International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878 (Online), Volume-8 Issue-4, November 2019

Product Quality through Process Improvement- A Pathway to Zero Defects

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Abstract: Quality is the most important factor needed by an organization. Defects are the common issues which arise in the production. Quality model is a strategy that tackles the quality issue that the companies have to control the defects. To improve the efficiency of the product defects needs to be minimised in the production. Zero Defects is a management tool aimed at the reduction of defects through prevention. Zero defects mean that manufacturing the products without any defects. To attain zero defects in production is not an easy task. In order to attain the zero defects in the production a perfect environment, machines, skilled labours are required. All the organisations are moving towards the goal of zero defects in order to provide quality products and to improve the efficiency of raw materials. In this study observation research is used. The data are collected by the observation method. The purpose of the study is to find out the ways to reduce defects in an organization and to check whether the defects in production process can be eliminated by statistic control methods.

Keywords: Quality, Control, Statistical Process Control, Zero Defects.

I. INTRODUCTION

Quality model is anapproach that confront the quality issue and control the defects arise in every step in manufacturing process. Because it mandatory for a company to survive in the market and satisfy their customer by delivering quality compliant product at every aspect. Quality is nothing but meeting the requirement stated or set for the particular product without any defect. Hence while we discuss on quality, that can be infer as defect less or Zero Defects. Zero Defects is an objective to reduce the defects through preventing them in advance. This aimed at encouraging workers to produce a defect less quality product at the first attempt by sheer concentration and desire for quality. The revolution in the production and operations have changed the face of the quality, which was seen as way of auditing and controlling the product delivery and not allowing the defective product to reach its end user. Whereas now the quality aspects are redefined as anticipating and preventing defects through conscious manufacturing process.

Manuscript published on November 30, 2019.
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This will not only improve the end user experiencebut also reduce the cost involves defective production.The concept of Zero Defect (ZD) is proposed by an employee named Philip Crosby, worked at Glen L Martin Company, anAmerican aerospace company. But there were different claims regarding who proposed and who got an idea. So it was not happened at one place, simultaneously it evolved in different regions at a time. The basic idea evolved from the war department of US where they used E-for Excellence campaign. Quality Is Free: The Art of Making Quality Certain: a work by Philip Crosby setup at the idea of Zero Defect (ZD) in a fourteen step quality improvement program and also the basics of the "Absolutes of Quality Management. The Zero Defect (ZD) approach directs no wastage in production in any form. Here the definition of waste not only includes the product that are unusable but also the product, machine and men which are unused. Hence anything unused and irrelevant for the current requirement at the place will be regarded as waste and it should be eliminated from the production function. It also expresses that continuous improvement in every process that involved in producing a product that marching towards perfection. The perfection means very right and perfect at the first time without defect, which refers to Zero Defect (ZD). Zero Defect (ZD) is every company's dream but it is not an easy task to achieve, it needs a perfect combination of perfect environment, machines, skilled labour. Every organisation marching towards achieving Zero Defect (ZD) in order to deliver quality products and to improve the efficiency of working syste.

II. REVIEW OF LITERATURE

End-of-line quality testing is usually applied to evaluate the item usefulness toward the finish of the procedure chain[1]. In any case, this methodology doesn't supportthe in-line counteractive action and redress of imperfections. Developing Key Enabling Technologies (KETs, for example, in-line information gathering arrangements, information stockpiling and correspondence guidelines, information examination apparatuses and computerized producing innovations offer new open doors for ZDM. These innovations are progressively getting to be fundamental piece of current creation frameworks [2]. On the off chance that these advancements are appropriately coordinated with a cross-KETs approach, new digital physical frameworks (CPSs) can be planned and actualized at shop floor level, to help foundational ZDM arrangements [2,3]. CPSs are generally characterized as frameworks incorporating calculation and physical activation capacities [4].

Peer-audit under obligation of the scientific advisory group of the eleventh CIRP Conference on Intelligent Computation in Manufacturing Engineering screen and control physical procedures, for the most part with input circles, where physical procedures influence calculations and the other way around. The monetary and social capability of CPSs is boundlessly more noteworthy than what has been acknowledged at this point, and significant ventures are being made worldwide to build up these arrangements in light of developing modern problems [5]. There are some issues in modelling for process quality management are denoted with works of scientists such as Walter A. Shewhart – who developed statistical methods for process management [13], Joseph Juran is proposed Quality Trilogy [14]. The quality trilogy comprises a sequence of quality planning, control, and improvement activities. Juran have developed a concept of CWQM (Company-Wide Quality Management). W. Edwards Deming have founded a concept of Total Quality Management [15]. His contributions were well connected with statistical process management development methods. His well-known contribution is development of a system approach to quality enhancement named as the PDCA cycle (Shewhart-Deming cycle). Armand Feigenbaum is an author of Total Quality Control principles [16]. Cause-consequence Ishikawa diagram is developed by Kaoru Ishikawa [17]. Genichi Taguchi pioneered in working on application of statistical methods in the manufacturing industry (Taguchi methods), he has also contributed industrial experiment planning techniques and suggested a concept of quality improvement while reducing costs [18]. Shigeo Shingo is one among the contributors of Just-in-Time, a well-known Japan system involved planning and production, and the founder of SMED (single minute exchange of die) method and PokaYoke (mistake proofing) system, which encompassed by Lean Production System nowadays. Philip Crosby have proposed the widely known Zero Defects quality program, contributed greatly to development of the quality improvement methods which are basically formulated as 14 steps to quality improvement [19].Concerning zero-imperfection assembling or creation, Wang [20] gives thoughts regarding how to utilize item, hardware and procedure information in an information mining structure used to improve learning finding and nature of items. Further, Myklebust [21] plots an item and plant-arranged methodology with utilization of continuous information and learning input circles to accomplish close to zero deformity level. Also, Teti [22] raises sign handling and basic leadership.

