Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Department of Statistics

UGC-SAP-DRS-I

Project Report on

"Implementation of Control Charts: Case Study of Shree Omkar Precision Works, Aurangabad."

Submitted by

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Guided by

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Dr. Babasaheb Ambedkar Marathwada University, Aurangabad

Department of Statistics

CERTIFICATE

This is to certify that the Project entitled **"Implementation Of Control Charts: Case Study of Shree Omkar Precision Works, Aurangabad"** Submitted to the Department of Statistics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad in the Partial fulfillment of the course, Master Degree in Statistics in academic year 2013-2014.

Submitted by

Mr. Saif Hosam Raheem

H.O.D	Examiner	Guide
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"Shree Omkar Precision Works, Aurangabad"

CERTIFICATE

This is to certify that, Mr. Saif Hosam Raheem

Student of M.Sc. IInd Year, Department of Statistics, Dr. Babasaheb Ambedkar Marathwada University, Aurangabad have completed the project entitled, "Implementation Of Control Chart: Case Study Of Shree Omkar Precision Works, M.I.D.C. Waluj , Aurangabad" under the guidance of Dr. A. Y. Tayade, Asst. Professor, Department of Statistics. We appreciate their efforts in applying the Control Charts & their application at our factory. It helped the factory in rectifying problem in the manufacturing process and reducing waste. This also resulted in saving of costs. We credit the Department of Statistics for the statistical consulting provided to us and are thankful for it. We hope the Department continues the good work in future as well.

Authorized Signature

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CHAPTER 1

Control charts &Process Capability

CONTENTS

Name: Dr. Walter A. Shewhart

Born	**: -**	**March 18, 1891**
		New Canton, Illinois
Died	**: -**	**March 11, 1967**
Fields	**: -**	**Physics, Engineering, Statistics**
Institution	**: -**	**Western Electric**
Alma mater	**: -**	**University of Illinois,**
		University of California,

1.1 Motivation:-

Being student of M.Sc.(Statistics) with Industrial Statistics and having studied a course on "Statistical Process Control". During our M.Sc. II was more interested in knowing working of industry and use of SPC tools. In this regard I requested **"Shree Omkar Precision Works"** to allow me for the project in their company.

1.2 Introduction:-

A control chart is an important aid or statistical device used for the study and control chart of the repetitive Process. Control charts were developed by Dr. W. A. Shewhart it is based upon the fact that variability does exist in all the repetitive processes.

"A Control Chart is the graphical representation of the collected information."

The information may pertain to measured quality characteristics or judged quality characteristics of sample. It detect the variation in processing and warns if there is any departure from the specified tolerance limit .The Control limit on the chart are so placed as to disclose the presence or absence of the assignable causes of the quality variation this makes possible the diagnosis and correction of many production trouble and often brings substantial improvement in product quality and reduction of the spoilage and rework.

With the help of a Control chart it is possible to find out the natural capability of a production process, which permits better decision on engineering tolerances and better comparison between alternative designs and also between alternative production methods. There are many types controlled chart designed for different control situations, each with its own advantages and disadvantages and with its own field of application.

It consist of graph with central line denoting the target value or standard and two limit line and either side of the central line called 'upper control limit' and 'lower control limit'. Quality measured periodically is plotted on the format of chart and status of control assessed. Format of control chart is shown in figure.

Upper control limit ----------

Central line ——————————

Lower control limit ----------

Fig: Format of control chart

Control charts a mean of marinating a process in a statistical control were pioneered by Dr. W. A. Tories, USA with a view to eliminating abnormal variations in process output by distinguish variation due to special causes from those due to common cause it involve

1) Periodic sampling of product (subgroups) from the process and inspection them for the characteristic under consideration.
2) Computing a suitable index of quality for each subgroup (statistics)
3) Comparing the actual value of the statistics it's the natural limit of variability (Control limits)
4) Taking actions to detect and eliminate special causes whenever control limit are exceeded or there are other indication of process being out of control.
5) Leaving the process along when there is no evidence of out of control.

Control chart technique can be used for both variable and attributes. If the quality characteristics can be measured with the help of an instrument, equipment or measuring process, it is called measurable characteristics. For example, diameter ,electrical resistance, yield ,carbon content , life of a bulb, etc. data obtained are called measurement or variable .Some quality characteristics may not be measurable on a quantitative scale . In such cease, the product is classified as a good or bad, acceptable /not acceptable, pass/ reject, etc. .Or we may count defect in product. For example defect in casting, number of rejected refrigerators, number of defect in a painted door, etc. data obtained thus, via, by classification or counting are termed attributer data.

1.3 History:-

The control charts was invented by Dr. Walter A. Shewhart while working for Bell Labs in the 1920s. The Company's engineers had been seeking to improve the reliability of their telephony transmission systems. Because amplifiers and other equipment had to be buried underground, there was a business need to reduce the frequency of failures and repairs. By 1920, the engineers had already realized the importance of reducing variation in a manufacturing process. Moreover, they had realized that continual process-adjustment in reaction to non-conformance actually increased variation and degraded quality. Shewhart framed the problem in terms of Common- and special-causes of variation and, on May 16, 1924, wrote an internal memo introducing the control chart as a tool for distinguishing between the two. Dr. Stewart's boss, George Edwards, recalled: "Dr. Stewart prepared a little memorandum only about a page in length. About a third of that page was given over to a simple diagram which we would all recognize today as a schematic control chart. That diagram, and the short text which preceded and followed it set forth all of the essential principles and considerations which are involved in what we know today as process quality control." Shewhart stressed that bringing a production process into a state of statistical control, where there is only common-cause variation, and keeping it in control, is necessary to predict future output and to manage a process economically.

Dr. Shewhart created the basis for the control chart and the concept of a state of statistical control by carefully designed experiments. While Dr. Shewhart drew from pure mathematical statistical theories, he understood data from physical processes typically produce a "normal distribution curve" (a Gaussian distribution, also commonly referred to as a "bell curve"). He discovered that observed variation in manufacturing data did not always behave the same way as data in nature (Brownian motion of particles). Dr. Shewhart concluded that while every process displays variation, some processes display controlled variation that is natural to the process, while others display uncontrolled variation that is not present in the process causal system at all times. In 1924 or 1925, Shewhart's innovation came to the attention of W. Edwards Deming, then working at the Hawthorne facility. Deming later worked at the United States Department of Agriculture and became the mathematical advisor to the United States Census Bureau. Over the next half a century, Deming became the foremost champion and proponent of Shewhart's work. After the defeat of Japan at the close

Of World War II, Deming served as statistical consultant to the Supreme Commander for the Allied Powers. His ensuing involvement in Japanese life, and long career as an industrial consultant there, spread Shewhart's thinking, and the use of the control chart, widely in Japanese manufacturing industry throughout the 1950s and 1960s.

1.4 Control charts limit:-

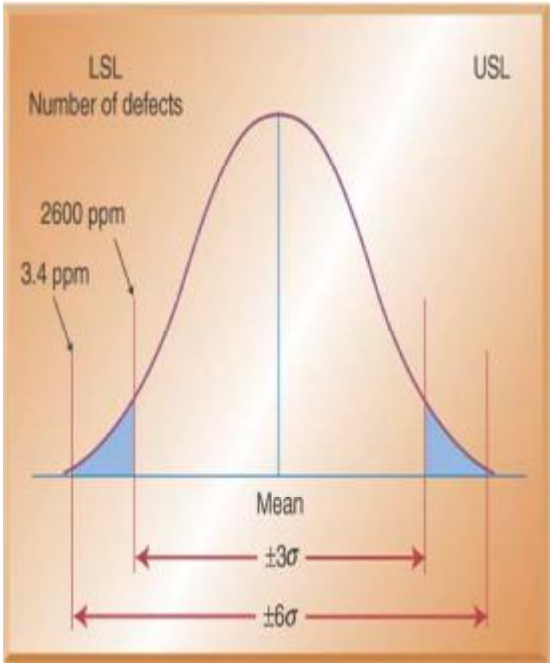
± 6 Sigma versus ± 3 Sigma

- **In 1980's, Motorola coined "six-sigma" to describe their higher quality efforts**

  Six-sigma quality standard is now a benchmark in many industries

  - Before design, marketing ensures customer product characteristics
  - Operations ensures that product design characteristics can be met by controlling materials and processes to 6σ levels
  - Other functions like finance and accounting use 6σ concepts to control all of their processes

PPM Defective for ±3σ versus ±6σ quality



Performance Standards

Greek Letter sigma represents process variation .Higher the number before sigma, lesser the variation, higher the product quality and Customer satisfaction

Sigma Rating

Σ	PPM	Yield
2	308537	69.1%
3	66807	93.3%
4	6210	99.38%
5	233	99.977%
6	3.4	99.9997%

1.5 Causes of variation

1) Chance Causes:-

Some stable pattern of variation or a constant cause system is inherent in any particular scheme of production and inspection. This pattern results from many minor causes that behave in a random manner .the variation due to the causes is beyond the human hard and cannot be prevented or eliminated under any circumstances. The range of such variation is known as “Natural Tolerance of the Process”.

2) Assignable Causes:

This type of variation in any production process is due to the nonrandom or the assignable causes and it termed as preventable causes. This causes may arises at any situation right from arrival of the raw material to the delivery of the raw material .Some important factor of assignable causes of variation is substandard or defective raw material, new techniques improper handling of machines , faulty equipment unskilled labor technical staff etc. All this causes are identified and eliminated in the production process.

Introduction of Control Chart Pattern

The Avg. for different subgroup plotted on X chart and the range on R charts, describes a pattern of variation on the control chart. Knowledge of the production process and the pattern of the variation on the control chart will leads to a proper interoperation of the working or the process .For any production process it is possible to find out the remember that X chart cannot be interpreted properly unless the corresponding R charts is in statistical control. The control charts pattern can be broadly classified into two categories.

a) Change causes (natural, random) pattern of variation.

b) Assignable causes (unnatural) pattern of variation.

The process will be in a state of statistical control if a chance pattern of a variation is exhibited by the X (bar) and R charts the unnatural pattern of variation indicated that the processes is out of control and corrective action is necessary.

The interpretation about the ability of the process to meet specified tolerance will depend upon the ability to distinguish between the chance pattern of the variation and the assignable pattern of variation.

Chance pattern of the variation:-

We know that central tendency is the cartelistic of the distribution that is the most of the observation tend to concentrated near the center of the distribution. Since the distribution is the symmetrical it is the natural to expect and equal number of points on either side of the central line. Also since the distribution extend up to three sigma limits on either side of a central line about 99.73% observation will lie between these limits.

Thus even if the process is interpreted by chance cause 3 in 1000 produced may fall outside the control limits.

A control chart having chance pattern of variation will thus have the following three characteristics.

1) Most of the points will lie near the central line.

2) Very few points will be near control limits,

3) none of the points (expect 3 in a thousand) fall outside the control limits

B) Assignable Causes (unnatural) Pattern of Variation

Most important types of assignable cause of pattern of variation are;

1) Extreme variation

2) Indication of trends

3) Shifts

4) Erratic Fluctuation.

1) Extreme Variation:-

It is recognized by the points falling outside the upper and lower control limits. The width of the control limit on the control chart to present the variation due to inherent characteristics of the process, that is, the normal permissible variation in the machines, material's and men. Thus when the sample points falls outside these limits on X charts P charts or both it means some assignable cause of error are present and corrective action is necessary to produce the products within the specified limits.

Causes of the Extreme Variation:

1) Error in measurement and calculation

2) Samples chose at a peak position of temperature and such other factors.

3) Wrong setting of the machine, tools etc.

4) Sample chosen at the commencement or end of an operation

2) Indication of Trends:-

If the consecutive points on X-bar or R-bar tend to move steadily either towards L.C.L. or U.C.L. it can be assume that process is indicating, 'Trend' that is change is taking place slowly and though all the points are lying within control limits, after some time it is likely that the process may go to of the control if proper car or corrective action is not taken.

Causes of Trends:

A) Tool wear.

B) Wear of threads on clamping devices.

C) Effects of temperature and humidity.

D) Accumulation of dirt and clogging of fixture and holds.

An increasing trend (upwards) on the R chart indicates gradual wearing of operating machine parts. A decreasing trend (downwards) on the R chart indication improvement in operations,

Better maintenance and improved control on back process.

3) Shifts:-

When a series of consecutive points fall above or below the center line on either X-bar or R chart it can be assume that Shift in the process has been taken places indication presence of some assignable cause. It is generally assume that when 7 consecutive points lie above are below the central line, shift has been occurred.

Causes Of Shift:-

1) Change in the material
2) Change in operator, inspector, inspection equipment.
3) Change in machine setting.
4) New operator, carelessness of the operator.
5) Loose fixtures etc.

4) Erratic Fluctuation:-

It is characterized by up s and down as shown in the below fig. this may be due to single causes or a group of causes affecting the process level and speed. The causes of erratic fluctuation are rather difficult to identify. It may be due to different causes acting at different times on the process.

Causes

1) Frequent adjustment of machine.

2) Different types of material being processed.

3) Change in operator, machine, test equipment etc.

Chart Details:-

A control chart consists of following:

- Points representing a statistic (e.g., a mean, range, proportion) of measurements of a quality characteristic in samples taken from the process at different times [the data]
- The mean of this statistic using all the samples is calculated (e.g., the mean of the means, mean of the ranges, mean of the proportions)
- A center line is drawn at the value of the mean of the statistic
- The standard error (e.g., standard deviation / sqrt(n) for the mean) of the statistic is also calculated using all the samples
- Upper and lower control limits (sometimes called "natural process limits") that indicate the threshold at which the process output is considered statistically 'unlikely' and are drawn typically at 3 standard errors from the center line

The chart may have other optional features, including:

- Upper and lower warning limits, drawn as separate lines, typically two standard errors above and below the centre line
- Division into zones, with the addition of rules governing frequencies of observations in each zone
- Annotation with events of interest, as determined by the Quality Engineer in charge of the process's quality

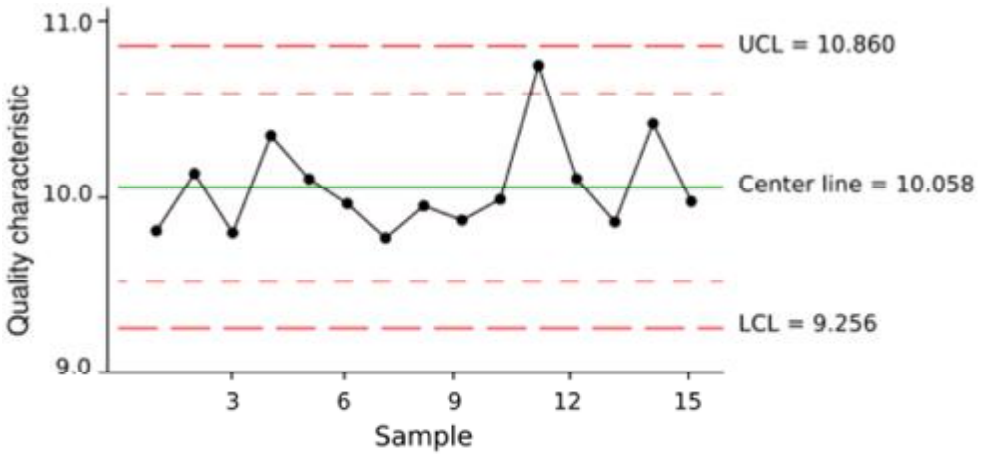


Chart Usage:-

If the process is in control (and the process statistic is normal), 99.7300% of all the points will fall between the control limits. Any observations outside the limits, or systematic patterns within, suggest the introduction of a new (and likely unanticipated) source of variation, known as a special-cause variation. Since increased variation means increased quality costs, a control chart "signaling" the presence of a special-cause requires immediate investigation.

This makes the control limits very important decision aids. The control limits provide information about the process behavior and have no intrinsic relationship to any specification targets or engineering tolerance. In practice, the process mean (and hence the centre line) may not coincide with the specified value (or target) of the quality characteristic because the process' design simply cannot deliver the process characteristic at the desired level.

Control charts limit specification limits or targets because of the tendency of those involved with the process (e.g., machine operators) to focus on performing to specification when in fact the least-cost course of action is to keep process variation as low as possible. Attempting to make a process whose natural center is not the same as the target perform to target specification increases process variability and increases costs significantly and is the cause of much inefficiency in operations. Process capability studies do examine the relationship between the natural process limits (the control limits) and specifications, however.

The purpose of control charts is to allow simple detection of events that are indicative of actual process change. This simple decision can be difficult where the process characteristic is continuously varying; the control chart provides statistically objective criteria of change. When change is detected and considered good its cause should be identified and possibly become the new way of working, where the change is bad then its cause should be identified and eliminated.

