iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** III **Month of publication:** March 2021

DOI: https://doi.org/10.22214/ijraset.2021.33161

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue III Mar 2021- Available at www.ijraset.com

Defect Analysis on VMC Machined Copper Components through Statistical Tools in Quality Control Process

B. Kamesh Srikar[1], J DurgaVenkata Satyanarayana[2], Venkatraman Ramamoorthi[3], Raghuraman Srinivasan[4], Sivachidambaram Pichumani[5]
[1, 2]Post Graduate students, [3, 4]Professor, [5]Research Scholar, School of Mechanical Engineering, SASTRA University, Thanjavur – 613401, Tamil Nadu, India.

Abstract: The main objective of the work is to investigate the defects that occur in forged/machined components. During the production process, quality check for each and every component is leads to increase in production cost. Reducing the inspection time and number of rejections, during manufacturing is addressed using Lean-Six Sigma principles. This helps to reduce the inspection as well as rework times leads to reduction in cost. Deviations in hole diameters were identified and improvements were suggested using statistical quality control tools.
Keywords: SQC, X-bar Chart, R-bar Chart, Histogram, Process capability, Performance capability.

I. INTRODUCTION

Meaning of Lean, The term Lean was utilized without precedent for 1988, amid the International Motor Vehicle Program, which went for understanding the distinctions in profitability amongst Japanese and Western ventures [1]. The term was then advanced by Womack in their book "The Machine That Changed the World" [2]. Lean Manufacturing is an idea of improve the speed and effectiveness of a process.The wellspring of Lean Manufacturing originated from the Toyota Production System, it depends on the guideline of killing all types of squandered an incentive inside the venture. Administration standards of LM For some creators, LM is a long haul corporate system and a reasoning of corporate administration. Toyota prevailing with regards to incorporating LM [3] in its association and has kept on doing as such for over 40 years. Another procedure of lean six sigma joining was proposed and tried in a flying machine industry by Siddhartha ramamoorthy from madras. The examination includes the gathering of the upper primary section entryway of a business stream [4]. Then again Six Sigma is a persistent change arrange for that is proposed to diminish fluctuation [5]. By applying both lean & Six Sigma can help in taking out waste, improve the quality of product.It improves smooth control of machining operations and helps to decreasing the machining cost and time.

II. METHODOLOGY

Table 1: Milling Process Parameters

Process Parameters	Values
Feed	28mm/min
Speed	750 rpm
Fixture No	SCH/M/003

Milling and Drilling process are performed by using Vertical milling centre (VMC) is used for removal of material surface layer with specified dimensions using milling tool and there milling parameters are mentioned in table 1 and drilling paramters are mentioned in table 2.Finally inspect themachened components shows in figure 1 &2, to check with desired dimension and gives a results whether it is accepted or not to the specification mentioned by the customer, Otherwise it will be considered as defective product. Quality has to check in each and every process at different stages, to evaluate the process and reduce the defect of the product during the machining procedure. 2D height guage is used collect the data for the and rocreded in table 3.

Table 2: Drilling Parameters

Process Parameters	Values
Machine	VMC
Tool Diameter	6.225mm drill
Feed	200mm/min
Speed	100 rpm
Drill Depth	19.0 max
Coolant Oil	Water Soluble Oil
Tool Bit Material	Carbide Tool
Cycle time	53
Cutting Time	44

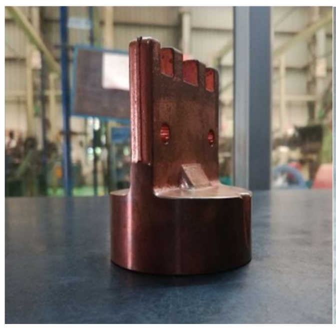


Figure 1: Electrical Breaker Component Figure 2: Component Bottom View

III. DATA COLLECTION & ANALYSIS OF DATA FOR PRODUCT – BOTTOM HOLES

Table 3: Drilled Hole diameter Values (mm)

