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Reduction of Non Conformative Rate of Bearing Rings Using Six Sigma Methodology

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Abstract - The fast changing economic condition such as global competition declining profit margin ,customer demand for high quality product ,product variety and reduced lead time etc had a major impact on manufacturing industries .To respond to these needs a new paradigm in this area of manufacturing strategies is six sigma .The six sigma approach has been increasingly adopted worldwide in the manufacturing sector in order to enhance productivity and quality performance and to make the process robust to quality variation This project discuss the process variation. This project discuss the process variation reducing the process variation and bearing reducing the rework by Appling DMAIC approach Project deals with application of six sigma DMAIC methodology in an industry which provides a frame work to identify quantity and eliminate sources of variation in an operation process in question to optimize the operation verifies improve and sustain performance process yield with well exerted control plans six sigma improve the process performance of the critical operational process leading better utilization of recourses decreases variation and maintain consistent quality of the process output.This study focus on Reducing Non-confirmative Rate of Bearings Rings Using DMAIC approach of six sigma methodology.

Keywords – Six Sigma, DMAIC, Pareto Chart, Fish Bone Diagram , C- Chart

I. INTRODUCTION

Six Sigma is a business performance improvement strategy that aims to reduce the number of mistakes /defects to as low as 3.4 occasions per million opportunities. Sigma is a measure of “variation about the average” in a process which could be in manufacturing or service industry. Six Sigma improvement drive is the latest and most effective technique in the quality engineering and management spectrum.

Six sigma is based on six basic principles that help with launching the initiative implementation of Six Sigma method to production companies or service industries. Sigma uses the base tools to improve the quality of products and processes as MSA (Measurement System Analysis), IPO Diagram (Input-process-output), CE (Cause-and-effect diagram), Histogram, Pareto diagram, DMAIC (Define, Measure, Analyze, Improve, Control) ,Run chart, Control chart, Scatter diagram, Regression Analysis, DOE (Design of Experiments), FMEA (Failure Mode and effect analysis), SOP (Standard Operating Procedure) and QFD (Quality Function Deployment).

Non-conformity is an unintentional departure from or absence of characteristics specified in

- Customer requirements
- Product specifications
- Manufacturing product instructions

Parts that cannot be recovered are scrapped. In other cases, we are able to recover suspected non conforming lots by taking corrective actions. This allows us to optimize the production process. The Six Sigma approach to managing is all about identifying what is known and not known about the various processes that a company relies upon to conduct its business, and then taking action in the form of problem solving teams working on projects in targeted areas, to reduce the errors and rework within these processes errors that cost time, money, opportunities, and customers. It must be kept in mind, however, that a successful Six Sigma initiative is not just about data tools and defect calculations.

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II. SIX-SIGMA METHODOLOGY

The Six Sigma approach to managing is all about identifying what is known and not known about the various processes that a company relies upon to conduct its business, and then taking action in the form of problem solving teams working on projects in targeted areas, to reduce the customers. It must be kept in mind, however, that a successful Six Sigma initiative is not just errors and rework within these processes errors that cost time, money, opportunities, and about data tools and defect calculations.Six Sigma is a quality improvement management doctrine developed by Motorola in 1985.

2.1 DEFINITION OF SIX-SIGMA

Sigma: A term used in statistics that measures standard deviation. In business, it is an indication of defects in the outputs of a process and how far these outputs deviate from perfection.

Six Sigma: A statistical concept that measures a process in terms of defects. At the six sigma level, there are only 3.4 defects per million opportunities. Six Sigma is also a philosophy of managing that focuses on eliminating defects

through practices that emphasize understanding, measuring, and improving processes.[6]

2.2 SIX-SIGMA TOOLS

Six Sigma is based on six basic principles that help with launching the initiative implementation of Six Sigma method to production companies or service industries.

Sigma uses the base tools to improve the quality of products and processes as [3]

1. MSA (Measurement System Analysis)
2. IPO Diagram (Input-process-output)

3. CE (Cause-and-effect diagram)4.Histogram, Pareto diagram

5. DMAIC (Define, Measure, Analyze, Improve, Control)

6. Run chart, Control chart, Scatter diagram, Regression

   Analysis,

7. DOE (Design of Experiments)

Machine No.	**Total Qty.**	**Good Qty.**	**Turning Rejection Qty.**	**Grinding Rejection Qty.**	**Grinding Rework Qty.**
FG-03	124220	123377	27	139	677
FG-04	73699	73470	219	8	2
CG-01	77788	76414	795	79	500
CG-02	0	0	0	0	0
CG-03	68452	68448	2	2	0
IG-02	17910	16284	133	84	1409
IG-03	0	0	0	0	0
IG-05	31310	27877	15	221	3197
IG-08	16136	15146	39	72	879
IG-09	20117	19164	14	54	885
IGC-01	34863	32801	47	151	1864
IGC-02	23107	20411	29	357	2310
IGC-03	23889	22564	49	69	1207
ODT-01	5635	5031	102	4	498
ODT-02	79480	79122	22	92	244
ODT-03	28339	28247	19	1	72
ODT-04	50568	50355	20	114	79
H-01	18627	18315	0	1	311
H-02	21997	21964	0	0	33
H-03	45931	45929	2	0	0
H-04	2725	2725	0	0	0
Cumulative	762068	133570	1534	1448	14167
			Total Good Qty	**Total Rejection**	**Total Quantity**
Cumulative Rejection			**133570**	**2982**	**136552**
			Total Rejection %	**2.18378**	

Table –I

8. FMEA (Failure Mode and effect analysis)

9. SOP (Standard Operating Procedure)

10. QFD (Quality Function Deployment)

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2.3 DMAIC

The DMAIC (define-measure-analyse-improve-control) approach has been followed here to solve an underlying problem of reducing process variation and the associated high defect rate.

2.3.1 DEFINE:

Problem identification and definition takes place in define phase.

Manufacturing Process of Bearing Rings.

In this study focus is only on internal ring and outer ring Different process by which rings are manufactured is given below.

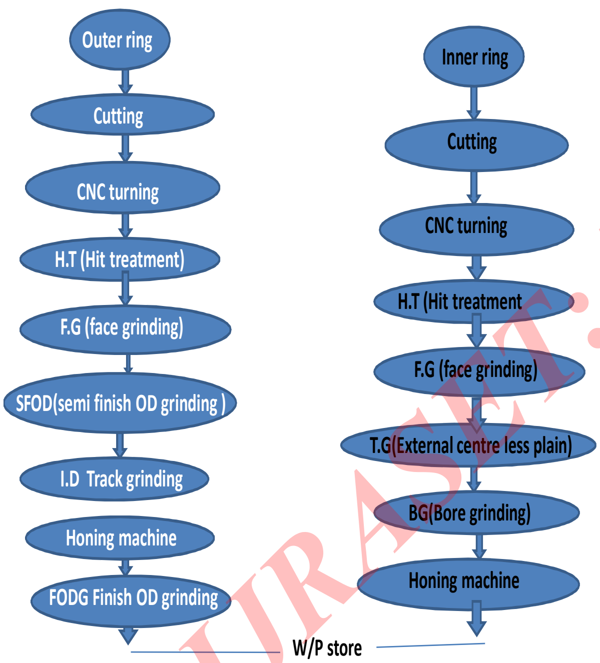

Fig.1Ring Manufacturing Process

MONTH WISE DATA COLLECTION OF DIFFERENT MACHINES WISE REJECTION, REWORK CHART

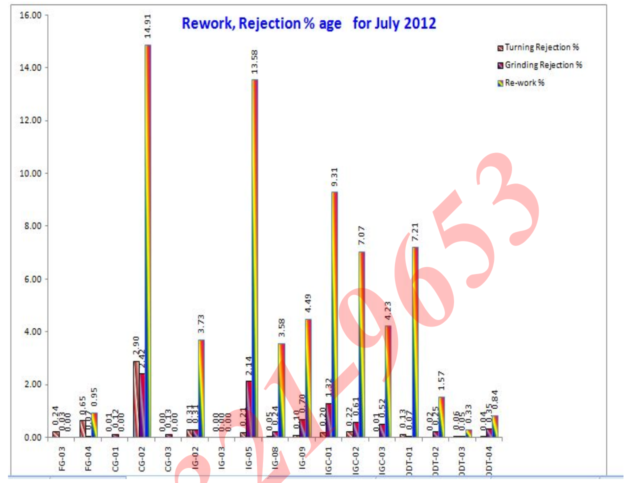

Fig.2 Rework, Rejection

- From the data it has been found that IGC_1, IGC-2, and CG-2 produces high non conformative rate.after discussion with management, IGC-1 was choosen for this study.

Fig.3 IGC-1

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TABLE II

SCOPE OF PROJECT

Sr. No.	Parameter	Present Status	Approximated Status
1	Average Bearing Ring Manufacturing/Month	18900	22000
2	Average Bearing Ring Rejection %	1.14	0.6
3	Average Bearing Ring Rework %	7.6	3.5
4	Sigma Level	2.94	3.8

2.3.2 MEASURE PHASE

This phase presents the detailed process mapping, operational definition, data collection chart, evaluation of the existing system, assessment of the current level of process performance etc. In the measure phase, performance of process in pain areas is determined and operations data was collected.

Number of rings are produced by IGC-1. But All the rings produced by the machine are not going for final phase, some of them are going for rework and others are getting rejection. Some of the problems were found for rejection and rework.

1. Size variation
2. Tapper variation
3. Ovality or roundness more than the specifications
4. Run out of the ring
5. Straightness
6. Roughness
7. Chatter mark on a ring
8. Cracks on the ring

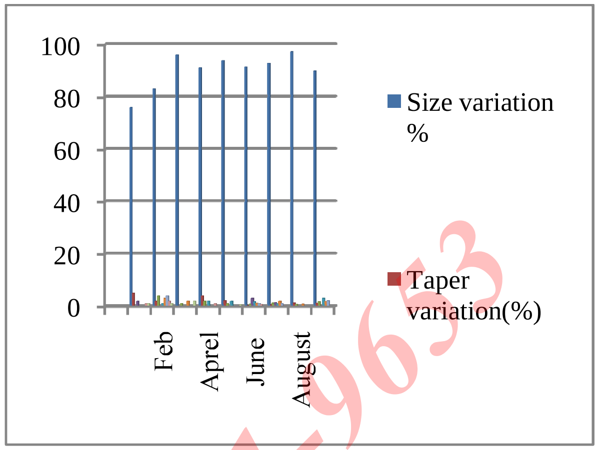

Fig.4 Problems produced in bearing rings

2.3.3 ANALYZE PHASE

The analyze phase is the third step in the DMAIC improvement cycle. This section describes the work and result of the cause and effect diagram to identify probable causes. This phase describes the potential causes identified which have the maximum impact on the operational wastages. From the data, maximum rework occurs by the problem of size variation.

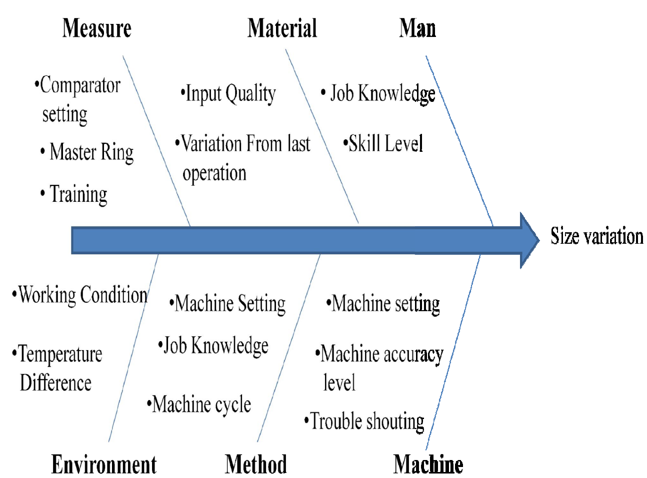

Fig.5 Fish Bone Diagram

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Pareto Chart

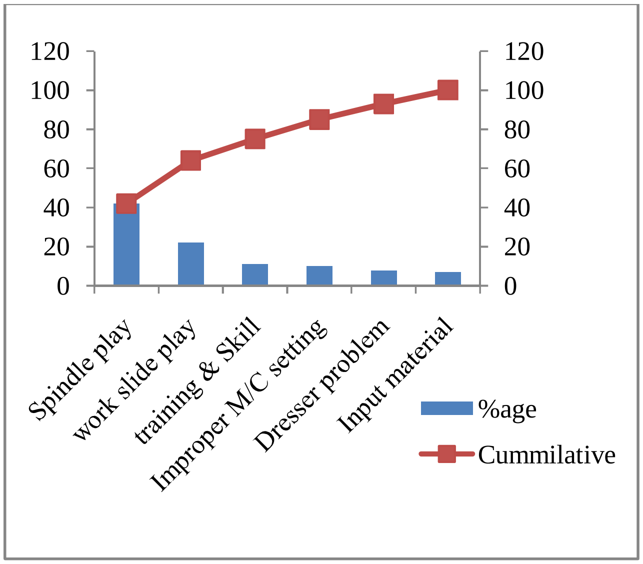

Fig .6 Pareto Chart

Figure,6 shows that the highest impact has Working Slider Play 42 %, It affect is high production service costs, were successfully reduced with internal system reorganization of company. Based on Pareto chart, formed team made decision to analyze and make improvements within labour and tools cost area, which together have amount of 48% of total expenses. Also, there were submitted that quality improve and reducing Rework and Rejection and it also reflect in sigma level.

2.3.4 IMPROVE PHASE:

The Improve phase is the fourth step in DMAIC improvement cycle and its aim is to find and implement measures that would solve the problem. Proposed solutions to the Size variation are given in

Table 3

Size variation is major cause in IGC-01 and it producing rework and rejection of Bearing rings Finding all problem of size variation .first solve assignable causes which is easily to identify and remove by operation After discussing above solutions with the Company's Manager and Engineers, they are gives us to permission to implementation of solution and they are gives us to guides.

Table-III

Sr. No.	**Nature of problem**	**Cause for problem**	**Problem Solution**
1	**Size variation**	a) O.D. Size variation.	Group the O.D. size within 5 microns.
		b) Grinding allowance variation.	Check input quality of rings.
		c) Shoe plate loose or shoe bolt loose.	Check shoe plate and shoe setting and tight all bolts.
		d) Ring lifting or ring stop while rotation.	Reset the shoe setting.
		e) Poor Grinding wheel quality.	Change Grinding wheel or change wheel grad.
		f) Less coolant amount	Set proper coolant amount.
		g)Excessive feed rate.	Set required feed rate.
		h) Low Grinding wheel RPM	Set required wheel RPM
		i) Faulty limit switch setting.	Set proper limit switch position.
		j) Play in Dresser unit.	Check the play and rectify Dresser unit.
		k) Dresser centre height not OK	Adjust the centre height.
		l) Wheel spindle not at centre.	Adjust the center height.
		n) Play in Slide.	Check the play and rectify Slide play.
		o) Feed start position not proper	Check the feed start position and feed amount.
		p) Feeding not proper or jerks while feeding.	Check the feeding and reset feeding unit.

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- **Process capability after taking corrective action**
  Causes removed by taking above corrective action, after that process capability of ICG- 01 has been founded.
- Chart shows the value Cp and Cpk.
- Size of bearing rings are 28 mm and 16mm of outer dia. And bore dia. Respectively.

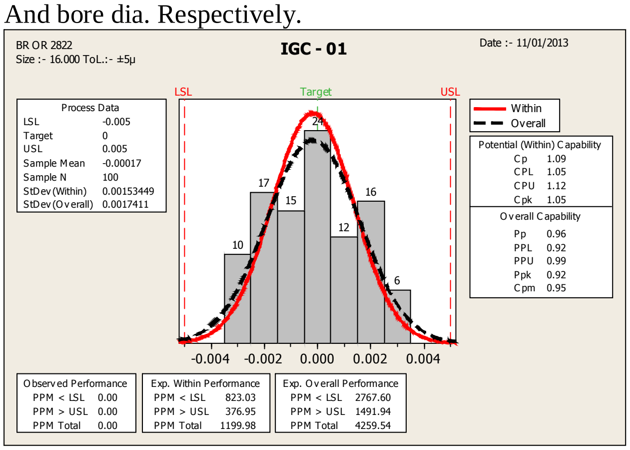

Fig.7 Cp & Cpk value

Fig.8 Inspection of bearing rings

Table IV

Before Implementation of six-sigma

(Data January-12 to December-12)

Month	Re-work sigma level
12-Jan	3.11
12-Feb	2.960
12-Mar	3.06
12-Apr	2.980
12-May	2.900
12-Jun	2.680
12-Jul	2.83
12-Aug	3.06
12-Sep	2.92

TABLE V AFTER IMPLEMENTATION OF SIX- SIGMA METHODOLOGY

Month	Re-work Sigma Level
12-Oct	2.96
12-Nov	3.01
12-Dec	3.1
13-Jan	3.2
13-Feb	3.8
13-Mar	3.94

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2.3.5 CONTROL PHASE

The last phase of DMAIC is control, it is the phase in which we ensure that the processes continue to work well, produce desired output results, and maintain quality levels. This is about holding the gains which have been achieved by the project team. Implementing all improvement measures during the improve phase, periodic reviews of various solutions and strict adherence on the process yield is carried out. The Business Quality Council executed strategic controls by an on going process of reviewing the goals and progress of the targets. The council met periodically and reviewed the progress of improvement measures and their impacts on the overall business goals.

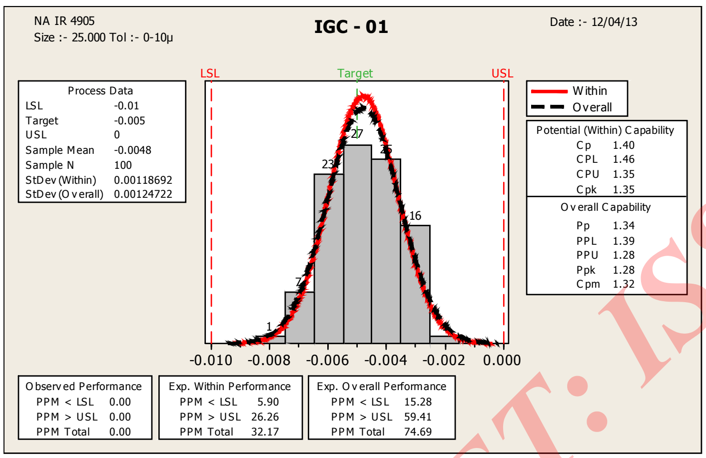

Fig .9 Process capability after DMAIC

Fig.9 shows process capability after DMAIC. All the data of the month from January to February has been collected by taking all the corrective actions.

In the month April monitoring of IGC-01 was applied and 100 piece of bearing ring was taken for finding out the results.

Cp and Cpk value are improved and it is in control It reduce the non confirmative rate of bearing rings. This shows in figure.9

III. RESULT AND DISCUSSION

The Six Sigma based methodology has been used to optimize the Re-work. The results obtained are in the form of improvement for Size variation in Sigma level (Previous =2.92, Improved=3.94). It has been found that organization achieved breakthrough in reducing rework due to Six Sigma DMAIC Methodology. Six Sigma was found to be the greatest motivator behind moving everyone in the organization and bringing radical transformation. People in the workplace have developed the required statistical thinking with their involvement in this particular study. Benefits of implementation have been found to be enormous in this case study. However further research is possible in the direction of what the people and organization has to sacrifice for getting this breakthrough in their process. As no gains possible without companying improvement in work habit Six Sigma is continues improvement process involving all operations in the work place and more such opportunities are potentially available in the workplace.

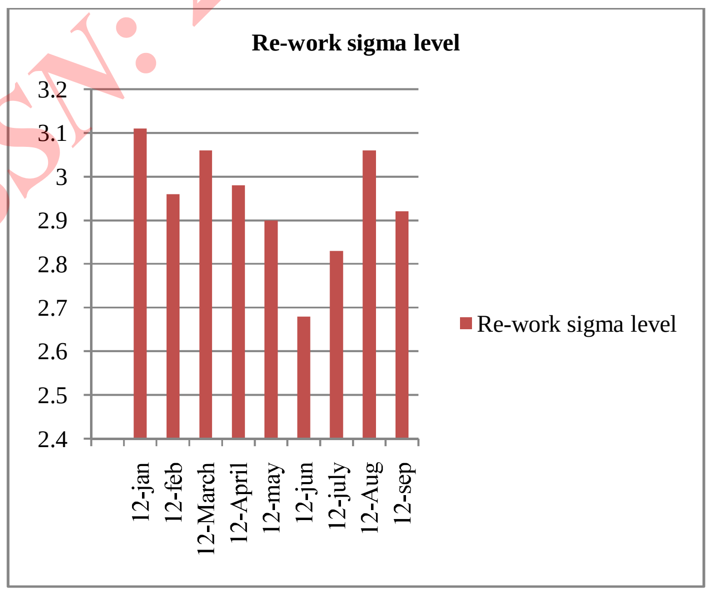

Fig .10 Before implementation of six sigma methodology

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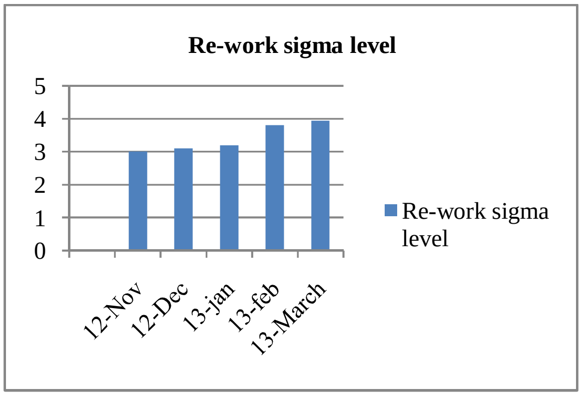

Fig. 11 After implementation of six sigma Methodology

- Figure shows sigma level value from the month January to September is fluctuated by moving up and down
- There is no continuous improvement.
- Figure shows sigma level value is continuous improved after DMAIC. So, there is continuous improvement

IV. CONCLUSION

As can be seen from the study that six-sigma can be very successfully implemented in manufacturing unit .In this study results obtained in the form of improvement for bearing rings in sigma level.

- Machine can be selected on which six Sigma implementation can be done This can be achieved by define phase of DMAIC model
- Causes for the problems can be measured, highly affected problem was measured and finally route cause for the problem was also measured. this can be achieved by measure phase of Six-Sigma
- Analysis of the data can be done by using analyze phase of DMAIC
- Improvement in machine can be achieved by taking corrective action.
- Whether the problems are in control or not? It can be checked in control phase.

The breakthrough improvement using Six Sigma can be achieved

In this Study Rejection of bearing rings is reduced, non conformative rate of bearing rings is reduced, quality is improved, coast reduction. All could be achieved by using DMAIC model of Six-sigma Methodology.

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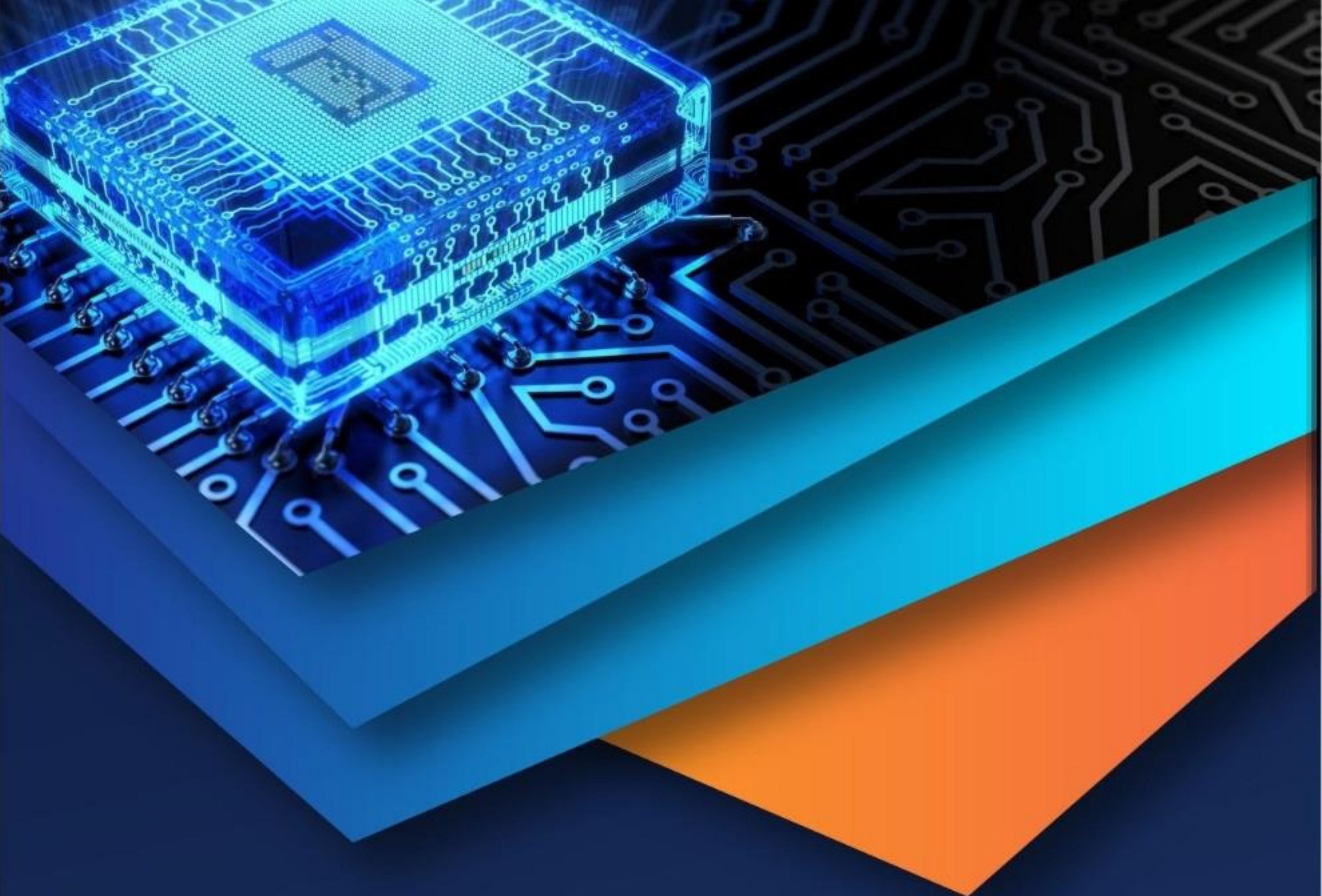

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