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Assembly Line Balancing with The Yamazumi Method

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Assembly Line Balancing with The Yamazumi Method

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Abstract.K81 A Cross Comp bracket which is a variant of automatic motor parts that functions as a jog lock, when the motor is refueled. In recent years the number of productions often does not meet the target. For example, the amount of production in March 2019 production results that occur far below the target. This decrease in production amount is due to a gap in the time of the K81 Bracket Cross Comp production process. This is because there is a delay at each work station due to unbalanced cycles of all stations. Based on the background described above, the aim of this study is to improve the line balancing by increasing the efficiency of the track in order to increase the amount of production. The research method used is the Yamazumi method to improve track balance. From the day of improvement of some work elements that have been carried out there has been an increase in line efficiency as fast as 19.14%, thereby reducing idle time and increasing the amount of production.

1. Introduction

Manufacturing companies now place great emphasis on competitiveness and look for ways to utilize their resources more efficiently [1]. Reduction in cycle time and / or increased utilization and functional efficiency will help the industry to gain competitive advantage through the costs of leadership, differentiation, and responsiveness [2]. Line balancing focuses on increasing line efficiency, which aims to increase productivity. The problem of assembly line balancing is related to minimizing the number of work stations, minimizing cycle time, and maximizing the equal workload to increase line efficiency [3]. line balancing uses the approach of balancing the assignment of work elements from the production line to the work station (work station) to minimize the number of work stations and minimize the total idle time (idle time) at all stations for a certain level of output [4]. The purpose of implementing line balancing is to minimize the idle time of the work station on the production line [5]. By minimizing the number of work stations aimed at maximizing the level of production [6]. Line balacing problems are usually associated with the allocation of tasks at a Work Station (WS) by considering the time difference between each existing Work Station. The allocation of unbalanced tasks results in high delay times and also bottlenecks at a Work Station. From this it results in disharmony between workers, where workers with lighter tasks will work more relaxed and lighter while workers with heavier tasks will work nonstop.

In one of the motorcycle spare part companies in Indonesia producing motor frames. There is one product called the K81 A Cross Comp Bracket which is a variant of automatic motor parts that function as a jog lock, when the motor is refueled. As shown in Figure 1.

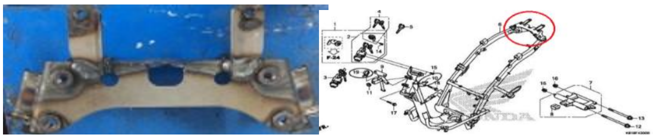

Figure 1. Bracket Cross Comp K81 A

K81 A Cross Comp bracket produced on 2 production lines. In recent years the number of productions often does not meet the target. For example, the amount of production in March 2019 produced far below the target as shown in Figure 1. This decrease in production amount is due to a gap in the time of the K81 Bracket Cross Comp production process. This is because there is a delay at each work station due to unbalanced cycles of all stations. Based on the background described above, the purpose of this study is to improve line balance by increasing line efficiency in order to increase production.

2. Theory and Methods

This study focuses on the production process of K81 A Bracket Cross Comp at the Welding Department. Data collection is done in 3 ways, namely by interview, documentation, and observation. Data collection and processing is done using the Yamazumi Charts Assembly Line Balancing method. Several corrective steps will be implemented such as rearranging the production layout, eliminating unnecessary activities in the assembly process, reducing cycle times, and balancing the workload of labor using line balancing through Yamazumi charts and Tact time. [7]

Research activities begin with:

Calculating the Average Cycle Time

Cycle time is the time needed to make one product unit at one workstation [8].

Number of Workstations [9]

Work station is a place on the assembly line where the assembly process is carried out. After determining the cycle time interval, the number of efficient work stations can be determined by the formula:

Takt Time (TT)

Takt Time is based on the Standard Space Unit (SSU), labor and performance factors. [10]. Takt time is obtained based on the formula:

Precedence Diagram

Precedence diagrams are spreadsheets that illustrate the sequence and interrelationships between work elements of the assembly of a product [11].

Line Efficiency

Is a grouping of operations into work stations after knowing the ranking of each operation.[12].

Balance Delay

Balance delay is the ratio between idle time in assembly lines and available time [4].

Yamazumi Diagram

Yamazumi's graph is used as a tool to continue Kaizen for line balancing [13]. The Yamazumi chart is a bar chart that shows the total cycle time for each operator when carrying out their processes in the production flow.

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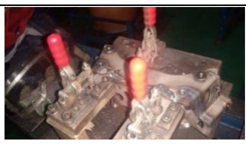
3. Result and Discussions

3.1 Work Element

In the docking line, the assembly process has work elements that make the K81 A Cross Comp Bracket a complete product. This is the assembly stage:

Table 2 Assembly process of K81 Cross Comp Bracket A

NO	Figure	Process & material	Explanation
1		Assy Welding 1 (Robot 1) Material: *Nut Special*	This process combines special Nut with RR Cross Plate Bracket. Installation of 4 nuts in the jig block, after that the RR cross Bracket is placed on top of the Nut that has been paired to the jig block. Make sure the nut is not turned upside down and tilted. Welding length of 4 cm and 180o
2		Assy Welding 2 (Robot 1) Material: Bracket rear cross & sheath catch	This process combines between cross brackets that have been welded with a catch seat bracket. The 4-hole bracket must be precisely inserted. Welding length R / L14 cm x 2
3		Assy Welding 3. (Robot 1) Material: *Patch RR, R/L Grip*	This process combines the Assy weld 2 process with part patch R/L and grip. Part position must not be reversed and tilted and must be tight against the jig block. R/L patch length is 4 cm and the grip length is 3.5 cm.
4		Assy Welding 4 (Robot 2) Material: *Stay R/L Comb*	The fourth welding process is the installation of RR R / L Comb with the components that have been assembled in the robot 1. The hole stay must be in a jig block, welding length of 6 cm.
5		Assy Welding 5 (Robot 2) Material: *Stay B R/L Fender*	Assy Welding 5 process is the incorporation of Stay B R / L RR Fender with assembled component parts. Installation of Stay B R / L RR Fender with Bracket seat cath. Stay holes must enter jig blocks, welding length Stay B R RR Fender 2.5 cm and Stay B L RR Fender 2.5 cm
6		Assy Welding 6 (Robot 2) Material: Patch RR Grip Stay	The final process in assembly using a robot manipulator machine that is Welding Patch RR Grip Stay inside. Make sure all visual welding is not perforated, spatter and undercut. Welding length 4 cm.
7		Manual Welding	The process of manual welding is a process of refinement of the results of welding robots that are not good, as for the criteria such as welding holes and less. But if often found in these items. Will be evaluated and improved by the maintenance team and programmer.
8		Clean Spatter & Check Visual	The process where cleaning spatter in goods that have been done by robot welding and manual welding. Attempted parts of the critical point no spatter

9		Tapping	Namely the process of smoothing the screw thread area. so that there is no spatter in the nut
10		Check Inspection	The inspection process is a process in which whether the goods produced are in accordance with quality standards in dimensions or not.
11		Buffing	Buffing is the process of smoothing the RR Cross Bracket surface. The condition of the buffing area is smooth and there is no spatter.

The results of the calculation of the average operating time of the K81 A Bracket Cross Comp Product with the amount of data for each element 30 times as shown in Figure Table 2. From Table 2 the processing time of each working element is in balance. This causes idle in every process. Table 2. Data on average operating time of each work element the results of the calculation of the average operating time of the K81 A Bracket Cross Comp Product with the amount of data for each element 30 times as shown in Figure Table 1. From table 1 the processing time of each working element is in balance. This causes idle in every process.

Table 2. Data on Average Operating Time of Each Work Element

Workstation	Work Element	Type of Work Element	Operation Time (Second)
	1	Assy Weld 1	16,1
1	2	Assy Weld 2	29,09
	3	Assy Weld 3	16,44
	4	Assy Weld 4	10,07
2	5	Assy Weld 5	11,09
	6	Assy Weld 6	5,09
	7	Manual Weld	4,07
3	8	Check Visual & Clean Spatter	4,33
	9	Re tapping	4,57
	10	Check Inspection	5,4
	11	Buffing	4,43
Total			110,86

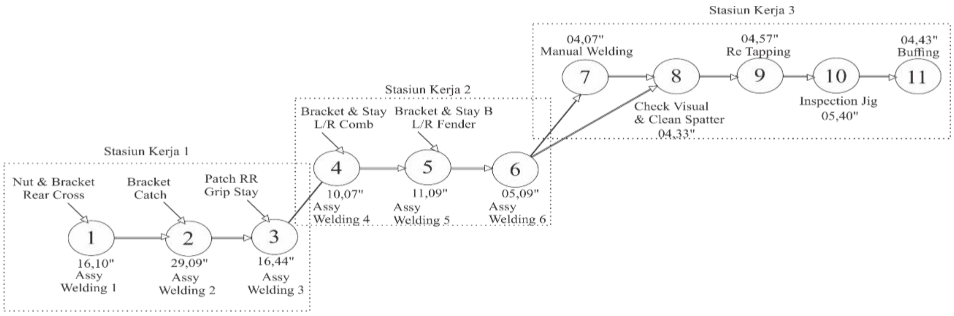


Figure 2. Cross Process Bracket Cross Comp

Figure 2 shows the production line for all production work elements of the K81 A Bracket Cross Comp product in Department Welding 1 from beginning to end of all work stations. When viewed from the existing cycle time, it is known that all stations have unbalanced cycle times or that result in a lot of idle time and not achieving production targets, especially at work stations 1 and 2. According to Baroto (2002), production line is the placement of areas work where operations are arranged in succession and the material moves continuously through balanced operation. So that the K81 a Bracket Cross Comp production line needs to be balanced so that it can reduce idle time and increase the amount of production. [13].

Tact Time

$Tact\ Time = \frac{480\ min}{317 unit/day} = 1{,}51\ min/unit/day$ or 111 sec/ Unit

Line Efficiency

Line Efficiency $= \frac{110{,}68\ detik}{3x\ 62{,}63\ detik} = 59{,}86$ **%**

Balance Delay Calculation

BD = $100\% - 58{,}86 = 41{,}14\%$

Idle Time Calculation

d = $(3\ Stastion\ x\ 62{,}63\ sec) - 110{,}68\ sec = 77{,}21\ sec$

3.2 Yamazumi Method

In this method, it is done based on the division of categories. Work elements are categorized or grouped by VA (Value Added), NVA (Non-Value Added), NVAN. (Non-Value Added Necessary).

Table 3 Work Elements in the production of K81 Cross Comp Bracket A
With the VA, NVA and NVAN categorization

Work station	Operation	Work Element	category VA	NVA	NVAN	CT (Sec)
Assy Welding Robot 1 Type 138	1	Installation of 4 nuts in the jig block, after which the RR cross Bracket is placed on top of the Nut that has been attached to the jig block	■			16,1
	2	Merging between cross brackets that have been carried out welding with the catch seat bracket			■	29,09
	3	Combining the Assy weld 2 process with part patch R / L and Grip.	■			16,44
Assy Welding Robot 1 Type 135	4	installation of Stay R / L RR Comb with components that have been assembled on the robot 1			■	10,7
	5	the incorporation of Stay B R / L RR Fender with assembled part components			■	11,09
	6	Welding Grip RR RR Grip inside	■			5,09
Finishing	7	Completion of Assy with manual welding	■			4,07
	8	cleaning spatter	■			4,33
	9	smoothing of the screw nut area	■			4,57
	10	Inspection Process	■			5,4
	11	smoothing surface of the RR Cross Bracket	■			4,43

After grouping work elements, the NVA category is in the process of assembly. There is no work element, but in the work element with the status of NVAN there are 3 elements but remain in the work station, because of the policy of the company because it is a process. The work elements included in the NVAN category are:

1. Work Element 2: Merging between Cross Comp Bracket that has been done by welding with. Seat Catch Bracket (29.09 sec)
2. Work Element 4: Installation of Stay R / L Comb with components that have been assembled in robot 1 (10.7 sec)
3. Work Element 5: incorporation. Stay B R / L RR Fender with assembled parts (11.09 sec)

Based on Figure 3 at work stations 1, 2, 3 that are still far below the tact time, therefore there should be an improvement proposal so that the work station is in the making. The Cross-Comp Compression can be more optimal than before. Following is the proposed improvement so that the existing work stations become more optimal:

Table 4. Proposed process improvement

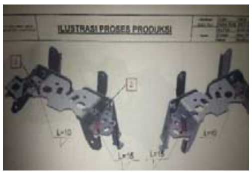
NO	Before	Figure	Improvement	Figure
1	Welding Assy Process 2. Initial welding pulls 14 cm x 2 (L / R) = 28 cm. This process takes 29.09 seconds.		Reduce by half the length of the welding pull in the Assy Welding 2 process, the total initial pull of 28 cm to 14 cm. Reduction of welding length is transferred to Assy Welding 4 & 5, respectively 7 cm / 7.2 seconds.	
2	Welding Assy 4, in this process the initial condition of welding pull length is 6 cm and 10.7 seconds processing time		The addition of a 7 cm welding pull in the left area of the front of the Left Comb, with the addition of the welding pull taken from process 2 will increase the processing time by 7 seconds. The total Assy Welding 4 process takes approximately 17 seconds,	
	Welding Assy 5, in this process the initial condition of welding pull length is 5 cm, and the processing time is 11.09 seconds		The addition of a 7 cm welding pull in the right area of the Stay B R Fender, with the addition of the welding pull taken from process 2, will add a processing time of 7 seconds. The total Assy Welding 5 process takes approximately 18 seconds,	

Table 5. Summary Table of Improvements

Before			Improvement			After	
Work Element 2	29.09	Sec	reduction time	14.54	Sec	14.55	Sec
Work Element 4	10.7	Sec	Addition time	7.2	Sec	17.9	Sec
Work Element 5	11.09	Sec	Addition time	7.2	Sec	18.29	Sec

From Table 5 there is an increase and decrease in work time so that work time in each work element is more balanced. And there is a reduction in waiting time for each work element.

Table 6 Work Station Cycle Times after incorporation of Work Elements

Work Station	Cycle Time (sec)
1	47.09
2	41.28
3	22.8
Total	111.17
Average	37.06

From the proposed improvements above, the cycle time and number of work stations that have changed, here is the Yamazumi Chart after several work stations:

Line Efficiency = $\frac{111,17}{3\ x\ 47,09} x\ 100\% = \mathbf{79}\%$

Balance Delay BD = $100\% - 79\% = \mathbf{21}\%$

Idle Time d = $(3\ x\ 84,85\ sec) - 195,32\ sec = \mathbf{59,23\ sec}$

4. Conclusions

By doing work improvement on 3 elements of work that are non-value added, there is an increase in work efficiency from 59.86% to 79% there is a significant increase in efficiency.

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