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Analysis of Cylinder Comp Product Quality Control with Proposed Improvements at PT. Jakarta Automotive

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Abstract:- In the era of globalization, the manufacturing industry faces its biggest challenge, namely the demands of consumer needs with high quality standards. Various kinds of waste often occur in the production process, one of which is caused by a poor layout of facilities, for example the arrangement of machines on the production line that is not suitable. This is a problem in the production process of machining *cylinder comp* at PT. Jakarta Automotive. With the aim of finding out the factors that cause product defects in machining *cylinder comp* and finding design of improvement proposals to reduce the defects that occur, this study uses a quantitative method to find DPMO and *sigma* values as an analysis of the cause of the problem. The result of this study was the discovery of less than optimal engine layout settings that caused *TAP NG defects* in the product. So that a design of a proposed improvement was made in the form of a change in the engine layout. In conclusion, in this study, it was identified that the non-optimal engine layout was the cause of the high defects. Therefore, improvements are proposed in the form of changing the engine layout on the production line with the aim of reducing *the* level of defects caused by a less than optimal layout.

Keywords:- *Six Sigma, Engine Layout, Cylinder Comp.*

I. INTRODUCTION

Some of the important factors in the manufacturing industry are quality control and productivity. Both take a crucial role in profit-oriented businesses. Quality control is a very crucial means for production management to maintain, maintain, and improve product quality so that it remains in accordance with the set standards. The activities are monitoring and inspecting quality standards in production activities in the field. If there are many defects or *abnormalities* during the production process, a thorough evaluation will be carried out to reduce all of them. This is an effort to maintain product quality standards so that the level of consumer satisfaction remains high. Various kinds of waste often occur in the production process caused by one of them due to the poor layout of the facility, for example the distance between the machines is too far so that it requires a larger number of operators than the actual material transfer activities, the production route is too long, and there is also one machine that is separate from the production line that should be, so that it has an impact on the risk of process jumps and irregular operator work lines. Therefore, it is necessary to redesign the layout of the new facility to rearrange the layout of the machine and the material traffic path more appropriately, so as to minimize the risk of process jumping as well as regularity in the operator's path. The *Machining cylinder comp* department is the part that forms the engine cylinder, where this cylinder functions to produce the thrust needed for the vehicle to move. The process of *machining cylinder comp* involves the use of a special machine called a lathe. This machine is used to remove material from the outer surface of the engine cylinder so that it reaches the desired dimensions. In this process, there was *a fairly high* defect, namely *TAP NG* of 53% of the total number of defects during the research period. This figure is quite high so that improvements are needed to reduce the percentage of these defects.

II. LITERATURE REVIEW

A. Quality

Quality is a measure of satisfaction that has certain standards in an organization or market to meet functional, aesthetic, and value elements that depend on producers as well as preferences from consumers.

B. Quality Control

Quality control is a systematic process that includes a variety of activities to ensure that products meet the standards that have been set and meet customer expectations. Quality control involves not only the detection and correction of errors, but also the prevention of errors and continuous improvement in their production processes.

C. Quality Control Tools

In an effort to effectively supervise, analyze, and improve product quality, the use of *QC 7 tools* is an important foundation in quality control. The tools are as follows:

- Checksheet
- Pareto diagram
- Histogram
- Control chart

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- Fishbone diagram
- Flow chart
- Scatter Diagram

D. Defective Products

Defective products are products that do not meet the quality standards that have been set, either because of damage that occurs during the production process or because they do not meet quality standards. This can result in the product being difficult to sell or even requiring repair costs that are not proportional to its selling value.

E. Six Sigma

Six sigma is a management approach that focuses on the elimination of defects by placing emphasis on understanding, measuring, and improving processes. This approach aims to identify as well as eliminate deviations or defects that may occur in the product or service. The main goal is to reduce the likelihood of imperfections that can affect customer satisfaction and the company's reputation.

F. Kaizen

Kaizen is a continuous improvement process that aims to improve work methods, improve quality, and output productivity by instilling discipline in employees and creating a comfortable work environment. This process involves all members in the company's hierarchy, both management and employees.

