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USING QUALITY CONTROL TO REDUCE PRODUCTION DEFECTS IN THE ALUMINIUM MANUFACTURING INDUSTRY

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ABSTRACT

The Research was carried out to help control the defects seen in produced aluminium rolls in First Aluminium Plc, Six sigma method was adapted as a way to curb the defects experienced in the batches produced. Data of produced batches of aluminium of 200 pieces each was collected from the firm to be analyzed. Out of all the samples, 2 was the lowest recorded defects and 8 was the maximum. Additionally, some analysis was done on the data to graph out and locate the non-conforming samples in the batches in which samples 21, 25, 26, 28, 37, 38, 39, 42, 52 and 57 of the batch where closest to the Upper Control Limit, power outage was one of the major cause of these defected samples. At the end of the research, it was seen that the sigma level based on 20 batches produced from 2008 to 2012 was on an average of 3.55s and the defect level ranges from 10,000 to 40,000 units with a mean of 2.17 % out of a million outcomes. The results obtained requires improvement to be controlled. Additionally, based on the results obtained from the data analysis it was observed that lesser defects occurs during the beginning of the year which is due to the major maintenance done on machines in the beginning of the year. More defects was observed at the end of the year due the holidays and festivity during these times. Thus, factors that causes these defects where further broadened into power outage and poor operator's dedication during the festive times. Checking these factors relating to these defect can help improve the quality of the aluminium by a great percent thereby keeping the sigma level at level higher than 3.55s.

KEYWORDS: Aluminium Plc, Upper Control Limit.

I. INTRODUCTION

During production of aluminium raw materials are passed through different phases and as they are converted from one state to another (melting of scrap aluminium) several distortion can happen in terms of material composition which can as well effect the stability of the end product (Aluminium rolls or sheets). In most cases of production variation from what is intended is not on a close limit but in cases where everything is critical it becomes imperative to adhere to certain standards during production and after production. This is because most times these defects can cause loss of credibility of the firm, loss of capital on the side of the consumer, insecurity of life and property (in the case of stability or composition of the material), increase in product return etc. Thus, the firm has to device a means to manage and reduce defects where ever they occur. This is done by carrying out inspections on selective point on the line of production or at the end of production, the former is more effective but sometimes both can be used.

Aluminium production can suffer defects that are very expensive if incurred in an Aluminium producing firm. Aluminium rolls production defects includes;

i. **Rolling mill defects:** which includes; edge cut, herringbone mark, holes, bad build-up, strip breakage, etc.
ii. **Coating Defects:** which includes; over-baking, Paint starvation, tension dragline.
iii. **Power outage:** In developing countries like Nigeria where power outage can happen unexpectedly causing downtime during the time it takes to switch to backup power supply.

Therefore, to reduce these defects aluminium production firm was chosen to analyze their produced batches, investigate several problems and defects faced during production and at the end try to provide a proper quality control method to help reduce the defects accompanied with aluminium rolls production.

In order to effectively understand the importance of quality control some case of where it has been effective in reducing defects will be review. This is to understand the stages involved in aluminium production and defects experienced in the section or stage.

The importance of this research is that the management will be enlightened on the methods to adapt to reduce the occurrence of defects in the Aluminium output. It can also serve as reference for future research and improvement.

II. LITERATURE REVIEW

2.1. PDCA cycle quality control method

Shewhart & Deming (1939), in a journal stated that a happy customer is more preferable to a loyal customer, this is because a happy customer is a one who is satisfied while a loyal customer whom regardless of the service gotten still returns for more service. Thus, to maximize profit a firm must aim at trying to get more satisfied customers. Tachiki (2008) reviewed notable works of Edward W deming in 1949 with JUSE (Union of Japanese Scientist and Engineers) in a seminar. In this seminar a methods in which organization can achieve quality departmentally and managerially was introduced as the PDCA (Plan, Do, Check, Action) cycle. Deming (1994) stated that producing quality product and services is not just less costly but it is very essential for long term organizational survival. Therefore, the more quality the more survival of product in the market. Tachiki (2008) also explained two ways a business can help improve quality, TQC (Total Quality Control) and TQM (Total Quality Management), TQM was adopted in 1980.

(Hackman & Wageman 1995) highlighted some strategies in applying quality control they include; Assumption about quality, Organization, People and roles of senior management. Assumption involves determining how much quality the firm intends to project in their product. Organization. It's about the removal of systems that create fear such as punishment for poor performance or judgment systems that involve the comparative evaluation of employees. People is about making sure that quality control is applied across every functional point of the production line.

2.2. Six Sigma Method of Quality Control

Another method of quality control can be seen in Garcia (2014), Six Sigma method was used by Motorola in 1987 In which it cause some of a series of changes in the quality area beginning in the late 1970s, with determined ten-fold advance drives Desale (2013), the leading organization management along with CEO Robert Galvin developed a theory called Six Sigma Santty et al (2013). From 1987 to 1997, Motorola got a fivefold increase in sales with income climbing nearly 20 percent per year, cumulative investments at $14 billion and stock price gain compounded to a once a year rate of 21.3 % Khan (2005).

