

IMPLEMENTATION OF SIX SIGMA TECHNIQUE FOR WELDING DEFECT REJECTION

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ABSTRACT

In any organization, six sigma is the tool to enhance the existing process, product, component performance. Six sigma is a quality tool used for improving productivity, reducing flaws and making process economical. Additionally, six sigma technique helps to boost profitability, increase market share and improve customer satisfaction using statistical tools that can lead to breakthrough quantum gains in quality. In this work, rejection reduction in welding defects of different pipes of K2 (Pulsar 180) chassis like main pipe, centre pipe, head pipe are minimized by using six sigma tools in Badve Autocomps Pvt. Ltd.

Keywords: DMAIC, DPMO, Six Sigma, Zero defects

I.INTRODUCTION

Implementation of quality initiatives in any business leads to improvements in the performance of the organization through the generation of high quality products and services, and improved efficiency and competitiveness. The DMAIC (define-measure-analyze-improve-control) approach has been followed here to solve a problem of reducing rework time and the associated high defect rate. The Greek letter σ or 'sigma' is a notation of variation in the sense of standard deviation. For a stable process parameters should be within suitable limits. Six Sigma, a statistically-based quality improvement program, helps to improve business processes by reducing the waste and costs related to poor quality, and by improving the efficiency and effectiveness of processes.