III.PROBLEM IDENTIFICATION

Water pumps is the one of the most common thing which is used for agriculture, production of oil and natural gas, petroleum refining, petrochemicals, power generation, domestic and household utilities in our day to day life. A water pump manufacturing is the largest industry sector where many companies are in involving in manufacturing the water pumps. In order to sustain in this large market sector, each and every company wants to show unique in their manufacturing product. Our company Deccan Pump sets is producing large number of water pump sets. In the production area, the products cannot be produced without any defect in the product. The products cannot be produced with zero defects. Thus this study thereby analyze the defect causing area during the production process in Deccan pump sets and to concentrate more on the particular area to improve the quality of the product and to reduce the defects. This will leads to efficient usage of the resources.

IV. RESEARCH DESIGN

A Research Design is the set of methods and procedures used in collecting and analyzing measures of the variables specified in the research study that aims to combine relevance of the research purpose with economy in procedure. The Research Design used for this study is ―Observation Research‖.

A. Observation Research

Observational research is a research in which a researcher observes ongoing behaviour. It is a systematic data collection approach. It is a social research technique that involves the direct observation of phenomena in their natural setting.

Researches use all of their senses to examine people in natural occurring situations.

Observation of a field setting involves:

- Prolonged engagement in a setting or social situation
- Clearly expressed, self-conscious notations of how observing is done
- Methodological and tactical improvisation in order to develop a full understanding of the setting of interest
- Imparting attention in ways that is in some sense standardized
- Recording ones observation

There are two types of observation namely participant observation and Nonparticipant observation.

B. Participant Observation:

- Participant observation "combines participation in the lives of the people being studied with maintenance of a professional distance that allows adequate observation and recording of data"
- Participant observation underscores the person's role as participant in the social setting he or she observes

C. Non-participant observation:

- Non-participant observation is observation with limited interaction with the people one observes
- Researchers who study how people communicate often want to examine the details of how people talk and behave together
- Non-participant observation involving the use of recording devices might be a good choice

- Non-participant observation may provide limited insight into the meaning of the social context studied. If this contextual understanding is important, participant observation might be needed

V. ANALYSIS AND INTERPRETATION

Table: 1.1 Total Products

Components	Total products(week 1-week 10)
Spindle	2080
Rotor	1880
Stator	1940
Outer Body	1900
Shaft	1770
Diaphragm	1990
Winding	1125
Cabling	1125

The above table denotes the total products of each component in a particular period that is used to manufacture the pumps.

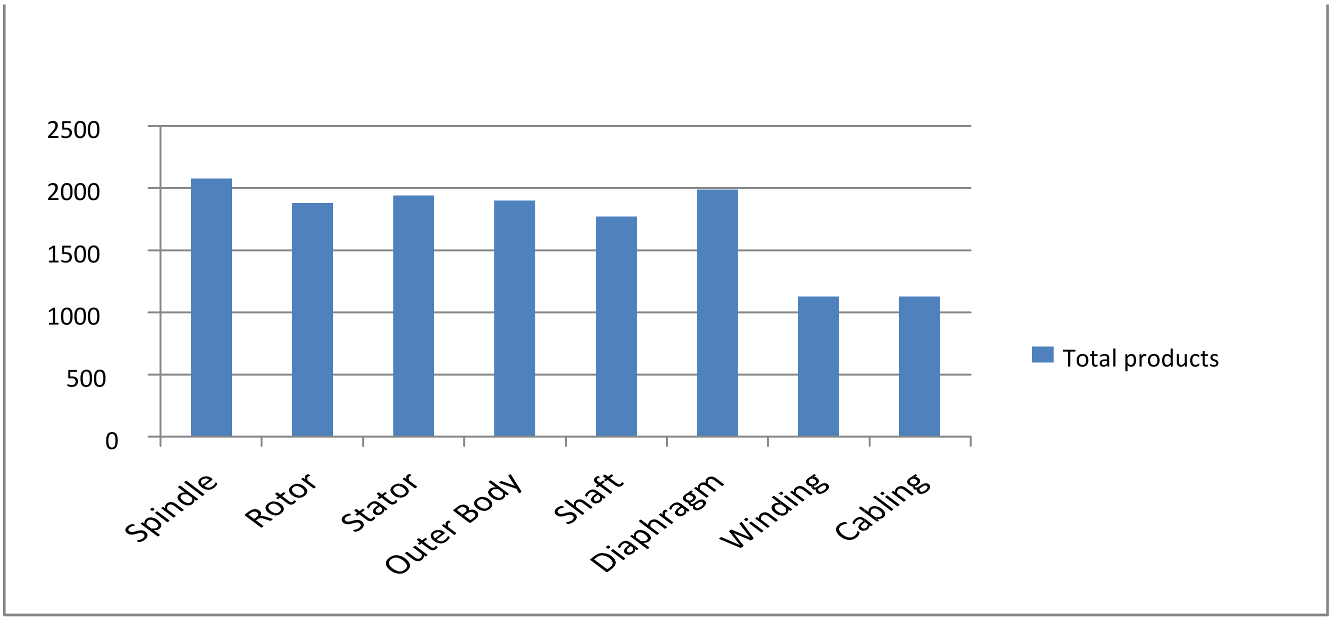

Fig: 1.1Total Products

Table: 1.2 Total Defects

Components	Total Defects
Spindle	31
Rotor	29
Stator	27
Outer Body	29
Shaft	22
Diaphragm	35
Winding	17
Cabling	19