S.NO	1	2	3	4	5	6	7	8	9	10
1	6.8920	6.7820	6.7800	6.7500	6.7580	6.7800	6.7500	6.7500	6.8000	6.7700
2	6.7880	6.6980	6.7900	6.8875	6.7780	6.8000	6.7700	6.7860	6.7700	6.7900
3	6.8000	6.8020	6.7580	6.8000	6.7700	6.8020	6.7800	6.8020	6.7600	6.7600
4	6.7800	6.7900	6.7820	6.7680	6.8010	6.8100	6.7600	6.8100	6.7580	6.8000
5	6.7680	6.8000	67600	6.8020	6.8100	6.8100	6.800	6.7800	6.7770	6.7800

Table 4: Calculation for Histogram (mm)

S.NO	1	2	3	4	5	6	7	8	9	10
X-large (mm)	6.8920	6.8020	6.7900	6.8750	6.8100	6.8100	6.8000	6.8100	6.8000	6.8000
X-small (mm)	6.7680	6.6980	6.7580	6.7500	6.7580	6.7800	6.7500	6.7500	6.7580	6.7600
Range	0.1240	0.1040	0.0320	0.1250	0.0520	0.0300	0.0500	0.0600	0.0420	0.0400
Average	6.8056	6.7744	6.7740	6.7990	6.7834	6.8004	6.7720	6.7856	6.7730	6.7800

1) *Formulas Used*

X-bar:

Upper control limit = x-bar + A_2*R-bar

Lower control limit = x-bar - A_2*R-bar

R-bar:

Upper control limit = D_4* R-bar

Lower control limit = D_3* R-bar

Other Formulas:

$$\text{Standard deviation } (\sigma) = \frac{R-bar}{2}$$

$$\text{Process capability } C_p = \frac{T}{6\sigma}$$

$$\text{Starting point of interval} = X_{min} - \frac{LC}{2}$$

$$\text{Interval} = \frac{Process\ Width}{Tolerance}$$

Collect as many subgroups as possible before calculating control limits. With smaller amounts of data, the X-bar and R chart may not represent variability of the entire system.. When you begin improving a system, use them to assess the system's stability**.** After the stability has been assessed, determine if you need to stratify the data. You may find entirely different results between shifts, among workers, among different machines, among lots of materials, etc. To see if variability on the X-bar and R chart is caused by these factors, collect and enter data in a way that lets you stratify by time, location, symptom, operator, and lots. You can also use X-bar and R charts to analyze the results of process improvements. X-bar and R charts for standardization**.** This means you should continue collecting and analyzing data throughout the process operation. Without a control chart, there is no way to know if the process has changed or to identify sources of process variability