Five major defects were found in chassis,

- Spatter
- Weld burn
- Incomplete weld
- Welding undercut
- Blow holes

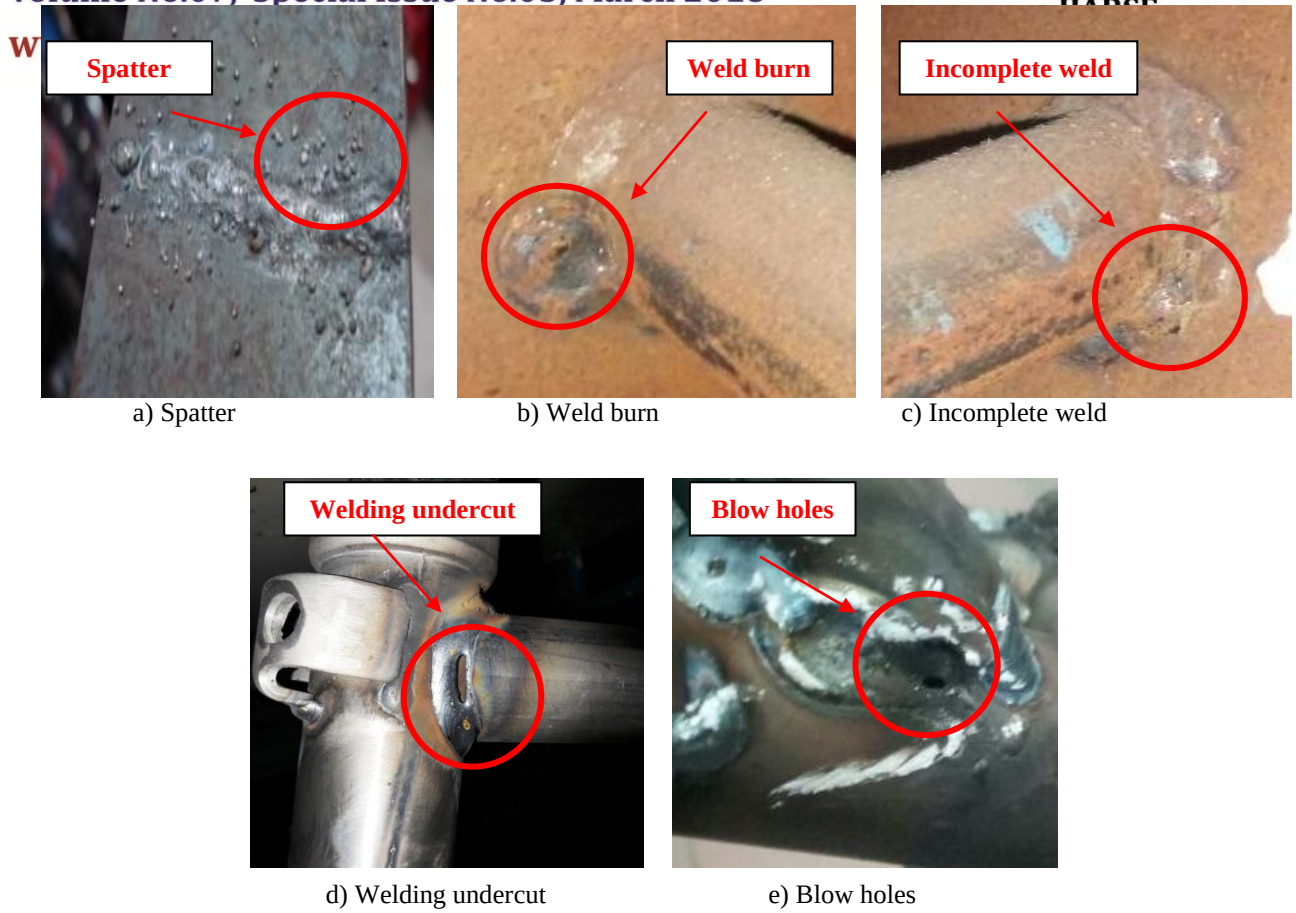


Figure 1: Welding defects a), b), c), d), e)

II. LITERATURE REVIEW

In (2005), Jiju Antony argued that many of the SMEs are not aware of Six Sigma and many do not have the resources to implement Six Sigma projects. More importantly, the most common reason for not implementing Six Sigma is unawareness of Six Sigma [1].

In (2004), Gutierrez et al states that Six Sigma is a strategy of continuous improvement of the organization to find and eliminate the causes of the errors, defects and delays in business organization processes [2].

In (2004), T Pfeifer et al stated that the future challenges for the implementation of Six Sigma will be the link of Six Sigma with the existing approaches of quality management and a ‘smart’ qualification that is oriented at the existing knowledge in the organization [3].

In (2005), M S. Raisinghani, stated in his publication emphasized the importance of the integration of Six Sigma and Lean Management and has stated that today “Six Sigma is a combination of the Six Sigma statistical metric and TQM, with additional innovations that enhance the program’s effectiveness while expanding its focus”[4].

III.METHODOLOGY

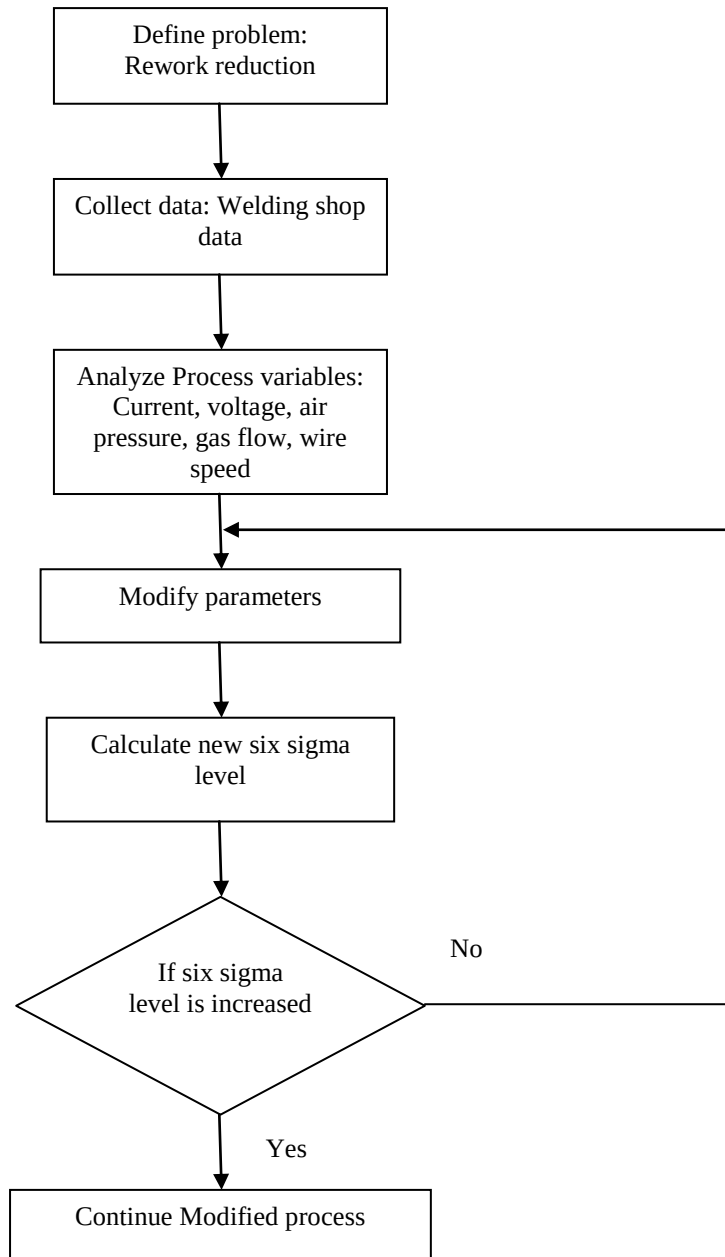


Figure 2: Methodology approach

By using DMAIC methodology, Define phase is described in below. SIPOC diagram is one of the statistical method used give brief information about flow of process.

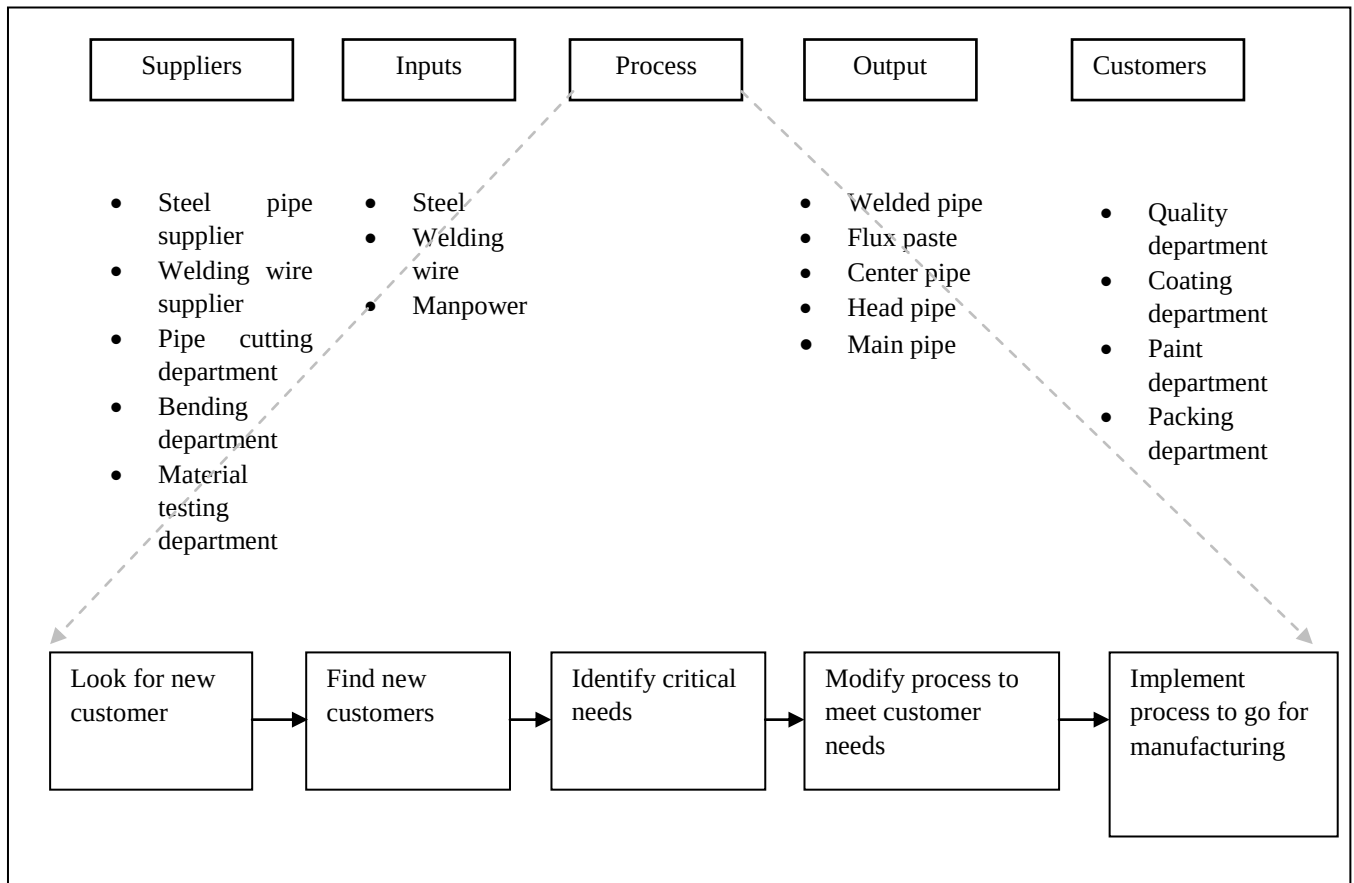


Figure 3: SIPOC Diagram

Six sigma is a business improvement strategy which focuses on reducing the defects and/or reducing the cycle time and improving the customer oriented quality. The data of components which was collected initially before implementation of six sigma tool is used to calculate standard deviation and hence process capability.

Quantity of components inspected, for 500 chassis

Main Pipes: 500

Centre Pipes: 1000

Head Pipes: 500

Check sheet data for three pipes

Sr. No.	Defects	Quantity		
		Main pipe	Centre pipe	Head pipe
1	Spatter	76	23	46
2	Weld burn	57	16	32
3	Welding incomplete	7	4	6
4	Welding undercut	5	2	3
5	Blow holes	3	2	1

Table No 1: check sheet data for three pipes

Pareto Chart for Main Pipe

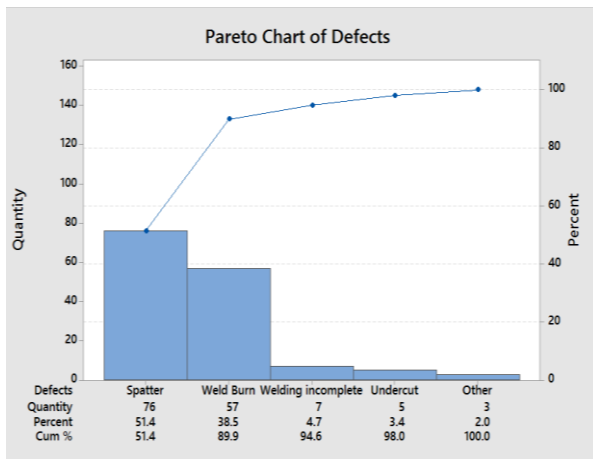


Figure 4: Pareto Chart for Main Pipe

Pareto Chart for Centre Pipe

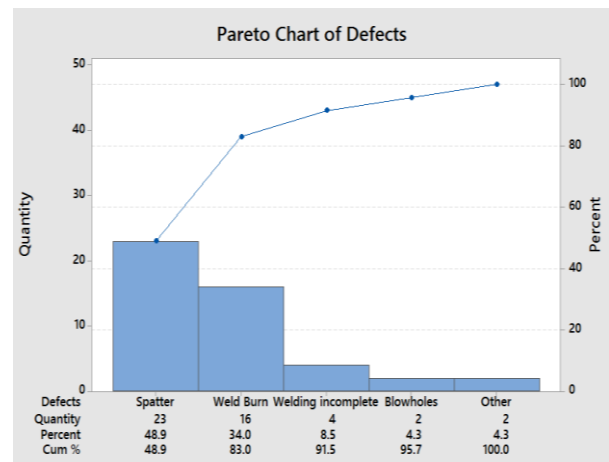


Figure 5: Pareto Chart for Centre Pipe

Pareto Chart for Head Pipe:

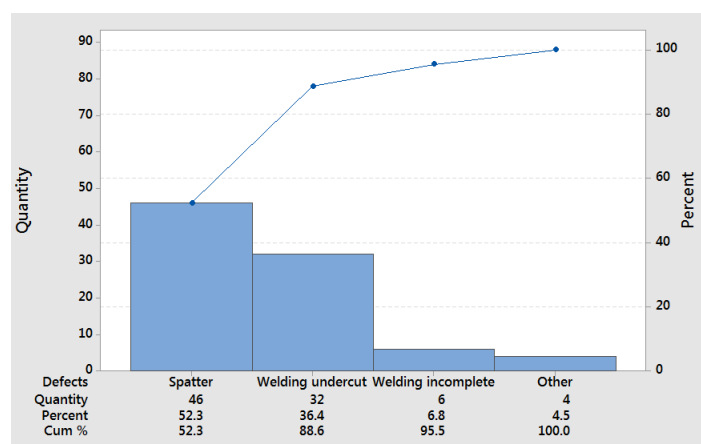


Figure 6: Pareto Chart for Head Pipe

Check sheet of No. of defects after six sigma implementation

Sr. No.	Defects	Quantity		
		Main pipe	Centre pipe	Head pipe
1	Spatter	24	6	8
2	Weld burn	33	10	11
3	Welding incomplete	0	0	0
4	Welding undercut	0	0	0
5	Blow holes	1	2	1

Table No 2: Check sheet of No. of defects after six sigma implementation

IV.MEASURE

Defects per million opportunities (DPMO) is the average number of defects per unit observed during an average production run divided by the number of opportunities to make a defect on the product under study during that run normalized to one million.

Sigma performance levels- One to six sigma	
Sigma Level	DMPO
1	690,000
2	308,537
3	66,807
4	6,210
5	233
6	3.4

Table No 3: Standard Sigma performance levels

Defects per Million Opportunities (DPMO)

$$= \frac{\text{Total no.of defects found in a sample}}{\text{Total no.of defects opportunities in a sample}} \times 1000000$$

Six sigma level for each component

Sr. No.	Component	DPMO	Sigma Level
1	Main Pipe	59200	3.125
2	Centre Pipe	9400	3.947
3	Head Pipe	35600	3.515
4	Overall	28400	3.63

Table No 4: Six sigma level for each component

V.ANALYZE

This phase involves detailed examination to identify causes behind the defects. Table no. gives the process parameters that affect the occurrence of defects with their observed values.

Parameters	Specifications
Current	200 A
Voltage	25 V
Gas flow	7 lpm
Wire speed	18 m/min
Air pressure	4-5 Kg/m ²

Table No 5: Specifications of variable parameter

Based on process observations cause and effect diagrams can be plotted as:

Fishbone Diagram for spatter

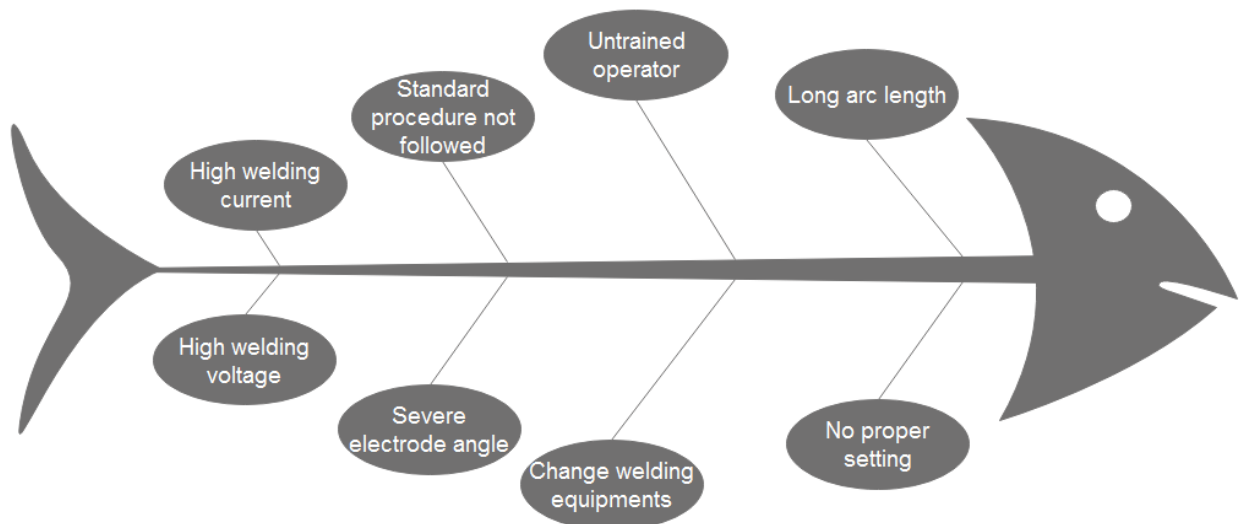


Figure 7: Fishbone diagram for Spatter

Fishbone Diagram for weld burn



Figure 8: Fishbone diagram for Weld burn

Fishbone Diagram for welding incomplete

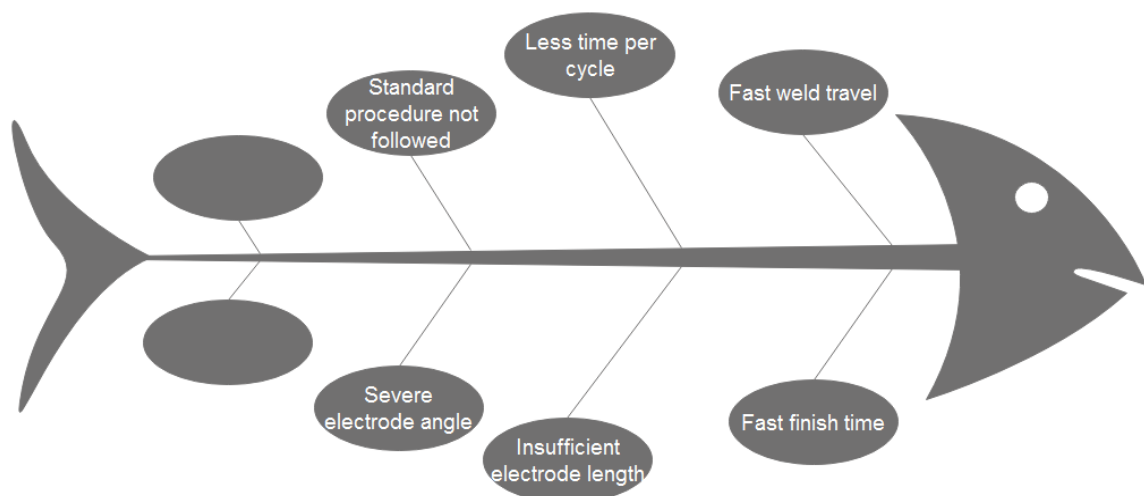


Figure 9: Fishbone diagram for Welding incomplete

Fishbone Diagram for welding undercut

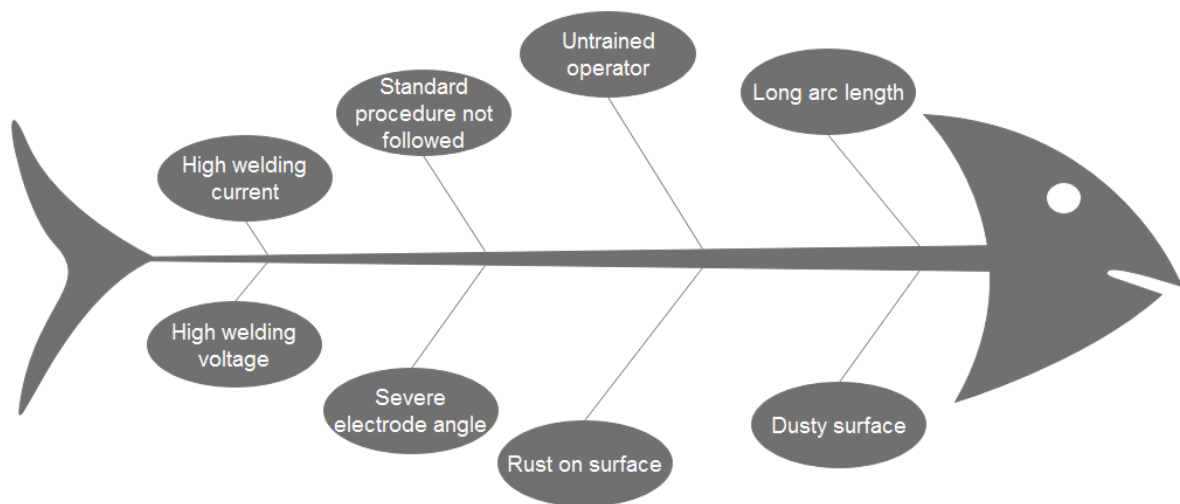


Figure 10: Fishbone diagram for Welding undercut

Fishbone Diagram for blow holes

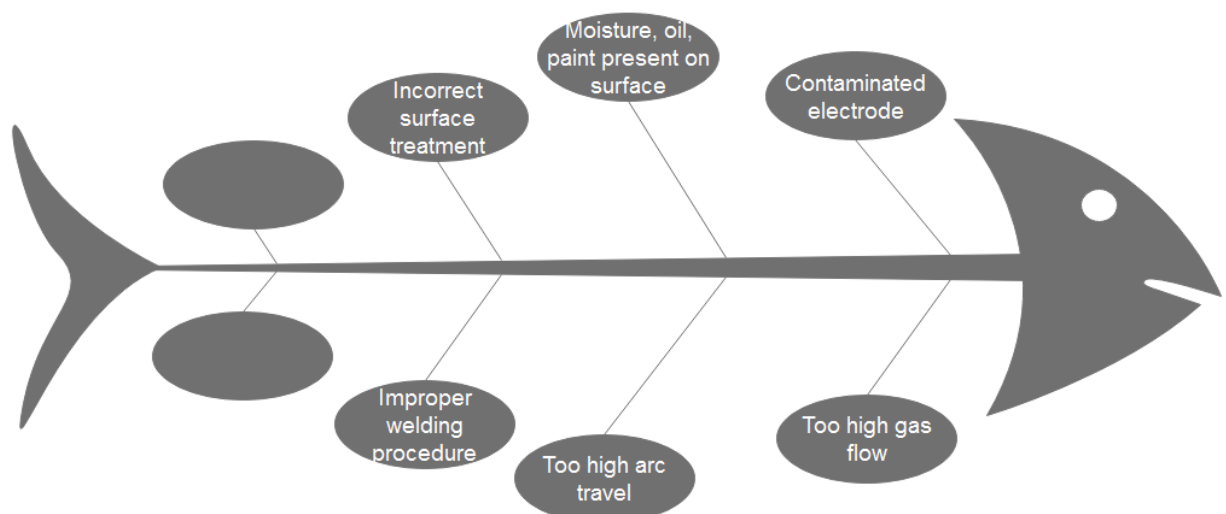


Figure 11: Fishbone diagram for Blow holes

VI.IMPROVE

The observed values of process parameters were found to be improper for the manufacturing process. Further studies about defects revealed that the defects occurring during manufacturing can be minimized by changing the process parameters to some extents. Table no. gives the improved values of process parameters.

Parameters	Range
Current	160-180 A
Voltage	18-20 V
Gas flow	10-15 Lpm
Wire speed	9-15 <i>m/min</i>
Air pressure	4-5 <i>Kg/m²</i>

Table No 6: Improved range of process parameters

VII.CONTROL

This phase includes implementation and periodic reevaluation of changes made in process or process parameters. After changing the process parameters the quantity of defects was reduced considerably as shown in Table no. 7 .

Sr. No.	Defects	Quantity					
		Main pipe		Centre pipe		Head pipe	
		Before	After	Before	After	Before	After
1	Spatter	76	24	23	6	46	8
2	Weld burn	57	33	16	10	32	11
3	Welding incomplete	7	0	4	0	6	0
4	Welding undercut	5	0	2	0	3	0
5	Blow holes	3	1	2	2	2	1

Table No 7: Quantity of defects before and after implementation of six sigma

VIII. CALCULATION AND RESULTS

Sigma levels for all components are found out using Table no. 3 by interpolation. Table no. 8 gives previous and later values of DPMO and sigma level after application of six sigma tools.

$$\text{Sigma Level} = \text{SL2} - \frac{\text{DPMO(2)} - \text{DPMO(OBS)}}{\text{DPMO(2)} - \text{DPMO(1)}} \times (\text{SL2} - \text{SL1})$$

For Main Pipe previous observation,

$$\text{Sigma Level} = 3 - \frac{66807 - 59200}{66807 - 6210} \times (3-4) \\ = 3.125$$

Similarly, calculations are obtained for other components

Sr. No.	Component	DPMO		Sigma Level	
		Before	After	Before	After
1	Main Pipe	59200	24995	3.125	3.69
2	Centre Pipe	9400	3760	3.947	4.4
3	Head Pipe	35600	6150	3.515	4.01
4	Overall	28400	9600	3.63	3.94

Table No 8: Result table

IX. CONCLUSION

From above thesis it is can be seen that by changing process parameters the occurrence of defects in inspected components are minimized.

Operating parameters considered are:

- Welding current
- Voltage
- Welding speed
- Gas pressure

Thus the overall sigma level of product was 3.63 which was increased to 3.94 due to implementation of six sigma.

The overall sigma level is increased by 8.53%.

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