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Waste Reduction Analysis with Lean Manufacturing Approach

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Abstract

UPT Logam Yogyakarta is a manufacturing industry engaged in metal casting services. One of the products is the Panasonic Downlight NN511. The problem that occurs is that there is waste in the production process which results in losses because production results are not optimal. The production capacity of 1040 pcs per day cannot be achieved, and is only capable of producing 200-300 pcs. As a reference for calculations to determine the degree of accuracy, data adequacy and uniformity tests will be carried out, then calculating factor ratings and determining allowances for calculating normal time and standard time. After testing and adjusting the data with rating factors and allowances, it was found that there was a cycle time that was greater than the taktime. This explains that the metal UPT must reduce the cycle time at the finishing and packaging stations. One of the biggest wastes is waiting time in the production process. Improvements are made by improving the production process flow, balancing and arranging the layout using the Activity Relationship Chart. From these improvements, it is hoped that UPT Logam Yogyakarta, which produces the Panasonic Downlight NN511, can achieve a higher level of productivity.

Keywords : Normal Time, Standard Time, Cycle Time, Takt Time, Fishbone Diagram, Value Stream Mapping, Valsat, Line Balancing, Activity Relationships Chart, Diagram Corlap.

INTRODUCTION

UPT Logam Yogyakarta is located in East Kranon, Nitikan Umbulharjo, Yogyakarta. It is a technical service unit that was founded in 2009, and operates in the field of metal printing based on orders, one of its products is the Panasonic Downlight NN511. The problem faced by UPT Metals is waste that occurs in the production process which results in losses for the company. This waste causes suboptimal production results. The capacity of die casting machines with the ability to produce products every 45 seconds cannot be utilized optimally. As a result, the production capacity of 1040 pcs per day cannot be achieved, and is only able to produce 200-300 pcs.

RESEARCH METHOD

Lean Concept

Lean is a concept for making efficiency in everything involved in the production process. According to Gasperz in Lestari (2019), there are five basic principles in lean, including:

1. To identify the value of a product or service, namely superior quality, competitive price, and timely completion.
2. Identify value stream mapping.
3. Eliminate waste that does not add value
4. Organize materials, information and products so that they flow smoothly and efficiently
5. Look for various repair tools and techniques to achieve improvement

Value Stream Mapping (VSM)

According to Wommack et al (2003) Value Stream is a description of the specific actions required to produce a particular product, either goods, services, or a combination of both. Based on the principle of key management tasks, namely problem solving tasks that run from concept design to production rollout engineering, identifying the entire value stream in lean thinking is a step that is rarely undertaken by companies but can demonstrate significant youth.

Value Stream Analysis Tool

Value Stream Analysis Tool (VALSAT) is a method used in lean manufacturing to weigh waste, then from that weighting the most appropriate tool is selected according to the weighting that has been done. Selection using a matrix. There are seven tools in VALSAT, including PAM, SCRM, PVF, QFM, DAM, DPA, and PS.

Process Cycle Efficiency

PCE indicates the effectiveness of a process. Gaspersz (2011) in Yola et al (2017) A process can be said to be lean if the PCE value is > 30%.

$$Process\ Cycle\ Efficiency \frac{Value\ Added}{Total\ Lead\ Time}\ x\ 100\ \% \quad (1)$$

Takt Time

$$Takt\ Time = \frac{Net\ time\ available\ for\ production}{Customer's\ daily\ demand} \quad (2)$$

Takt time is used as a reference for how long the production time at a station is carried out or it can be said that the maximum time for a production station is to complete one product. The use of takt time is useful for knowing the actual conditions of the ongoing production process speed.

Fishbone Diagram

The function of the fishbone is basically to identify and regulate the possible causes of an effect then look for the root cause, then test the hypothesis whether the addition or subtraction can have the expected impact. (Heri Murnawan, 2014).

Line Balancing

According to Gasperz (2004) in Panudju, A. et al (2018), Trenggonowati (2019) line balancing is a tool used to balance the assignment of task elements from one assembly line to workstations to minimize total idle time at each station in a certain output level. In balancing these tasks, the time requirements per unit of product will be specified for each task and sequential relationships must be considered.

Activity Relationships Chart

According to Richard Muther in Safitri (2017), values that indicate the degree of relationship are recorded with the underlying reasons in the work map. These activities can be built with the following procedure; identify each facility that will be arranged in the layout, conduct interviews with employees, define relationship criteria and assign relationship values, analyze results with management.