Six Sigma methods use Defects per Unit (DPU) like a measurement tool. DPU is a good method to determine the quality of product or a process. The defects are generally relation between the time and the cost. The sigma value additional shows the frequency at which failures happen; as a result, as upper sigma value means the lower defect possibility. The defect is definite as the displeasure of the customer. Therefore, as sigma level raises, cycle time and cost reduce and at the same time customer satisfaction raises. In Six Sigma method there are two tools namely: DMAIC (Define-Measure-Analyze-Improve-Control) and DFSS. The overall method to solve problem by DMAIC method consist of: translation of a practical problem into a statistical problem, discover a statistical solution, and then translation of that statistical solution into a practical solution and implementation appropriately in the industry Khekale et al (2010). Gijo et al (2011) shows the application of the Six Sigma method in decreasing the defects in a fine grinding process of an automotive company.

The Six Sigma method involves a scale of reference called the Six Sigma scale which is shown below;

Table 2: The sigma scale.

Sigma	Percent Defective	Defect per Million
1	69%	691,462
2	31%	308,538
3	6.70%	66,807
4	0.62%	6,210
5	0.02%	233
6	0.00%	3.4
7	0.00%	0.019

2.3. Aluminium Production and Defects

EFIG (1996) introduced two types of aluminium production, the secondary production which involves the production of Aluminium from Aluminium-containing scrap, while the Primary involves the production of Aluminium from bauxite ore. Zhao (2014) stated the defects accompanied with production of aluminium rolls. They include; power outage which can cause oxidation and formation of dross, dross formation, Bonner (2015) highlighted that dross formation occurs molten aluminium is exposed to air during the process of skimming and pouring the molten aluminium. After melting the aluminium the molten aluminium is treated to manage the properties of Al, Mn, Zn, Cr, N, Ti, Fe, Sn, and Mg, bonner (2015), stated the importance of this process because controlling metallurgical properties of the molten aluminium can help improve its quality.

During production another defect experienced is the defect due to high pressure die-casting. Elena, Giulio, Lars, Elisabetta, & Franco (2015) wrote that due to high pressure die-casting where by the pressurized aluminium alloy at 700°C is introduced to the die at a very high pressure and then after 30 to 40 sec it is instantaneously sprayed with die release agent at room temperature. Thus, the process are prone to cause defects due to high turbulence of molten aluminium alloy at high pressure and the instantaneous cooling of the die-cast. This is supported by lattanzia, Fabrizi, Fortini, Merlin, & Timelli (2017) in a journal, they emphasized that aluminium alloy tends to lose its mechanical properties due to High Pressure Die Casting (HPDC).

Based on investigation defects experienced in First Aluminium Plc. Includes; rolling defects, Casting Defects, Coating defects.

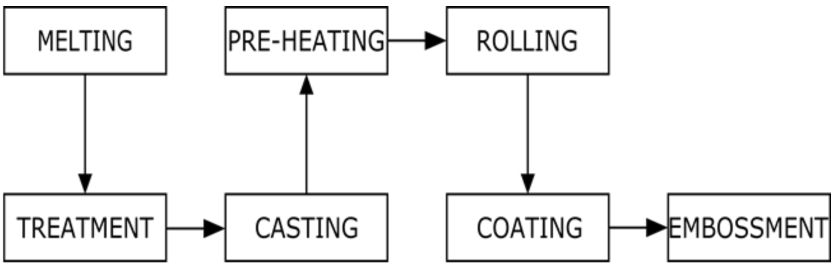
In the virtue of the reviewed literature, this work will introduce ways to improve the quality of aluminium rolls/coils produced with the use of several approaches from the six sigma method of quality control.

III. RESEARCH METHODS

3.1. Analysis of Production in First Aluminium Plc

The necessary data needed for the purpose of this research is obtained from First Aluminium Plc. Port Harcourt. They are an overview of the processes involved in the production of aluminium rolls in First Aluminium, and will be used to process, analyze and therefore obtain a good quality control in the production of aluminium rolls.

Aluminium Production in First Aluminium follows the stage below;



3.2. Charging the aluminium

In First Aluminium Plc there are two sources of aluminium logs, which are the primary and the secondary.

i. Primary Source or the virgin material, which is 99.9% pure aluminium and comes in the form of a T-bar or a piglet.

ii. Secondary source or scrap, which are gotten within the plant or are bought outside.

In First Aluminium, after obtaining the necessary raw materials needed for production, the scraps are then processed in a reverberatory furnace. The reverberatory furnace has already been covered in sub-section 2.1.4. In First Aluminium Plc. there are two reverberatory furnaces, the first has a capacity of 8tons and then the second has a capacity of 7tons. In the reverberatory furnace shell gas is the heat source for the furnace since it burns faster and it's environmentally friendly. After the scrap metal has been treated in the reverberatory furnace 1 and 2, it is then taken to the boiler where it is compress and then pushed into the third (3rd) furnace which is the holding furnace.

The first step in charging the furnace is adding the appropriate amount of alloying agents; scrap, virgin, and hardeners. Hardeners are elements which are added to a bath of aluminium to increase the strength and give the final product the characteristics desired such as; finish, strength, grain refinement. These elements are as follows: silicon (Si), Iron (Fe) copper (Cu), magnesium (Mg), manganese (Mn), chromium (Cr), zinc (Zn), titanium (Ti), and Boron (Br). Silicon, iron, copper, magnesium, manganese, chromium and zinc are used to increase strength and to improve finish. Titanium and boron are for grain refinement. The processes followed after melting are as follows; Treatment of molten Aluminium to avoid impurities, Casting, Preheating, Rolling, coating and embossment.