III. RESEARCH METHODS

A. Place and Time of Research

This research was conducted at PT. Jakarta Automotive for three months, starting from January to March. PT. Jakarta Automotive, which is engaged in the production of motorcycles, was chosen as the research location to identify and analyze the causes of defects in the products produced.

B. Data Type

In this type of data, researchers use primary and secondary data types. Gathering information through direct observation in the area of the machining cylinder comp and its products. In addition to observations and interviews, data were also collected through production reports as well as defects that occurred during the research period.

C. Data Collection

In this study, there are 3 data collection methods used, namely:

➢ *Observation*

Observations were made on the observed area, namely *the machining cylinder comp* and its products. How is the production flow, how it works, the equipment used, and the quality control system implemented.

➢ *Interview*

Another method of data collection is conducting interviews with machine operators and *indirects* in the research area to dig up more detailed information.

➢ *Documentation*

In addition to conducting observations and interviews, data collection was also carried out through production reports and *defects* that occurred during the research period. This data is accessed to complement and provide a comprehensive overview of the topic being researched.

D. Data Analysis

To conduct data analysis, the researcher carried out several stages of discussion. Here's the full explanation:

➢ *Production Process*

To be able to produce products in the form of *cylinder comps*, there are several stages of the process in it. It begins with a process in the *Die Casting department,* where molten metal is inserted into a mold with high pressure to produce a product mold in the form of *a cylinder comp* that is still rough. After that, it is continued in the *Machining* department with the following process flow:

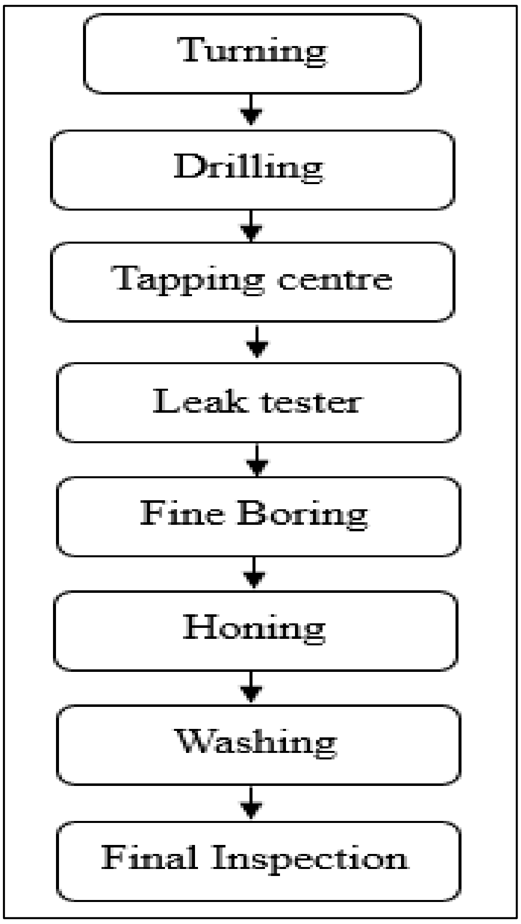

Fig 1 Production Process of Cylinder Comp

➢ *Production Quantity*

Data on the number of production at PT Otomotif Jakarta in the form of *K58 engine cylinder comp* products taken from the period of January 2, 2023 – March 31, 2023. This data is generated in the *K58 line area* from Turning, *Drilling, Tapping Centre, Leak tester, Fine boring, Honing, Washing,* to *Final inspection* which is recorded in the temporary storage area. The data on the amount of production collected can be seen in the following table:

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Table 1 Production quantity Machining *Cylinder Comp* Line K58

Moon	Department	Total Production (Pcs)
January	Machining *Cylinder comp*	13.640
February	Machining *Cylinder comp*	12.400
March	Machining *Cylinder comp*	13.020
Sum		39.060

➢ *Checksheet*

The first step in data processing for quality control research is to create *a checksheet* or table in Microsoft Excel that records production data and the type of damage to *cylinder comp* products that do not meet company standards. The creation of this check sheet aims to facilitate data collection and further analysis. The results of the data processing that has been carried out can be seen in the table below:

Table 2 Number of defects in January - March 2023

Types of Defects	Moon			Total defects
	January	February	March	
Porous	9	12	15	36
Drill NG	4	3	3	10
Lumpy	8	5	6	19
Leaky	17	9	23	49
Tap NG	53	41	36	130
Total	91	70	83	244

➢ *Histogram*

The next step after creating the checksheet is to create a histogram, which aims to present tabulation data to identify the most common types of product defects. The following is a histogram table showing the percentage of damage to *cylinder comp* products during the period January to March 2023 at PT Jakarta Automotive.

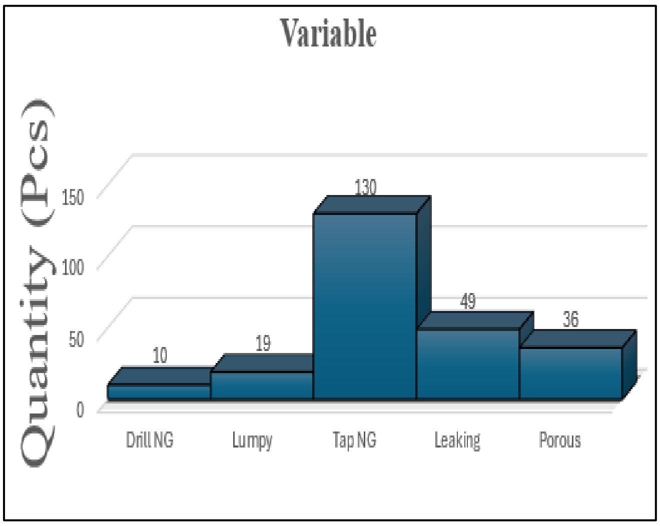

Fig 2 Histogram

Based on the histogram chart above, the most common type of damage is *Tap NG*, with the amount of damage reaching 130 per cylinder component. In contrast, the rarest defect is *the NG Drill*, with only 10 per cylinder component. From the histogram diagram obtained, it can be seen that the shape of the histogram resembles a normal bell curve, so it can be concluded that the data distribution is normal, so it is useful to describe the data distribution pattern that is commonly used in statistical analysis and decision-making.

➢ *Defect Per Million Opportunities (DPMO) and sigma value*

- *Dpmo Calculation*

✓ *Unit* (U)

The total production of *K58 cylinder comps* in January – March 2023 was 39,060 Pcs.

✓ *Opportunities* (OP)

Based on the requirements of the characteristics of customer needs, it can be concluded that the characteristic of the occurrence of a highly influential defect (*potential CTQ*) is *the Tap NG* defect. Based on the type of defect produced, this means that there is one type of chance for defects to occur in each unit produced.

✓ *Defect* (D)

In January - March 2023, there were 244 pcs *defects* in the production process of *the Machining cylinder comp* K58.

✓ *Defect per Unit* (DPU)

$$DPU = \frac{D}{U} = \frac{244}{39.060} = 0.0062468$$

✓ *Total Opportunities* (TOP)

$$TOP = U \times OP = 39.060 \times 1 = 39.060$$

✓ *Defect per Opportunities* (DPO)

$$DPO = \frac{D}{TOP} = \frac{244}{39.060} = 0.0062468$$

✓ *Defect per Million Opportunities* (DPMO)

$$DPMO = DPO \times 106 = 0.0062468 \times 106 = 6.246.8$$

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Based on the results of the calculation, it is known that the number of defects per one million opportunities (DPMO) is 6,246.8 pcs.

- *Sigma Level Calculation*

Once the company's DPMO value is known, the next step is to calculate the company's current sigma level. The sigma level is obtained by converting the company's DPMO value using the available sigma level table. From the previous calculation, it is known that the company's current DPMO is 6,246.8.

In the sigma level table, the value of 16,426 DPMO is at the sigma level between 3.99 and 4.00. To accurately determine the company's Sigma Level, interpolation is carried out. Based on the DPMO value, the sigma level of 3.99 corresponds to 6,387 DPMO and the sigma level of 4.00 corresponds to 6,210 DPMO. Therefore, the company's sigma level is:

$$\frac{6.387-6.246,8}{6.246,8-6.210} = \frac{4-x}{x-3,99}$$

$$\frac{140,2}{36,8} = \frac{4-x}{x-3,99}$$

$$140,2(x - 3,99) = 36.8\ (4 - x)$$

$$140.2x - 559,398 = 147.2 - 36.8x$$

$$140.2x + 36.8x = 147.2 + 559,398$$

$$177x = 706,598$$

$$x = 706,598 / 177$$

$$x = 3.99$$

The calculation results show that the company's sigma level for the production process *of the K58 comp machining cylinder* is currently at the level of 3.99. Based on the results of data processing, the DPMO value for the production *of the K58 comp machining cylinder* in the period January – March 2023 is 6,246.8 DPMO and the sigma level for the production process of *the K58 comp machining cylinder* is at the level of 3.99. This shows that the number of *Tap NG defects* in the production *of machining cylinder comps* is still quite high.

- *Pareto Diagram*

After finding the DPMO and sigma values, the next step is to create a Pareto diagram. This diagram is useful for identifying major problems in quality improvement, sorting product defects from largest to smallest based on the number detected during the production process. Pareto diagrams help in separating product defects from good ones based on the frequency of breakdowns, as well as showing the cumulative percentage of each dominant type of problem occurring. This diagram is also useful for exposing significant differences in frequency between some of the main problems.

Table 3 Percentage of Cylinder Comp Product Defects

Types of Defects	Number of defects (pcs)	Defect Percentage	Cumulative Percentage
Porous	36	15%	15%
Drill NG	10	4%	19%
Lumpy	19	8%	27%
Leaky	49	20%	47%
Tap NG	130	53%	100%
Total	**244**	**100%**	

Based on the data recorded above, it can be shown in the pareto diagram as follows:

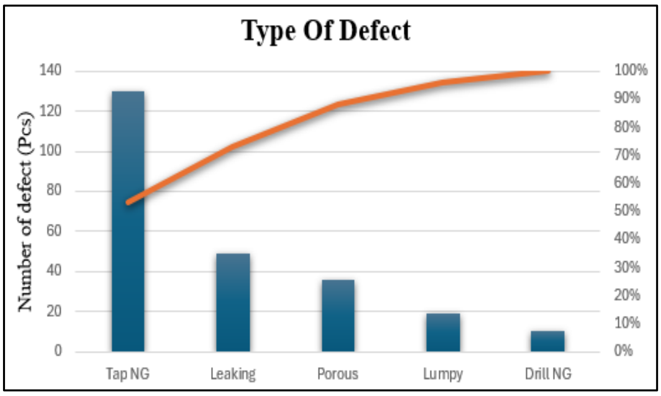

Fig 3 Pareto Diagram

From the Pareto diagram, it can be seen that the type of defect and the frequency of defects during January to March in the Cylinder comp production process. *Tap NG* gives rise to the highest percentage of defects of 53%, with the number of defects reaching 130 Pcs. Leaky defects occupy the percentage of defects of 20%, with the number of defects of 49 Pcs. Crop defects produce a percentage of defects of 15%, with the number of defects reaching 36 Pcs. Lump defects occupy the percentage of defects of 8%, with the number of defects of 19 Pcs. While Drill NG has the lowest percentage of defects of 4%, with a total defect of 10 Pcs.

IV. RESULTS AND DISCUSSION

G. *Results of Analysis of Factors Causing Defects*

After conducting an analysis using checksheet tools, histograms, and Pareto charts to identify and visualize data related to the problems that occurred, the next step is to perform a Why-Why Analysis. This step helps to dig deeper to find the root cause of the problem that has been identified. With this method, it will be easier to understand the cause-and-effect relationship in more detail, making it possible to design more effective and comprehensive solutions. The highest defect is in *Tap NG,* so the next problem analysis will be more condensed into the most frequent product defects.

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Table 4 Why-Why Analisys

Problem That Happen	**Why 1**	**Why 2**	**Why 3**	**Why 4**	**Why 5**
Tap NG	The *drilling* process is missed so that the *tapping process* becomes defective	The occurrence of *the jumping process* at one of the *work* stations	The layout of the drill machine is not aligned	Initial layout design is not optimal	Layout planning is not done with an in-depth analysis of workflow efficiency

After conducting a Why-Why Analysis to identify the root cause of the problem, we will proceed with the 5W1H approach. This method helps gather more comprehensive information about the problem at hand, by asking five basic questions: what, who, when, where, why, and how. This approach allows us to understand the context and all related aspects, so that we can develop more effective and comprehensive solutions.

Table 5 5W1H

It	**Analysis**		**Answer**
1	What?	What causes a defect in Tap?	The occurrence of *the jumping process* causes the *drilling* process to be missed so that the *Tapping process* becomes defective
2	Who?	Who has the potential to cause this defect to occur?	The *engineer* who designs the machine layout and the production operator who runs the production process
3	Where?	Where does the potential *for the jumping process* occur?	*The jumping process* occurs in the sequence of *Drilling* and *Tapping machines*
4	When?	When can this potential defect occur?	When after the operator performs the drilling process *on the product*
5	Why?	Why can this defect occur?	Because the *Drilling* and *Tapping* machines are not aligned, so that the *drilling* process is missed and the *Tapping process* becomes defective
6	How?	How can this defect be controlled?	Conduct a comprehensive analysis of the workflow and improve the machine layout to support a more efficient production flow.

H. Proposed Improvements

After conducting an in-depth analysis by considering *the Why-Why Analysis* and the *5W1H (Who, What, When, Where, Why, How) elements, the* author has identified several things that need to be improved, namely changes in the engine layout. This layout change aims to improve operational efficiency and optimize the workflow at *the comp cylinder machining* production facility, especially in *the K58 line*.

The image below shows the layout before and after the proposed fix. Previously, the layout of the machine and the work area were often not optimal, causing the potential for *jumping processes* that led to substandard tapping processes. Through careful analysis and a structured improvement plan, the author has redesigned the layout of the machine so that it is more in line with the required production flow. This change is expected to minimize the potential for the jumping process, improve operational efficiency, and increase the overall productivity of the factory.

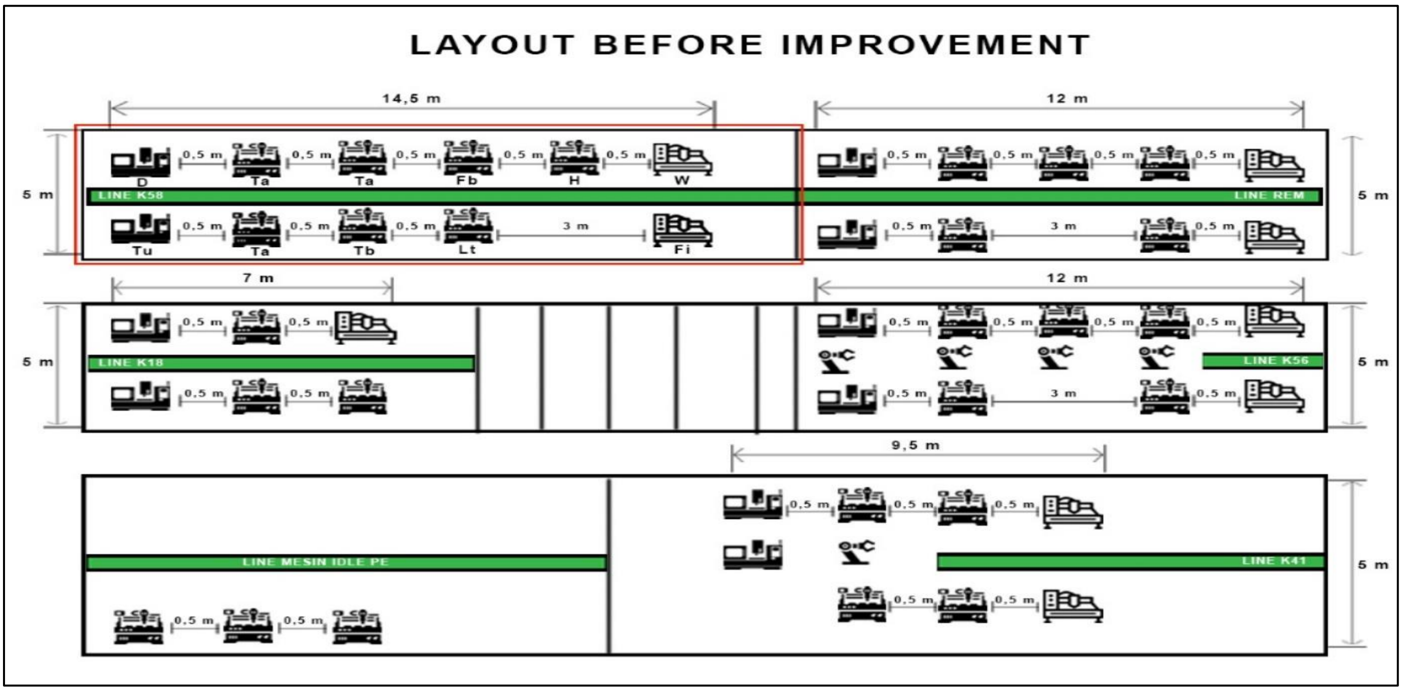

Fig 4 Layout before Repair

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Based on observations in the picture, there are several things that can be noted related to the layout and production flow. First, there is a potential for a jumping process because of the process flow and zigzag placement of the machine on *the K58 line* which is marked in red. *The jumping process* often occurs when one of the stages of the machine process is skipped without being executed correctly, which can result in findings at the final inspection stage of the production line. This problem is also the main topic raised in this article, namely quality control in *the K58 line*.

In addition to the main problem above, there are also other problems, namely the layout of the Ex Piston line which is in the *Iddle PE* area and the engine is still installed even though it is not used in the current production process, even so some machines remain in the production area that was previously used to produce marketing goods. Then the next problem is that *the K58* and K41 lines are located in separate areas, resulting in *less efficient* indirect control.*Line K58* is specifically for producing *Cylinder comp components for* CUB type K58 motorcycles, while Line K41 is for CUB type K41 motorcycles.

The image below illustrates the proposed layout after the refurbishment has been made, in an effort to improve efficiency and optimize workflow in the production facility. This change is based on an evaluation of the previous layout, with the aim of reducing potential major issues such as the jumping process and improving consistency in process control.

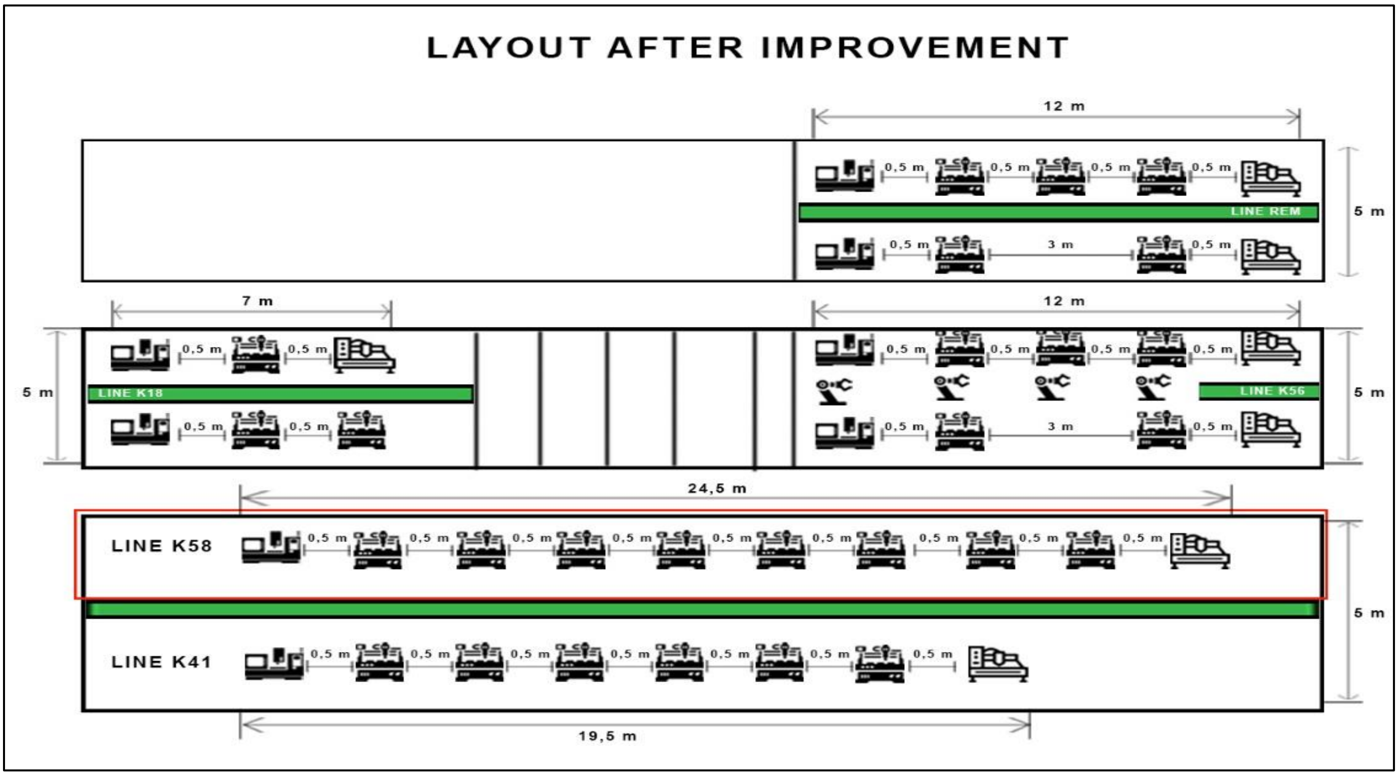

Fig 5 Layout after Repair

In the image above, it can be seen that the area that is in the red line is the area that is being researched about quality control. This proposed layout improvement addresses several identified issues. The main benefit is an effort to minimize the potential *for jumping process* on *the K58 line* so that the level of *defects* due to *Tap NG* can be suppressed. The *washing machine* on the *K58 line* was also moved because it was replaced manually using *an air gun* in the *honing machine*. *Next* is the activity *of Seiri* or sorting of unnecessary items for the Ex Piston engine in the previous *PE Iddle* area. In addition, the combination of *the K58* and K41 lines in one area is also able to improve the efficiency of *indirect* control. Then the last is that the layout redesign is carried out by considering the 4K principles, namely cleanliness, neatness, order, and discipline, to increase the overall operational effectiveness.

V. CONCLUSION

From the results of the research and analysis that has been carried out, the following can be concluded:

- After conducting an in-depth analysis using the *Why-Why Analysis method* and 5W1H elements, the author has identified a number of necessary improvements, especially changes in the engine layout at the *machining cylinder comp* production facility on *the K58 line*. This analysis reveals that the previous engine layout was not optimal, often causing the jumping process, which had an impact on the *tapping process* that did not meet the standards. In addition, the placement *of separate* K58 *and* K41 lines resulted in *less efficient* indirect control.

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- The proposed layout changes aim to improve operational efficiency and optimize workflow. By redesigning the engine layout to be more in line with the required production flow, the potential for *the jumping process* can be minimized. *The Seiri* activity is applied to *the Ex Piston* engine in the *Iddle PE area*, while the incorporation of *the Line K58* and *K41* in one area will improve the efficiency of *indirect* control. This change also considers the 4K principles (cleanliness, neatness, order, and discipline) to improve the overall effectiveness of operations.

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