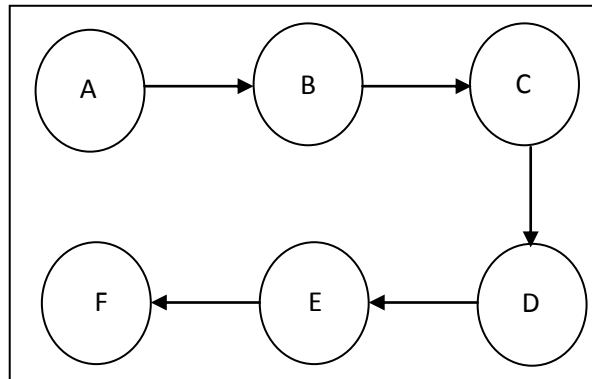
Table 1: Work Inventory and Time for Completion of The Production Process at The Suyadi Tofu Factory in 2022

Job	Symbol	Preceding Job	Time (minutes)
Immersion	A	-	(150)
Milling	B	A	8
Boiling	C	B	30
Filtering	D	C	28
Pressing	E	D	23

Printing	F	E	16
Total Working Time			105

Source: Suyadi Tofu Factory Data, 2022

The network in this study describes the work order of the Tofu Factory from processing raw materials to getting output in the form of tofu products.



Picture 1. Suyadi Tofu Factory Network in 2022

Before determining the permitted cycle time, an adequate production capacity must first be determined, namely by:

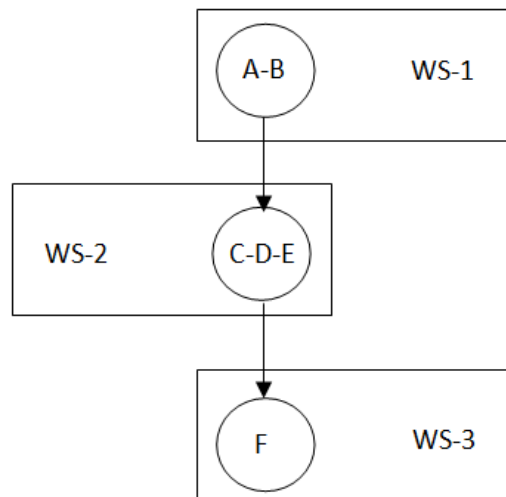
$$\begin{aligned}
 Q &= \frac{\text{Available Time per Day}}{\text{Cycle Time Required per Day}} \\
 &= \frac{15 \times 60 \text{ minutes}}{105 \text{ minutes}} \\
 &= \frac{900 \text{ minutes}}{105 \text{ minutes}} \\
 &= 8,57 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 \text{Cycle Time} &= \frac{\text{Working Time per Day}}{\text{Desired level of output per day}} \\
 &= \frac{15 \text{ hours} \times 60 \text{ minutes}}{28 \text{ x productions}} \\
 &= \frac{900}{28} \\
 &= 32,14 \text{ minutes}
 \end{aligned}$$

Calculation of the minimum number of work stations is done to find out how many work stations must be made on the production line. Calculation of minimum work stations is done by:

$$\begin{aligned}
 \text{Work station (N)} &= \frac{\text{Total Working Time}}{\text{Maximum Cycle Time}} \\
 &= \frac{105}{32,14} \\
 &= 3.26 \text{ (rounded up to 3 work stations)}
 \end{aligned}$$

The minimum work station diagram at the Suyadi Tofu Factory can be described as follows:



Picture 2. Work Station Diagrams of Tofu Suyadi Factory in 2022

The calculation of idle time at the Suyadi Tofu Factory is as follows:

$$\begin{aligned}
 \text{Idle time} &= (N \times Cy) - T \\
 &= (3 \times 32,14) - 105 \\
 &= 96,42 - 105 \\
 &= -8,58
 \end{aligned}$$

$$\begin{aligned}
 \text{Balancing delay} &= \frac{\text{Idle Time}}{\text{Total Working Time}} \times 100\% \\
 &= \frac{\text{Idle Time}}{Cy \times N} \times 100\% \\
 &= \frac{8,58}{32,14 \times 3} \times 100\% \\
 &= \frac{8,58}{96,42} \times 100\% \\
 &= 8,89\%
 \end{aligned}$$

Balancing delay at the Suyadi Tofu Factory was 8.89%. Furthermore, it can be measured the level of efficiency. The efficiency level is obtained from the calculation of 100% minus the percentage of balancing delay (Bd). For more details can be seen in the following calculations:

$$\begin{aligned}
 \text{Efficiency level} &= 100\% - Bd \\
 &= 100 - 8,89\% \\
 &= 91,10\%
 \end{aligned}$$

Table 2. Results of Measurement of Distance and Load of Tofu Production Facilities at Suyadi Tofu Factory in 2022

Number	From	To	Distance (meter)	Load (kg)
1.	Warehouse of Raw Materials	Soaking	4,2	61,6
2.	Soaking	Milling	6,6	8,8
3.	Milling	Boiling	6	23,8
4.	Boiling	Filtering	4,5	20,1
5.	Filtering	Pressing	4,3	16,3
6.	Pressing	Printing	4	15,6

7.	Printing	Warehouse	8	15,8
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Source: Suyadi Tofu Factory Data, 2022

Table 3. Results of Measurement of Distance and Load of The Proposed Tofu Production Facility at The Suyadi Tofu Factory in 2022

Number	From	To	Distance (meter)	Load (kg)
1.	Warehouse of Raw Materials	Soaking	1,2	61,6
2.	Soaking	Milling	6,6	8,8
3.	Milling	Boiling	1,5	23,8
4.	Boiling	Filtering	4,5	20,1
5.	Filtering	Pressing	4,3	16,3
6.	Pressing	Printing	4	15,6
7.	Printing	Warehouse	2	15,8

Source: Suyadi Tofu Factory Data, 2002

Table 4. Comparison of Initial Layout Efficiency and Layout of Proposed Productin Facilities at The Suyadi Tofu Factory in 2022

From-to	Distance (meter)		Burden (kg)		Efficiency	
	Before	After	Before	After	Before	After
A-B	4,2	1,2	61,6	61,6	258,72	73,92
B-C	6,6	6,6	8,8	8,8	58,08	58,08
D-E	6	1,5	23,8	23,8	142,8	35,7
E-F	4,5	4,5	20,1	20,1	90,45	90,45
F-G	4,3	4,3	16,3	16,3	70,09	70,09
G-H	4	4	15,6	15,6	62,4	62,4
H-I	8	2	15,8	15,8	126,4	31,6
Efficiency					808,94	422,24

Source: Measurement Results (Reprocessed), 2022

As for knowing the percentage increase in the proposed efficiency level from the initial layout which can be seen as follows:

$$\begin{aligned}
 \text{Increased Efficiency Level} &= \frac{\text{Proposal Efficiency}}{\text{Initial Efficiency}} \times 100\% \\
 &= \frac{808,94}{422,24} \times 100\% \\
 &= 52,19\%
 \end{aligned}$$

IV. Discussion

In this study, the data obtained is data from the results of interviews with informants who are owners and also employees at the Suyadi Tofu Factory in Jember. As well as observations of the factory. The data collected is in the form of factory area, initial factory layout, map of the operating process, production machines used, work inventory and work time for the completion of the production process, job scheduling and work time for the completion of the production process, network drawings, and production capacity.

The Suyadi Tofu Factory has an area of approximately 220 m² consisting of a raw material warehouse, fuel warehouse, production room, finished goods warehouse and offices. The machines used in the production

process are grinding machines, boiling furnaces, filters, presses, and printers with one unit each.

The steps in the production process that raw materials go through to become finished products are by carrying out operational activities, namely soaking for 150 minutes, milling for 8 minutes, boiling for 30 minutes, filtering for 28 minutes, pressing for 23 minutes, and printing for 16 minutes to produce 105 (excluding soaking activities) minutes in one production process. In analysis activities, the immersion process is not counted into the calculation of operational activities in one production process.

Suyadi Tofu Factory divides work into 2 shifts, namely the morning shift and the afternoon shift. The morning shift starts from 06.00 - 15.00 while the afternoon shift starts at 15.00 - 21.00. So the total working hours is 15 hours. The operation process is carried out 28 times and 7 sessions a day, producing 400 tofu in each process. The capacity of soybeans processed in one process weighs 2,2 kg with one grinding and boiling session for four production processes, namely 8,8 kg. So that the total capacity of soybeans produced per day is 61,6 kg and produces 11.200 tofu.

Then the collected data is processed using the Line Balancing method with the following steps:

1. Determine Cycle Time (Work Cycle)

Cycle Time (Work Cycle) obtained is equal to 32,14 minutes. This value is obtained from the result of working time per day divided by the desired level of output per day.