Total Closeness Rating (TCR)

According to Setyawan et al (2017) the formation of ARC is the basis for calculating the TCR used for allocating facilities. TCR calculations are performed with detailed values for each degree of proximity. This calculation is done by converting each proximity to the following; A=5, E=4, I=3, O=2, U=1, and X=0.

Algoritma Computerized Relationship

According to Setiyawan et al (2017), the Computerized Relationships Algorithm (CORELAP) is used to select facilities that are placed first in the layout where the relationships between activities are considered in the calculations. How to design and allocate layouts as follows; select the department with the maximum total proximity value, select the next department that has a close relationship with the highest ranking department and place it next to the previous department, repeat this until all departments are mapped according to their TCR ranking.

Performance Rating

According to Niebel in Dyah et al (2012), adjustment factor is a technique to perform the equation of time observed by an operator who is completing his task by calculating the time required by a normal operator to complete his work. The value of the adjustment factor (p) has three limitations, namely: p > 1 if the gauge thinks the operator is working above normal (too fast), p < 1 if the gauge thinks the operator is working below normal (too slow), p = 1 if the gauge is sure that the operator is working well.

Allowance

Allowances are given as a form of leeway for operators to be able to carry out activities that cannot be avoided Slack is divided into three types based on its function, namely; allowance for personal needs, allowance to relieve fatigue (fatique), and allowance for unavoidable things.

Normal Time

$$Normal\ Time = Rating\ Factor\ x\ Siklus\ time \quad (3)$$

Standard Time

$$Standar\ Time = Normal\ Time\ x\ \frac{100\%}{100\% - \%Allowance} \quad (4)$$

Cycle Time

Cycle time according to Purnomo in Dyah et al (2012) is the time it takes to make one unit of product at the work station. The work cycle time for running the job elements in general.

RESULT AND DISCUSSION

Data Sufficiency Test

$$N' = \left[\frac{\frac{k}{s}\sqrt{N\sum X_t^2 - (\sum X_t)^2}}{\sum X_t}\right]^2 = \left[\frac{\frac{2}{0,1}\sqrt{10(2576)-(160)^2}}{160}\right]^2 N' = 2,5 \approx 3 \quad (5)$$

From these calculations, the amount of data that must be achieved to be considered sufficient is 3, while in the study 10 data were taken. So the data is considered sufficient

Performance Rating

The performance ranking is based on the Westing house system table using four assessment factors, namely skill, effort, condition, and consistency. Operators are assumed to work normally under normal conditions, and have the same skills so that the operator's performance rating is 1.

$$Performance\ Rating = 1 + (skill + effort + conditions + consistency) \quad (6)$$

Determination of Allowances

Table 1. Allowance factor ILO

Category	Variable	Activity						
		Casting	Trimming	QC 1	Polishing	Buffing	Finishing Packing	Inventory
Constant Allowance	Personal	5	5	5	5	5	5	5
	Basic Fatigue	4	4	4	4	4	4	4
Varialble Allowance	Standing	2	2	2	0	0	0	2
	Abnormal positioning	0	0	0	0	0	2	0
	Use Force	0	1	0	1	0	0	0
	Bad Light	0	0	0	0	0	0	0
	Atmosphere conditions	10	5	5	0	0	0	0
	Close attention	0	2	5	0	2	5	0
	Noise Level	0	0	0	2	0	0	0
	Mental Strain	1	1	4	1	1	4	0
	Monotony	0	4	4	1	1	0	0
	Tediousness	0	2	2	0	2	2	0
Total Allowance (%)		22	26	31	14	15	22	11

Normal Time and Standard Time

Table 2. Normal time and standard time

No	Process	Cycle time (sec)	Normal Time	Standard time
1	Casting	47 x 1	47	60,25
2	Trimming	11 x 1	11	14,86
3	QC 1	7 x 1	7	10,14
4	Polishing	97 x 1	97	112,79
5	Buffing	179 x 1	179	210,59

6	Finishing, Packaging	340 x 1	340	435,9
7	Inventory	5 x 1	5	5,62

Facility Layout

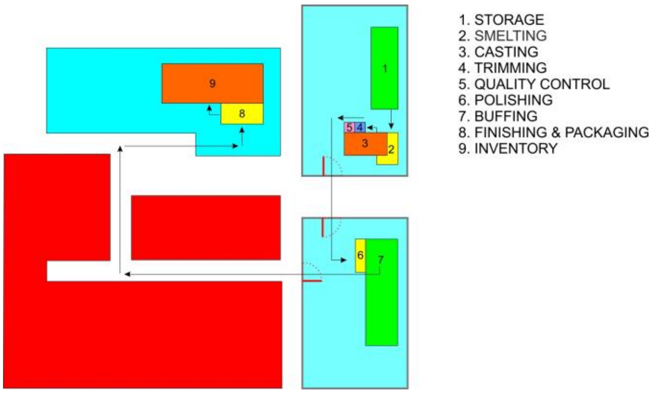

Figure 1. Metal UPT production layout

Figure 2. is the layout and production flow at UPT Logam. The production flow starts from taking aluminum material in storage, until the downlight is stored ininventory. The following is the travel time and distance traveled by downlights in the production process.

Table 3. Production distance and lead time

No.	Activities	Distance (m)
1	Aluminum ingot inventory comes from Supplier	334000
2	Transfer ingots from storage to furnace smelting	7
3	The casting results are transferred to trimming	1
4	Trimming results are transferred to QC I	1
5	Transfer to polishing process	13
6	Transfer from polishing process to process Buffing	1
7	Transfer from buffing to process Finishing	23
8	Transfer from packaging to inventory	2

Current State Value Mapping

Based on CVSM there is an imbalance between processes. The total cycle time is 18,602 seconds and the total lead time is 209,130 seconds, with the largest lead time in the process of transporting raw materials from the Supplier to the Metal UPT at 172,800 seconds. This activity does not provide added value, but causes long production times. From this data, Value Added Time is 18.597 seconds and Non Value Added time is 190.533 seconds.

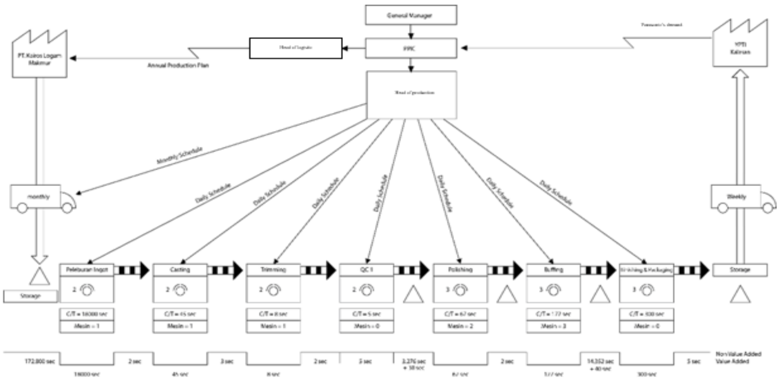

Figure 2. Current state value stream mapping

Waste Questionnaire

The questionnaire was conducted to obtain score data about the indications of waste.

Table 4. Waste questionnaire 1

No	Waste	K1		K2		K3	
		Rank	Nilai	Rank	Nilai	Rank	Nilai
1	Defect	1	7	1	7	1	7
2	Overproduction	7	1	4	4	7	1
3	Waiting	3	5	2	6	6	2
4	Transportation	6	2	7	1	2	6
5	Inventory	5	3	6	2	5	3
6	Motion	2	6	3	5	4	4
7	Extra Processing	4	4	5	3	3	5

Value Stream Analysis Tools

Table 5. Criteria assessment

No	Waste	K 1	K 2	K3	Score	%	Rank
1	Defect	7	7	7	21	25 %	1
2	Overproduction	1	4	1	6	7,1 %	7
3	Waiting	5	6	2	13	15,5 %	3
4	Transportation	2	1	6	9	10,7 %	5
5	Inventory	3	2	3	8	9,5 %	6
6	Motion	6	5	4	15	17,9 %	2
7	Overprocessing	4	3	5	12	14,3 %	4
Total					84	100%	

Based on the results of waste identification, the dominant types of waste are Defect (25%), Motion (17.9%), Waiting (15.5%), Overprocessing (14.3% %), Transportation (10.7% %), Inventory (9.5%), and Production Excess (7.1%). The scoring results from the identification of waste that occurs become the basic data for selecting tools that are relevant to VALSAT. From the calculation of the score then obtained the most dominant tool for Identifying the waste that occurs is Process Activity Mapping (34.1%).

Table 6. Valsat tool rating conversion

Waste/ Structure	Skor	PAM	SCRM	PVF	QFM	DAM	DPA	PS
Transportation	21	189	-	-	-	-	-	21
Waiting	6	54	54	6	-	18	18	-
Overproduction	13	1	26	-	13	26	26	-
Defect	9	9	-	-	81	-	-	-
Inventory	8	16	8	16	-	72	16	8
Motion	15	135	135	-	-	-	-	-
Overprocess	12	108	-	24	12	-	-	-
Total		558	248	162	166	145	283	75
%		34,1	15,1	9,9	10,1	8,9	17,3	4,6
Rank		1	3	5	4	6	2	7

Process Activity Mapping (PAM)

After grouping the Value Added and Non Value Added processes, a summary of PAM is obtained in table 7.

Table 7. Summary of PAM

Activity category	Time (sec)	Percent (%)
VA	18.597	8,9%
NVA	17.728	8,5%
NNVA	172.805	82,6%
Total	209.130	100%

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Activity	Result	Percent (%)
Operation	5	29,4 %
Transportation	7	41,2 %
Delay	2	11,8 %
Storage	1	5,9 %
Inventory	1	5,9 %
Operation+Inspection	1	5,9 %
Total	17	100%
Activity Type	Time (seconds)	Percentage (%)
Operation	18.297	8,7 %
Transportation	172.898	82,7 %
Delay	17.628	8,4 %
Storage	0	0 %
Inventory	5	0,002 %
Operasi+Inspeksi	300	0,1 %
Total	209.130	100 %

From table 7, it can be seen that the highest proportion of transport time is 172.898 seconds (82.7%), operational activities with a time of 18.297 seconds (8.7%), and delay with a time of 17.628 seconds (8.4%).

Process Cycle Efficiency (PCE)

Based on the previous data, the calculation of the PCE value is as follows;

$$Process\ cycle\ efficiency = \frac{18{,}597\ detik}{209{,}130\ detik}\ x\ 100\ \% = 8{,}89\ \% \quad (7)$$

Determination of Takt Time

The calculation of takt time in the manufacturing process of the Panasonic Downlight NN 511 is as follows: Customer request : 189 pcs/day, Available time : 780 minutes/day

$$Takt\ Time = \frac{780\ menit}{189\ pcs} = 4{,}127\frac{menit}{pcs} = 247{,}62\frac{detik}{pcs} \quad (8)$$

From calculations it is known that the maximum time for each work station is 247.62 seconds. Next, a comparison is made between takt time and cycle time. Based on the comparison in the table, it can be seen that at the finishing station there is a cycle time that is greater than the takt time, which means that the workload on the process exceeds the required capacity.

Table 8. Comparison of cycle time and takt time

No	Process	Cycle time (second)	Takt time (second)
1	Casting	60,25	247,62
2	Trimming	14,86	247,62
3	Quality Control 1	10,14	247,62
4	Polishing	55,81	247,62
5	Buffing	210,59	247,62
6	Finishing and Packaging	435,9	247,62
7	Inventory	5,62	247,62

Current Line Balancing

Furthermore, the path balancing is carried out to obtain the optimal level of path efficiency. To find out, the trajectory calculation is carried out before line balancing is carried out and after being used as a comparison.

$$Eficiency\ of\ work\ station = \frac{Wi}{Ws} \times 100\% \quad (9)$$

Table 9. Workstation efficiency

Work Station	Station time (Wi/sec)	The largest Workstation (Ws/sec)	Workstation Efficiency
Casting	60,25	435,9	13,8 %
Trimming	14,86	435,9	3,4 %

QC1	10,14	435,9	2,3 %
Polishing	112,79	435,9	25,87%
Buffing	210,59	435,9	48,31 %
Finishing	435,9	435,9	100 %
Inventory	5,62	435,9	1,6 %

$$Line\ Effieciency\ = \frac{\sum_{i=1}^{k} STi}{K \times CT} \times 100\% = \frac{850,15}{7 \times 435,9} \times 100\% = 27,85\% \quad (10)$$

$$\text{Idle Time} = n.Ws - \sum_{i=1}^{n} Wi$$

$$= 7 \times 435,9 - (60,25 + 14,86 + 10,14 + 210,59 + 112,79 + 435,9 + 5,62) = 2201,5 \quad (11)$$

$$Balance\ Delay\ = \frac{n.C - \sum ti}{n.ti} \times 100\% = \frac{7.(435,9) - 850,15}{7.(435,9)} \times 100\% = 72,14\% \quad (12)$$

$$Smoothing\ Index\ (SI) = \sqrt{\sum_{i=1}^{k} (ST\ max - STi)^2}$$

$$= \sqrt{(375,65)^2 + (421,04)^2 + (425,76)^2 + (323,11)^2 + (225,31)^2 + (430,28)^2} = 938,1 \quad (13)$$

The results of calculations using the above formula can be seen that each idle at each station is as follows;

Table 10. Idle at every station

Stasiun	CT	Idle
Casting	60,25	375,65
Trimming	14,86	421,04
Quality Control 1	10,14	425,76
Polishing	112,79	323,11
Buffing	210,59	225,31
Finishing dan Packaging	435,9	0
Inventory	5,62	430,28
Total	850,15	2.201,5

RECOMMENDATIONS

Fishbone Diagram

Determines the waiting time as a problem that must be solved, because this increase in waste will affect other high rank wastes. From the above analysis, improvements were made to the layout and track balancing. As for fishbone diagram can be seen in Figure 5.

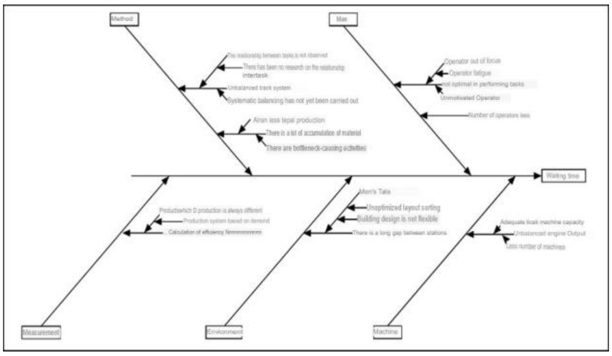

Figure 3. Waiting time fishbone diagram analysis

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Activity Relationships Chart

The layout improvement is done simply by using the activity relationship chart method. ARC at each production station of Panasonic Downlight NN511 can be seen in figure 6.

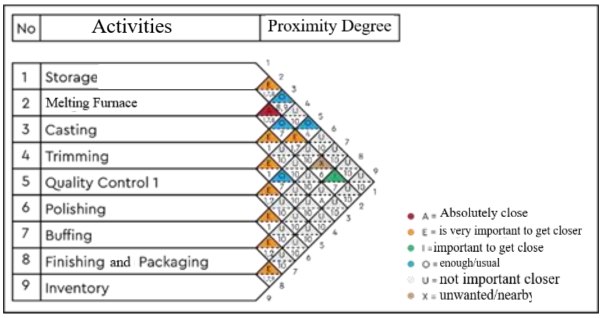

Figure 4. Activity relationship chart

Table 11. Total closeness rank

Dept		1	2	3	4	5	6	7	8	9	A	E	I	O	U	X	TCR	PS
1	1		E	O	U	O	U	U	U	U	0	1	0	2	5	0	12	7
2	2	E		A	O	E	U	X	I	U	1	2	1	1	2	1	31	1
3	3	O	A		E	U	U	U	U	U	1	1	0	1	5	0	26	3
4	4	U	O	E		E	O	U	U	U	0	2	0	2	4	0	22	5
5	5	O	E	U	E		E	U	U	U	0	3	0	1	4	0	31	2
6	6	U	U	U	O	E		E	U	U	0	2	0	1	5	0	21	6
7	7	U	X	U	U	U	E		E	U	0	2	0	0	5	1	10	9
8	8	U	I	U	U	U	U	E		E	0	2	1	0	5	0	25	4
9	9	U	U	U	U	U	U	U	E		0	1	0	0	7	0	10	8

Each of the reasons presented in the ARC is described in table 11.

Table 12. Activity relationship reason code

Reason Code	Reason Description
1	Order of material/process flow
2	Reduce waiting time
3	Security and safety
4	Use of the same working record
5	Ease of supervision
6	Disrupt production activities
7	Easy product transfer and materials
8	Use of labor/machine same
9	Facilitate employee coordination
10	Have no relationship

Total Closeness Rating

After knowing the relationship between each station, then each relationship is given a weight, using the Total Closeness Rating. The weight assessment for each department is carried out by adding up the total relationships (A, E, I, O, U, and X) then after each relationship is multiplied by; if A times factor is 15, E times factor is 10, I times factor is 5, O times factor is 1, U times factor is 0, and X times factor is – 10. After the weighting is done, it is known which departments should be placed close together. The relationship is described in table 11.

Algoritma Computerized Relationships

Based on the Total Closeness Rating, the departments that must be close are as follows;

a. **Iteration 1**

The smelting department (B) is allocated the center, because it has the highest order of placement and has one absolute relationship.

8	7	6
1	B	5
2	3	4

b. **Iteration 2**

The casting department (C) ranked second. Department C is placed adjacent to department B. Then in third place is the QC 1 (E) department, and is placed adjacent to B.

3	2	1
C	B	6
4	E	5

c. Iteration 3

The triming department (D) is allocated because it has the fourth highest order of placement. Meanwhile, based on the TCR, department D is placed next to departments C and E.

1	2	3
C	B	4
D	E	5

d. Iteration 4

The polishing department (F) is allocated because it has the fifth highest ranking order of placement. Meanwhile, based on the TCR department F is placed next to department E.

1	2	3
C	B	4
D	E	5
7	F	6

e. Iteration 5

Department allocation made fan (G). Meanwhile, based on the TCR department F is placed next to department E.

1	2	3
C	B	4
D	E	5
9	F	6
8	G	7

f. Iteration 6

The finishing and packaging department (H) is allocated. Meanwhile, based on the TCR, department H is placed adjacent to department G.

1	2	3
C	B	4
D	E	5
8	F	6
H	G	7

g. Iteration 7

Inventory department allocation (H). Meanwhile, based on the TCR, department I is placed next to department H.

1	2	3
C	B	4
D	E	5
I	F	6
H	G	7

Proposed Layout Improvement

From the explanation above, it is necessary to rearrange the layout by moving stations according to the Computerized Relationships Algorithm by taking into account the conditions in the field so that the layout is depicted in figure 7.

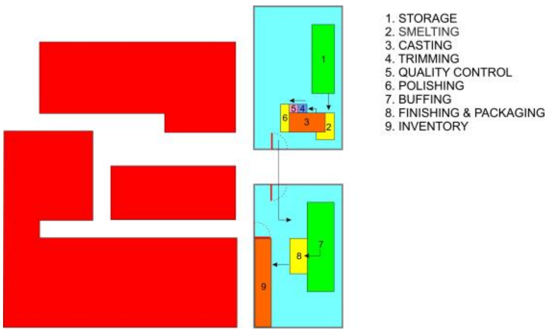

Figure 5. Proposed layout improvements

After making improvements to the layout and then calculating with simple measurements, the distance between stations and the time taken by each station becomes;

Table 13. Proposed travel time and distance between stations

No.	Activities	Distance (m)	Time Fixed	Time (sec)
1	Casting - Trimming	1	-	3
2	Trimming – QC 1	1	-	2
3	QC 1 - Polishing	±1	30 - 27	3
4	Polishing - Buffing	13	-	30
5	Buffing - Finishing	±4	40 - 34	6
6	Finishing - Inventory	±4	5 + 1	6

From the results of the above layout improvements, it will produce a new cycle time due to the shortening of the QC 1 line – polishing, buffing – finishing, finishing – inventory, thus shortening transportation time. From the shortening of the transport path, the cycle time becomes as follows;

Table 14. Cycle time after layout improvement

No	Process	Normal Time	Cycle time (second)
1	Casting	47	60,25
2	Trimming	11	14,86
3	Quality Control 1	7	10,14
4	Polishing	70	81,39
5	Buffing	207	243,52
6	Finishing dan Packaging	306	392,31
7	inventory	6	6,74

Fulfilling Consumer Demand

Table 15. Comparison of cycle time and takt time

No	Process	*Cycle time* (*second*)	*Takt time* (*second*)
1	Casting	60,25	247,62
2	Trimming	14,86	247,62
3	QC1	10,14	247,62
4	Polishing	81,39	247,62
5	Buffing	243,52	247,62
6	Finishing, Packing	392,31	247,62
7	Inventory	6,74	247,62

Based on the table it is known that the finishing station must be repaired. The number of operators is doubled at the finishing and packaging stations, assuming the operators have the same skills. Then the cycle time for finishing and packing is distributed to 196.16 seconds.

Improved Helgeson-Birnie Line Balancing (Ranked Positional Weight)

After repairing based on weighting, there are four stations. The station cycle time from the table 16 is taken from the largest station time, which is 243.52 seconds. Then the idle time can be known by the following calculation;

Table 16. Workstation efficiency

Work Station	Station time (Wi/ second)	The largest Workstation (Ws/second)	Workstation Efficiency
Station 1 (casting, trimming, QC 1, Polishing)	166,64	243,52	68,43%
Station 2 (Buffing)	243,52	243,52	100%
Station 3 (Finishing 1, inventory)	202,9	243,52	83,31%
Station 4 (Finishing 2, inventory)	202,9	243,52	83,31%

$$\text{Idle Time} = n.Ws - \sum_{i=1}^{n} Wi = 4\,x\,243{,}52 - (\,166{,}64 + 243{,}52 + 202{,}9 + 202{,}9\,) = 158{,}12 \quad (14)$$

$$Balance\ Delay = \frac{n.C - \sum\ ti}{n.ti} \times 100\% = \frac{4.(143{,}52) - 815{,}96}{4.(243{,}52)} \times 100\% = 16{,}23\% \quad (15)$$

$$Smoothing\ Index\ (SI) = \sqrt{\sum_{i=1}^{k} (ST\ max - STi)^2}$$

$$Smoothing\ Index\ (SI) = \sqrt{(243{,}52^2 - 166{,}64)^2 + (243{,}52^2 - 202{,}9)^2 + (243{,}52^2 - 202{,}9)^2} = 95{,}97 \quad (16)$$

From the results of calculations using the above formula, it can be seen that each idle at each station is as follows;

Table 17. Idle time at repair station

Station	CT	Idle
Station 1	166,64	76,88
Station 2	243,52	0
Station 3	202,9	40,62
Station 4	202,9	40,62
Total	815,96	158,12

Future State Mapping

Waiting time in the production process of the Panasonic Downlight NN511 is one of the wastes that has a major impact on productivity and lead time. Waiting time occurs because the process is waiting for the fulfillment of the production batch after the QC 1 process and the Buffing process. Waiting time occurs when the production batch collection takes 3276 seconds on temporary inventory QC 1 and 14,352 seconds on temporary inventory buffing.

Based on Figure 9. There is an increase in product flow to reduce lead time, namely by eliminating temporary inventory in the QC 1 and Buffing processes, increasing the performance/productivity of finishing and packaging stations up to twice that of other stations. stations, and arrange the layout using the Activity Relationships Chart method. Then at the polishing station, products that have gone through QC 1 are prepared at the start of production, so there is no waiting time

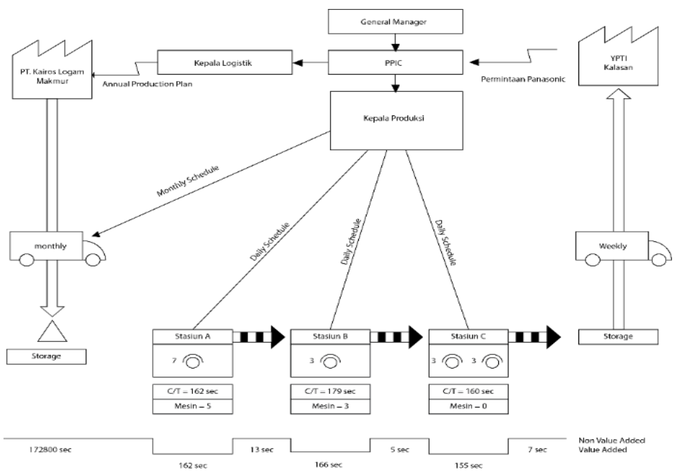

Figure 6. Value stream mapping future

CONCLUSION

The UPT Metal production process flow starts from the ingot smelting process and ends with inventory to be sent to YPTI Kalasan. Based on the waste identification results, it was found that the dominant types of waste were Defect (25%), Motion (17.9%), Waiting (15.5%), Overprocessing (14.3%), Transportation (10.7%), Inventory (9.5%), and Excess Production (7.1%). In this study, one of the VALSAT tools with the highest dominance level of 34.1% was used, namely Process Activity Mapping (PAM). Based on weighting operations with PAM, the proportion of transportation time was 172.805 seconds (82.6%), operational activity was 18.597 seconds (8.9%), and delay was 17.728 seconds (8.5%). The PCE value in the Panasonic Downlight NN511 production process is 8.89%, indicating quite poor process efficiency. The waste that is prioritized for repair is waiting time. Improvements were made by changing the layout. Layout changes using the ARC method and Computerized Relationships Algorithm. Before linebalancing improvements were carried out, the efficiency value was 27.85%; idle time is 2,201.5 seconds, balance delay is 72.14%, and the smoothest index is 501.06. The work station efficiency value after repairs increased to 83.77%, idle time to 158.12, delay balance to 16.23%, and smoothness index value to 95.97.

REFERENCES

Fernando, Y. C., Noya, S. 2014. *Optimasi Lini Produksi Dengan Value Stream Mapping Dan Value Stream Analysis Tools.* Jurnal Ilmiah Teknik Industri Vol. 13, No. 2.

Heri Murnawan, Mustofa. 2014. *Perencanaan Produktivitas Kerja dari Hasil Evaluasi Produktivitas dengan Metode Fishbone di Perusahaan Percetakan Kemasan PT.X.* Jurnal Teknik Industri HEURISTIC. Vol. 11. No. 1.

Jakfar, Ahmad et al. 2014. *Pengurangan Waste menggunakan Pendekatan Lean Manufacturing.* Jurnal Ilmiah Teknik Industri. Vol.13. No.1.

Lestari, Kartika dan Susandi, D. 2019. *Penerapan Lean Manufacturing untuk mengidentifikasi waste pada proses produksi kain knitting di lantai produksi PT. XYZ*. Industrial Research Workshop and National Seminar.

Muhammad, C.R., dan Prasetyaningsih, E., 2014. *Peningkatan Kinerja Operasional Industri Kerajinan Kulit Dengan Pendekatan Lean Manufacturing (Studi Kasus di Cibaduyut- Bandung).* Prosiding Seminar Nasional Penelitian dan PKM: Sains, Teknologi, dan Ilmu Kesehatan. Bandung: Universitas Islam Bandung

Panudju, Tri A. et al. 2018. *Analisis Penerapan Konsep Penyeimbangan Lini (Line Balancing) dengan Metode Ranked Position Weight (RPW) pada Sistem Produksi Penyamakan Kulit di PT. Tong Hong Tannery Indonesia Serang Banten.* JISI : Jurnal Integrasi Sistem Industri. Vol. 5. No. 2.

Ramadhan, M. I. et al. 2018. *Analisis Kelayakan Aspek Teknis Industri Pengolahan Biofarmaka Berbahan Baku Bawang Tiwai.* Jurnal Rekayasa Sistem Industri. Vol.7, No.2.

Ravizar, Agung dan Rosihin, Rosihin. 2018. *Penerapan Lean Manufacturing untuk Mengurangi Waste pada Produksi Absorbent.* Jurnal INTECH Teknik Industri

Rother, M., dan Shock, J., 1999. *Learning To See: Value Stream Mapping To Create Value and Eliminate Muda*. Brookline, MA: The Lean Enterprise Institute.

Safitri, N. D. dkk. 2017. *Analisis perancangan tataletak fasilitas produksi menggunakan metode activity relationship chart (ARC).* Jurnal Managemen, 38 – 47. Vol. 9 (1)

Setiyawan, Danang T. *et al.* 2017. *Usulan Perbaikan Tata Letak Fasilitas Produksi Kedelai Goreng dengan Metode BLOCPLAN dan CORELAP (Studi Kasus pada UKM MMM di Gading Kulon, Malang).* Jurnal Teknologi dan Manajemen Agroindustri. Vol.6 No. 1:51-60.

Trenggonowati, D Lintang. dan Nuzilia Febriana. 2019. *Mengukur Efisiensi Lintasan dan Stasiun Kerja menggunakan Metode Line Balancing Studi Kasus PT. XYZ.* Journal Industrial Servicess Vol.4 No.2.

Widyahening, C. E. T. 2018. *Penggunaan Teknik Pembelajaran Fishbone Diagram Dalam Meningkatkan* Keterampilan *Membaca Siswa.* Fakultas Keguruan dan Ilmu Pendidikan Universitas Slamet Riyadi. Jurnal Komunikasi Pendidikan Vol. 2, No. 1.

Womack, James P. and Daniel T. Jones. 2003. *Lean Thinking: Banish Waste and Create Wealth in your corporation. Second Edition. London: Free Press Business.*

Yola, Melfa et al. 2017. *Value Stream Mapping untuk Mereduksi Waste Dominan dan Meningkatkan Produktivitas Produksi di Industri K*. Jurnal Hasil Penelitian dan Karya Ilmiah dalam bidang Teknik Industri. Vol. 3, No.2