A. X-Bar

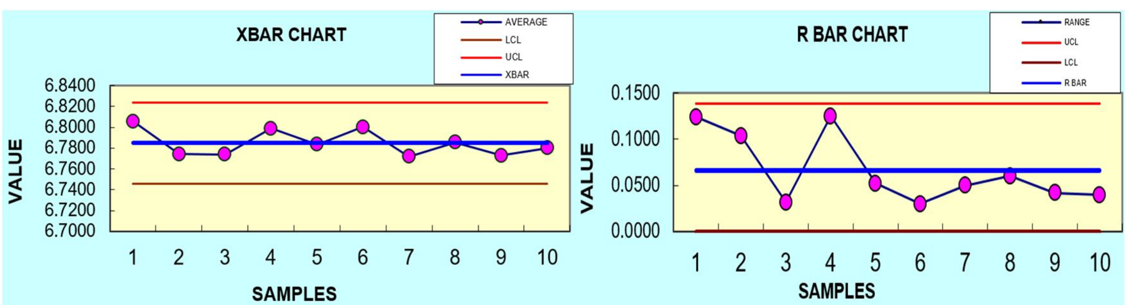


Figure 3: X-Bar ChartFigure 4: R-Bar Chart

An x-bar chart or average chart

1) We take 50 samples are taken and arrange them in 5-sub-group size with 10 numbers each in sub-groups.
2) On the vertical axis, we take average of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
3) Indicate the U.C.L & L.C.L values on the graph, by this it is easy to find out how many components are not within the limits
4) Formulas used to calculate the control limits U.C.L = X-bar+A_2*R-bar and
5) L.C.L = X-bar-A_2*R-bar
6) Obtain values are U.C.L = 6.8236 and L.C.L = 6.7458
7) Plot the average value readings on graph with respective to the number of sub-group size
8) Make a line by adding all these values
9) Then it shows clearly that the components are in within the limits or not

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue III Mar 2021- Available at www.ijraset.com

B. Range Chart

An R-chart (or range chart) is specifically designed for detecting changes in variability

1) On the vertical axis, we take range values of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
2) Range means difference of maximum values to minimum value
3) Indicate the U.C.L & L.C.L range values on the graph, by this it is easy to find out how many components are not within the limits
4) Formulas used to calculate the control limits U.C.L = D_4* R-bar and
5) L.C.L = D_3* R-bar
6) Obtain values are U.C.L = 0.1390 and L.C.L = 0
7) Plot the plot value readings on graph with respective to the number of sub-group size
8) Make a line by adding all these values
9) Then its shows clearly that variable values of components are in within the limits or not

C. Histograms

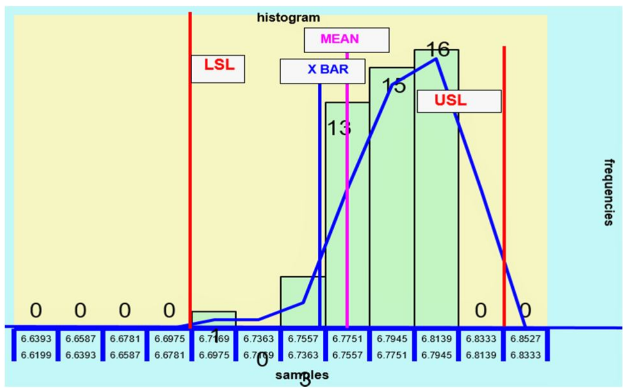


Figure 5: Histogram

A histogram is a bar graph which shows frequency distribution

1) On the vertical axis we are taking frequencies and on the horizontal axis intervals of components diameters are plot the frequencies values according is plotted as to its intervals
2) The height of each bar should be equal to the frequency of its corresponding interval
3) The cumulative frequency values are taken by adding the number of components that are occur between the intervals according to the frequencies
4) Indicate the values of U.S.L & L.S.L to find the number of components are accepted final components and the defected components
5) U.S.L = 6.910 and L.S.L = 6.650

D. Final Collection

Table5: Calculated Values

Descriptions	Values
U.C.L = $\overline{X}+A_2*\overline{R}$	6.823621
L.C.L = $\overline{X}-A_2*\overline{R}$	6.74586
U.C.L = $D_4*\overline{R}$	0.139049
L.C.L = $D_3*\overline{R}$	0
Std.Dev.=$\sigma=\overline{R}/D_2$	0.02833
Cp=(T/6σ)	1.52949
C_{pk}	1.47372

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue III Mar 2021- Available at www.ijraset.com

Table 6: Histogram Frequency Distribution

INTERVAL		Number of frequency	Cumulative frequency
6.6975	6.7169	1	1
6.7169	6.7363	0	1
6.7363	6.7557	3	4
6.7557	6.7751	13	17
6.7751	6.7945	15	32
6.7945	6.8139	16	48
6.8139	6.8333	0	48
6.8333	6.8527	0	48

IV. DATA COLLECTION & ANALYSIS OF DATA FOR PRODUCT – SIDE HOLES

Table7: Side Hole Diameter Values (mm)