3.3. Adaptation of quality control (Six Sigma Method)

To adopt six sigma method DMAIC (Define, Measurement, Analyze, improvement and control) phase has to be followed.

3.3.1. Phase 1 (Define)

This phase of the DMAIC methodology is aimed at defining the scope and goals of implementing Six Sigma in terms of customer requirements and developing a process that delivers these requirements. Major tools that will be used in this phase are the project charter and the SIPOC (Supplier Input Process Output Customers) – a diagram which identifies the process being examined, the inputs to and outputs of the process, and the relevant suppliers and customers.

3.3.2. Phase 2 (Measurement)

This phase entails gathering data to describe the current situation of Aluminium manufacturing firm. Define defect, opportunity, unit and metrics, selecting product characteristics; i.e., dependent variables, mapping the respective processes, making the necessary measurement, recording the results and estimating the current performance. Tools like P chart will be used.

Construction of a P chart

This chart can be acted as a diagnostics of the possible out of control state of the process. The process which is in control situation is considered as a stable process and the process which is out of control situation is considered as an unstable process. When the out of control situation is observed in the control chart then it is up to the operators, engineers or management of the process to find out the reason behind this out of control situation and trying to solve it.

To construct a P chart, the following equations are considered (Douglas, 2005).

$$\mathbf{\bar{p}} = \frac{\Sigma \mathbf{P}}{\mathbf{k}} \qquad \textbf{(3.3.1)}$$

Variance for the data involve is given as follows;

$$\sigma^2 = \frac{\bar{p} * (1-\bar{p})}{n}$$

Thus the standard deviation is derived as;

$$\sigma = \sqrt{\frac{\bar{p} * (1-\bar{p})}{n}}$$

Since the Upper Control limits and Lower Control Limits would be within 3s level

Therefore;

$$\mathbf{UCL} = \mathbf{\bar{p}} + \mathbf{3\sigma} \qquad \textbf{(3.3.2)}$$

$$\mathbf{LCL} = \mathbf{\bar{p}} - \mathbf{3\sigma} \qquad \textbf{(3.3.3)}$$

$$\mathbf{CL} = \mathbf{\bar{p}} \qquad \textbf{(3.3.4)}$$

Where,

s= Standard deviation

$\bar{p}$ = the estimate of the long-term process mean of fractions non-conforming

np = number of defects per sub groups

P = fraction non-conforming for sub groups

k = total number of sub groups

n = sample size

Σnp = sum of defects

UCL = upper control limit

LCL = lower control limit

CL = control limit (mean)

Calculation of present sigma level

The existing process capability is expressed in terms of sigma quality level for the purpose of comparing the improvement after the case study. Sigma quality level of each batch is calculated through the following steps:

Equations for the defect control analysis for improving quality and productivity (Breyfogle, 1999).

- Calculating defects per unit of the batch (DPU)
- Calculating defects per opportunities (DPO)
- Calculating defects per million opportunities (DPMO)
- Determining the sigma level corresponding to DPMO level.

The defects per unit (DPU)

$$\textbf{DPU} = \frac{\text{Total number of defects observed in the batch}}{\text{Total number of units produced in the batch}} \qquad \textbf{(3.3.5)}$$

The Defects per Opportunities (DPO) is

$$\textbf{DPO} = \frac{\textbf{DPU}}{\textbf{1}} \qquad \textbf{(3.3.6)}$$

The Defects per Million Opportunities (DPMO)

$$\textbf{DPMO} = \textbf{DPO} \times \textbf{1,000,000} \qquad \textbf{(3.3.7)}$$

The sigma quality level is determined by the equation

$$\textbf{Sigma quality level} = 0.8406 + \sqrt{29.37 - 2.221 \times \ln(\text{DPMO})} \qquad \textbf{(3.3.8)}$$

1.1.1 Phase 3 (Analysis)

The purpose of this phase is to determine the root causes of the process problems and inefficiencies in the Aluminium manufacturing firm. A variety of methods are used to identify potential root causes, narrow down the possibilities, and confirm the relationship between the suspected causes and the performance of the process. Statistical analysis is a key component of this step, and is used to demonstrate these relationships. Tools like the fish bone diagram, histogram, Pareto chart and run charts will be used.

i. The fish bone diagram; this is also known as a cause and effect diagram. It is a visualization tool and will be used to categorize the potential causes of the problem in order to identify the root causes.
ii. The Pareto chart; this tool will be used to analyse the frequency of problems or causes in the process. It identifies the most frequent defect.
iii. The run chart; this is a line graph of data plotted over time. It is used to find trends or patterns in the process, and how the process is running.

1.1.2 Phase 4 (Improvement)

This phase is related to establishing a means of countering or solving the root causes. Techniques involve brainstorming; FMEA (Failure Modes and Effects Analysis) will be used.

1.1.3 Phase5 (Control)

This last phase is initiated by ensuring that the new process conditions are documented and monitored via SPC (Statistical Process Control) methods. After the 'settling in' period, the process capability is reassessed. Depending upon the outcome of such a follow-on analysis, it may become necessary to revisit one or more of the preceding phases.