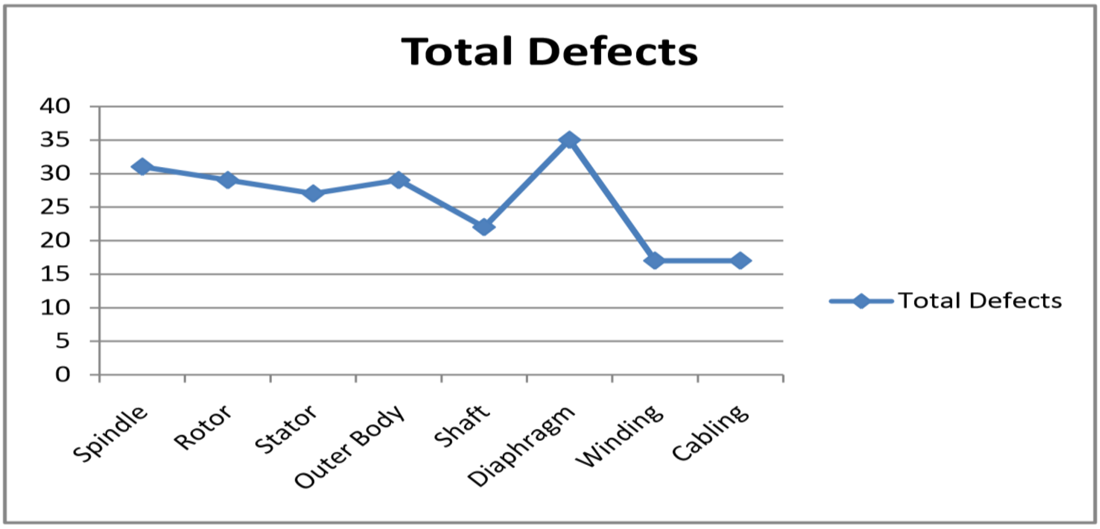

Fig: 1.2 Total Defects

Table 1.3 Percentage of Defects

Components	Total Products	Total Defects	% of Defects
Spindle	2080	31	1.49
Rotor	1880	29	1.54
Stator	1940	27	1.39
Outer Body	1900	29	1.53
Shaft	1770	22	1.24
Diaphragm	1990	35	1.76
Winding	1125	17	1.51
Cabling	1125	19	1.69

The above table denotes the total percentage of defects in each component in a particular period that is used to manufacture the pumps and it shows that total defects will be of around 2% of the total products. The result chart shows that on average 6% of spindle is found to be defective. None of the subgroup proportions are outside the control limits. This p-chart represents that the process is in control. Above chart shows the proportion defective varies between 0.040 and 0.120. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart all the point lies between the three zones. The maximum points lies near the average line. A 1st subgroup is in zone B, the particular sample wants to be check and then the special action should be taken to find the special cause and permanently remove it from the process.

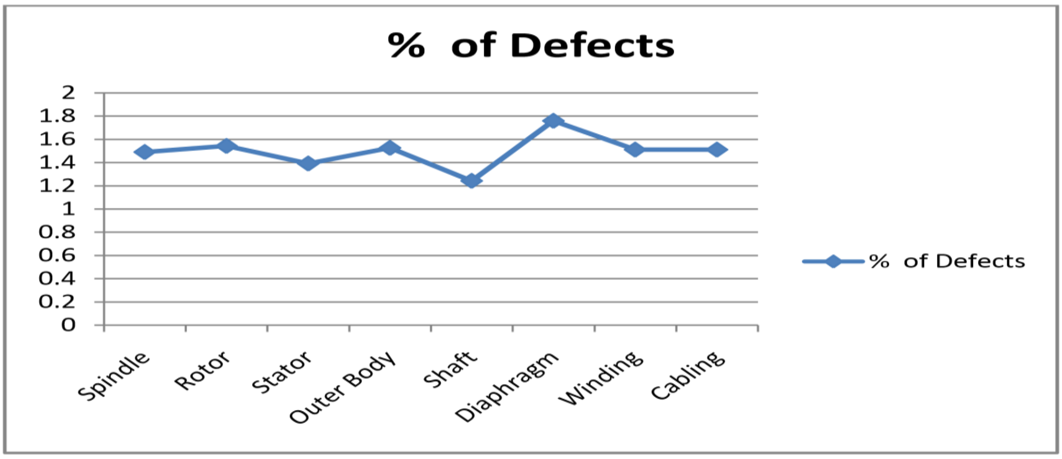

Fig: 1.3Percentage of Defects

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Table: 1.4 p-chart values of spindle

Sample	Number of Defectives	Proportion Defective	p̄	UCL	LCL
1	6	0.120	0.06	0.1643	0.0000
2	4	0.080	0.06	0.1643	0.0000
3	3	0.060	0.06	0.1643	0.0000
4	2	0.040	0.06	0.1643	0.0000
5	2	0.040	0.06	0.1643	0.0000
6	2	0.040	0.06	0.1643	0.0000
7	2	0.040	0.06	0.1643	0.0000
8	4	0.080	0.06	0.1643	0.0000
9	2	0.040	0.06	0.1643	0.0000
10	4	0.080	0.06	0.1643	0.0000
Total	31				

Result:

Particulars	Value
Mean	0.06
UCL	0.16
LCL	0.00

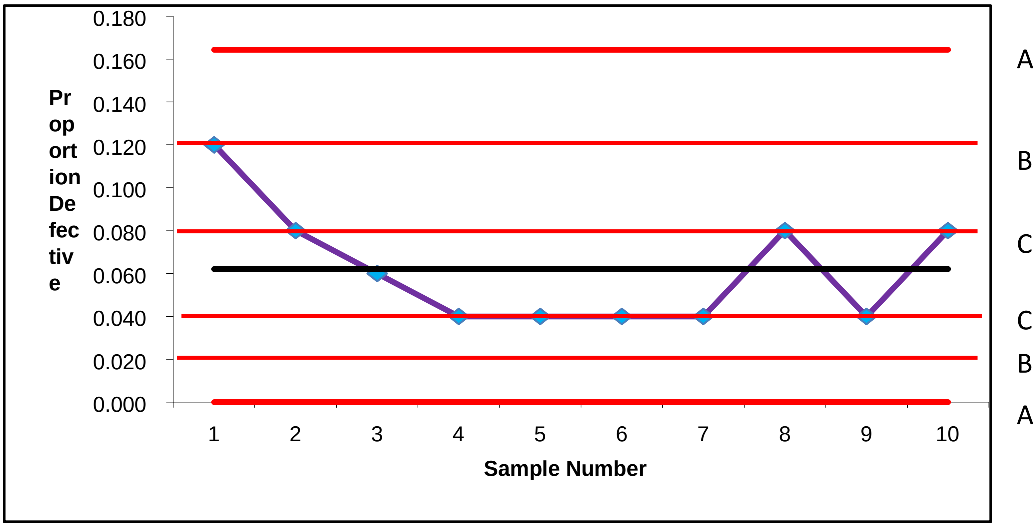

Fig: 1.4p-chart of spindle

1.5 p-chart values of Rotor

Sample	Number of Defectives	Proportion Defective	p̄	UCL	LCL
1	4	0.080	0.06	0.1572	0.0000
2	3	0.060	0.06	0.1572	0.0000
3	2	0.040	0.06	0.1572	0.0000
4	2	0.040	0.06	0.1572	0.0000
5	2	0.040	0.06	0.1572	0.0000

6	3	0.060	0.06	0.1572	0.0000
7	3	0.060	0.06	0.1572	0.0000
8	5	0.100	0.06	0.1572	0.0000
9	2	0.040	0.06	0.1572	0.0000
10	3	0.060	0.06	0.1572	0.0000
Total	29				

Result:

Particulars	Value
Mean	0.06
UCL	0.16
LCL	0.00

The chart represents that the process is consistent and predictable. On average 6% will be of defective. The higher percentage of defects can be of 16% and the lower will be of null. The process is said to be in statistical control.

Above chart shows the proportion defective varies between 0.040 and 0.1. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart all the point lies between the zone B and C. So the process is in control. But the sample 8 is quite near the zone A so sample group wants to be checks with the quality measures.

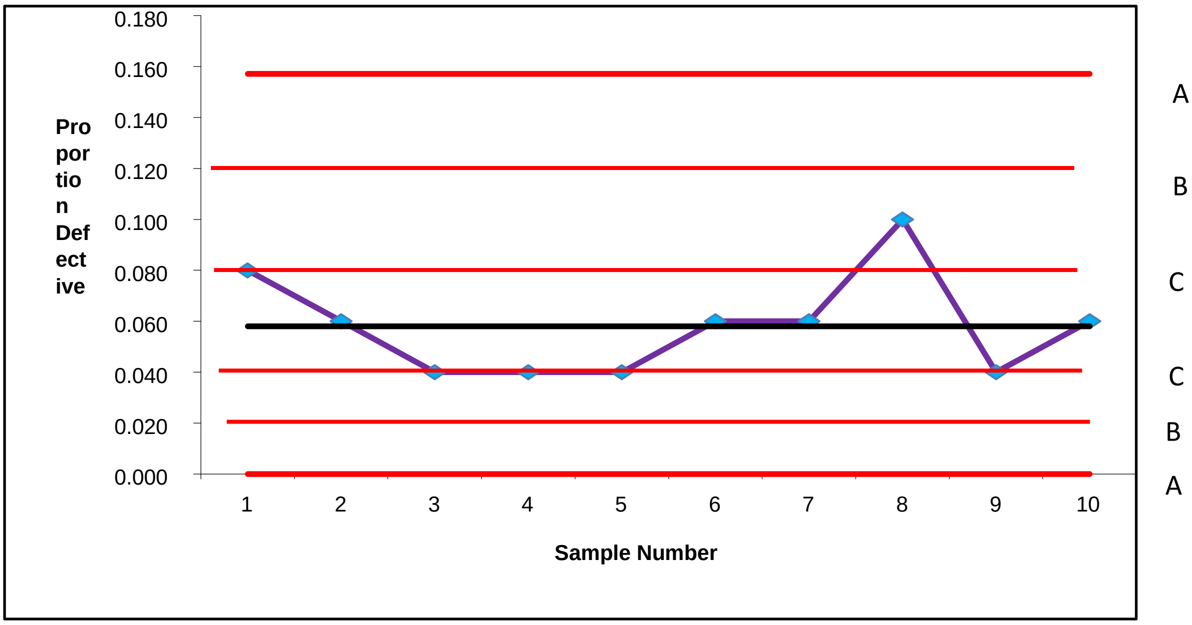

Fig: 1.5 p-chart of Rotor

1.6 p-chart values of Stator

Sample	Number of Defectives	Proportion Defective	p̄	UCL	LCL
1	4	0.080	0.05	0.1499	0.0000
2	3	0.060	0.05	0.1499	0.0000
3	2	0.040	0.05	0.1499	0.0000
4	4	0.080	0.05	0.1499	0.0000
5	1	0.020	0.05	0.1499	0.0000
6	2	0.040	0.05	0.1499	0.0000
7	1	0.020	0.05	0.1499	0.0000

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8	3	0.060	0.05	0.1499	0.0000
9	4	0.080	0.05	0.1499	0.0000
10	3	0.060	0.05	0.1499	0.0000
Total	27				

Result:

Particulars	Value
Mean	0.05
UCL	0.15
LCL	0.00

The chart shows that on average 5% of stator is found to be defective. The highest occurrence of defective will be of 15%. None of the proportions are outside the control limits. This p-chart represents that the process is in control.

Above chart shows the proportion defective varies between 0.040 and 0.080. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart maximum points lies between zone B and zone C. The points are scattered in the three zones. A two subgroup 5 and 7 is in zone B, if it exceeds the zone B then the special action should be taken to find the special cause and permanently remove it from the process.

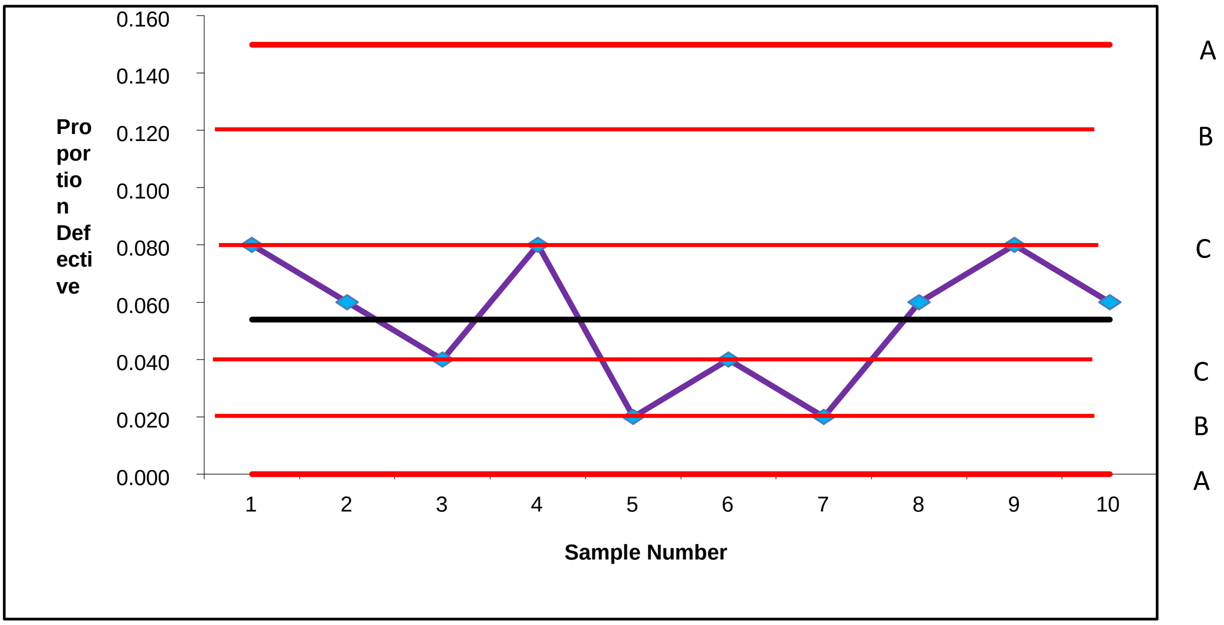

Fig: 1.6 p-chart of Stator

1.7 p-chart values of Outer Body

Sample	Number of Defectives	Proportion Defective	$\bar{p}$	UCL	LCL
1	3	0.060	0.06	0.1572	0.0000
2	3	0.060	0.06	0.1572	0.0000
3	2	0.040	0.06	0.1572	0.0000
4	4	0.080	0.06	0.1572	0.0000
5	2	0.040	0.06	0.1572	0.0000
6	3	0.060	0.06	0.1572	0.0000
7	4	0.080	0.06	0.1572	0.0000

8	3	0.060	0.06	0.1572	0.0000
9	2	0.040	0.06	0.1572	0.0000
10	3	0.060	0.06	0.1572	0.0000
Total	29				

Result:

Particulars	Value
Mean	0.06
UCL	0.16
LCL	0.00

The chart represents that the process is consistent and predictable. On average 6% will be of defective. The higher percentage of defects can be of 16% and the lower will be of null. The process is said to be in statistical control.

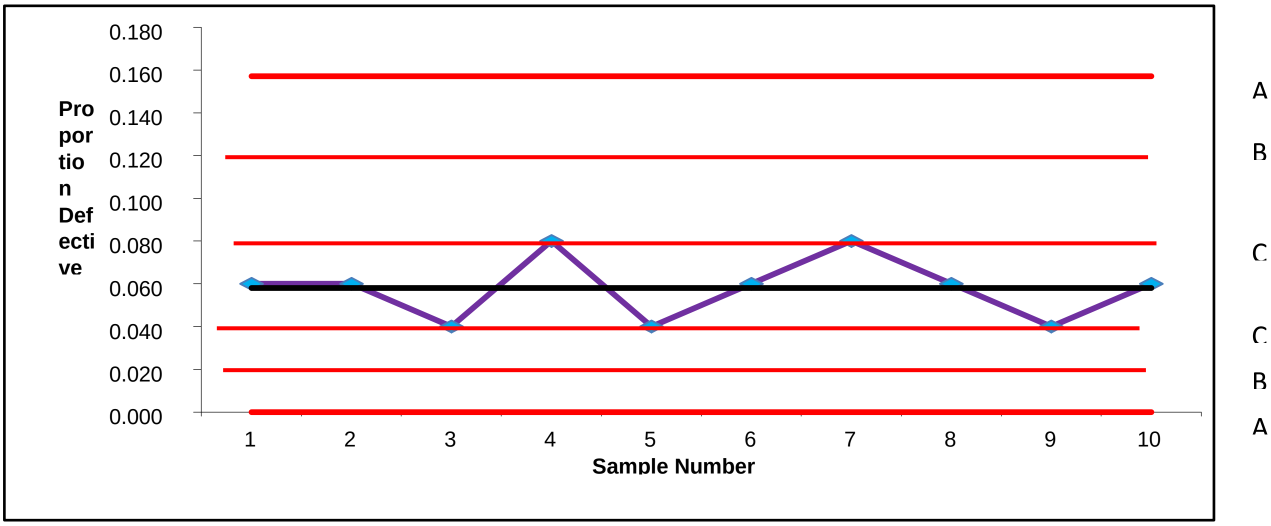

Fig: 1.7 p-chart of Outer Body

Above chart shows the proportion defective varies between 0.040 and 0.080. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart the maximum points lies near the average line. And the remaining points are scattered in zone C. As most of the subgroups are near the average line, the process is said to be in a statistical control manner.

1.8p-chart values of Shaft

Sample	Number of Defectives	Proportion Defective	$\bar{p}$	UCL	LCL
1	2	0.040	0.04	0.1310	0.0000
2	1	0.020	0.04	0.1310	0.0000
3	2	0.040	0.04	0.1310	0.0000
4	3	0.060	0.04	0.1310	0.0000
5	3	0.060	0.04	0.1310	0.0000
6	4	0.080	0.04	0.1310	0.0000
7	2	0.040	0.04	0.1310	0.0000
8	1	0.020	0.04	0.1310	0.0000
9	3	0.060	0.04	0.1310	0.0000
10	1	0.020	0.04	0.1310	0.0000
Total	22				

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Result:

Particulars	Value
Mean	0.04
UCL	0.13
LCL	0.00

The chart represents that the process is consistent and predictable. On average 4% will be of defective. The higher percentage of defects can be of 13% and the lower will be of null. The process is said to be in statistical control.

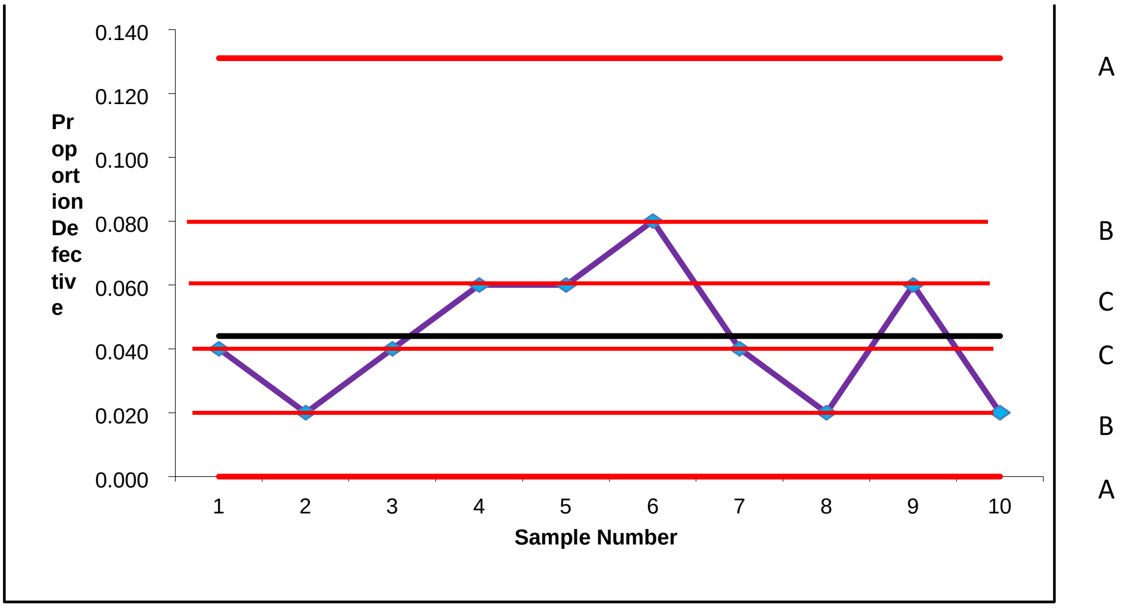

Fig: 1.8 p-chart of Shaft

Above chart shows the proportion defective varies between 0.020 and 0.080. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart the points are scattered randomly in the 2 zones. Subgroups 2,6,8 are in the zone B, so in order to get the process still in control and to improve the quality wants to provide special cause on the subgroups in the zone B. Suppose if it exceeds then the samples 2,6,8 wants to be removed.

1.9 p-chart values of Diaphragm

Sample	Number of Defectives	Proportion Defective	p̄	UCL	LCL
1	4	0.080	0.07	0.1782	0.0000
2	5	0.100	0.07	0.1782	0.0000
3	2	0.040	0.07	0.1782	0.0000
4	3	0.060	0.07	0.1782	0.0000
5	3	0.060	0.07	0.1782	0.0000
6	1	0.020	0.07	0.1782	0.0000
7	4	0.080	0.07	0.1782	0.0000
8	5	0.100	0.07	0.1782	0.0000
9	3	0.060	0.07	0.1782	0.0000
10	5	0.100	0.07	0.1782	0.0000
Total	35				

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DOI:10.35940/ijrte.D8027.118419
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Result:

Particulars	Value
Mean	0.07
UCL	0.18
LCL	0.00

The chart shows that on average 7% of diaphragm is found to be defective. None of the subgroup proportions are outside the control limits. This p-chart represents that the process is in control.

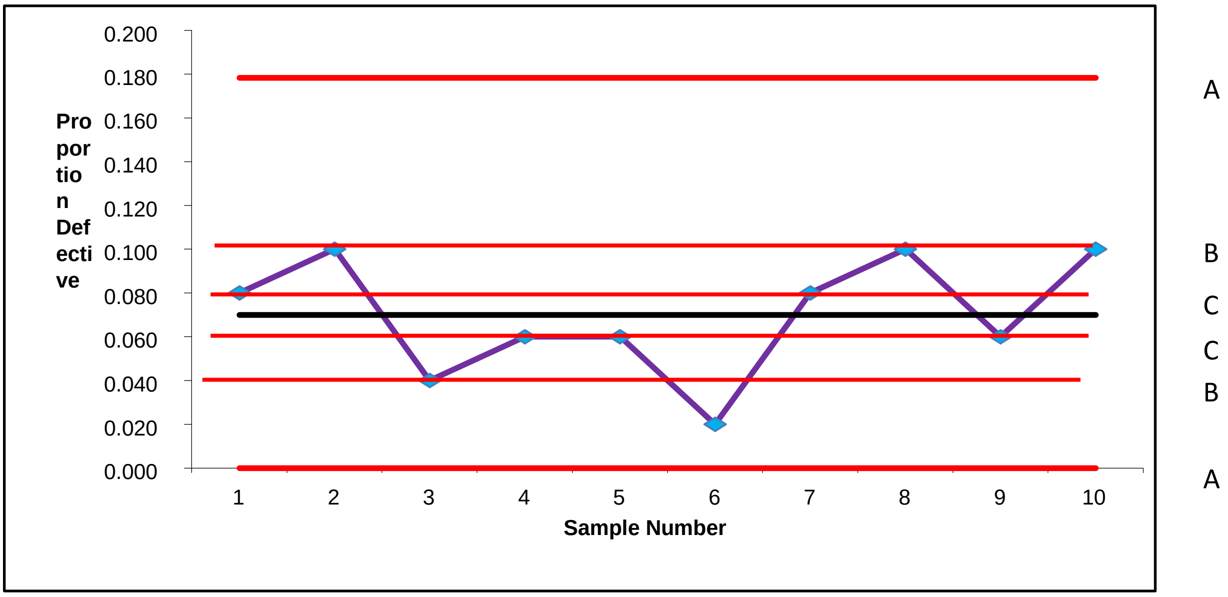

Fig: 1.9 p-chart of Diaphragm

Above chart shows the proportion defective varies between 0.020 and 0.1. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart all the point lies between the 2 zones. The maximum points lies near the average line. A 6th sample exceeds the zone B, and it's quite near the zone A, then the special action should be taken to find the special cause and permanently remove it from the process.

1.10 p-chart values of Winding

Sample	Number of Defectives	Proportion Defective	$\bar{P}$	UCL	LCL
1	3	0.060	0.03	0.1109	0.0000
2	3	0.060	0.03	0.1109	0.0000
3	1	0.020	0.03	0.1109	0.0000
4	1	0.020	0.03	0.1109	0.0000
5	2	0.040	0.03	0.1109	0.0000
6	1	0.020	0.03	0.1109	0.0000
7	1	0.020	0.03	0.1109	0.0000
8	2	0.040	0.03	0.1109	0.0000
9	1	0.020	0.03	0.1109	0.0000
10	2	0.040	0.03	0.1109	0.0000
Total	17				

Result:

Particulars	Value
Mean	0.03
UCL	0.11
LCL	0.00

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The chart represents that the process is consistent and predictable. On average 3% will be of defective. The higher percentage of defects can be of 11% and the lower will be of null. The process is said to be in statistical control.

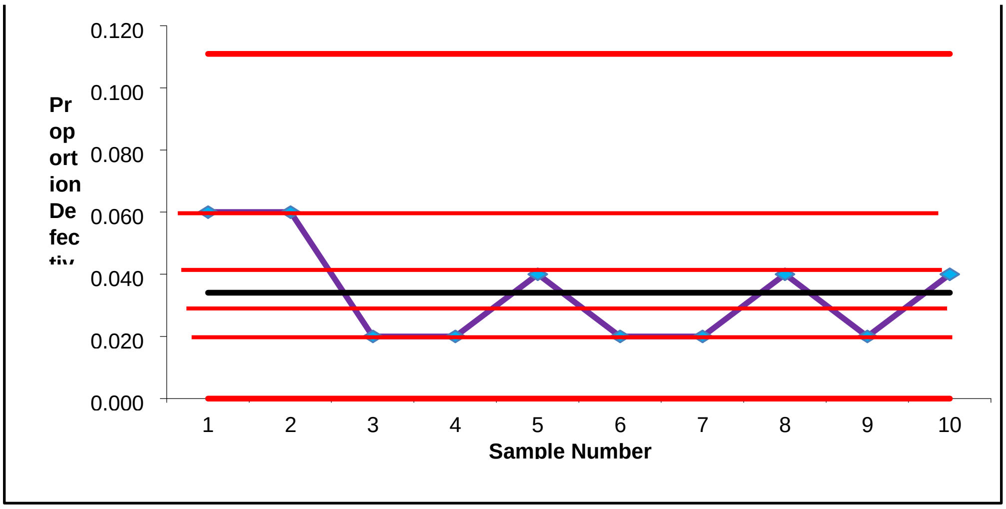

Fig: 1.10.p-chart of Winding

Above chart shows the proportion defective varies between 0.020 and 0.060. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart all the point mostly lies in the zone B. The maximum points near the average line. So the process is in control.

Table: 1.11. p-chart values of Cabling

Sample	Number of Defectives	Proportion Defective	$\bar{p}$	UCL	LCL
1	3	0.060	0.04	0.1191	0.0000
2	1	0.020	0.04	0.1191	0.0000
3	3	0.060	0.04	0.1191	0.0000
4	2	0.040	0.04	0.1191	0.0000
5	1	0.020	0.04	0.1191	0.0000
6	2	0.040	0.04	0.1191	0.0000
7	1	0.020	0.04	0.1191	0.0000
8	3	0.060	0.04	0.1191	0.0000
9	1	0.020	0.04	0.1191	0.0000
10	2	0.040	0.04	0.1191	0.0000
Total	19				

Result:

Particulars	Value
Mean	0.04
UCL	0.12
LCL	0.00

The chart represents that the process is consistent and predictable. On average 4% will be of defective. The higher percentage of defects can be of 12% and the lower will be of null. The process is said to be in statistical control.

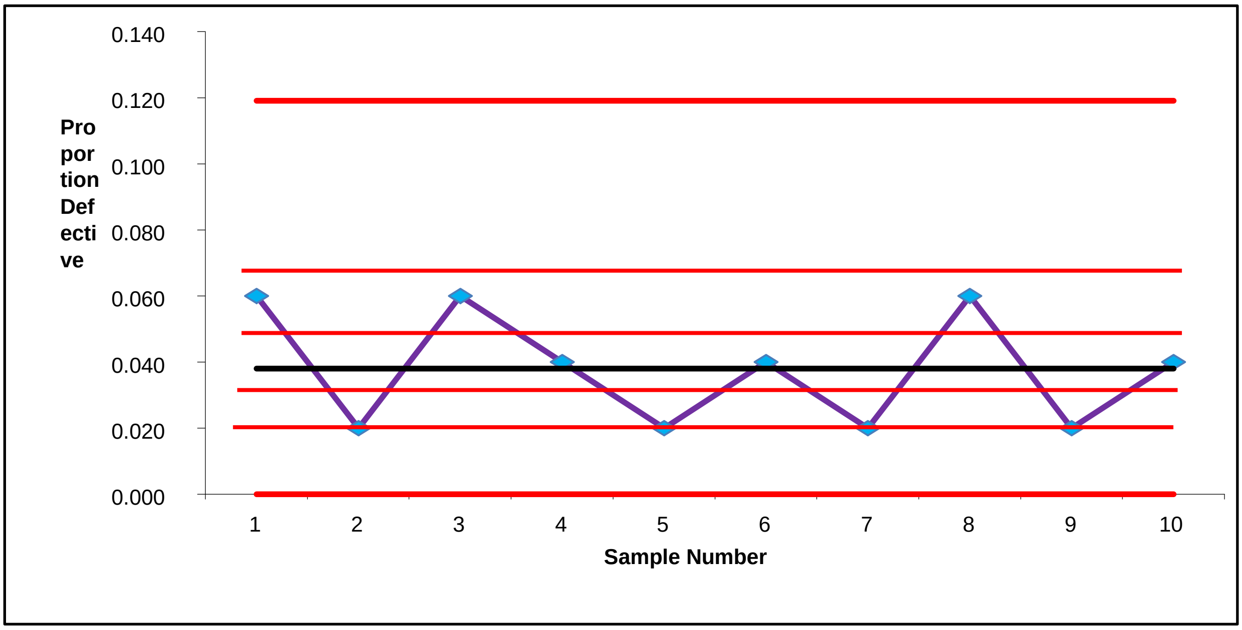

Fig: 1.11.p-chart of Cabling

Above chart shows the proportion defective varies between 0.020 and 0.060. The centre line is the average proposition of defective. Since the process is in control, the point varies randomly around the centre line. Most of the points are near the average line.

Zone Test:

From the above chart all the point lies between zone C and zone B. Samples except 2, 4 and 10 all the samples lies in the mid zone of B. If these sample points exceeds zone B then the process will not be in control and want to remove those samples to produce the quality products.

Result:

It shows that the process of production is said to be in statistical control. There exist a few percentages of defects in the each component. It can be reduced by the consistent steps of the quality measures and standards.

VI. FINDINGS OF THE STUDY

- It is found that the overall percentage of products defects will be of 2% from the total percentage of the products
- It is found that the spindle component defective can be on an average of 6% and the highest chance of getting defective will be of 16%
- It is found that the rotor component defective can be on an average of 6% and there exists a highest chance of getting defective of this component will be of 16%
- It is found that the Stator component defective can be on an average of 5% and the highest chance of getting defective will be of 15%
- It is found that the Outer Body component defective can be on an average of 6% and there exists a highest chance of getting defective of this component will be of 16%
- It is found that the Shaft component defective can be on an average of 4% and the highest chance of getting defective will be of 13%
- It is found that the Diaphragm component defective can be on an average of 7% and there exists a highest chance of getting defective of this component will be of 18%
- It is found that the Winding component defective can be on an average of 3% and the highest chance of getting defective will be of 13%
- It is found that the cabling defective can be on an average of 4% and there exists a highest chance of getting defective of this component will be of 12%

VII. SUGGESTIONS:

As the production defect rates are found to be in control there does not required much changes in the quality standards. A few changes want to be made to increase the quality efficiency. The choosing of raw materials and to use modernise automated machines for all the process. Some machines are manually operated by the humans as there is a chance of occurrence of human error as it may leads to the loss of efficiency rate of the products.

VIII. CONCLUSION

The study reveals that the making of the zero defects products is quite impossible in the production. But the goal can be fixed as a zero defects and the organisation can work towards this goal. The defects can be reduced by the consistent improvement in the process. The result of this study will helps us to concentrate on the particular component which causes the quite larger number of defects. From the analysis and the result further steps can be taken by the organisation to reduce the defects in their production which leads to zero defects.

Retrieval Number: D8027118419/2019©BEIESP
DOI:10.35940/ijrte.D8027.118419
Journal Website: www.ijrte.org

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

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