S.NO	1	2	3	4
1	6.2140	6.2340	6.2310	6.2530
2	6.2300	6.2230	6.2410	6.2210
3	6.2380	6.2240	6.2420	6.2460
4	6.2500	6.2460	6.2330	6.2080
5	6.2350	6.2250	6.2380	6.2390

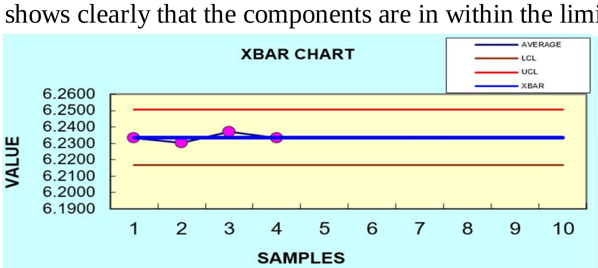
Table 8:Calculation for Histogram (mm)

S.NO	1	2	3	4
X-large (mm)	6.2500	6.2460	6.2420	6.2530
X-small (mm)	6.2140	6.2230	6.2310	6.2080
Range	0.0360	0.0230	0.0110	0.0450
Average	6.2334	6.2304	6.2370	6.2334

A. X-Bar

An x-bar chart or average chart

1) We take 50 samples are taken and arrange them in 5-sub-group size and 10 as number of sub-groups.
2) On the vertical axis, we take average of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
3) Indicate the U.C.L & L.C.L values on the graph, by this it is easy to find out how many components are not within the limits
4) Formulas used to calculate the control limits U.C.L = X-bar+A_2*R-bar and
5) L.C.L = Xbar-A_2*R-bar
6) Obtain values are U.C.L = 6.2505 and L.C.L = 6.2165
7) Plot the average value readings on graph with respective to the number of sub-group size
8) Make a line by adding all these values
9) Then it shows clearly that the components are in within the limits or not



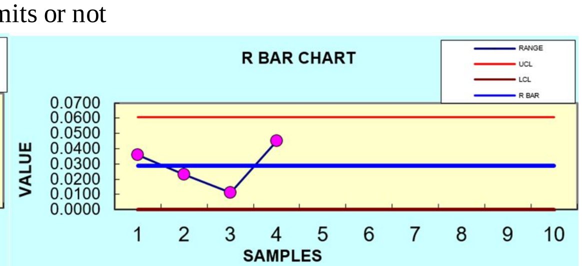


Figure 6: X-Bar ChartFigure 7: R-Bar Chart

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue III Mar 2021- Available at www.ijraset.com

B. Range Chart

An R-chart (or range chart) is specifically designed for detecting changes in variability

1) On the vertical axis, we take range values of 5-sub-group size each and on the horizontal axis, we take number of sub-group size as 10
2) Range means difference of maximum values to minimum value
3) Indicate the U.C.L & L.C.L range values on the graph, by this it is easy to find out how many components are not within the limits
4) Formulas used to calculate the control limits U.C.L = D_4* R-bar and
5) L.C.L = D_3* R-bar
6) Obtain values are U.C.L = 0.06066 and L.C.L = 0
7) Plot the plot value readings on graph with respective to the number of sub-group size
8) Make a line by adding all these values
9) Then it is clearly shows that variability values of components are in within the limits or not

C. Histograms

A histogram is a bar graph which shows frequency distribution

1) On the vertical axis we are taking frequencies and on the horizontal axis is plotted as intervals of components diameters
2) Plot the frequencies values according to its intervals
3) The height of each bar should be equal to the frequency of its corresponding interval
4) The cumulative frequency values are taken by cumulating the number of components that are occur between the intervals according to the frequencies
5) Indicate the values of U.S.L & L.S.L to find the number of components are accepted final components and the defected components
6) U.S.L = 6.300 and L.S.L = 6.150