IV. RESULT AND DISCUSSION

4.1. Define Phase

This phase defines the scope and goals of implementing Six Sigma in terms of customer requirements. Major tools that will be used in this phase are the project charter and the SIPOC as shown below.

Drafting the project charter worksheet

This project charter worksheet outlines the purpose, objectives, and scope of the project as shown in Table 4.1.

Table 4.1: Project charter worksheet.

Project title	Using six sigma to reduce production defects in the aluminium manufacturing industry
Business case	First Aluminium Plc produces varying amounts of typical aluminium products. Depending on the data collected from the marketing department, there has been a low production rate and profit due to some production defects.
Problem statement	A reduction in production rate and profit due to production defects
Goal statement	Improve production process by reducing production defects that appear frequently and in large quantities in the aluminium products, reduce production costs, raise profit and get better satisfaction for customer.

Developing process map (SIPOC Diagram)

The SIPOC diagram of this work describing the supplier, input, process, output and customer are as shown in Table 4.2.

Table 4.1: Supplier-Input-Process-Output-Customer (SIPOC) diagram.

Supply	Input	Process	Output	Costumer
Raw material store	Aluminium alloy Hardeners	Melting Treatment Casting Rolling Coating Embossment	Aluminium sheets	Leo-Frank Aluminium Ltd

4.2. Measure Phase

In the measure phase of DMAIC model, the primary purpose is to measure how frequently each and every defects occur and to decide whether the production process is going out of control or not as shown in Table 4.3.

7.2.1. Construction of a P chart

Table 4.2: Number of non-conforming pieces from 60 months with sample size n=200 pieces.

Sample no	**No of defects**	**Fraction non-conforming**	**Sample no**	**No of defects**	**Fraction non-conforming**
(months)	(np)	(P = % np/n)	(months)	(np)	(P = % np/n)
1	2	0.010	31	6	0.030
2	4	0.020	32	4	0.020
3	4	0.020	33	2	0.010
4	2	0.010	34	4	0.020
5	2	0.010	35	6	0.030
6	4	0.020	36	2	0.010
7	2	0.010	37	8	0.040

8	2	0.010	38	8	0.040
9	4	0.020	39	8	0.040
10	4	0.020	40	4	0.020
11	4	0.020	41	4	0.020
12	4	0.020	42	8	0.040
13	2	0.010	43	2	0.010
14	2	0.010	44	4	0.020
15	2	0.010	45	4	0.020
16	2	0.010	46	2	0.010
17	2	0.010	47	4	0.020
18	2	0.010	48	2	0.010
19	2	0.010	49	6	0.030
20	2	0.010	50	6	0.030
21	8	0.040	51	4	0.020
22	6	0.030	52	8	0.040
23	4	0.020	53	4	0.020
24	6	0.030	54	2	0.010
25	8	0.040	55	4	0.020
26	8	0.040	56	2	0.010
27	4	0.020	57	8	0.040
28	8	0.040	58	6	0.030
29	6	0.030	59	2	0.010
30	6	0.030	60	6	0.030
TOTAL				**Σnp =258**	**Σp = 1.29**

The estimate of the long-term process mean of fractions non-conforming given by Douglas (2005) is as follows;

$$\bar{p} = \frac{\mathbf{\Sigma p}}{\mathbf{k}}$$

Where,

$\Sigma p = 1.29$,

K = 60

$\bar{p} = 0.0215$

The control limit; $CL_1 = \bar{p} = 0.0215$

Douglas (2005) introduced the term UCL (Upper Control Limit), LCL (Lower Control Limit) given below,

The Upper Control Limit (UCL);

$\mathbf{UCL_1 = 0.0523}$

The Lower Control Limit (LCL);

$$LCL_1 = \bar{p} - \left(3 * \sqrt{\frac{\bar{p} * (1 - \bar{p})}{n}} \right)$$

LCL_1 = -0.00927= 0

The LCL is a negative value, which is infeasible, because fraction non-conforming cannot be negative; this is why it is taken as zero. The control limits were drawn in Figure 4.1, and subsequently 60 fraction non-conforming values were plotted. It is evident in the figure that the sample 21, 25, 26, 28, 37, 38, 39, 42, 52 and 57 are nearer to the upper control limit. So there may be a specific reason behind this and an investigation is needed to identify it.

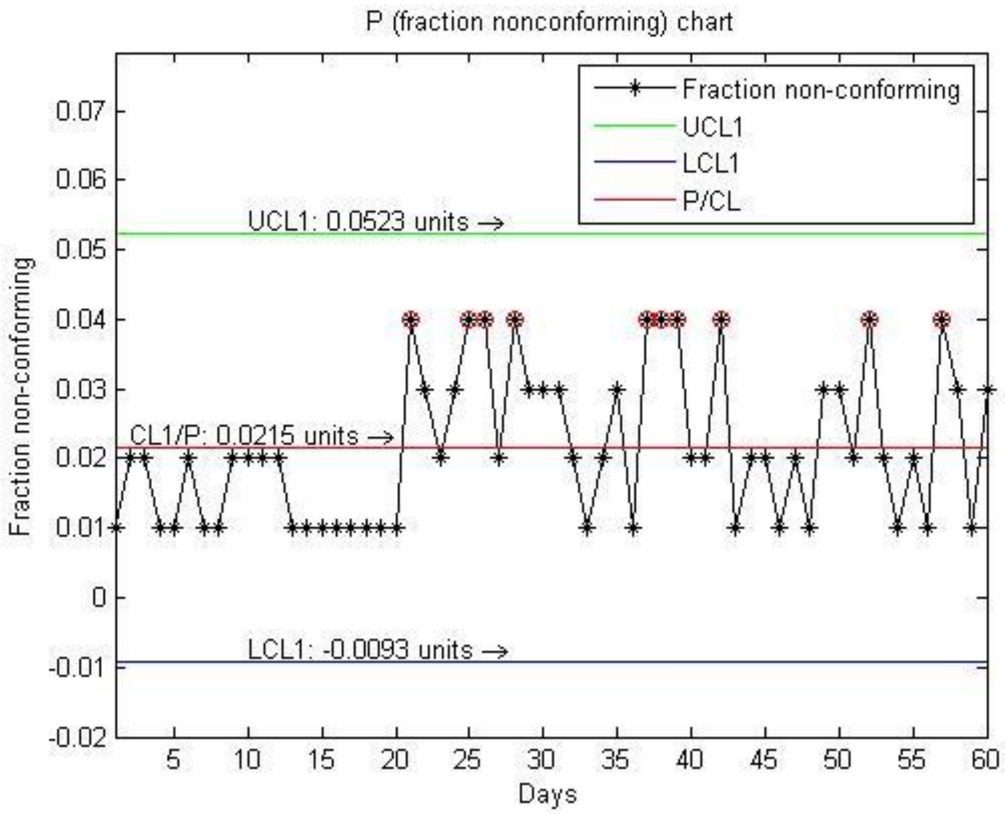


Figure 4.1: P (fraction nonconforming) chart.

After consulting with QC department it was found that unstable power supply was the cause of the production defects in two month. So it can be neglected. After neglecting those ten (10) sample data, the mean fraction non-conforming for the data of Table 4.3 is 0.018 and the modified control limits becomes;

$CL_2 = \bar{p} = 0.0178$

$UCL_2 = 0.0458$

$LCL_2 = -0.0102 = 0$

Then the revised control limits were plotted in another P chart shown in Figure 4.2. This shows all data are randomly distributed within the control limits with ten (10) points nearest to the upper control limits. Further investigation was needed to identify the root cause for these points.

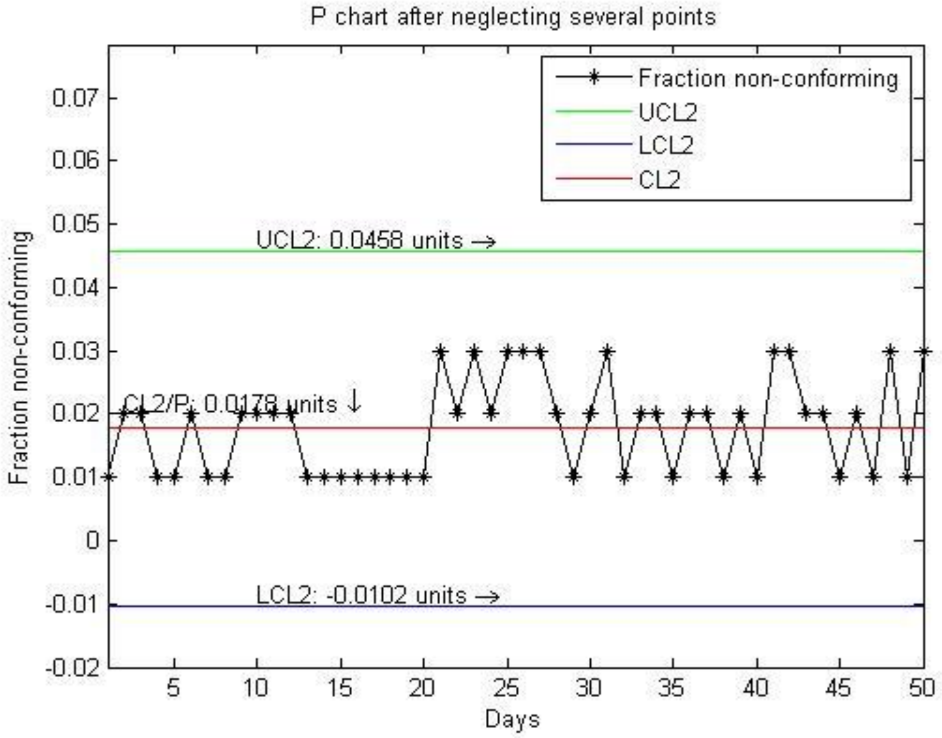


Figure 4.2: P chart after neglecting several points.

Calculation of present sigma level

Table 4.4 summarizes the sigma level calculation for all 20 batches of production and it clearly indicates that process performance is average and needs a little improvement. Existing process capability is varying from 3.26σ to 3.83σ with an average of 3.55σ and the defect level ranges between 10,000 to 40,000 units with a mean of 2.17 % out of a million outcomes.

Table 4.3: Sigma quality level for 20 batches of production.

Batch (Quarterly from 2008-2012)	Rej. (%)	DPU	DPMO	Sigma level	Batch (Quarterly from 2008-2012)	Rej. (%)	DPU	DPMO	Sigma level
1	1.67	0.0167	16,700	3.63	11	2	0.02	20,000	3.56
2	1.33	0.0133	13,300	3.72	12	2	0.02	20,000	3.56
3	1.33	0.0133	13,300	3.72	13	4	0.04	40,000	3.26
4	2	0.02	20,000	3.56	14	3	0.03	30,000	3.38
5	1	0.01	10,000	3.83	15	1.67	0.0167	16,700	3.63
6	1	0.01	10,000	3.83	16	1.33	0.0133	13,300	3.72
7	2	0.02	20,000	3.56	17	2.67	0.0267	26,700	3.44
8	2.67	0.0267	26,700	3.44	18	2.33	0.0233	23,300	3.49
9	3.33	0.0333	33,300	3.34	19	2.33	0.0233	23,300	3.49
10	3.33	0.0333	33,300	3.34	20	2.33	0.0233	23,300	3.49
Average defect level = 2.17%					Average sigma quality level =3.55				

4.3. Analysis Phase

This phase is to determine the root causes of the process problems and inefficiencies. The production defects are categorized as casting defects, rolling mill defects and coating defects.

The fishbone diagram for cause and effect analysis

Figures 4.3 to 4.5 shows the fishbone diagram for obtaining causes of the effects in the boxes. The effects in this case are casting defects, rolling mill defects and coating defects. All the causes as reflected in the fishbone diagrams were obtained through several discussions with the in house experts and brainstorming with other company technical personnel after observation of the process.

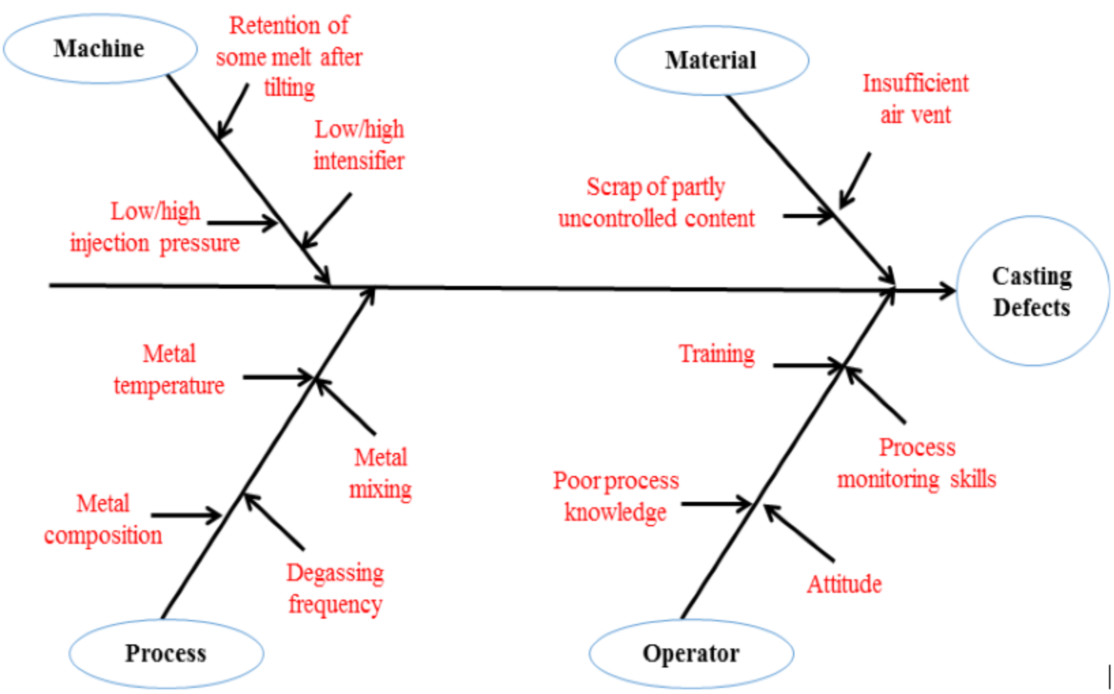


Figure 4.3: Fishbone diagram for casting defect.

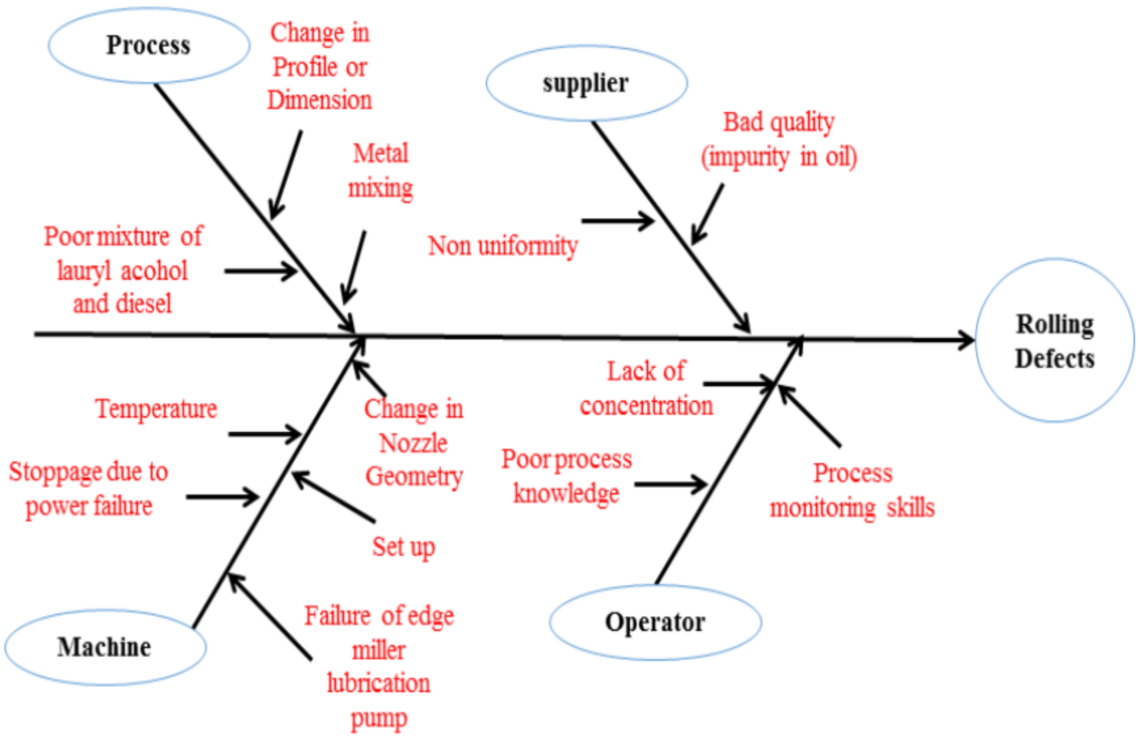


Figure 4.4: Fishbone diagram for rolling defect.

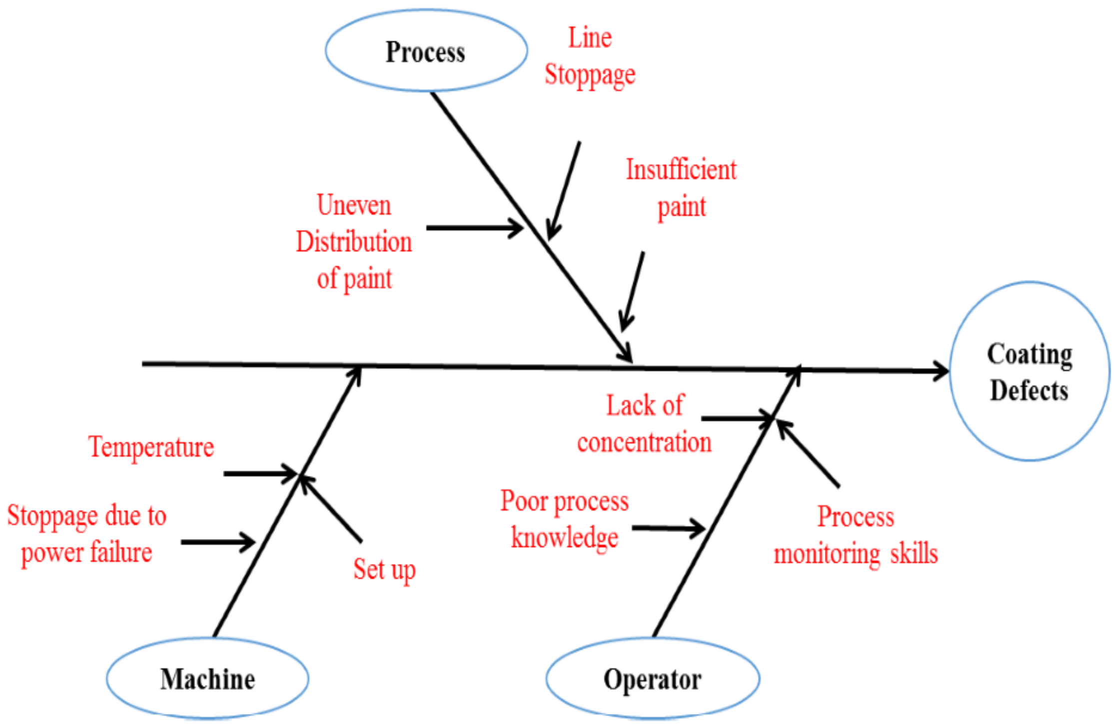


Figure 4.5: Fishbone diagram for coating defect.

Run chat for time analysis

This chart shows the values of percentage defects with respect to months of the year 2008 to 2012 (figure 4.6).

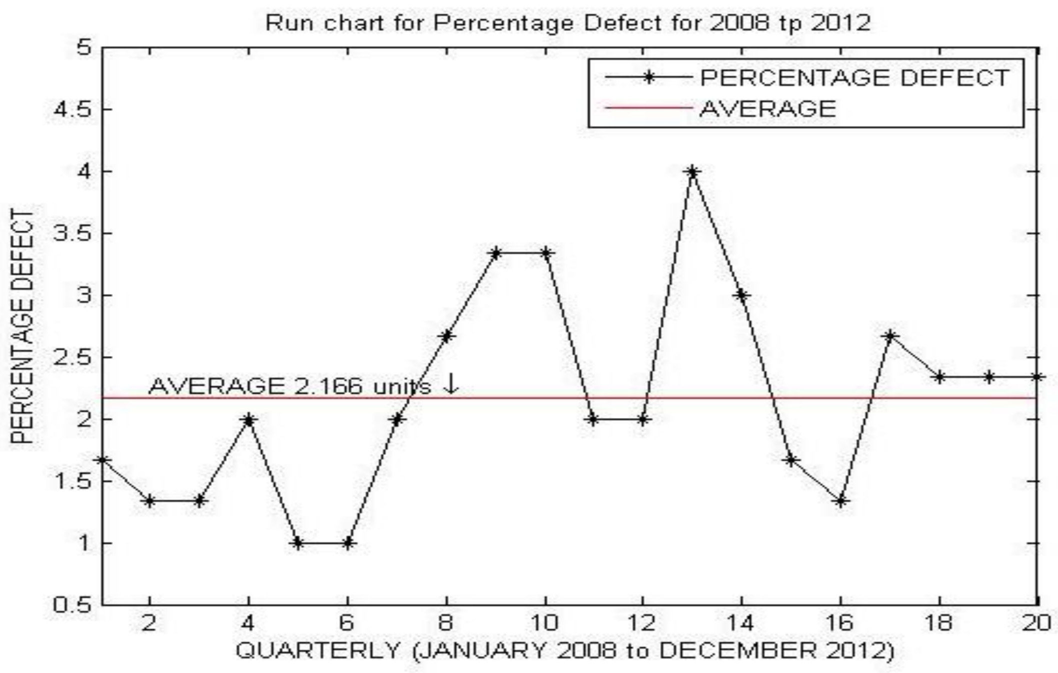


Figure 4.6: Run chart of percentage defects for 2008 to 2012.

From the run chart it is observed that there is a minimum percentage defects for year 2008 and 2009 especially in the months January to March which is the first quarter of every year. This is due to the major maintenance activity performed on the machines a month before January. But in the year 2010 to 2012 there are some sort of increase in percentage defects above the average line, this can be due to several aforementioned causes of the defects seen in aluminium but one of the hardest to control is power outage since it has been one major problems of businesses in Nigeria. Also lack of proper machine maintenance can also cause these irregular peak. Thus, a lot has to be done to investigate the causes of these defects.

4.4. Improvement Phase

Solutions were proffered to several areas of improvement identified in the analysis phase. Among the solutions identified includes:

- Investments into scrap sorting to improve the effectiveness of sorting process.
- Condition of the nozzle should be regularly monitored and serviced.
- Installing online profile monitoring device to alert operators of immediate change in profile and/or dimension.

- Monitoring the state of the edge miller on a daily basis so as to reduce rolling defects
- Automating the method of fluxing, degassing and dross removal
- Proper hot cleaning of the furnaces at least once in a week
- Availability of constant power supply during manufacturing operations.
- Availability of competent operators to always monitor the system
- Major maintenance of equipment quarterly instead of annually.

4.5. Control Phase

The next stage in Six Sigma deployment (after the implementation of improvement efforts) is the institutionalization of the improvement. It is aimed at locking in the benefits of the optimization and preventing the system from returning to its former state. The gains can be secured by following the following control mechanisms viz:

- Adaptation of the Six Sigma method by the quality control department and training of staffs accordingly. This will serve as a take-off point and guarantee high quality and continuous improvement in the manufacturing processes.
- Transforming the entire company into a Six Sigma company by training every staffs the philosophy and practices of Six Sigma. This will set everybody thinking in the direction of continuous improvement such that every sphere of company activities will be geared towards increased efficiency. This will invariably increase customers' satisfaction and provide positive bottom-line impact.
- Acquisition of the latest compatible equipment and testing devices for improved efficiency.
- Carrying out monthly process audits and statistical analysis of data from each component or machine. This will provide better understanding of the process, its components and their interactions.
- Giving higher priority to staff welfare as this affects dedication, attention and also improves the performance of their various jobs.
- Provision of conducive working conditions within the factory by improving ventilation to reduce discomfort and fatigue caused by high temperatures in the factory.

V. CONCLUSION

In this study, based on the results obtained from the analysis of the batches produced for 60 months with a sample size of 200 pieces per batch it is seen that one of the prime cause of defects and line stoppage of aluminium rolls production is power outages, power outage can cause a major problem by causing the defect level to spike up to 0.0523 in **Figure 4.1: P (fraction nonconforming) chart** which is the upper control limit of the standard deviation of the all the data analyzed. When these spikes was neglected and the graph re-plotted in **Figure 4.2: P chart after neglecting several points**defect level stayed very below the upper control limit. Thus, this proves the fact that controlling how steady electricity is served into the facility by reducing power interruption can help control the level of defects. Further investigation of 20 batches from 2008 to 2012 revealed that most firm adopt doing heavy maintenance during the beginning of the year when compared to the end of the year process our normally affected due to the festivity that normally occur during this time. By conducting maintenance monthly defects can be reduced while making sure that operators don't sacrifice their jobs due public holidays and festivity. The data reviewed was worked out to establish a sigma level of 3.55s which is good but can as well be improved. Thus making Statistical Process Control a way to go to reduce or eliminate defects and sustain customer's needs.

VI. REFERENCES

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