The purpose in adding warning limits or subdividing the control chart into zones is to provide early notification if something is amiss. Instead of immediately launching a process improvement effort to determine whether special causes are present,

, the Quality Engineer may temporarily increase the rate at which samples are taken from the process output until it's clear that the process is truly in control. Note that with three-sigma limits once out of every 370 points for normally distributed processes. He claimed that, under such conditions, 3-sigma limits provided ... a rational and economic guide to minimum economic loss... from the two errors.

1. Ascribe a variation or a mistake to a special cause (assignable cause) when in fact the cause belongs to the system (common cause). (Also known as a Type I error)
2. Ascribe a variation or a mistake to the system (common causes) when in fact the cause was a special cause (assignable cause). (Also known as a Type II error)

Choice Of Limits:-

Shewhart set 3-sigma (3-standard error) limits on the following basis.

- The coarse result of Chebyshev's inequality that, for any probability distribution, the probability of an outcome greater than *k*-standard deviations from the mean is at most $1/k^2$.
- The finer result of the Vysochanskii–Petunin inequality, that for any unimodal probability distribution, the probability of an outcome greater than *k*-standard deviations from the mean is at most $4/(9k^2)$.
- In the Normal distribution, a very common probability distribution, 99.7% of the observations occur within three standard deviations of the mean (see Normal distribution).

Types of Control Charts

There are two main categories of Control Charts, those that display attribute data, and those that display variables data.

Attribute Data:-

This category of Control Chart displays data that result from counting the number of occurrences or items in a single category of similar items or occurrences. These “count” data may be expressed as pass/fail, yes/no, or presence/absence of a defect.

Variables Data:-

This category of Control Chart displays values resulting from the measurement of a continuous variable. Examples of variables data are elapsed time, temperature, and radiation dose.

1.6 Control Charts for Variables:-

Control chart based upon measurement of quality characteristic are, called control chart for variable. The variable control charts that are most commonly used are average or X-bar, range or R- chart and S-chart. In general, control chart for variables, either X-bar and R or X-bar and S- chart are used for some or all of the following purposes:

X-bar and R or X-bar and S-chart are used in combination for the control process. X-bar chart shows the centering of the process i.e. it show the variation in the averages of sample. R chart shows the uniformity or the consistency of the process i.e. each show the variations in the range of samples. S chart shows the variations of the process.

A quality characteristic that is measured on a numerical scale is called variable. It included dimension such as length or width temperature and volume. Many qualities characteristics can be expressed in terms of numerical measurement. A signal measurable quality characteristics dimension, weight, volume called as variable. Control of the process averages or means quality level is usually done with the control chart for means charts .A control chart is in important aid or statistical device used for the study and control of the repetitive process. Control chart was developed by Dr. W .A. Shewart and it is based upon the fact that variability done not exist in all the repetition process.

Control Chart for X-bar chart and R- chart

Although X-bar and R-charts are widely used. It is occasionally desirable to estimate the Process standard deviation directly instead of directly through the use of the range R. this leads to control charts.

For X–bar and S, where S is the sample standard deviation .Generally X-bar and S charts are preferable to their counter parts. X (bar) and R chart when either.

The sample size n is moderately large if n>10 or 12 (Recall that the range for estimating sigma loses statistical efficiency for moderate to large sample.

The sample size n is variable.

Construction And Operation Of X-bar Charts And R charts:-

Setting up operation control charts for X and S require about the same sequence of steps as those for X and R charts, except that for each sample we must calculate the sample average X and the sample deviation S.

Consider the case where a standard value is given for σ .Since E(S) =C4σ, the central line for the chart is C4σ. The three- sigma control limits for S are then

$$\bar{x} = \frac{1}{\mathrm{m}} \sum_{i=1}^{m} s_i$$

The parameters of the S charts would be

UCL=$\bar{S}$+3$\frac{\bar{s}}{C4}\sqrt{1 - C_4}$

UCL=B4$\bar{S}$

Center line=$\bar{S}$

LCL= $\bar{S}$-3$\frac{\bar{s}}{C4}\sqrt{1 - C_4}$

LCL=B3$\bar{S}$

The Control chart on the corresponding X-bar Chart as

The parameters of the X̄-chart would be

UCL=$\bar{\bar{x}}$+3

UCL=$\bar{x}$+A3$\bar{S}$

Center Line =$\bar{\bar{x}}$

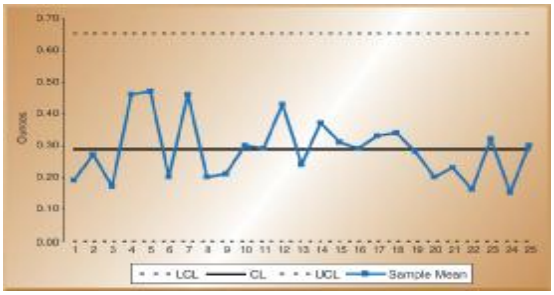
LCL=$\bar{\bar{x}}$-3

LCL=$\bar{\bar{x}}$-A3S

$\bar{\bar{x}}$ the “grand” mean is the average of all the observations.

R-CHART:-

R chart is used as a measure of sub –group dispersion. The importance of R chart depends on the types of a production process. There are many production processes in which it is difficult to maintain the uniform process dispersion: in such process R chart is extremely useful to for process control. It is useful for particularly for those processes where the skill of operators is important .the first in improving such processes should be to try to bring the process dispersion into statistical control. The purpose of R- chart and sigma chart is same, but generally R- chart is used instead of sigma chart. Because R- chart is easier to compute .Secondly, R is easier to understand. R has a measure of subgroup dispersion is always necessary to provide a basis for calculating limits on a control chart for X (bar) and also for estimating.$\sigma = \bar{R}/d2$



S-Chart:-

This chart is used for controlling process avg. and variability .the standard deviation is considerable to be ideal measure of dispersion. The3σ Control limit for STD deviation is given by

U.C.L=B2

L.C.L=B1

If Sigma is not known:

$$\mathbf{UCL=\bar{S}+3\frac{\bar{s}}{c4}\sqrt{1-c_4^2}}$$

UCL=B4$\bar{S}$

Center Line =s, LCL=$\bar{S}$-3$\frac{\bar{s}}{C4}\sqrt{1-c_4^2}$; LCL=B3$\bar{S}$

1.7 Control chart for Attributes:-

Attribute are those product characteristics which are not amenable to measurement. Such characteristics can only be identifying by their presence or an absence from the product .Attributes is judge either by proportion of units that are defectives or by the number of defects per units. When the quality control has to focus on a quality characteristic hard or expensive is measurable on a numerical scale. Attribute concern quality characteristics which are able to be classified in two types, conform and not conform to specifications. What is called nonconforming means that the unit controlled is not conformed to standard on one or more of examined quality characteristics. The goal of control chart for still to control mean and variability of a process but here, we focus of number of nonconforming units or nonconformities in a population. Three types of chart of chart exist. Their use depends on the production (which quality characteristics to control, how many to examine), the characteristics of controls (constant or variable sample size):

The control charts for attributes are as follow:

1] P-chart for proportion non-conforming:-

It is attribute control chart for quality that can be classified as either conforming to the specification ex. Dimension checked by Go –No_ Go gauges. the cost required for collecting data for P-Chart is less than cost of collecting data for X-bar and R-chart it best suited in cases where inspection is carried out with a view to classifying an article as accepted or rejected . The sample size is generally larger for P-chart than for X-bar and R-chart.

2] C-chart:-

It is control chart for number of defect. It applied to number of subgroup of constant size .Each a subgroup for C-chart consist of single article and the variable C consists of number of defects observed in one article .the control limit on C-chart is based on Poisson distribution.

- In many quality control problems the particular items being subjected to inspection may have more than one defect.
- We may wish to count number of defects instead of merely classifying at item as to whether or not it is defective.
- If C_i denotes the number of defects observed in the ith inspected item, we can safely assume that C_i has a Poisson distribution.

Since $E(C_i) = l$ and $Var(C_i) = l$, the control limits are:

$l \pm 3\sqrt{l}$.

If k items are inspected, then the unbiased estimator of l is:

$$\overline{C} = \frac{1}{k}\sum_{i=1}^{k} C_i.$$

The estimated control limits then become:

$\overline{C} \pm 3\sqrt{\overline{C}}$.

3] U-chart:-

When the subgroup size varies from sample it is necessary to use this chart .it is also used for non-conformities per unit.

1.8 Process capability

Process capability of process is the extent of variation in the quality characteristics of the process output, when the process is operating in a state of statistical control under a given set off condition. Concern with the ability of process to produce output meeting specification consistently. Take into account variation caused all ha possible sources of variation.

Data for process capability analysis should be collected over a period of time.

Process factor leading to variation are:

- Raw material
- Machine/ Measuring Equipment
- Setting of Machine
- Interruption
- Operator
- Measuring System
- Environment
- Distribution may not be within the specification limits
- 99.73% of the process output is expected

Process Capability:-

In the Six Sigma quality methodology, process performance is reported to the organization as a sigma level. The higher sigma level, the better the process is performing.

Another way to report process capability and process performance is through the statistical measurements of Cp,Cpk, Pp and Ppk

Definitions:-

Cp=Process Capability. A simple and straightforward indicator of process capability. Process capability is the natural varaiation in aprocess that result from chance causes.

Cpk=Process Capability Index. Adjustment of Cp for the effect of non-centered distribution.

Pp=Process Performance. A simple and straightforward indicator of process performance.

Ppk=Process Performance Index. Adjustment of Pp for the effect of non-centered distribution.

.

Process capability Ratio Cp:

- Use Cp to determine whether the process is capable when μ=target.
- Cp = USL-LSL / 6σ
- If Cp≥1, the process is capable.
- If Cp<1, the process is not capable.

Process capability index Cpk:

$$Cpk = \min\left\{USL-\mu/3\sigma,\ \mu-LSL/3\sigma\right\}$$

- If Cpk≥1, the process is capable.
- If Cpk<1, the process is not capable.
- We must use Cpk when μ does not equal the target.

Capability and Conformance of Quality:-

A process is capable if

- It is not in control.
- It consistently produces outputs that meet specifications.
- This means that both control limits for the mean must be within the specification limits.

A capable process produces outputs that have conformance quality (outputs that meet specifications).

Uses of Process Capability:-

- Provide information to facilitate design of product charecteristics / tollerence.
- Assist process planners to select or modify process.
- Assist in establishing the interval between sampling or process control.
- Specify the performance requirements of a new process.
- Compare the capability of various processes.
- Selection of operators.
- Assigning work to machines.
- Selection between comparing venders.
- Determining the economic nominal for an operation.
- Reducing variability in a process.

CHAPTER 2

Research Methodology

Contents

2.1 Introduction:-

It is a common sense of the term research refers to a search for knowledge. It is a part and parcel of human knowledge. It is a matter of raising question or problem and then trying to find its solution. It may be define as careful critical enquire or examination in seeking facts diligent investigation in order to ascertain something. Thus research is an activity of solving problem which adds new knowledge and developing theory as well as gathering evidence to test generalization. It is an art as well as science of investigation.

2.2 Silent Features:-

Research has been defined by different authority and it must possess certain features which are given below Logic and objective. The purpose of any research is to find out facts on the basis of these facts inferences are drawn. It is assumed that all vegetarian uneducated people in urban and rural areas have long life. On the basis of this assumption we can draw conclusion that vegetarian is the cause of longevity. Objects means observing true picture a phenomenon without being affected observers own opinion.

Reliability and validity: Truth is the fountain of research. This can be established on the basis of the evidence. Evidence is based on sufficient and reliability data. The reliability and validity can be attained when the error of bias or sampling is minimized.

Verification:-

Any conclusion drawn by the research is subject to the quality of verification. If a research is not based on observation and measurement the verification will not be possible and inference drawn from such studies will not serve the purpose.

Accuracy:-

Census and sampling methods are used in any type of research study. It should be based on accuracy. It is a duty of investigator that he should be well versed with the technique used for collecting information. Complete accuracy can be attained when standardized tools in collecting, recording, and analyzing are used.

Impartiality:-

The problem of impartiality is a part of the problem of objectivity. Knowing reality is based on the correct method dealing with logic. Partiality leads to wrong information and it fails to give truthful results to the investigators.

Scientific Approach:-

Traditional culture was based on the superstition and there was lack of scientific integrity. Modern culture is based on scientific attitude and scientific method of approach. There has been an advancement of knowledge.

Recording and Reporting:-

In a research every term is well defined every procedure is described in detail every limiting factor is taken into account. References used in research are carefully documented and the results drawn in the field of research are objectively recorded. Conclusion and generalization are drawn with care with limitation of methodology and data. When all these things are well recorded they can be used as a source of investigation for future research in future.

2.3 Objectives:-

1. The purpose of the research is to find out the solution of problem through the application of scientific methods and procedures.

2. It finds out the hidden truth which has not discovered yet. Each research subjects has its own specific objectives.

3. To attain new insights into a phenomenon any research study carried in with this objective is known as an exploratory or formulating research study.

4. To find out accurately the characteristics of a particular individual or a group or a situation the study with this objects in view are called descriptive research studies.

5. To find out the frequency with which anything associated with something else the study with this objects are called hypothesis testing studies.

2.4 Importance:-

Researching adds new knowledge to the existences stores. The role of the research in several fields of applied economics has greatly increased these days. Nature of business and government have undergone complex changes and for solving the solving the operational problems the importance of research has enormously increased in modern times. Research has been playing important role in solving various operational and planning problems of business and industry.

Research methods and research methodology it would be appropriate here to explain the difference between research methods and research methodology. Research methods may be defined as all these technique or methods that are used for conducting research. These techniques are methods which are used by the research in performing research operation. Research Methodology is categorizing follow collection of the data where the data is already available are not sufficient. Statistical techniques for establishing relationship between the data and the unknown.

2.5 Method To Evaluate Accuracy Of Test:-

Research methodology is a systematic way for solving research problem. It is a science of studying how research is done scientifically. It studies the various steps that are generally adopted by a research in studying his research problem. It is an essential aspect of research that a research should know not only the research techniques but also the research methodology. A research knows the different tests, calculation of the mean the mode the median the standard deviation or chi square test etc. which are research techniques? On the basis of these techniques researcher methodology is designed for this problem because the methodology differs from one problem to another. Research methodology has many dimensions and the research methods are an integral part of it. Research methodology has a wider scope than that of research methods. Under research methodology we not only study the research methods but also the logic behind all these methods used in research study and basis of using such methods but also the logic behind all these methods used in research study and basis of using such methods so that research results are capable of being evaluate either by the researcher himself or by others.

2.6 Scope of Study:-

- To know the manufacturing process of the industry.
- To set up control limits for manufacturing process.
- To set up control charts for different characteristics of product.
- To steer the process to behave in the desired way.
- Collection of data to check the quality of the product.
- The study of research methodology concepts.
- Uses of X- bar chart and R-chart for analysis purpose to see whether production process is in control or out of control and to check the quality of product.
- Process Capability Analysis provide information to facilitate design of product characteristics / tollerence

CHAPTER 3

Company Profile

CONTENTS

COMPANY PROFILE

Shri Omar Precision Work was established in 2008. The Company is engaged in manufacture and supply of various types of CNC Turned components for automobile industries & Export. Company's satisfied customers are:-

1) M/s Gahanna Industries.
2) M/s Santana Engineering
3) M/s Amish Forge Pvt. Ltd.
4) M/s Manish Engineering Work

End users are M/s Bajaj Auto Ltd. ,Kirloskar Oil Engines Ltd., M/s Greavse Ltd., M/s John Deer Equipments P. Ltd. & for US base customers.

List of Available Machines

Sr. No.	Machine Type	Make / Model	Capacity/Chuck /Table Size	Qty.
1	Turning Center (CNC)	Galaxy – Midas 6I	Ø165mm	1
2	Turning Center (CNC)	Galaxy – Midas 6I	Ø200mm	1
3	Turning Center (CNC)	Galaxy – Midas O	Ø165mm	1
4	Turning Center (CNC)	Jyoti Machinery	Ø250mm	1
5	Turning Center (CNC)	Electronica Elturn16	Ø165mm	1
6	Lathe	Rajkot Make	8" & 10"	4
7	Column Drilling	Rajkot Make	1½"	1

List of Available Measuring Instruments

Sr. No.	Type of Instruments	Make	Range / Specification
1	Digital Vernier Caliper	Baker	0-200mm
2	Digital Dial Height Guage	Mitutoyo	0-300mm
3	High Pressure Air Gauge Unit	KCP	±0.04mm
4	Plunger Dials	Mitutoyo	0-1mm LC 0.001 & 0.01
5	Lever Dials	Mitutoyo	1 mm
6	External Micrometers Set	Mitutoyo	0 to 25mm 25 to 50mm 75 to 100mm
7	Bore Dial Gauge	Mitutoyo	18-36mm
8	Between Center	Jafuji	300x125mm
9	Surface plate	Luthra	630x630mm

VAT TIN No. :- 27750721846V

CST TIN No. :- 27750721846C

Bank Details :-

Bank Of Maharashtra

Branch :- Kranti Chowk Aurangabad

Name of CA :-

Mr. Nikhil Gramle

Partners :

M.R. Kulkarni – DCE

S.K. Lokhande – DME

CNC Machine:-

Processing Machine:-

Measuring instruments:-

1) Air Guage:-

2) Micrometer Screw Guage:-

3) Vernier Caliper:-

4) Height Guage:-

Company Products:-

1) Job Body Centrifugal Oil Filter:-

2) Job Hub Turbine:-

CHAPTER 4

Data Collection And Analysis

Data Collection

This process is item by item technique. Five observations were taken randomly from the lot. After every sample a gap of fourteen minute is given. Twenty samples were taken during the period of four days (each day 8 hours) i.e. 80 observations for 1st group and second group for each. The data had been collected from the Turning Center (CNC) machine. We check the quality of product on the basis of outer diameter, inner diameter, total height, height, width, thickness. We have collected the data from 05 February to 22 February.