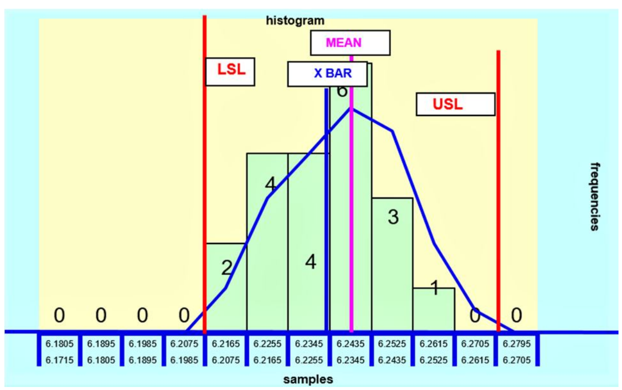


Figure 8: Histogram for side hole

D. Final Collection

Table 9: Calculated values

Descriptions	Values
U.C.L = $\bar{X}+A_2*\bar{R}$	6.2505125
L.C.L = $\bar{X}-A_2*\bar{R}$	6.21659
U.C.L = $D_4*\bar{R}$	0.0606625
L.C.L = $D_3*\bar{R}$	0
Std. Dev.=$\sigma=\bar{R}/D_2$	0.01236
Cp=(T/6σ)	2.02261
C_{pk}	1.79203

Table 10: Histogram Frequency Distribution

INTERVAL		Number of frequency	Cumulative frequency
6.2075	6.2165	2	2
6.2165	6.2255	4	6
6.2255	6.2345	4	10
6.2345	6.2435	6	16
6.2435	6.2525	3	19
6.2525	6.2615	1	20
6.2615	6.2705	0	20
6.2705	6.2795	0	20

V. RESULTS & DISCUSSION

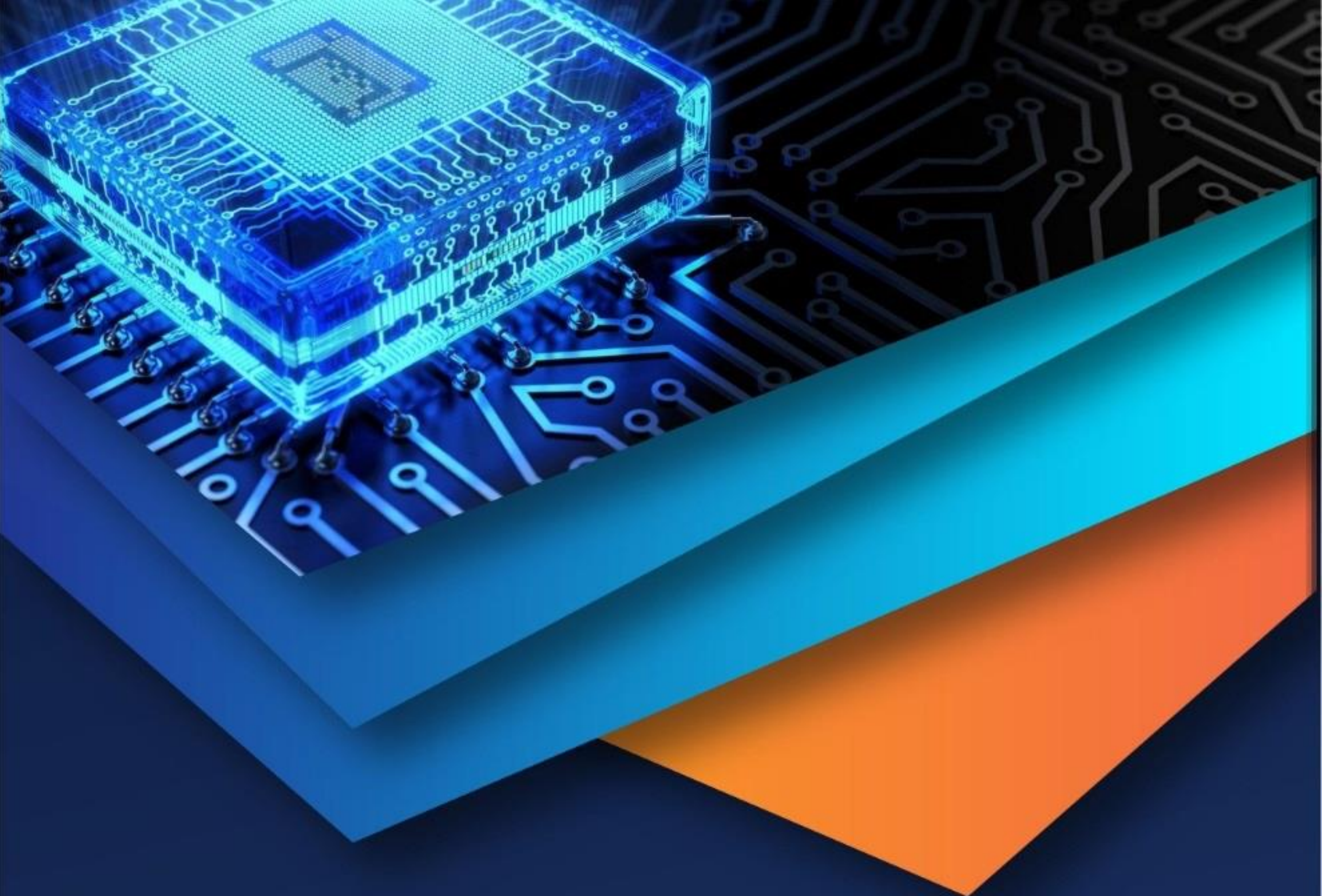
1) *Histograms:* In the obtained histogram during 7^{th}&8^{th} intervals more number of products are fall under this region and also within the range. A very few number of components are in outside the limits of U.S.L
2) *X Bar & Range Charts:* Here average of all the components are varies within the control limits and also all are in acceptable.
3) *Frequency Distribution:* The above table 6 and table 10 showed frequency distribution values of bottom hole and side hole respectively. This the number of components should be produced in the interval shows that the number of components categorized in accordance with the its range. This helps to address the causes for the higher number deviation in the manufactured components through analyzing the cause and effect diagram.

