



1. INTRODUCTION

The development of the service and manufacturing industries supported by advanced technology in this modern era is undoubtedly a form of intense competition for companies in the global market. To be able to compete with competitors, companies must be able to maintain and optimize the quality of the products produced with quality control activities. According to (Gaspersz, 2005), quality control is an important management tool to maximize product quality maintain and minimize product defects, generate value, and provide customer satisfaction (Gaspersz, 2005). The purpose of quality control is to create a finished product with good quality and according to plan before and during the production process, reduce errors that occur and increase productivity and cooperation between teams (Supriyadi, 2021)

Six Sigma method is a tool that is widely used in quality control processes. In Greek, Sigma means the standard deviation or standard deviation. Six Sigma is the right method to achieve zero defects because it is part of the vision of improving quality towards the target of 3.4 defects per million opportunity (DPMO) per product (goods or service) transaction (Tambunan, Sumartono and Moektiwibowo, no date). The zero defect concept refers to errors due to missing information that can be resolved with modern techniques. The causes of errors must be continuously analyzed to obtain a good production process and final result (Ahmad, 2019). It is hoped that implementing Six Sigma can satisfy customers, optimize company profits, minimize production costs, and add value to companies and business processes (Wulansari et al., no date). Six Sigma finds the best fix solutions to problems that occur using the DMAIC process steps. The steps of DMAIC are defining, measuring, analyzing, improving, and controlling, which are used to carry out continuous improvement to achieve six sigma goals. (Arifin and Khairunnisa, no date)

Improving quality by decreasing company failures can be implemented by recommending improvements using the Failure Mode and Effect Analysis (FMEA) method. This method is effective for processing the potential failure, the impact that occurs from the failure condition, and the severity of the failure mode effect. With this method, it will be possible to define, identify, and eliminate errors and problems in the

production process and problems detected (Prakasa, 2020). In the FMEA method, it will be known that the Risk Priority Number value obtained is based on the calculation result of the identification of severity, occurrence, and detection factors which with the highest to lowest RPN values will be used to provide priority recommendations for improvement (Ahyari, 1990).

PT. INKA Multi Solusi is a subsidiary of PT. Industri Kereta Api engaged in manufacturing services, manufacturing and trading spare parts and products for land transportation, and manufacturing railway components according to customer specifications. The product currently being worked on is the type 50 FT flat carriage (UGL) product ordered by the KiwiRail company, Australia, with a total production in November 2022 to April 2023 of 791 carriages. Maintaining product quality from the production process, especially the UGL train type 50 FT in PT INKA Multi Solusi, still faces many defects. This product has three components: headstock arrangement, bolster, and center sill. The components that have the most number of defects are the headstock arrangement components, with the four most common types of defects that are undercut, porosity, overlap, and unequal leg length defects, with a total of 1582 headstock arrangement units which have a total of defects in November 2022 to April 2023 of 408 units exceeding the standard of company limit of 8.7%.

Therefore, based on the problems that occurred at PT. INKA Multi Solusi needs to conduct product quality research on the welding results of the UGL train in the headstock arrangement section to find out the reason factors defects that appear using the six sigma method and give recommendations for appropriate improvements regarding the quality of the welding joints, especially in the headstock arrangement so that can be resolved using Failure Mode Effect Analysis (FMEA) method to PT. INKA Multi Solusi.

2. METHODS

This research was conducted in PT. INKA Multi Solusi that located at Jalan Surabaya-Madiun KM 161 Number 1 Madiun, East Java. This research was carried out in March 2023 until the required data was fulfilled. Research data is

obtained from interviews, observations, and company internal data. This research requires data for the period November 2022 to April 2023 which consists of data on the total production of UGL train type 50 FT, data on the total output of headstock arrangement components for UGL train type 50 FT, data on the number of defects, and data on types of defects.

This research in processing and analyzing data uses the six sigma method with the concept of DMAIC (Define, Measure, Analyze, Improve, and Control). The first stage is defined; the author will determine the problem and focus on objects, goals, objectives, and the parameters used in this step (Hidayat, 2018). The second step, namely measure, measures the characteristics and capabilities of existing processes to provide improvements (Fauzi and Safirin, 2021). Determine the Critical to Quality (CTQ) of the product and plan data collection by measuring the process level, output level, and outcome, then making a control chart, calculating the DPO and DPMO values, also calculating the sigma level by interpolating the DPMO values into the sigma table (Teja, Ahmad and Laricha, no date). The third step is analysis, namely identifying the causes of existing problems and controlling them using a cause-and-effect diagram (Rafif Seno et al., 2022). Fishbone

diagrams are used to determine factors that cause product defects and the cause-effect of these factors on the product (Meidiarti, 2020). The fourth step is to improve; this step aims to implement improvements suggestions obtained from the previous step to minimize the causes of existing defects (Wicaksono et al., 2022). Failure Mode and Effect Analysis determines the impact of all failures and priority preventive and corrective actions by deciding that the product produced will work properly and as desired in subsequent production (Suseno and Kalid, 2022). The fifth step is control, which controls the process continuously during the improvement phase[16].

3. FINDINGS AND DISCUSSION

3.1. Data collection

Data collection was carried out from November 2022 to April 2023 in the form of data on production quantities, data types of defects, and data on the number of defects in Table 1 below. This table shows that the highest number of production and total defects in February 2023 were 280 and 88 units, for the lowest production and defects in April 2023 of 258 units and 23 units.

Table 1. Data on production and product defects of the UGL train type 50 ft part of the headstock arrangement

Month	Data (Unit)	Number of Porosity Defects (Units)	Number of Undercut Defects (Units)	Number of Overlap Defects (Unit)	Number of Unequal Leg Length Defects (Unit)	Total of Defects (Unit)	% Defects Monthly
November 2022	262	27	28	6	7	68	26%
December 2022	274	9	27	23	22	81	29.6%
January 2023	258	9	12	6	5	32	12.4%
February 2023	280	15	40	25	8	88	31.4%
March 2023	250	9	18	5	10	42	16.8%
April 2023	258	7	9	4	3	23	8.9%
Total	1582	76	134	69	55	334	

(source: PT. INKA Multi Solusi)

3.2. Data processing

Data processing in this study uses the six sigma DMAIC (Define, Measure, Analyze, Improve, and Control) stages as follows: The first step is to define. Implementation of identification of research objects and objectives

to be achieved where the object for this research is focused on the production process of the UGL type 50 FT train in the Headstock Arrangement section from November 2022 to April 2023 because there is a defect percentage of the UGL type 50 FT train product, especially in the

headstock arrangement which exceeds Company standards can be seen in Figure 1 below.

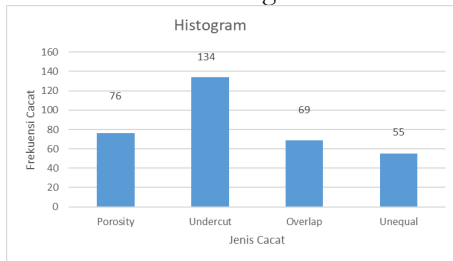


Figure 1. Graph of Histogram of Defect Types for February-August 2022

The graph above of defects is not constant for each type of defect, and the highest defects are undercut defects at 134 units, porosity defects at 76 units, overlap defects at 69 units, and unequal leg length at 55 units.

The second step is a measure. Determination of key quality characteristics or Critical to Quality (CTQ) in the production process of the UGL type 50 FT train, especially in the headstock arrangement consisting of 4 types, including porosity defects, undercut, overlap, and unequal leg length, which is attached in Figure 2 to Figure 5 below.



Figure 2. Porosity defect (source: PT. INKA Multi Solusi)



Figure 3. Undercut Defect (source: PT. INKA Multi Solusi)



Figure 4. Overlap Defect (source: PT. INKA Multi Solusi)



Figure 5. Unequal Leg Length Defect (source: PT. INKA Multi Solusi)

This stage also uses a Pareto chart to determine the percentage of defects that occur each month, which is depicted in Table 2, table 3, table 4, table 5, table 6, figure 6, figure 7, figure 8, figure 9, and figure 10. Table 2 and Figure 6 shows that the highest type of defect is an undercut defect of 134 with a defect percentage of 40.1%. Table 3 and Figure 7 shows that the highest porosity defect was in November 2022, with 27 units with a defect percentage of 36%.

Table 4 and Figure 8 shows that the highest type of undercut defect was in February 2023 of 40 units with a defect percentage of 30%. Table 5 and Figure 9 shows that the highest type of overlap defect was in February 2023, of 25 units with a defect percentage of 36%. Table 6 and Figure 10 shows that the highest type of unequal leg length defect was in December 2022, with 22 units and a defect percentage of 40%.

Table 2. The percentage of defects and the cumulative percentage of defects in November 2022 – April 2023

Defect Type	Number of Defects (Unit)	Defect Percentage (%)	Defect Cumulative Percentage (%)
Porosity	76	22.8%	22.8%
Undercut	134	40.1%	62.9%
Overlap	69	20.7%	83.5%
Unequal Leg Length	55	16.5%	100.0%
Total	334		

(source: Primary Data Processed)

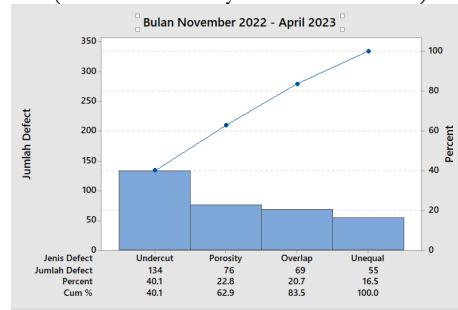


Figure 6. Defect Pareto Chart for November 2022 – April 2023

Table 3. The percentage of defects and the percentage of cumulative porosity defects in November 2022 – April 2023

Month	Number of Defects (Unit)	Defect Percentage (%)	Defect Cumulative Percentage (%)
November 2022	27	36%	36%
December 2022	9	12%	47%
January 2023	9	12%	59%
February 2023	15	20%	79%
March 2023	9	12%	91%
April 2023	7	9%	100%
Total	76		

(source: Primary Data Processed)

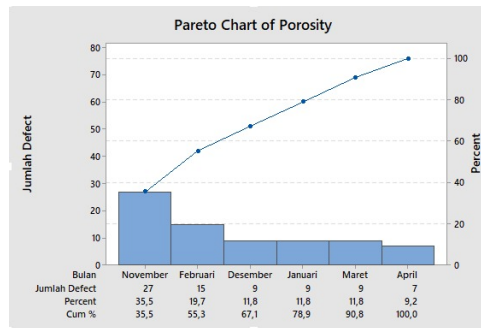


Figure 7. Pareto Chart of Porosity Defects in November 2022 – April 2023

Table 4. The percentage of defects and the percentage of cumulative undercut defects in November 2022 – April 2023

Month	Number of Defects (Unit)	Defect Percentage (%)	Defect Cumulative Percentage (%)
November 2022	28	21%	21%
December 2022	27	20%	41%
January 2023	12	9%	50%

February 2023	40	30%	80%
March 2023	18	13%	93%
April 2023	9	7%	100%
Total	134		

(source: Primary Data Processed)

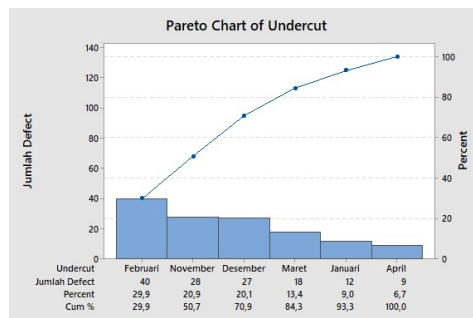


Figure 8. Pareto Chart of Undercut Defects in November 2022 – April 2023

Table 5. The percentage of defects and the percentage of cumulative overlap defects in November 2022 – April 2023

Month	Number of Defects (Unit)	Defect Percentage (%)	Defect Cumulative Percentage (%)
November 2022	6	9%	9%
December 2022	23	33%	42%
January 2023	6	9%	51%
February 2023	25	36%	87%
March 2023	5	7%	94%
April 2023	4	6%	100%
Total	69		

(source: Primary Data Processed)

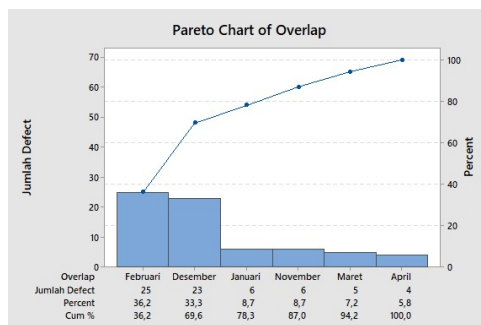


Figure 9. Pareto Chart of Overlap Defects in November 2022 – April 2023

Table 6. The percentage of defects and the percentage of cumulative unequal leg length defects in November 2022 – April 2023

Month	Number of Defects (Unit)	Defect Percentage (%)	Defect Cumulative Percentage (%)
November 2022	7	13%	13%
December 2022	22	40%	53%
January 2023	5	9%	62%
February 2023	8	15%	76%

March 2023	10	18%	95%
April 2023	3	5%	100%
Total	55		

(source: Primary Data Processed)

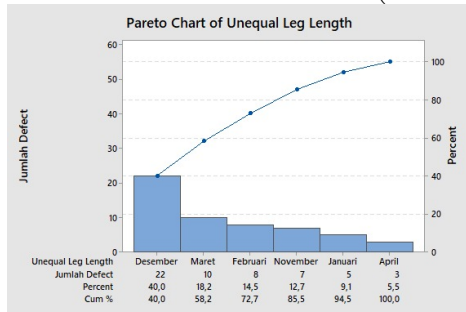


Figure 10. Pareto Chart of Unequal Leg Length in November 2022 – April 2023

After knowing the percentage of defects, the next step is to make a control chart for each type of defect. In the control chart image, it will be seen that data exceeds the control limits, as in Figure 11, it is known that there is data that is out of control, namely on the first (November 2022) with a total production of 262 units and a total defect of 27 units, which means that the production process is doesn't work well and needs repair. Based on Figure 12, it can be seen that the data that exceeds the control limit is in the 4th period (February 2023), with a total production of 280 units and a total defect of 40 units, which means that the production process is not going well and requires improvement.

Based on Figure 13, it can be seen there are data that exceed the control limits, namely in the 2nd and 4th periods (December 2022 and February 2023). In the second period, with a total production of 274 units and a total defect of 23 units. Meanwhile, for the 4th period, the total production was 20 units and a total defect of 25 units which means that the production process is not going well and needs improvement.

Based on Figure 14, it can be seen that there is data that exceeds the control limit, namely in the 2nd period (December 2022), with a total production of 274 units and a total defect of 22 units, which means that the production process is not going well and requires improvement.

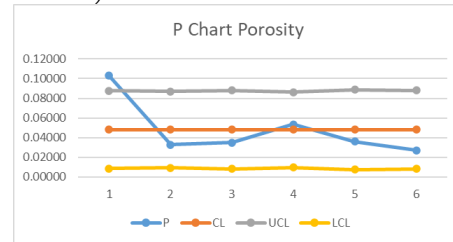


Figure 11. P- Chart of porosity defect

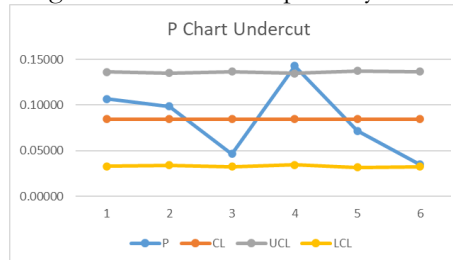


Figure 12. P- Chart of undercut defect

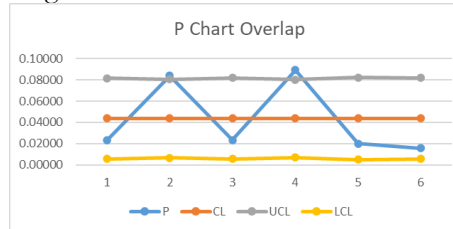


Figure 13. P- Chart of overlap defect

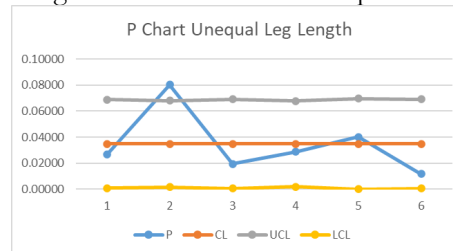


Figure 14. P - Chart of unequal leg length defect
The next step of measure is to calculate the DPO and DPMO values to determine the sigma level in each period and the chance of a defect occurring on one million occasions. In Table 7 below, it is known that the average sigma value of PT. INKA Multi Solusi is 3.16, which means still far from the six sigma value. So, quality improvement is still needed for the production process of the UGL *type* 50 FT train in the *Headstock Arrangement* section at PT. INKA Multi Solusi.

Table 7. DPO, DPMO, and sigma level values of UGL Train *type* 50 ft part headstock arrangement at November 2022 – April 2023

Month	Total Production (Unit)	Number of Defects (Unit)	CTQ	DPO	DPMO	Sigma levels
November	262	68	4	0.064885	64885	3.02
December	274	81	4	0.073905	73905	2.94
January	258	32	4	0.031008	31008	3,36
February	280	88	4	0.078571	78571	2.91
March	250	42	4	0.042000	42000	3,23
April	258	23	4	0.022287	22287	3.51
Average				0.052314	52314	3,16

(source: Primary Data Processed)

The third step in the six sigma method is the analysis phase. Analyze the results of the measurements and the root causes of the problems using a cause-and-effect (fishbone diagram) shown in Figure 15 below. By using a fishbone diagram, it will be known the causes of disability from several factors. For porosity defects, the cause of the problem is viewed from three factors, namely material, human, and environment. For undercut defects, the cause of the problem is viewed from four factors: material, human, environment, method, and machine. For overlap defects, the cause of the problem is known from man, environment, method, and machine. For unequal leg length defects, the cause of the problem is known from three factors: human, material, and method.



Figure 15. Fishbone Diagram of Overlap Defect

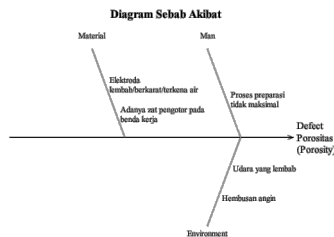


Figure 16. Fishbone Diagram of Porosity Defect



Figure 17. Fishbone Diagram of Undercut Defect



Figure 18. Fishbone Diagram of Unequal Leg Length Defect

The fourth step is to improve; this step will give improvement ideas to deal with defects using the FMEA (Failure Mode and Effect Analysis) method. This method will obtain an RPN (Risk Priority Number) value which is useful in determining the order of priority treatment for causes of disability. Improvement priorities will be based on the highest to lowest RPN values [7]. The following is the formula for calculating the RPN value:

$$RPN = Severity \times Occurance \times Detection$$

The table below shows the analysis results obtained with the severity, occurrence, and detection values obtained from the interviews with the welder who did the welding on the headstock arrangement part for the UGL train type 50 FT product at PT. INKA Multi Solusi. The following table contains recommendations

for each cause of the disability problem, which will then form a recapitulation of the RPN values from the highest to the lowest for each type of defect. There are three recommendations that must be made based on Table 8 to improve the quality of the UGL train type 50 FT production process for headstock arrangement. The first highest RPN value of 343 is recommended to improve the welder's supervision when welding

and ensure that all welders have read & understood the SOP used. The second highest RPN value of 294 is recommended for improvement in cleaning (blasting) the workpiece to remove residual dirt from welding. The third-highest RPN value of 245 is given a recommendation in the form of providing a memo regarding the welding results to the next welder

Table 8. Porosity FMEA

Modes of Failure	Effect of Failure	S	Cause of Failure	O	Current Controls	D	RPN
Porosity	The headstock arrangement of UGL train type 50 FT product contains small holes which cause corrosion and cracks to appear when the product is loaded.	7	Material	6	Handle electrodes according to procedures	4	168
			Moist/rusty/water-affected electrodes				
			The presence of impurities in the workpiece	7	Checking the cleanliness of the workpiece before & after welding	6	294
			Man	5	Supervise the preparation process properly	5	175
			The preparation process is not optimal.				
			Environment	5	Installing a hygrometer and adding an exhaust fan to the workspace	4	140
			Moist air				
			Wind breeze	3	Protect the welding area with a protective sheath	3	63

Table 9. Undercut FMEA

Modes of Failure	Effect of Failure	S	Cause of Failure	O	Current Controls	D	RPN
Undercut	The headstock arrangement of UGL train type 50 FT contains irregular holes, which cause cracks when exposed to loads and reduce the strength of the welded joints.	6	Material	4	Set the position of the electrode according to the procedure	5	120
			Incorrect electrode position				
			The electrodes used are not suitable	4	Checking the size & specifications of the electrode before carrying out the welding process	3	72
			Man	5	Conduct briefings & provide job training once every 6 months to improve welder's ability to do welding	6	180
			The welder's hand swing is unstable.				
			Welder fatigue & defocus	4	Monitor the welding process carried out by the welder	4	96

			Welding speed is too high	6	Conduct training and welder certification exams	4	144
			Method	6	Attach the welding machine procedure manual & prepare the machine to regulate the welding current used according to the WPS	5	180
			Welding current is too high				
			Machine	5	Tighten the SOP to adjust the length of the welding arc according to the position of the electrode with the workpiece	5	150
			Welding arc length too high				

Table 10. Overlap FMEA

Modes of Failure	Effect of Failure	S	Cause of Failure	O	Current Controls	D	RPN
Overlap	The headstock arrangement of UGL train type 50 FT contains the liquid pools on the base metal without bonding (non-fusion).	7	Man	6	Conduct briefings and training for welders to master the use of welding machines better	7	343
			<i>The welder's welding movement is wrong. That is, it is too wide.</i>				
			Machine	5	Adjusts the ampere parameter according to the WPS used	4	140
			Use of low amperage				
			Environment	4	Set room lighting standards according to <i>Occupational Safety and Health Administration</i> (OSHA) rules	3	84
			Lighting is lacking				
			Method	6	Set the electrode angle according to the procedure	5	210
			Incorrect electrode angle determination				

Table 11. Unequal Leg Length FMEA

Modes of Failure	Effect of Failure	S	Cause of Failure	O	Current Controls	D	RPN
Unequal Leg Length	The headstock arrangement of UGL train type 50 FT contains defects where the welding legs are not equal, which will cause cracks and fractures when exposed to loads and reduce the strength of the welded joint.	7	Man	5	<i>Welder</i> work and provide welding training to improve <i>welder skills</i>	4	140
			Negligence and lack of <i>welder expertise</i> in welding				
			<i>Welder</i> replacement	6	Inform directly the next <i>welder</i> who will continue welding	5	245
			Material	4	Checking the quality of the root of the weld to comply with	3	84
			The root <i>face</i> is too thin.				

		predetermined standards		
Method	5	Take measurements with an assistive device (<i>cast</i>) & ensure that <i>the root gap</i> is in accordance with the procedure	5	175
Setting the distance of the material to be welded (<i>root gap</i>) is too wide.				

After determining the recommendations for each cause of the defect, a recapitulation of the RPN values from the highest to the lowest for each type of defect will be formed. Three recommendations must be made based on Table 12 to improve the quality of the UGL train type 50 FT production process in the headstock arrangement. The first highest RPN value of 343 is recommended to improve the welder's supervision when welding and ensure that all *welders* have read & understood the SOP used. The second highest RPN value of 294 is recommended for improvement in cleaning (*blasting*) the workpiece to remove residual dirt from welding. The third-highest RPN value of 245 is recommended to provide a memo regarding the welding results to the next *welder*.

Table 12. Recapitulation of the value of the RPN of all recommendations for improvement

Priority Number	Causes of Failure	RPN	Recommendations
1	The welder's welding movement is wrong. Which is too wide.	343	Supervise the <i>welder</i> when welding and ensure that all <i>welders</i> have read & understand the SOP used
2	The presence of impurities in the workpiece	294	Perform cleaning (<i>blasting</i>) on the workpiece to remove residual dirt from the welding
3	<i>Welder</i> replacement	245	Provision of a memo regarding the results of the welding to be given to the next <i>welder</i>
4	Incorrect electrode angle determination	210	Set the electrode angle according to the procedure
5	The welder's hand swing is unstable	180	Conduct <i>briefings</i> & provide job training once every six months to improve <i>welder's ability</i> to do welding.
6	The welding current is too high	180	Attach the welding machine <i>procedure manual</i> & prepare the machine to regulate the welding current used according to the WPS.
7	Setting the distance of the material to be welded	175	Take measurements with an assistive device (<i>cast</i>) & ensure that <i>the root gap</i> is in

	(<i>root gap</i>) is too wide		accordance with the procedure.
8	The preparation process is not optimal	175	Conduct a <i>briefing</i> before each welding
9	Moist/rusty electrode exposed to water	168	Use the recommended procedure for electrode <i>treatment</i>
10	Welding arc length too high	150	Tighten the SOP to adjust the welding arc's length according to the electrode's position with the workpiece.
11	Negligence and lack of <i>welder expertise</i> in welding	148	<i>Welder</i> work and provide welding training to improve <i>welder skills</i>
12	The welding speed is too high	144	Conduct training and <i>welder certification exams</i>
13	Use of low amperage	140	Adjusts the ampere parameter according to the WPS used
14	Moist air	140	Installing a <i>hygrometer</i> and adding an <i>exhaust fan</i> to the workspace
15	Incorrect electrode position	120	Set the position of the electrode according to the procedure
16	The root <i>face</i> is too thin	84	Checking the quality of the root of the weld to comply with predetermined standards
17	Lighting is lacking	84	Set room lighting standards according to <i>Occupational Safety and Health Administration</i> (OSHA) rules
18	The electrodes used are not suitable	72	Checking the size & specifications of the electrode before carrying out the welding process
19	Wind breeze	63	Protect the welding area by providing a sheath/curtain/screen

3.2. Discussion

Step define, identifies the object to be studied: the high percentage of the defects, which is porosity, undercut, overlap, and unequal leg length, which are outside the company's standard

limits that occur in the train production process. UGL *type* 50 FT. The focus of the research object is the production process for the UGL *type* 50 FT train, the headstock arrangement, in the period from November 2022 to April 2023.

The step measure obtained the highest percentage of defects in November 2022 - April 2023, namely undercut defects, that is 41.2%; 33.3%; 37.5%; 45.5%; 42.9%; 39.1%; 40.1%. Meanwhile, the highest percentage of defects per CTQ for the type of porosity defects occurred in November 2022, with a defect percentage of 36%. The highest type of undercut defect occurred in February 2023, with a defect percentage of 30%. For the type of overlap, the highest defects occurred in December 2022, with a defect percentage of 33%. For the highest type of unequal leg length defects occurred in December, with a defect percentage of 40%. The next step is to make a control chart (P-chart) for each CTQ where based on the control chart, it can be seen that there is data that is out of control, which means that the production process is not going well and needs to be repaired.

The next step is calculating the average DPMO value and level of Sigma for November 2022 – April 2023, which was 52,314, and the Sigma level average was 3.16. This value is still less than the six sigma value, so it is necessary to analyze the causes of failure at the analyze step and provide recommendations for improvement at the improve step.

In the step analyze, analysis and determination of the root causes of the CTQ problem are carried out using a *fishbone* diagram. In porosity defects, there are several factors that affect, including damp/rusty electrodes exposed to water, the presence of impurities on the workpiece, the preparation process not being optimal, wind blows, and moist air. For undercut defects caused by several factors, including improper electrode position, inappropriate electrode used, unstable welder hand swing, welder fatigue and defocus, too high welding current, too high welding speed, and too high welding arc length. Overlap defect is caused by several factors, including the wrong welder welding movement which is too wide, the electrode angle not set correctly, the use of low amperage, and insufficient lighting. For unequal leg length defects caused by several factors, namely the replacement of the welder, determining the distance of the material to be welded (root gap) is too wide, negligence and lack of welder expertise in welding, and the root face is too thin.

The next step is improve. Improvements in this study used the FMEA method to rank

improvements from the highest to the lowest RPN value. For the highest RPN value of 343, a recommendation for improvement is supervising the *welder* when welding and ensuring that all *welders* have read & understood the SOP used. For the value of RPN 294, a recommendation for improvement is blasting the workpiece to remove residual dirt from welding. For the value of RPN 245, a suggestion for improvement is providing a memo regarding the results of the welding to be given to the next *welder*. Furthermore, for an RPN value of 180, suggestions for improvements are given in the form of conducting *briefings* & providing job training every six months to improve *the welder's ability* to do welding and, attach manual procedures for welding machines & carry out machine preparations to regulate welding currents used according to WPS. Furthermore, for an RPN value of 175, suggestions for improvement are given by measuring with tools (gips) & ensuring the root gap distance is in accordance with the procedure. The last step of Six Sigma is control. At this step, the company has a process control system both in controlling specification standards and controlling work instructions so that each process can be controlled, out specs that occur can be reduced by the company, and the target of six sigma quality improvement can be achieved. However, this research was not carried out at the control stage because it only came to giving recommendations for improvement.

4. CONCLUSION AND SUGGESTION

Based on the results of research conducted on the production process of the UGL train type 50 FT for the headstock arrangement part at PT. INKA Multi Solusi for the period November 2022 to April 2023, it was concluded that the average sigma value obtained was 3.16, which means that it has not reached the standard target of Six Sigma. Recommendations for improvement using the Failure Mode and Effect Analysis method to determine the factors that cause defects that occur are obtained based on the highest RPN value. The first highest RPN value of 343, suggestions for improvement are given in the form of conducting briefings and training for welders to be more adept at using welding machines. The second highest RPN value of 294, a proposed improvement is given by blasting the workpiece to remove residual dirt from welding.

The third highest RPN value of 245, a proposed improvement is given by providing a memo regarding the current welding results to be given to the next welder. The fourth highest RPN value of 210 was given a suggestion for improvement by setting the electrode angle according to the procedure. The fifth highest RPN value of 180 is given a suggestion for improvement by conducting briefings and providing job training once every six months to improve the ability of welders to do welding.

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DESIGN TOOLS TO MINIMIZE DEFECT IN COUPLING HEAD COMPONENT FINISHING PROCESS USING SIX SIGMA METHOD IN PT XXX.