The data collection is given in the table form and we have checked normality of data by plotting normality curve using Kolmogrove-Smirnov's method in Minitab and then analysis on that data is done by using X-bar and R-chart and Process Capability Analysis. The result is shown immediately after the charts.

Formulae:-

Control Limits for R-chart

(For sample size n=5 value of B4 is 2.09 and value for B3=0)

Central line= $\overline{R}$

Upper Control Limit = UCL = $D4\overline{R}$

Lower Control Limit = LCL = $D3\overline{R}$

Control Limits for X-bar chart

Central line= $\overline{\overline{x}}$

Upper Control Limit = UCL = $\overline{\overline{x}}+A2\overline{R}$

Lower Control Limit = UCL = $\overline{\overline{x}}-A2\overline{R}$

JOB 1

BODY CENTRFUGAL OIL FILTER

Data Collection (Outer Diameter)

Target Outer Diameter = 40

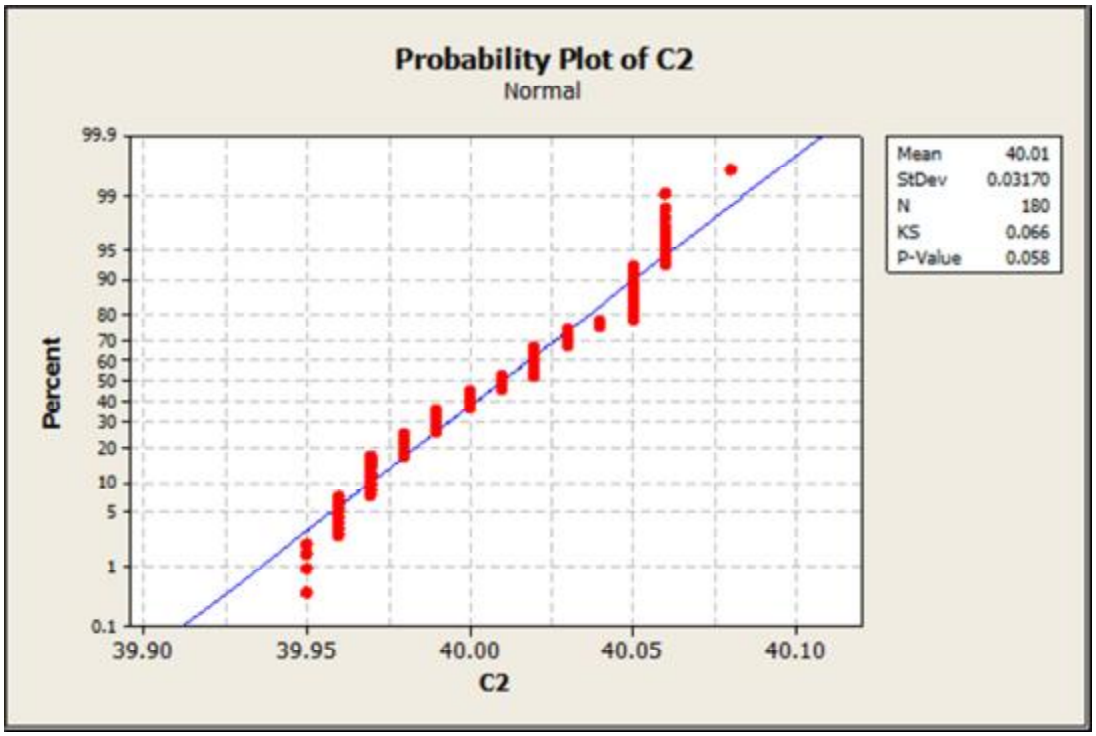
40.05	39.98	40.05	39.98	40.01	40.02	40.03	40	40.01
40.06	40.02	40.02	39.97	40.06	40.03	40.05	40.02	39.97
40.04	40.03	40.03	39.99	40.05	39.97	40.02	40.01	39.98
39.99	40.04	40.06	39.99	40.02	39.96	39.98	40.03	40.02
39.96	40.05	40.08	40	39.99	39.98	39.97	40.05	40.03

40	40.06	40.01	40	39.96	40.02	39.97	40.06	40.04
40.03	40.03	40.02	40.01	39.99	39.99	39.96	40.01	40.05
40.05	40	39.97	40.02	39.99	40.06	39.95	39.99	40.06
40.02	40.05	39.97	40.02	40	40.05	40	39.97	40.03
39.98	39.99	40	40.03	40	39.97	40	40.05	40

39.97	39.98	40.04	40.05	40.02	39.95	40.02	40.02	40.05
39.98	40.02	40.01	40.02	40.01	39.99	40.01	39.98	40.05
40.05	39.97	40.02	39.98	40.03	40.03	40.06	39.97	39.98
40.05	39.95	39.99	39.97	40.05	40.03	40.05	39.98	40.01
39.98	39.99	40.02	39.97	40.06	40.02	40.02	40.05	39.99

39.97	40	40.03	39.96	40.01	39.98	39.99	40.05	40.05
40.06	40.02	40.01	39.95	39.99	39.96	39.96	39.98	40.06
40.05	40.03	40.05	40	39.97	39.96	39.99	39.97	40.04
40.01	40.02	40.05	40	39.99	40.05	39.99	40.06	39.99
39.97	40.05	39.99	40.02	40	40.02	40	40.05	39.96

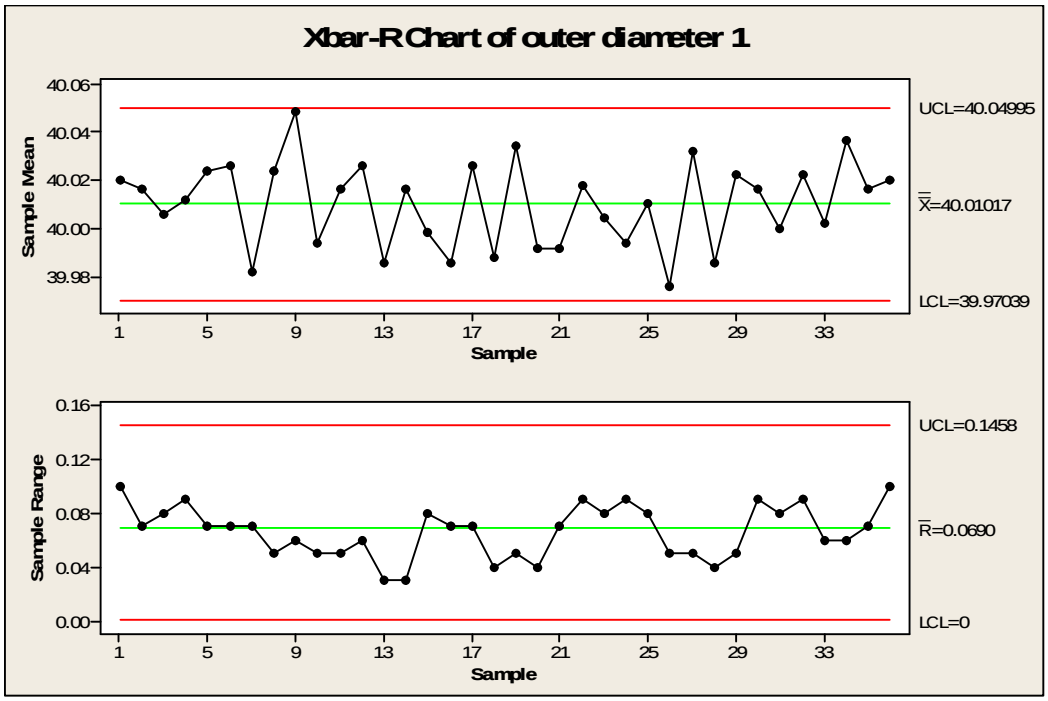
Normality Graph:-



Conclusion:-

p-value is greater than 0.05. Hence the data is normal.

Xbar-R Chart Of Outer Diameter 1:-

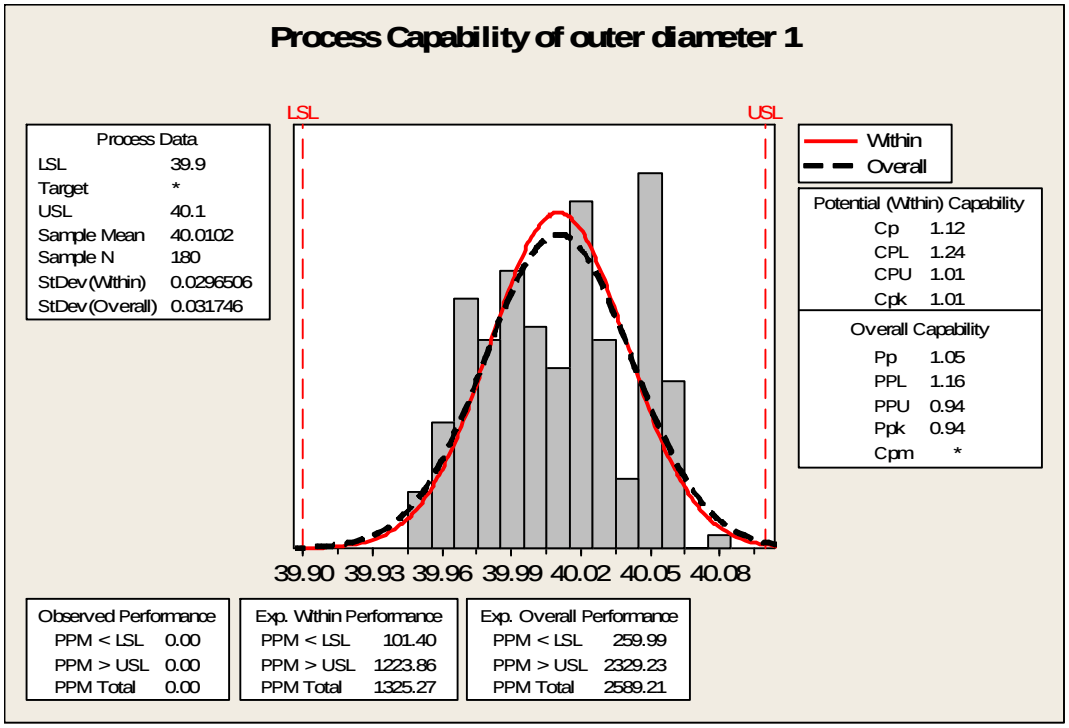


Conclusion :-

1- From X-bar chart, clearly the process Average is in control. Since the point (sample means) lies inside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph Of Outer Diameter 1:-



Conclusion :-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cpk >1] the process is capable & centered between LSL & USL.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection (Outer diameter)

Target Outer Diameter = 27.20

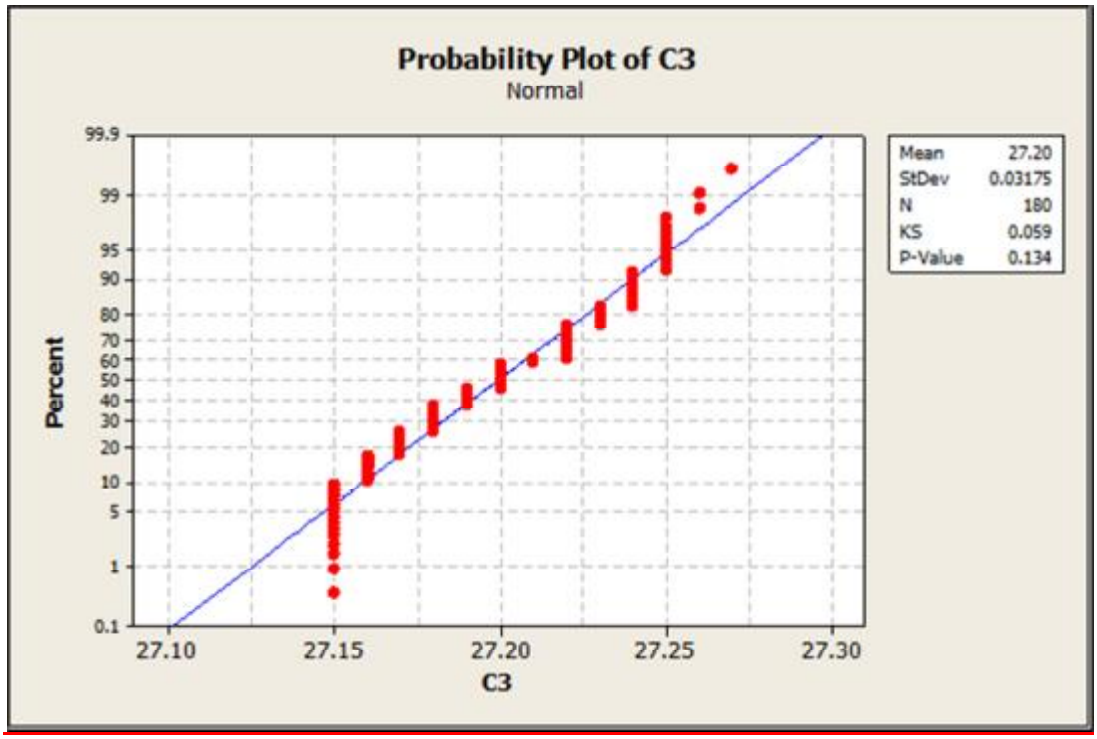
27.25	27.19	27.24	27.19	27.21	27.22	27.2	27.16	27.15
27.16	27.19	27.23	27.2	27.2	27.19	27.15	27.2	27.25
27.24	27.15	27.22	27.22	27.19	27.17	27.18	27.23	27.22
27.22	27.22	27.18	27.23	27.23	27.24	27.15	27.17	27.22
27.18	27.25	27.17	27.2	27.19	27.24	27.25	27.18	27.2

27.17	27.15	27.2	27.18	27.18	27.16	27.18	27.2	27.22
27.16	27.16	27.2	27.22	27.22	27.15	27.2	27.18	27.25
27.24	27.18	27.19	27.23	27.23	27.22	27.21	27.19	27.24
27.22	27.24	27.2	27.19	27.26	27.26	27.18	27.19	27.23
27.17	27.22	27.21	27.18	27.24	27.19	27.27	27.15	27.22

27.18	27.23	27.23	27.24	27.15	27.17	27.22	27.23	27.25
27.17	27.2	27.19	27.24	27.25	27.18	27.2	27.17	27.22
27.19	27.21	27.22	27.2	27.16	27.15	27.17	27.18	27.22
27.2	27.2	27.19	27.15	27.2	27.25	27.16	27.15	27.2
27.22	27.19	27.17	27.18	27.23	27.22	27.24	27.25	27.17

27.22	27.22	27.16	27.24	27.15	27.16	27.18	27.2	27.25
27.17	27.22	27.24	27.22	27.18	27.18	27.15	27.23	27.16
27.15	27.2	27.22	27.24	27.15	27.24	27.25	27.17	27.24
27.16	27.17	27.17	27.2	27.25	27.22	27.16	27.18	27.22
27.18	27.2	27.15	27.15	27.16	27.16	27.2	27.15	27.18

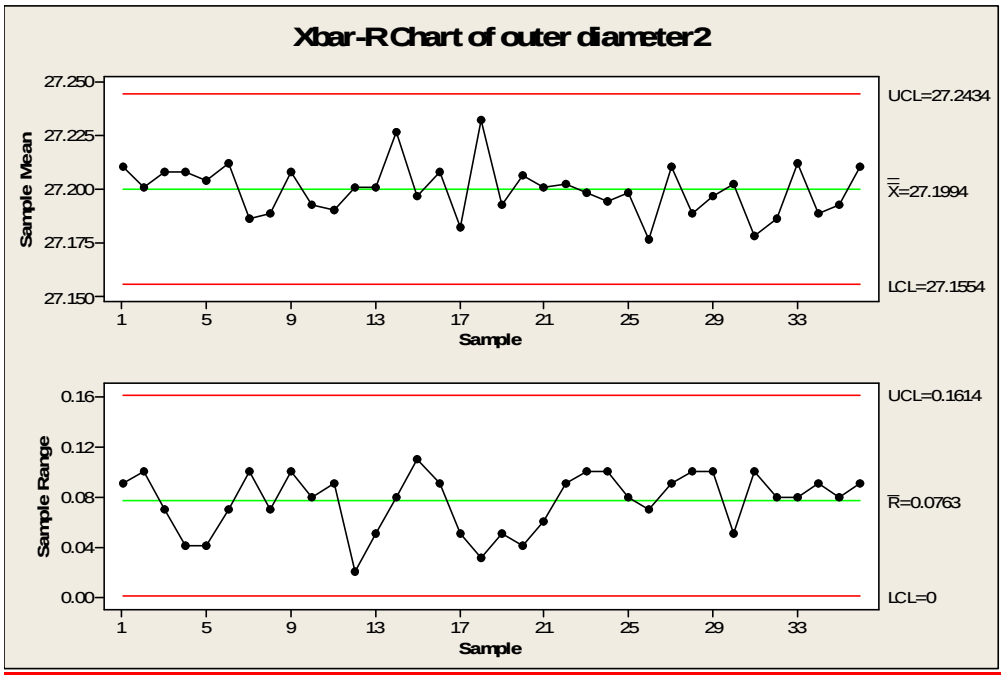
Normality Graph:-



Conclusion :-

p-value is greater than 0.05. Hence the data is normal.

X bar-R Chart of Outer Diameter 2:-

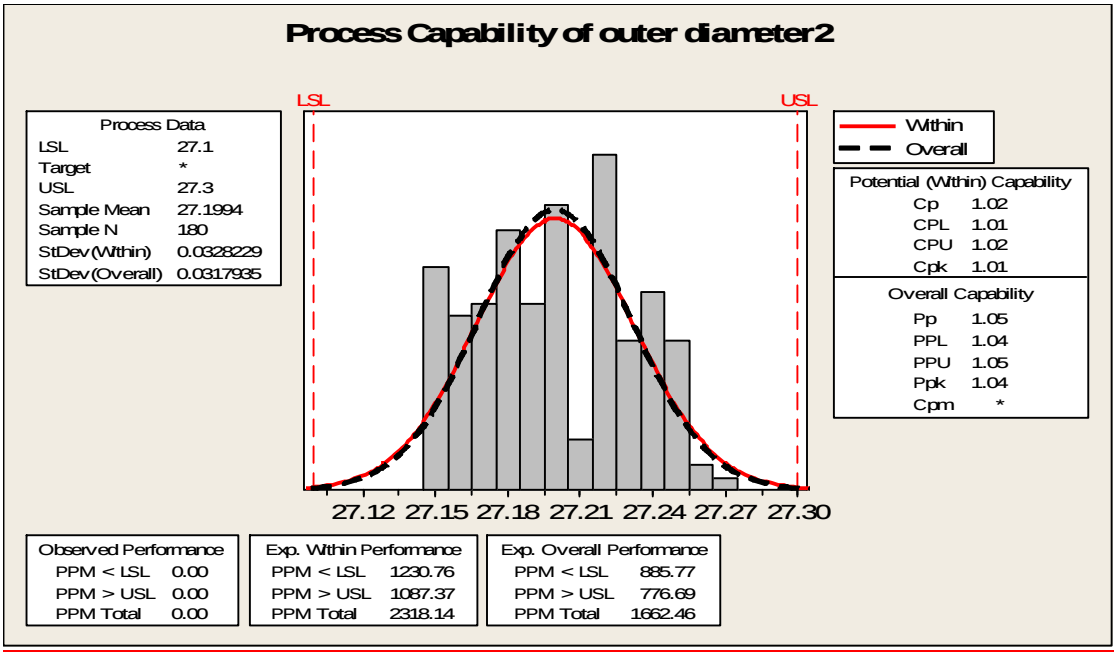


Conclusion :-

1- From X-bar chart, clearly the process Average is in control. Since the point (sample means) lies inside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph of Outer Diameter 2:-



Conclusion :-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cpk >1] the process is capable & centered between LSL & USL.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.
4- [Cp =Cpk] then the overall average is in the center of the specification limits.

Data Collection (Outer Diameter)

Target Outer Diameter=59.80mm

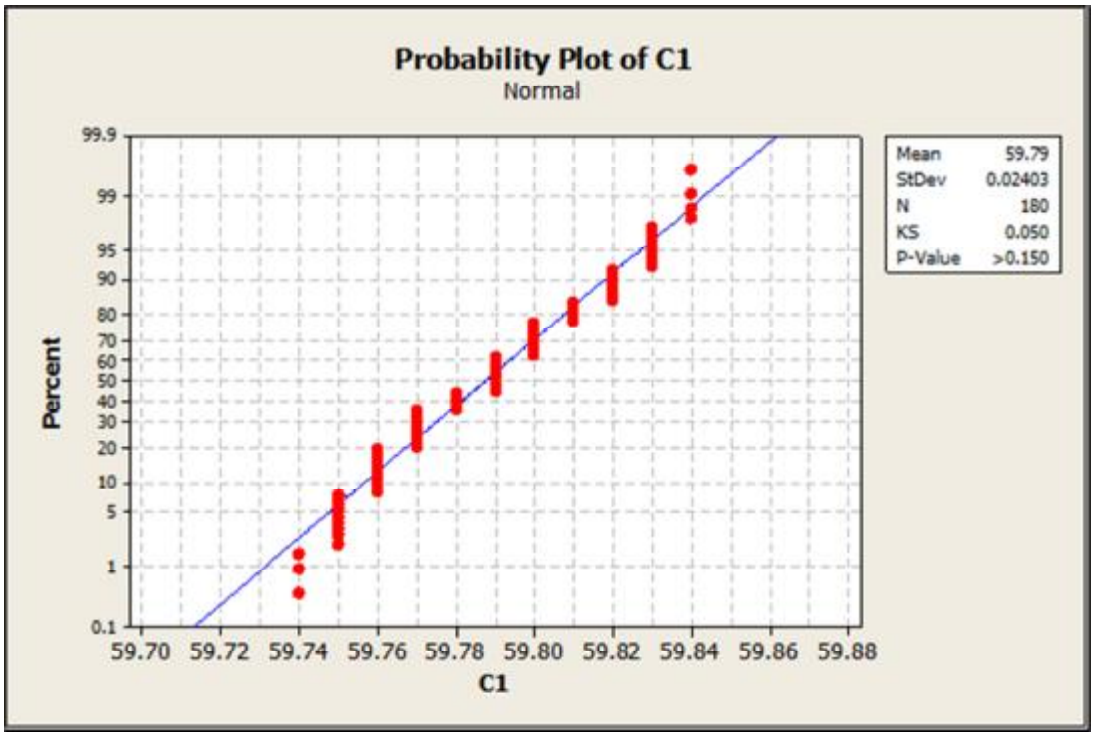
59.84	59.79	59.82	59.8	59.78	59.8	59.81	59.75	59.75
59.76	59.8	59.79	59.83	59.78	59.84	59.83	59.82	59.75
59.78	59.81	59.77	59.81	59.76	59.8	59.79	59.8	59.84
59.79	59.81	59.79	59.76	59.82	59.76	59.77	59.79	59.75
59.77	59.79	59.81	59.82	59.83	59.79	59.77	59.8	59.79

59.76	59.8	59.82	59.8	59.79	59.74	59.79	59.8	59.8
59.78	59.77	59.81	59.78	59.77	59.76	59.78	59.77	59.82
59.77	59.8	59.75	59.77	59.79	59.77	59.79	59.78	59.81
59.78	59.8	59.83	59.77	59.8	59.79	59.75	59.78	59.82
59.8	59.77	59.76	59.8	59.81	59.83	59.79	59.79	59.76

59.81	59.78	59.79	59.76	59.82	59.76	59.8	59.8	59.76
59.8	59.79	59.76	59.79	59.83	59.77	59.82	59.79	59.75
59.81	59.8	59.79	59.82	59.76	59.78	59.76	59.82	59.75
59.84	59.8	59.74	59.77	59.74	59.8	59.78	59.8	59.77
59.8	59.82	59.76	59.82	59.76	59.81	59.83	59.77	59.77

59.76	59.79	59.76	59.79	59.77	59.82	59.76	59.77	59.77
59.77	59.79	59.77	59.77	59.75	59.8	59.77	59.79	59.81
59.78	59.79	59.78	59.79	59.75	59.77	59.77	59.76	59.83
59.78	59.8	59.75	59.79	59.78	59.76	59.79	59.76	59.79
59.79	59.81	59.83	59.77	59.83	59.77	59.8	59.79	59.77

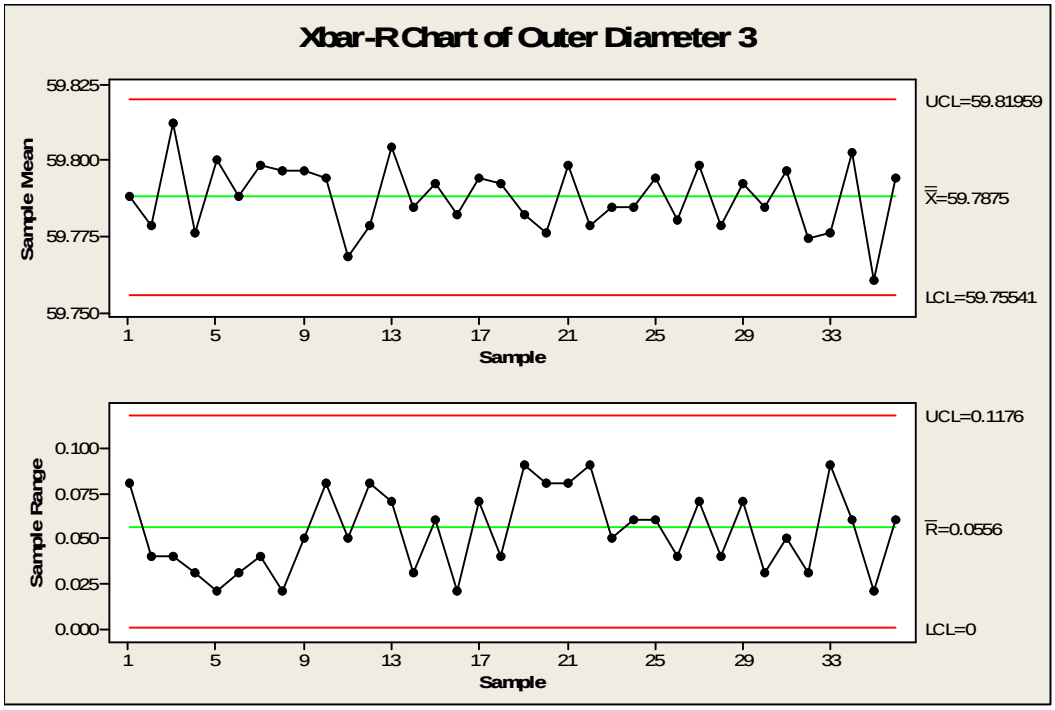
Normality Graph:-



conclusion:-

p-value is greater than 0.05. Hence the data is normal.

Xbar-R Chart Of Outer Diamiter3:-

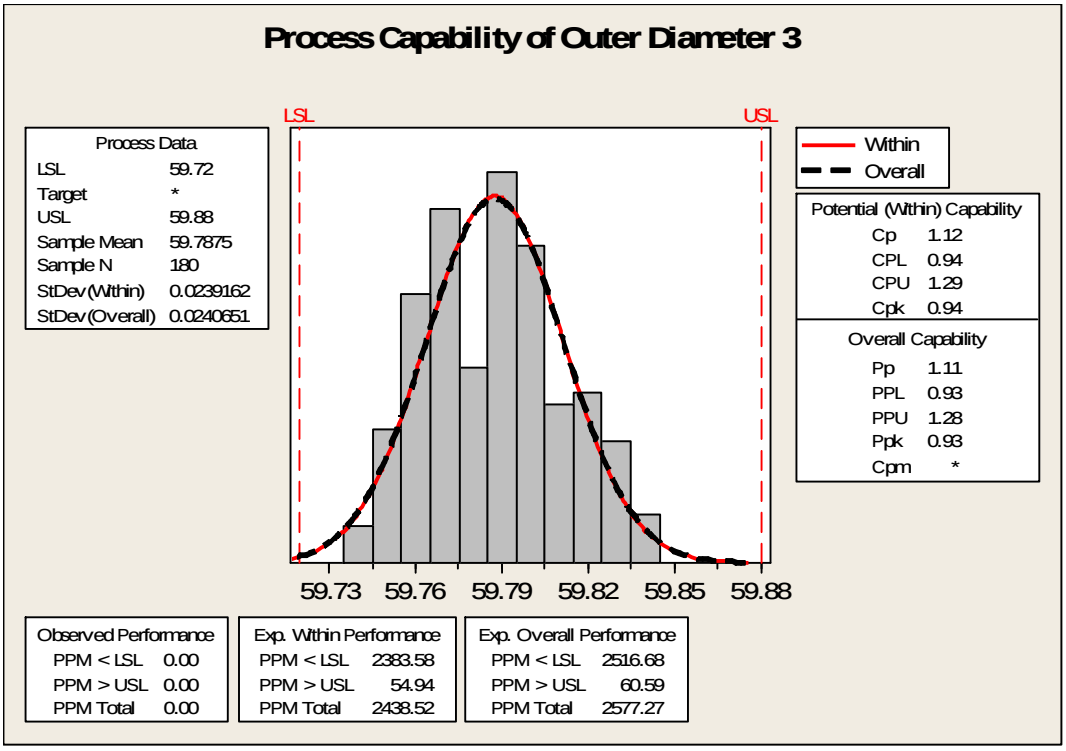


conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since the point (sample means) lies inside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph Of Outer Diameter 3:-



conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection (Tapper)

Target Tapper=29.5

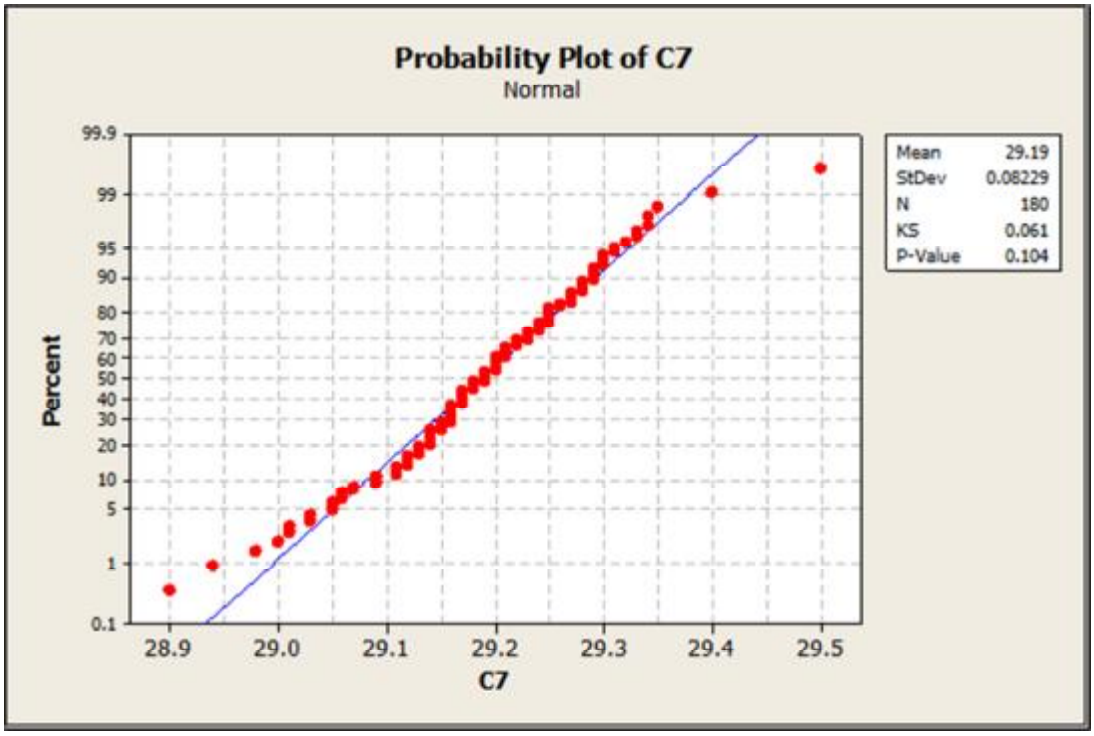
54.5	54.53	54.56	54.53	54.58	54.55	54.51	54.47	54.58
54.56	54.58	54.56	54.56	54.53	54.57	54.56	54.54	54.55
54.56	54.51	54.55	54.57	54.53	54.56	54.56	54.54	54.58
54.55	54.54	54.56	54.55	54.53	54.57	54.51	54.56	54.51
54.47	54.56	54.54	54.58	54.55	54.53	54.56	54.56	54.51

54.59	54.55	54.56	54.52	54.53	54.53	54.57	54.56	54.53
54.59	54.55	54.55	54.57	54.53	54.55	54.53	54.55	54.5
54.58	54.54	54.54	54.56	54.55	54.55	54.56	54.55	54.51
54.58	54.55	54.5	54.54	54.54	54.55	54.55	54.55	54.56
54.51	54.52	54.54	54.59	54.54	54.52	54.54	54.57	54.56

54.57	54.52	54.53	54.59	54.56	54.48	54.56	54.51	54.55
54.57	54.51	54.53	54.54	54.55	54.53	54.53	54.58	54.56
54.59	54.52	54.54	54.56	54.54	54.55	54.56	54.55	54.54
54.54	54.52	54.5	54.58	54.54	54.55	54.58	54.58	54.56
54.53	54.5	54.52	54.56	54.56	54.55	54.55	54.53	54.55

54.58	54.51	54.54	54.58	54.55	54.57	54.56	54.55	54.54
54.54	54.51	54.55	54.59	54.54	54.51	54.54	54.55	54.53
54.53	54.53	54.52	54.57	54.53	54.58	54.57	54.55	54.53
54.55	54.5	54.54	54.56	54.51	54.55	54.57	54.57	54.54
54.53	54.51	54.54	54.55	54.55	54.58	54.53	54.51	54.5

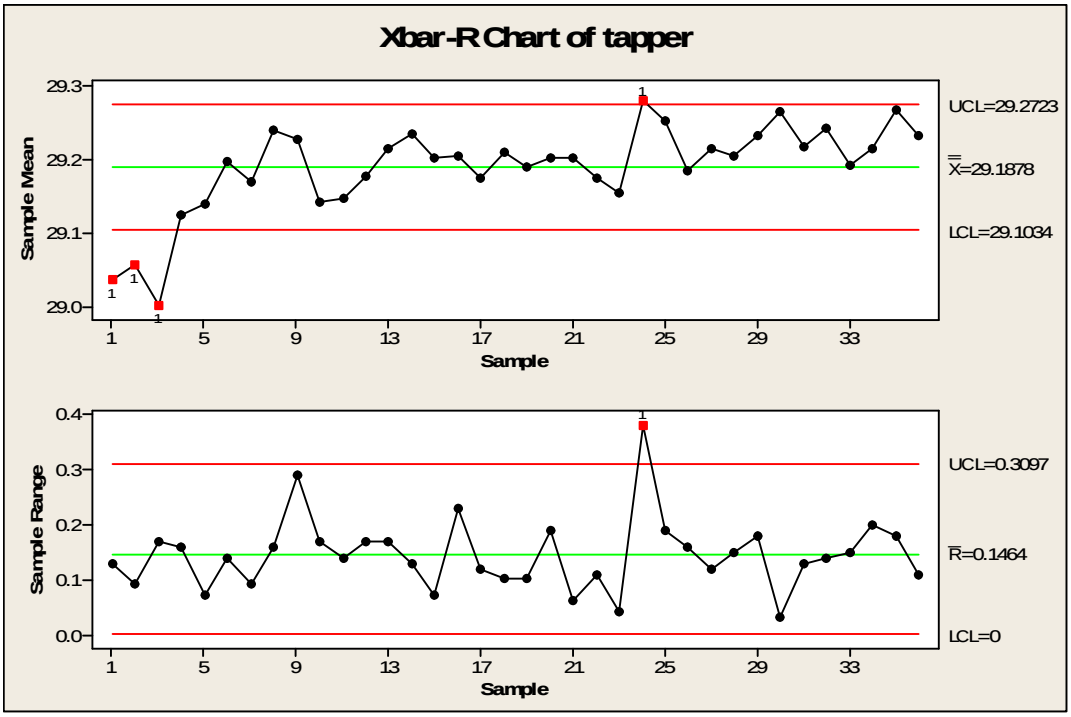
Normality Graph:-



conclusion:-

p-value is greater than 0.05. Hence the data is normal.

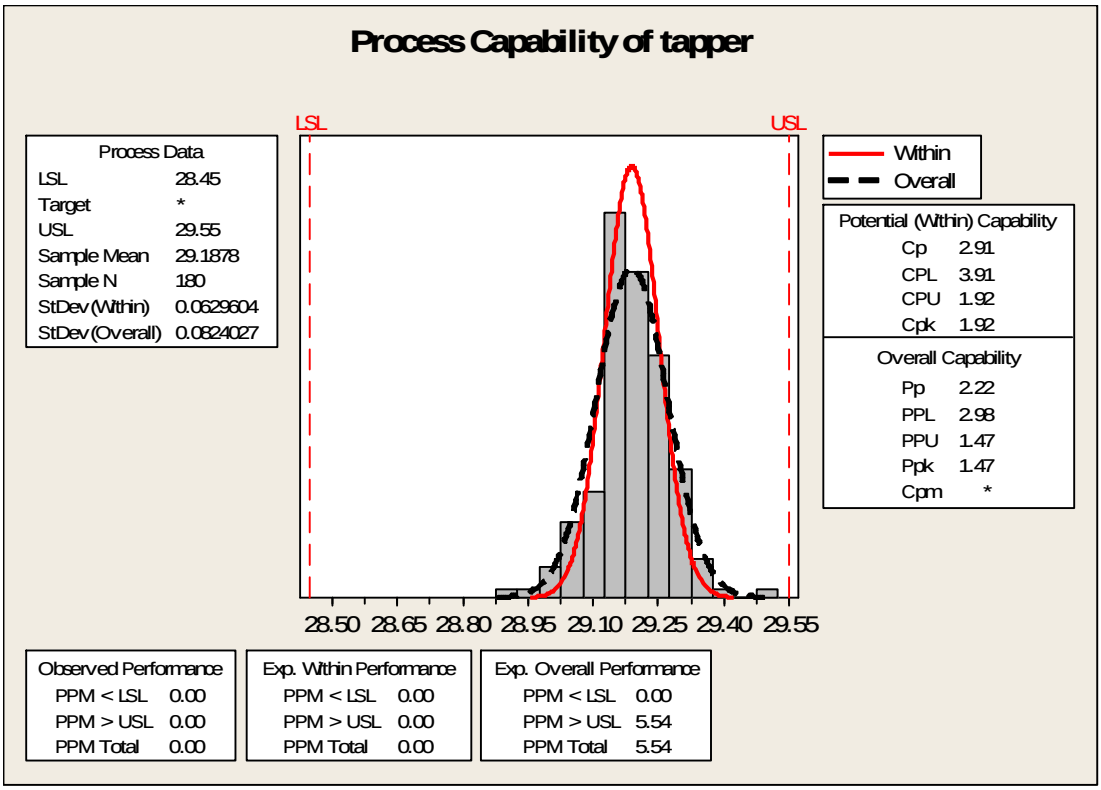
Xbar-R Chart Of Tapper:-



conclusion:-

1- From X-bar chart, clearly the process Average is in control, because only four points (sample means) lies outside the control limits.
2- From R-bar chart, clearly the process Average is in control. Because only one point (sample range) lies outside the control limits.

Cp-Cpk Graph of Tapper:-



conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection (Total Height)

Target Total Height=54.50

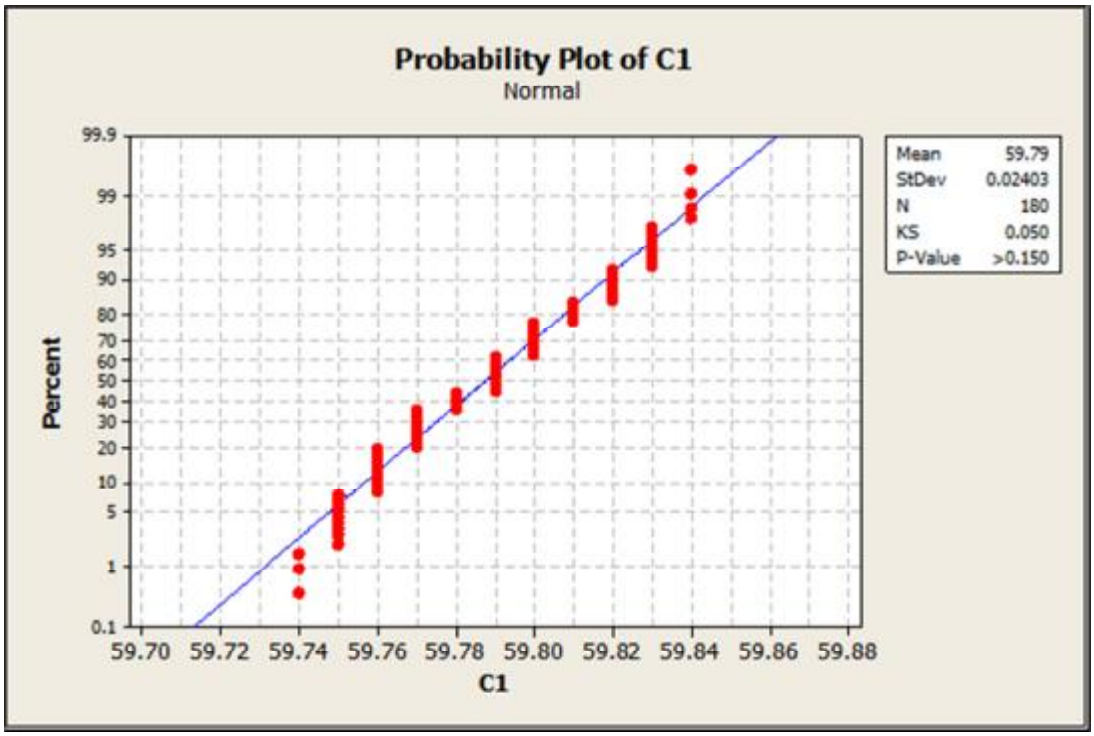
29.07	29.09	29.11	29.23	29.21	29.17	29.19	29.16	29.28
28.98	29.16	29.2	29.2	29.14	29.23	29.15	29.34	29.13
29.03	29.16	29.4	29.13	29.23	29.23	29.33	29.25	29.14
29.01	29.14	29.21	29.21	29.18	29.17	29.24	29.19	29.2
29.11	29.14	29.21	29.3	29.11	29.2	29.34	29.21	29.2

29.07	29.12	29.09	29.2	29.2	29.14	29.14	29.26	29.17
29.09	29.19	29.14	29.24	29.21	29.16	29.17	29.25	29.13
29	29.16	29.22	29.29	29.23	29.21	29.13	29.25	29.19
29.06	29.25	29.2	29.16	29.15	29.12	29.19	29.27	29.24
29.06	29.26	29.05	29.27	29.25	29.23	29.29	29.28	29.33

29.01	29.16	29.16	29.23	29.18	29.13	29.26	29.24	29.27
29.07	29.13	29.05	29.21	29.19	29.17	29.19	29.3	29.35
28.94	29.16	29.15	29.16	29.15	29.17	29.2	29.19	29.29
29.06	29.17	29.18	29.18	29.25	29.16	29.27	29.18	29.25
29.03	29.22	29.19	29.22	29.17	29.14	29.15	29.17	29.17

29.01	29.31	29.14	29.09	29.31	29.12	29.24	29.3	29.29
29.14	29.15	29.17	29.2	29.16	29.25	29.12	29.28	29.29
29.17	29.28	29.28	29.14	29.24	29.5	29.27	29.16	29.2
29.17	29.25	29.18	29.32	29.17	29.3	29.22	29.25	29.18
29.12	29.2	29.11	29.27	29.12	29.22	29.16	29.21	29.19

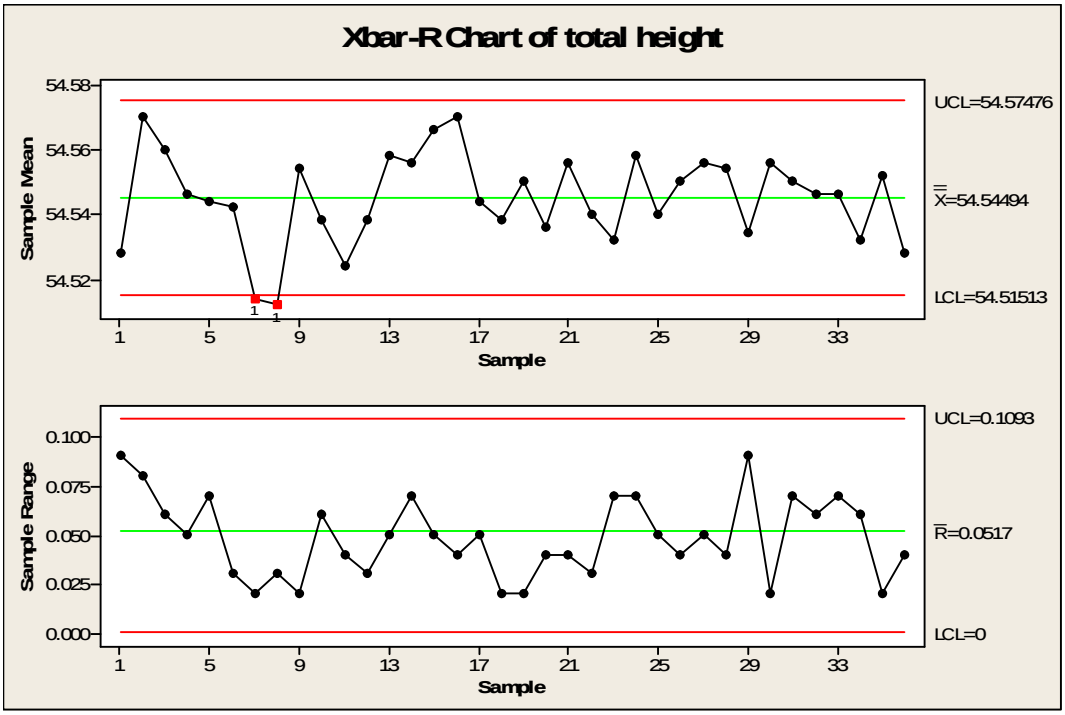
Normality Graph:-



conclusion:-

p-value is greater than 0.05 hence the data is normal.

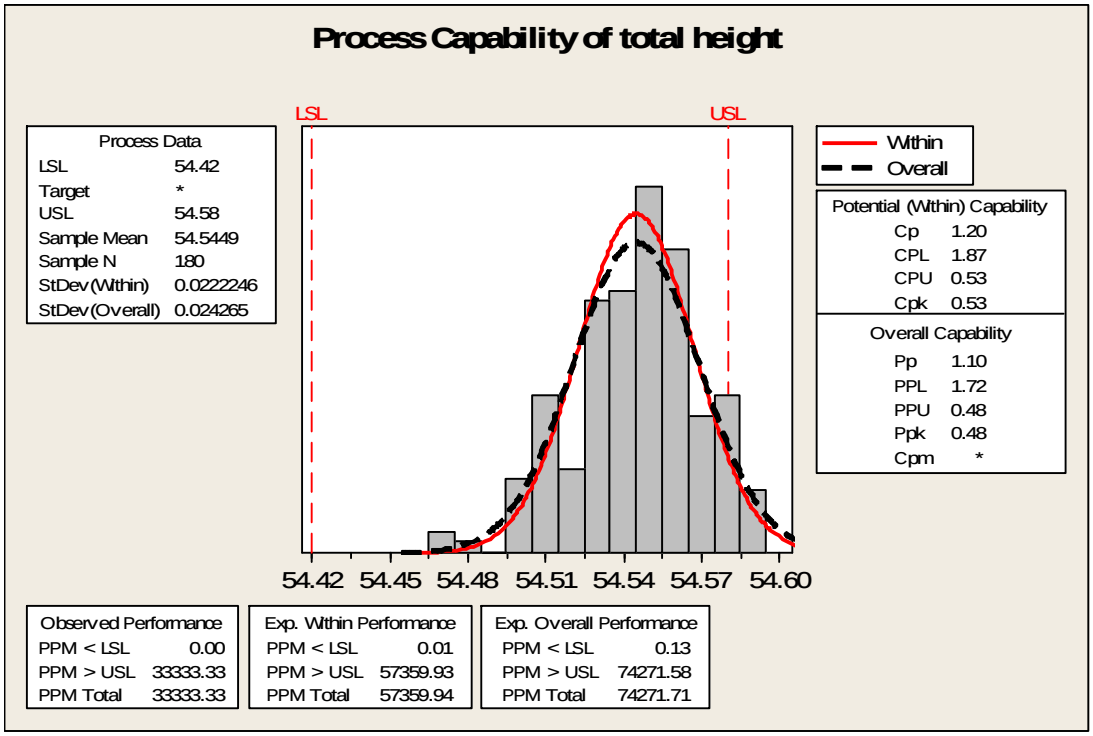
Xbar-R Chart Of Total Height:-



Conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since the only two point (sample means) 7^{th} and 8^{th} sample lies outside the control limits.
2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph of Total Height:-



Conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Job 2

HUB TURBINE

Data Collection (Outer Diameter)

Target Outer Diameter =102.87mm

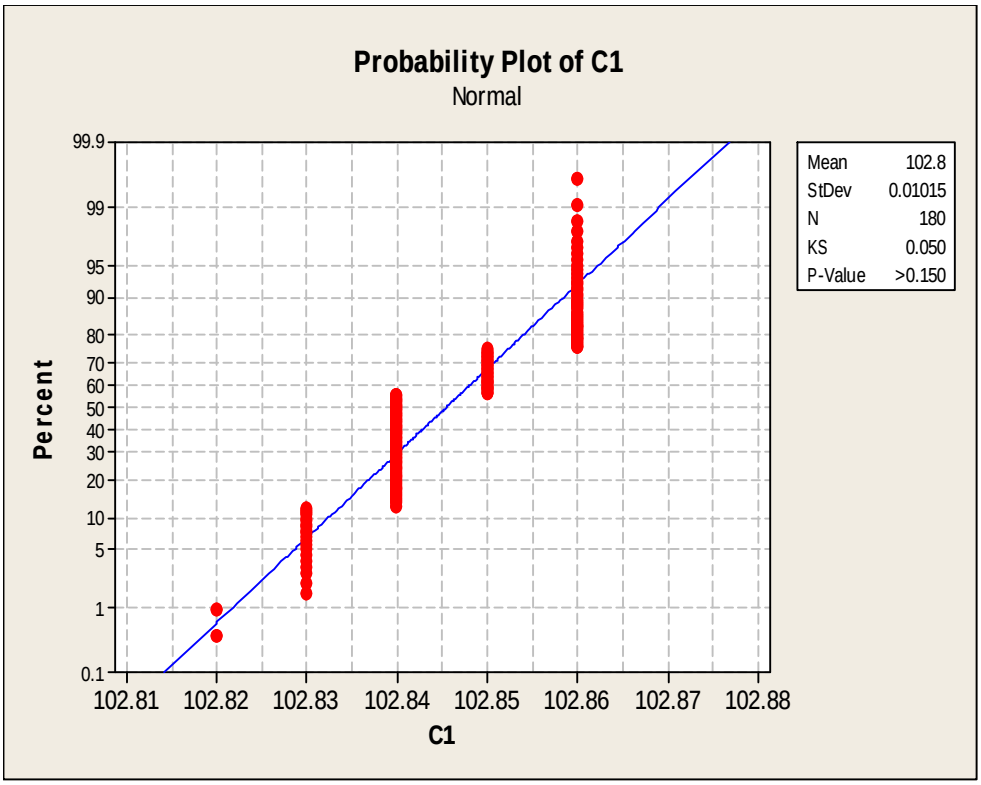
102.85	102.83	102.84	102.84	102.86	102.86	102.85	102.84	102.86
102.84	102.85	102.86	102.86	102.84	102.86	102.84	102.84	102.84
102.84	102.84	102.84	102.84	102.84	102.86	102.85	102.85	102.86
102.82	102.84	102.83	102.84	102.86	102.86	102.84	102.84	102.85
102.84	102.84	102.84	102.85	102.84	102.86	102.84	102.84	102.83

102.85	102.84	102.85	102.84	102.84	102.86	102.84	102.84	102.84
102.84	102.84	102.86	102.85	102.86	102.85	102.85	102.84	102.83
102.86	102.85	102.86	102.86	102.85	102.86	102.84	102.83	102.84
102.85	102.86	102.84	102.86	102.84	102.86	102.84	102.85	102.83
102.84	102.86	102.86	102.85	102.83	102.85	102.85	102.86	102.84

102.84	102.84	102.84	102.84	102.84	102.84	102.84	102.84	102.84
102.83	102.84	102.84	102.83	102.83	102.84	102.83	102.84	102.84
102.86	102.84	102.83	102.84	102.86	102.84	102.85	102.86	102.86
102.83	102.84	102.85	102.83	102.83	102.84	102.84	102.84	102.84
102.84	102.83	102.86	102.84	102.84	102.83	102.84	102.83	102.84

102.85	102.84	102.86	102.84	102.84	102.83	102.84	102.86	102.86
102.86	102.86	102.85	102.84	102.86	102.85	102.84	102.85	102.84
102.84	102.86	102.84	102.84	102.84	102.84	102.84	102.86	102.85
102.84	102.86	102.85	102.85	102.86	102.86	102.85	102.86	102.86
102.86	102.86	102.84	102.84	102.85	102.85	102.86	102.84	102.86

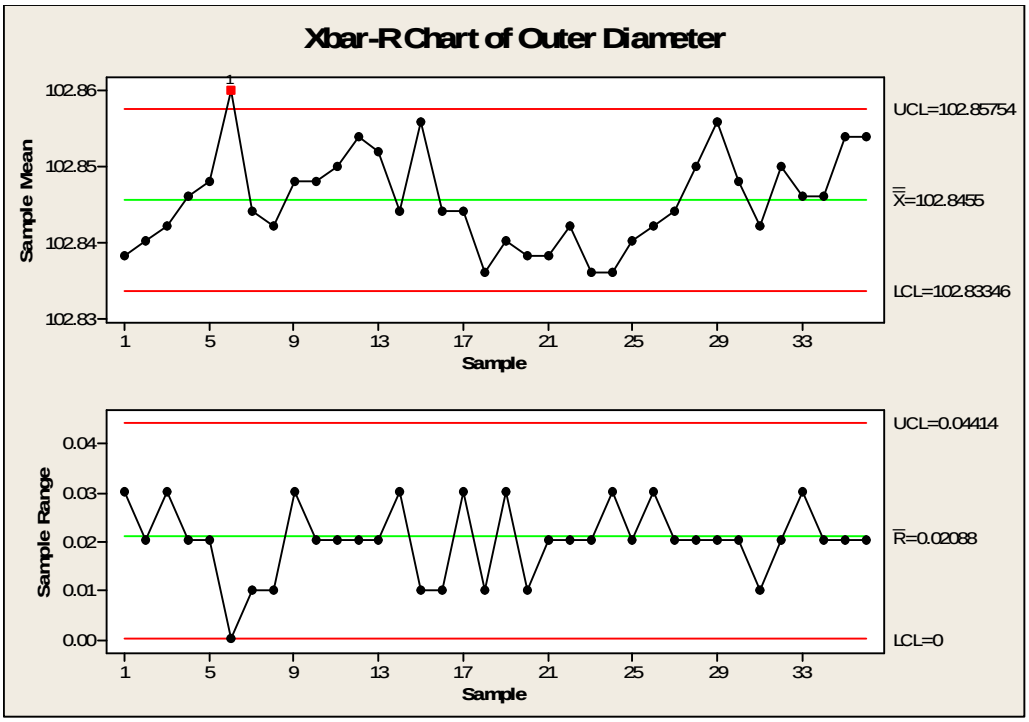
Normality Graph:-



conclusion:-

p-value is greater than 0.05. Hence the data is normal.

X bar-R Chart Of Outer Diameter:-

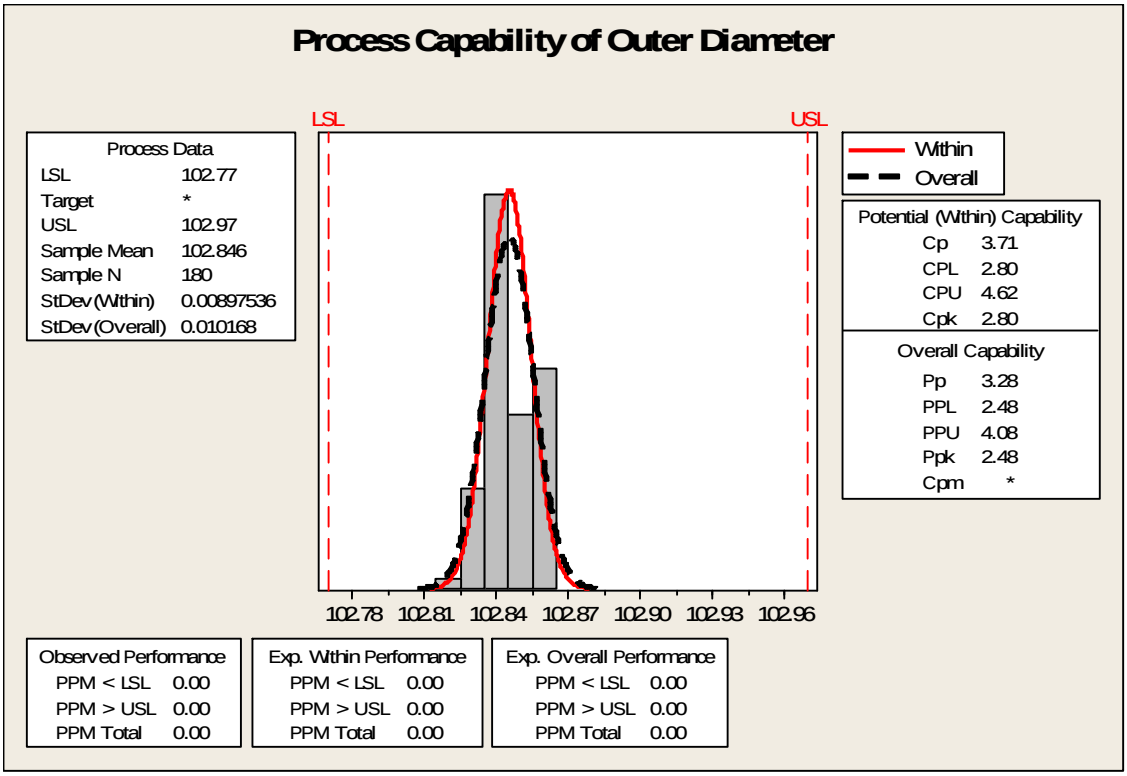


Conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since only one point (sample means) 6th lies outside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph Of Outer Diameter:-



Conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection (Outer Diameter)

Target Outer Diameter =47.90mm

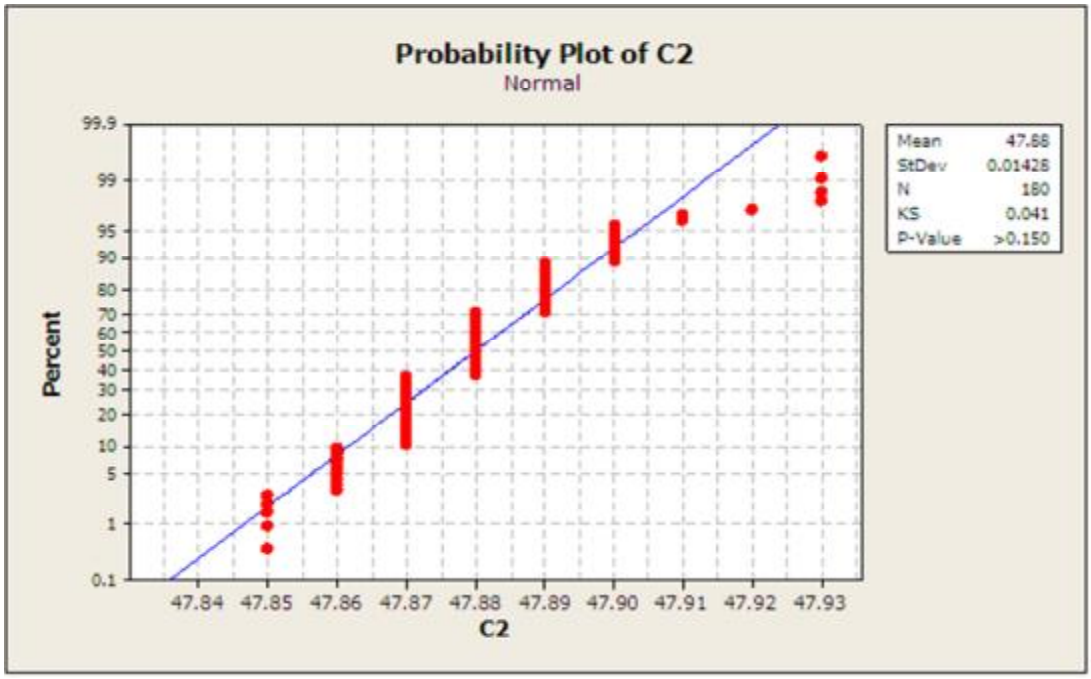
47.9	47.93	47.93	47.87	47.87	47.85	47.88	47.87	47.86
47.89	47.88	47.89	47.87	47.88	47.87	47.87	47.86	47.89
47.89	47.88	47.9	47.87	47.88	47.87	47.86	47.86	47.89
47.88	47.88	47.88	47.88	47.88	47.87	47.87	47.88	47.87
47.9	47.89	47.88	47.87	47.86	47.87	47.87	47.88	47.88

47.88	47.87	47.9	47.88	47.86	47.78	47.87	47.87	47.87
47.87	47.87	47.89	47.85	47.86	47.88	47.86	47.88	47.87
47.87	47.87	47.89	47.85	47.85	47.88	47.88	47.89	47.87
47.88	47.88	47.88	47.87	47.85	47.89	47.87	47.88	47.89
47.88	47.87	47.89	47.89	47.88	47.88	47.88	47.89	47.87

47.86	47.89	47.87	47.87	47.88	47.9	47.89	47.93	47.93
47.88	47.88	47.89	47.86	47.89	47.89	47.91	47.88	47.89
47.88	47.91	47.88	47.87	47.89	47.89	47.88	47.88	47.9
47.88	47.93	47.89	47.89	47.89	47.88	47.88	47.88	47.88
47.87	47.92	47.87	47.88	47.87	47.88	47.9	47.89	47.88

47.87	47.87	47.86	47.89	47.87	47.89	47.88	47.89	47.87
47.87	47.87	47.88	47.87	47.88	47.89	47.88	47.9	47.87
47.87	47.87	47.88	47.88	47.88	47.88	47.88	47.88	47.88
47.88	47.87	47.86	47.88	47.87	47.9	47.89	47.88	47.88
47.87	47.86	47.89	47.87	47.9	47.93	47.93	47.87	47.89

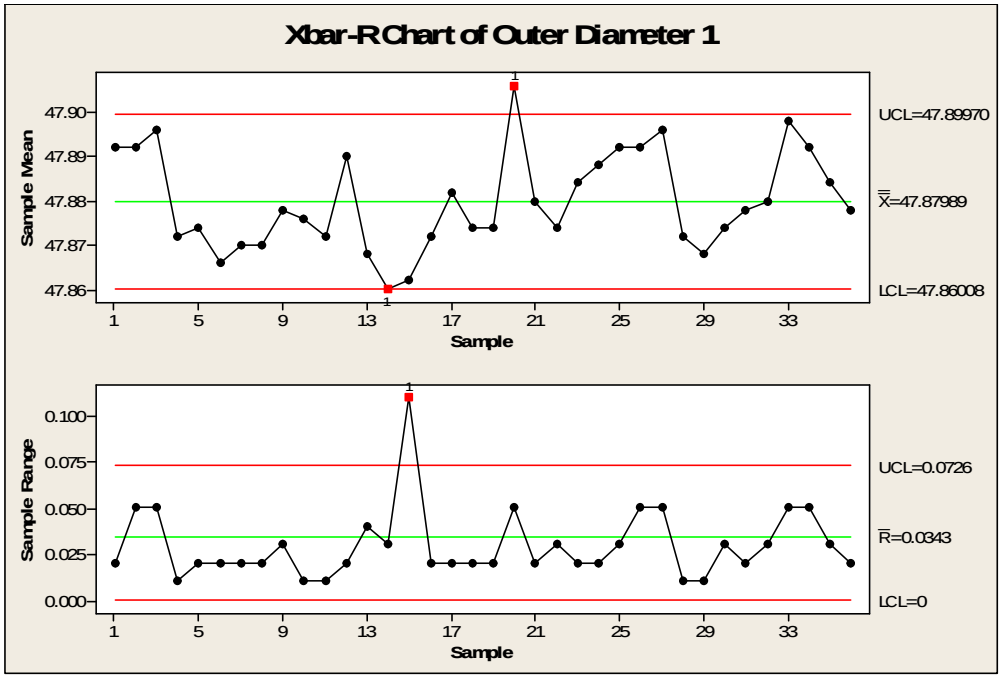
Normality Graph Of Outer Diameter:-



Conclusion:-

p-value is greater than 0.05. Hence the data is normal.

Xbar-R Chart Of Outer Diameter:-

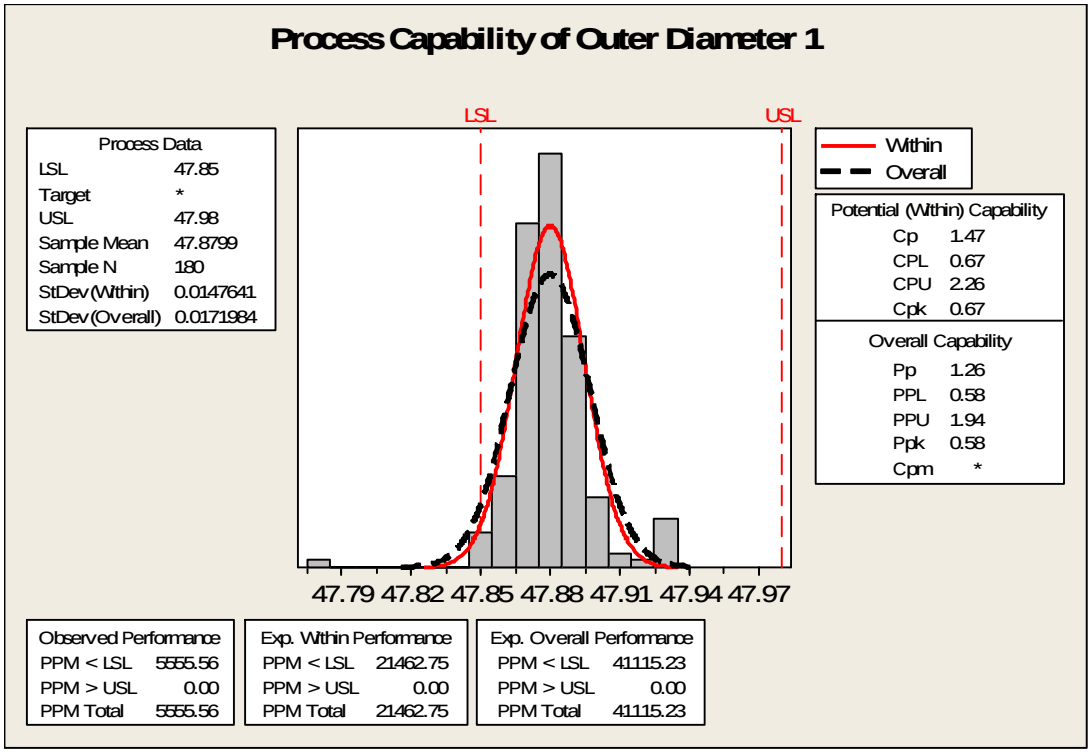


conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since only two point (sample means)14th& 20th lies outside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) 4th lies outside the control limits.

Cp-Cpk Graph Of Outer Diameter:-



conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection Of Total Height

Target Total Height = 51.05

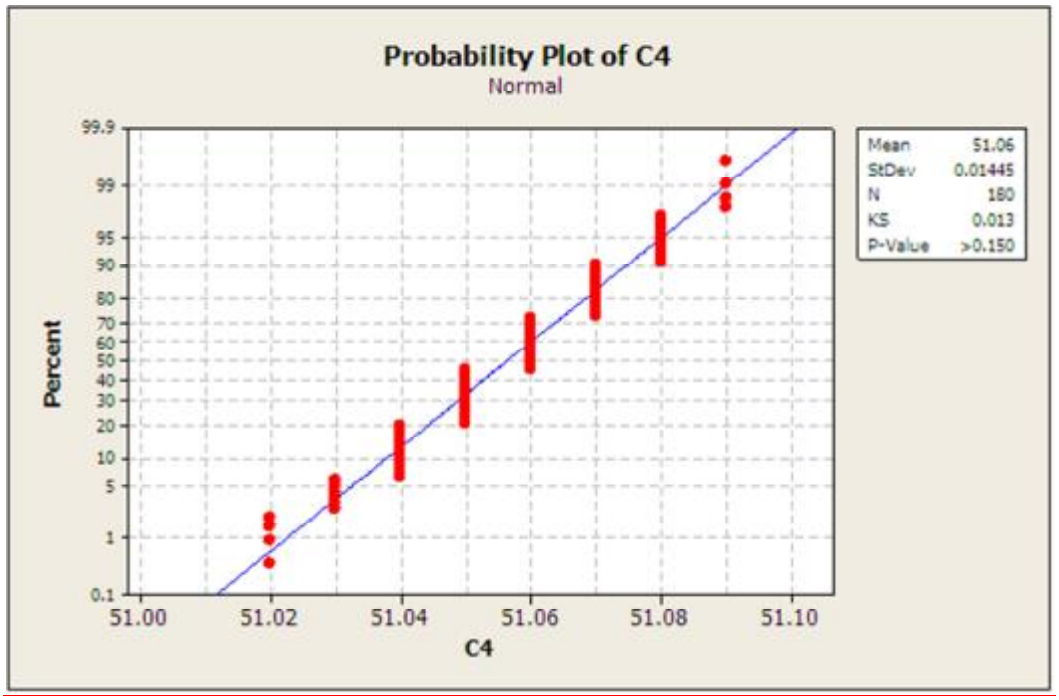
51.06	51.07	51.06	51.05	51.05	51.05	51.07	51.06	51.06
51.07	51.06	51.06	51.07	51.05	51.05	51.05	51.05	51.06
51.02	51.05	51.06	51.04	51.05	51.04	51.06	51.07	51.05
51.04	51.07	51.04	51.05	51.05	51.08	51.07	51.09	51.06
51.07	51.06	51.06	51.04	51.06	51.08	51.06	51.07	51.05

51.06	51.08	51.07	51.09	51.08	51.08	51.05	51.05	51.05
51.08	51.07	51.07	51.08	51.08	51.03	51.04	51.04	51.04
51.07	51.08	51.07	51.08	51.09	51.03	51.05	51.04	51.04
51.08	51.08	51.07	51.06	51.08	51.05	51.05	51.04	51.05
51.07	51.07	51.07	51.06	51.04	51.05	51.06	51.05	51.07

51.07	51.03	51.03	51.06	51.05	51.06	51.05	51.07	51.06
51.06	51.05	51.05	51.05	51.06	51.06	51.05	51.02	51.05
51.04	51.05	51.05	51.05	51.06	51.06	51.05	51.04	51.07
51.05	51.09	51.03	51.05	51.04	51.04	51.04	51.07	51.06
51.03	51.02	51.04	51.04	51.06	51.03	51.06	51.07	51.06

51.06	51.07	51.05	51.06	51.06	51.07	51.04	51.07	51.06
51.06	51.04	51.05	51.05	51.06	51.04	51.07	51.06	51.05
51.04	51.05	51.05	51.07	51.04	51.06	51.07	51.06	51.07
51.06	51.04	51.06	51.06	51.06	51.07	51.06	51.06	51.04
51.05	51.05	51.05	51.06	51.05	51.02	51.05	51.06	51.06

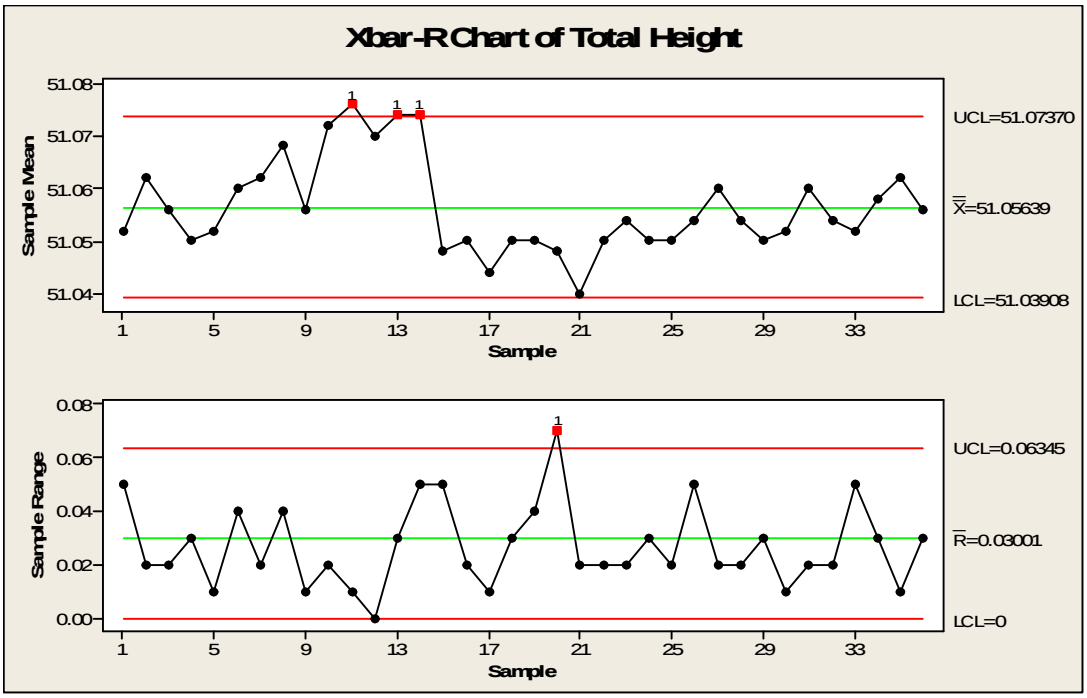
Normality Graph Of Total Height:-



conclusion:-

p-value is greater than 0.05 hence the data is normal.

Xbar-R Chart Of Total Height:-

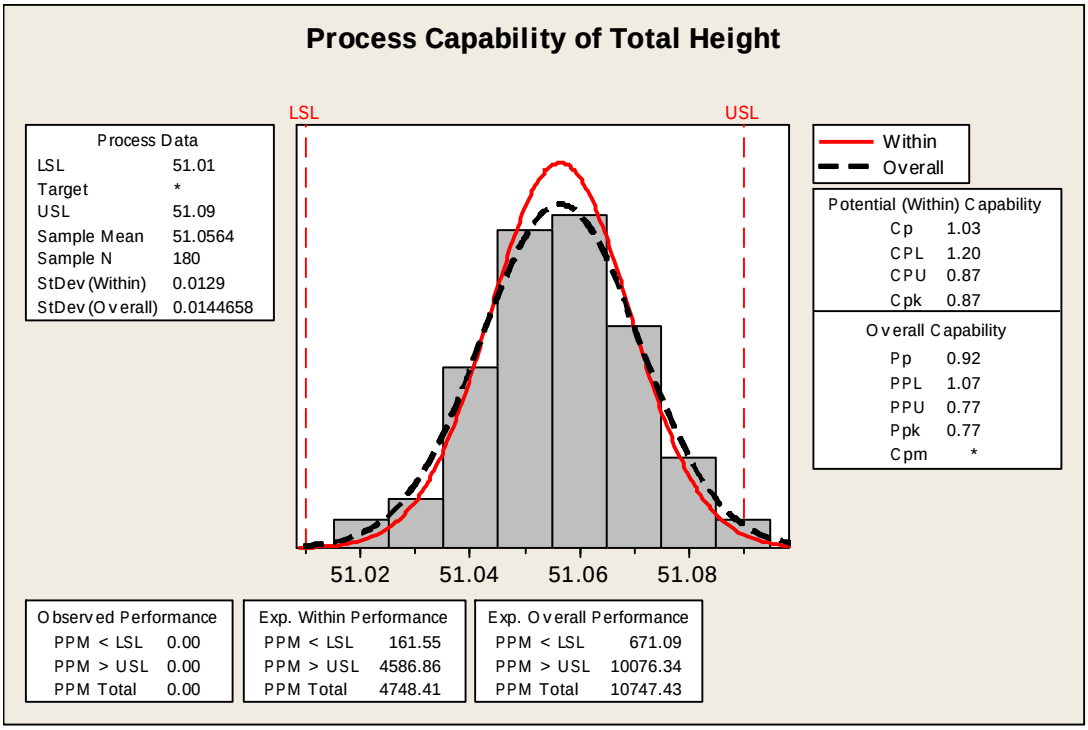


Conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since only three point (sample mean) 11^{th} ,12^{th} ,14^{th} lies outside the control limit.

2- From R-bar chart, clearly the process Average is in control. Since only one point (sample range) lies outside the control limits.

Cp-Cpk Graph Of Total Height



Conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data Collection Of Height

Target Height = 42.67

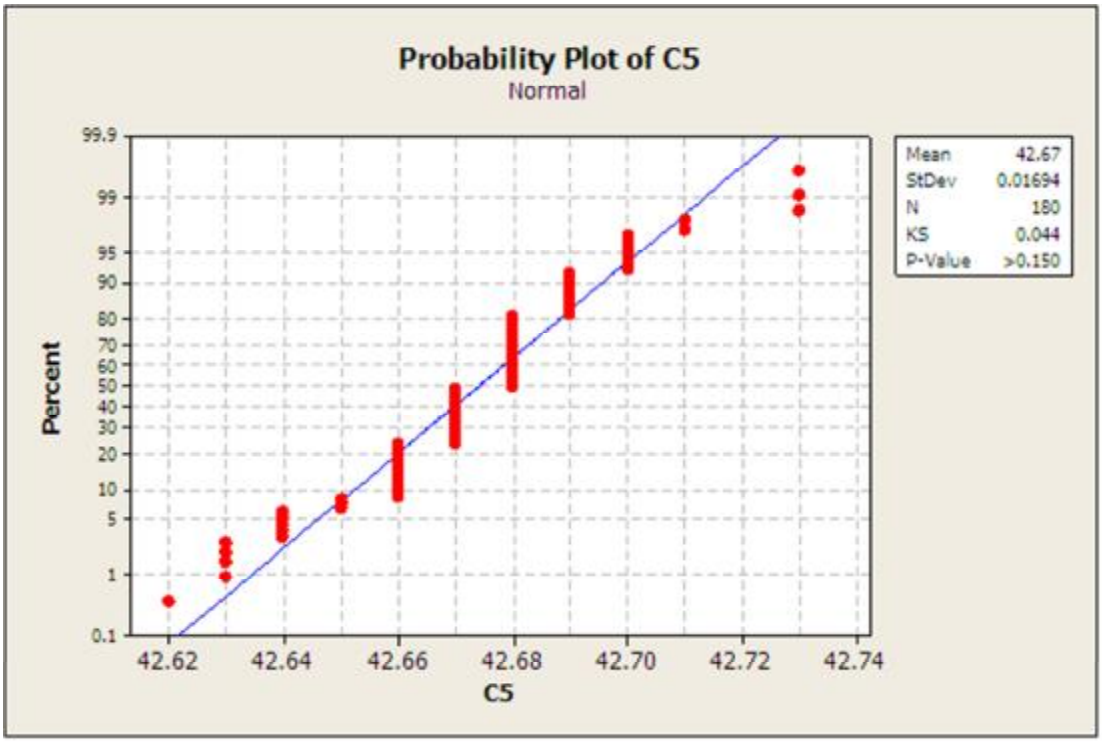
42.67	42.69	42.68	42.67	42.67	42.68	42.7	42.68	42.69
42.68	42.68	42.68	42.67	42.67	42.67	42.69	42.62	42.69
42.66	42.68	42.68	42.68	42.68	42.68	42.69	42.67	42.69
42.67	42.67	42.63	42.68	42.69	42.68	42.63	42.66	42.69
42.68	42.67	42.64	42.68	42.67	42.69	42.69	42.67	42.7

42.69	42.69	42.71	42.69	42.68	42.66	42.66	42.66	42.69
42.68	42.69	42.7	42.7	42.64	42.66	42.67	42.66	42.68
42.71	42.69	42.69	42.7	42.64	42.68	42.66	42.66	42.68
42.73	42.7	42.66	42.7	42.68	42.68	42.66	42.66	42.66
42.73	42.7	42.67	42.65	42.68	42.66	42.65	42.67	42.64

42.65	42.65	42.68	42.67	42.67	42.66	42.68	42.68	42.68
42.67	42.67	42.67	42.67	42.68	42.67	42.66	42.68	42.68
42.67	42.68	42.68	42.68	42.68	42.67	42.67	42.67	42.63
42.7	42.66	42.68	42.68	42.66	42.67	42.68	42.67	42.64
42.73	42.66	42.66	42.67	42.66	42.67	42.69	42.68	42.67

42.67	42.67	42.66	42.66	42.67	42.66	42.68	42.68	42.68
42.68	42.68	42.68	42.67	42.67	42.66	42.66	42.68	42.68
42.68	42.69	42.67	42.67	42.68	42.67	42.67	42.67	42.63
42.68	42.68	42.68	42.68	42.68	42.67	42.68	42.67	42.64
42.67	42.66	42.68	42.68	42.66	42.67	42.69	42.68	42.67

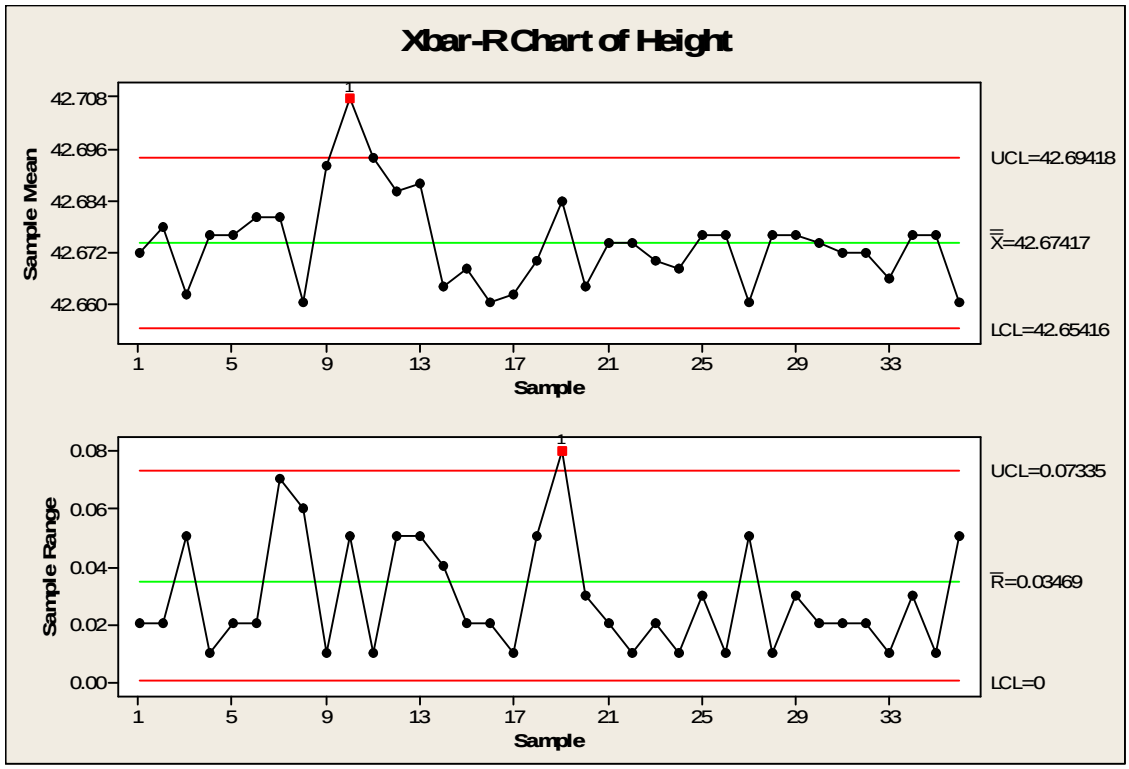
Normality Graph Of Height:-



conclusion:-

p-value is greater than 0.05 hence the data is normal.

Xbar-R Chart Of Height:-

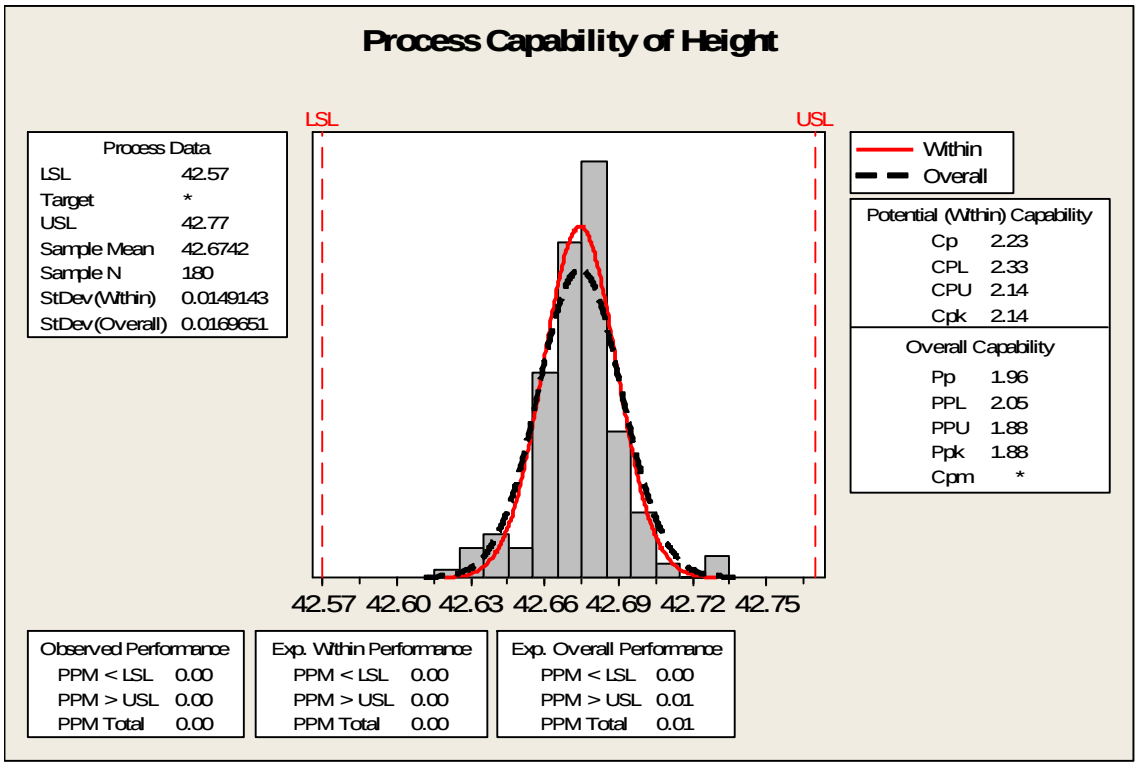


conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since only one point (sample means) lies outside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since only one point (sample range) lies outside the control limits.

Cp-Cpk Graph Of Height:-



conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

Data collection of Depth

Target Depth =19.5

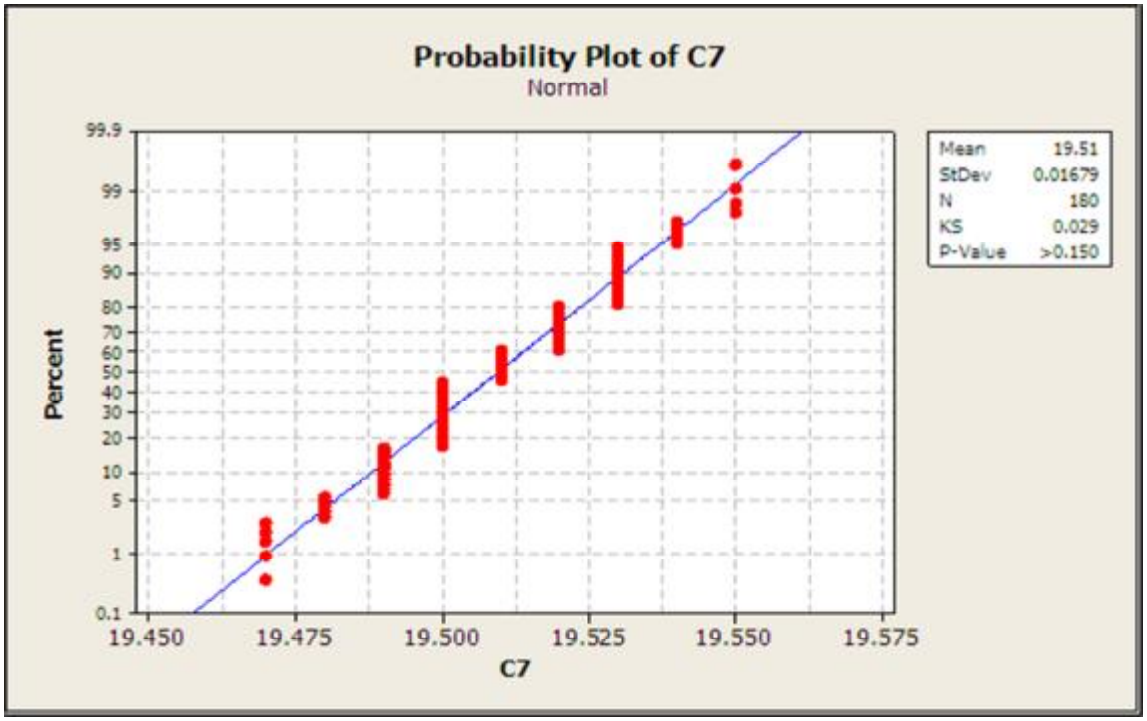
19.51	19.49	19.5	19.53	19.52	19.52	19.51	19.51	19.53
19.5	19.49	19.51	19.51	19.5	19.51	19.49	19.52	19.53
19.53	19.5	19.51	19.47	19.51	19.52	19.5	19.52	19.54
19.5	19.5	19.53	19.5	19.49	19.51	19.52	19.53	19.54
19.55	19.47	19.53	19.48	19.52	19.52	19.5	19.53	19.53

19.52	19.54	19.52	19.52	19.5	19.5	19.51	19.5	19.52
19.53	19.53	19.53	19.52	19.5	19.5	19.49	19.49	19.51
19.52	19.52	19.5	19.49	19.49	19.5	19.5	19.5	19.52
19.53	19.52	19.54	19.48	19.5	19.5	19.51	19.5	19.52
19.53	19.52	19.54	19.49	19.5	19.5	19.49	19.5	19.52

19.51	19.51	19.5	19.52	19.52	19.5	19.5	19.5	19.53
19.5	19.48	19.5	19.5	19.52	19.5	19.55	19.47	19.53
19.52	19.49	19.5	19.51	19.53	19.51	19.49	19.5	19.53
19.53	19.51	19.51	19.49	19.5	19.5	19.49	19.51	19.51
19.5	19.5	19.51	19.52	19.52	19.53	19.5	19.51	19.47

19.5	19.49	19.5	19.5	19.49	19.51	19.47	19.51	19.53
19.48	19.52	19.52	19.53	19.5	19.53	19.5	19.49	19.55
19.52	19.52	19.5	19.5	19.5	19.53	19.48	19.52	19.49
19.5	19.52	19.5	19.55	19.5	19.53	19.52	19.52	19.49
19.51	19.53	19.51	19.49	19.51	19.51	19.5	19.52	19.5

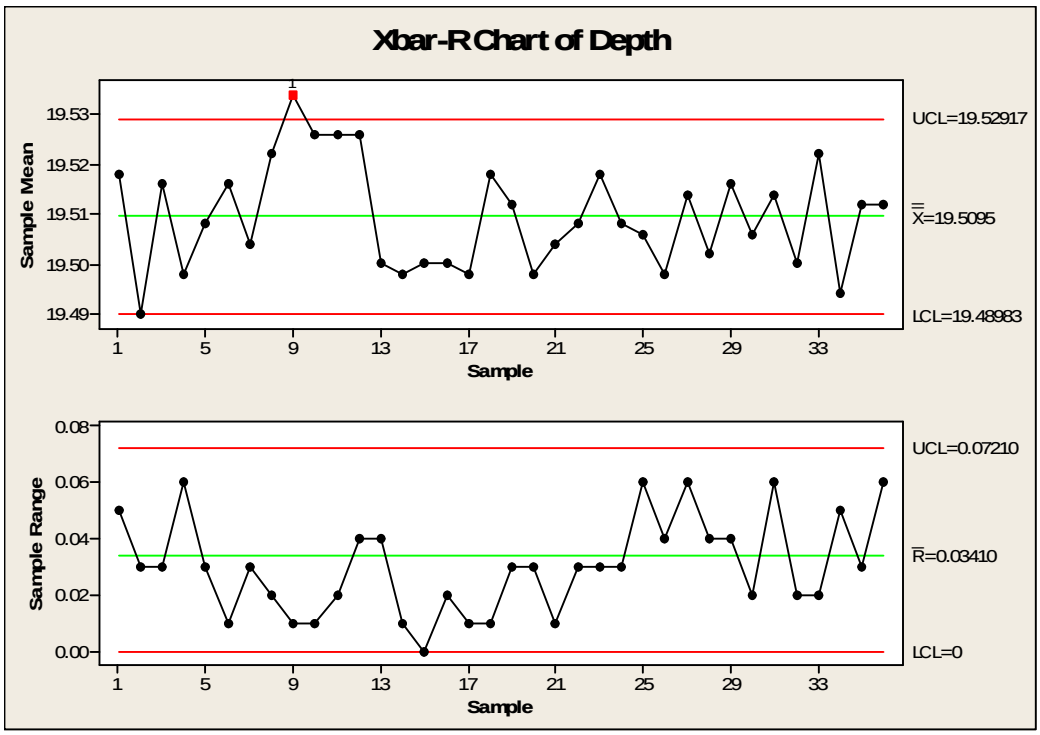
Normality Graph Of Depth:-



conclusion:-

p-value is greater than 0.05 hence the data is normal.

X bar-R Chart Of Depth:-

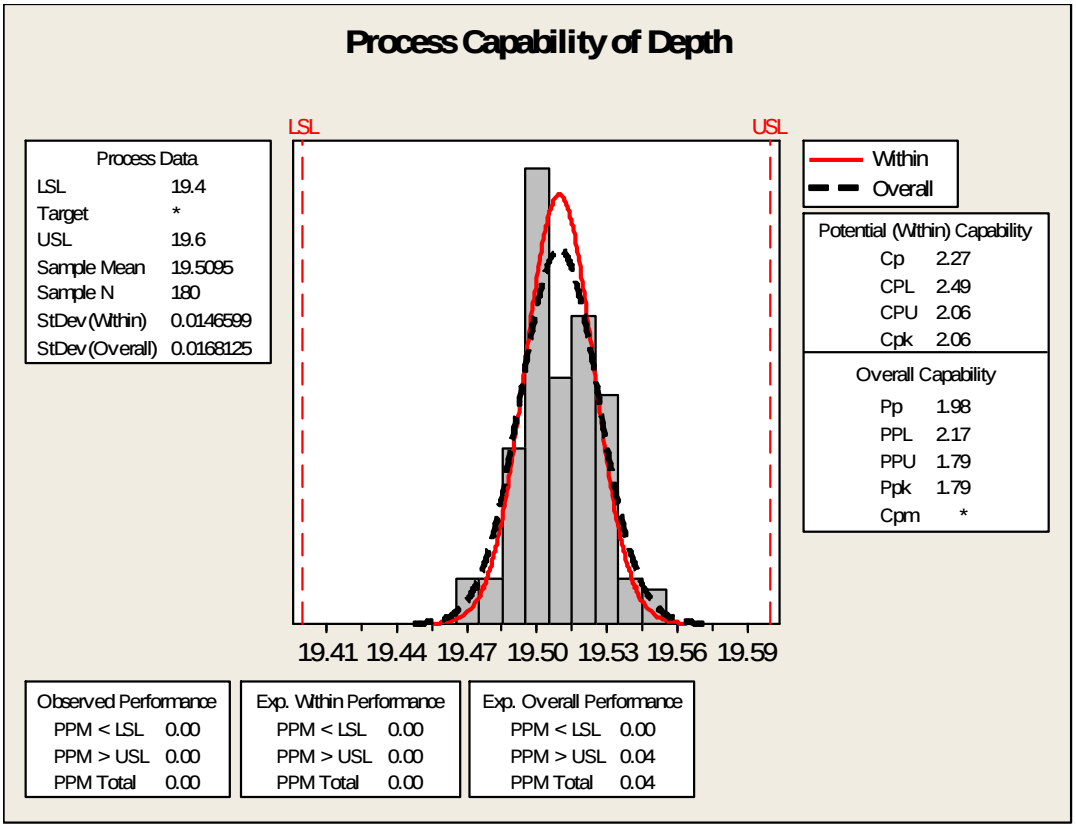


conclusion:-

1- From X-bar chart, clearly the process Average is in control. Since only one point (sample means) lies outside the control limits.

2- From R-bar chart, clearly the process Average is in control. Since the point (sample range) lies inside the control limits.

Cp-Cpk Graph Of Depth:-



conclusion:-

1- [Cp >1] hence the Process is Capable and the process will fit within the specification limits.
2- [Cp ≠Cpk] then the overall average is not centrally located.
3- Practically all the products manufactured will meet specifications as long as the process stays in control.

CHAPTER 5

Conclusion and suggestion

Job first:- Body Centrifugal Oil Filter

Conclusion and suggestion:-

After studying the above process &while comparing to the results, following are the fact come in exist such as:

- From X bar and R chart we conclude that the all the parameters are in control.
- The process capability shows that all the values of Cp is greater than or equal to one hence we say that the process is capable.
- All the process is not centered between USL and LSL except 2nd outer diameter. Hence we suggest that,
- Tolerances should be slightly wider without affecting the functioning of the product. At the same time it is absolutely necessary to maintain the centring of the process.

Job Second: - Body Hub Turbine

Conclusion and suggestion:-

After studying the above process &while comparing to the results, following are the fact come in exist such as:

- From X bar and R chart we conclude that all the sample points fall the specification limits. This means that as long as control is maintained all is well, therefore the process exhibits statistical control.
- All the parameters meets in specification. This means that both control limits for the mean are within the specification limits.
- In case of outer diameter 1 some products falls below the LSL. Hence it is absolutely necessary to maintain the centring of the process.
- Hence we suggest that it is still important to maintain the centering of the process.

APPENDIX

Sr.no	Outer Diameter	Depth	Height	Total Height

References:-

1) Introduction to statistical Quality Control :- D. C. Montgomery.

2) Statistical Quality Control: - M. S. Mahajan.

3) Research Methodology: - C. M .Chaudhary.

4) Total Quality Management :- K. Sridhar Bhat

5) Softwares used Minitab, MS-OFFICE

6) Wikipedia.com

7) Websites :- Google

: www.jmp.com

: www.isixsigma.com

:www.skymark.com