2. Calculating Minimum Workstations

The minimum total work stations are obtained by dividing the total work time by the maximum work time cycle. In this study, the results obtained were 3,26 (rounded up to 3) work stations.

3. Determine Idle Time

The total value of idle time at the Suyadi Tofu Factory is -8,58 (negative 8,58), which means that the work station is quite good because the overall value does not get a positive value indicating the idle time of workers. This result is obtained from the number of work stations multiplied by the cycle time then reduced by the total processing time.

4. Determine Balancing Delay (Level of Delay)

Balancing Delay is obtained from idle time divided by the total working time multiplied by 100%. The results obtained were 8,89%.

5. Determining the Level of Efficiency

The efficiency level is obtained by calculating 100% minus the percentage of balancing delay. The results obtained were 91.10%, which means the level of efficiency in this factory is high.

To achieve the perfect level of efficiency, a proposed layout for the Suyadi Tofu Factory is required. The final layout is made based on the proposed layout that has the shortest distance and load between stations.

The calculation results above show that if the new design layout is applied, it will increase the efficiency of the production facility layout by 52,19% from the initial layout. This result is obtained from the initial efficiency divided by the proposed efficiency then multiplied by 100%.

V. Conclusion

Based on the results of research conducted at the Suyadi Tofu Factory in Jember, the researchers can draw the following conclusions:

a. The type of layout used at the Suyadi Tofu Factory is product layout because the production process is sequential and the placement of production machines or facilities is arranged according to the sequence of the production process from raw materials to final products. Laying out these production facilities can streamline the time in the production process so that there is no wastage of time in preparing tofu production materials which can increase production. In addition, the advantage of this product layout is that it is easy to arrange production facilities located inside the tofu factory and the materials produced are quickly processed and the supervision aspect is relatively easy so that the product layout is the layout of choice to be applied to the Suyadi Tofu Factory.

b. The production process at the Suyadi Tofu Factory is divided into six stages, namely the soaking process, the grinding process, the boiling process, the filtering process, the pressing process, and the molding process. The Suyadi Tofu Factory divides work into 2 shifts, namely the morning shift and the afternoon shift. The morning shift starts from 06.00 - 15.00 while the afternoon shift starts at 15.00 - 21.00. So the total working hours is 15 hours. The Suyadi Tofu Factory operates 28 times and 7 sessions a day, producing 400 tofu in each process. The capacity of soybeans processed in one process weighs 2,2 kg with one grinding and boiling session for four production processes, namely 8,8 kg. So that the total capacity of soybeans produced per day is 61,6 kg and produces 11.200 tofu.

By using the line balancing method, the efficiency level of the tofu production process at the Suyadi Tofu Factory is relatively high, namely 91,10% with an adequate capacity of 8,57 kg and a cycle time of 32,14 minutes. The number of work stations that must be made on the production line is 3 work stations. This calculation is in accordance with the current number of work stations. Idle time at the Suyadi Tofu Factory is -

8,58 which indicates the maximum time for workers at the work station. Meanwhile, the balancing delay at the Suyadi Tofu Factory was 8,89%.

To achieve a high level of efficiency, a relayout is required by considering the distance between the facilities and the material transfer load as well as the location of the employees. Reducing the distance between one facility and another can be done by getting closer or assembling equipment that has a considerable distance and a relatively heavy load through a trial and error process. Judging from the efficiency level of the initial layout of the production facility at the Suyadi Tofu Factory, namely 808,94 material flow loads and the efficiency level of the new design layout at the Suyadi Tofu Factory production facility, namely 422,24 material flow loads. So that the value of the material flow load and the efficiency level of the proposed layout is lower with a difference of 386,7 material flow load from the initial layout. If the new design layout is implemented, it will increase the efficiency of the production facility layout by 52,19% from the initial layout.

Based on the research that has been done, the authors provide suggestions related to the calculation results that have been obtained. These suggestions include:

a. For the Suyadi Tofu Factory

In selecting the layout of the production placement facilities that were applied to the Suyadi Tofu Factory, it was efficient, but in the placement of production facilities, the layout that had been proposed by the researcher could be used to achieve a maximum level of efficiency.

b. Researchers For Next

If the next researcher is interested in conducting research with a different object and with the same method, so that he will further explore this research and be able to add or expand other indicators and dimensions listed in this study. Then it can be broader regarding policies that can support the good of the company in the future. So that it can improve existing research.

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