VI. CONCLUSION

The techniques such as Histogram, X bar chart, R bar chart, are plotted to understand the defects & how its causes. From Histogram, X-bar chart, R-bar chart are used to find the UCL – upper control limit, LCL- lower control limit are used to evaluate the process to be defect free before reaches the customer, where customer This helps to reduce the inspection as well as rework times leading to reduction in cost. During the manufacturing process,deviations are occurs in the hole diameters of machined componentsthrough VMC machine are identified.

REFERENCES

[1] Lean process management implementation through enhanced problem solving capabilities by PerumalPuvanasvaran, HamdanMegat, Tang Sai Hong, Muhamad MohdRazali, SHamouda Abdel Magid in JIEM ISSN: 2013-0953.
[2] A Survey on Lean Manufacturing Implementation in Malaysian Automotive Industry by NoraniNordin, Baba MdDeros and DzuraidahAbdWahab in International Journal of Innovation, Management and Technology, Vol. 1, No. 4, October 2010 ISSN: 2010-0248
[3] Lean Manufacturing Tool and Techniques in Process Industry by Sharma Neha, MatharouGurpreet Singh, Kaur Simran, Gupta Pramod in International Journal of Scientific Research and Reviews ISSN: 2279-0543
[4] Implementation of Lean Manufacturing Principles in Foundries by Praveen Tandon, Dr. Ajay Tiwari, ShashikantTamrakar in International Journal Of Modern Engineering Research (IJMER) ISSN: 2249–6645
[5] Enhancement in Productivity through Leanmanufacturing by P.V.Avinash, L.Ramesh in International Journal of Engineering Trends and Technology (IJETT) - Volume4Issue5- May 2013 ISSN: 2231-5381



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY