Quality Assurance (IE 508)

Mini Project-2

Process Control and Capability

Group No - 1

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Objective - To determine if the stopwatch app, as used by your team, has acceptable repeatability and reproducibility when measuring helicopter flight time.

1. In your own words, explain the purpose of a process control study. Why is this analysis important?

Answer –

A process control study is a study of the statistical techniques that are used for process control. In general, several methods and technologies are employed to monitor the behavior of the process, assist in the detection of internal system flaws, and aid in the resolution of production-related difficulties.

To examine the process and take corrective action before multiple nonconforming units are produced, one of the primary objectives of statistical process control is to quickly determine the occurrence of assignable causes of process shifts. Control charts can be helpful for eliminating defects as an outcome. A control chart is an effective tool for online process monitoring in this context.

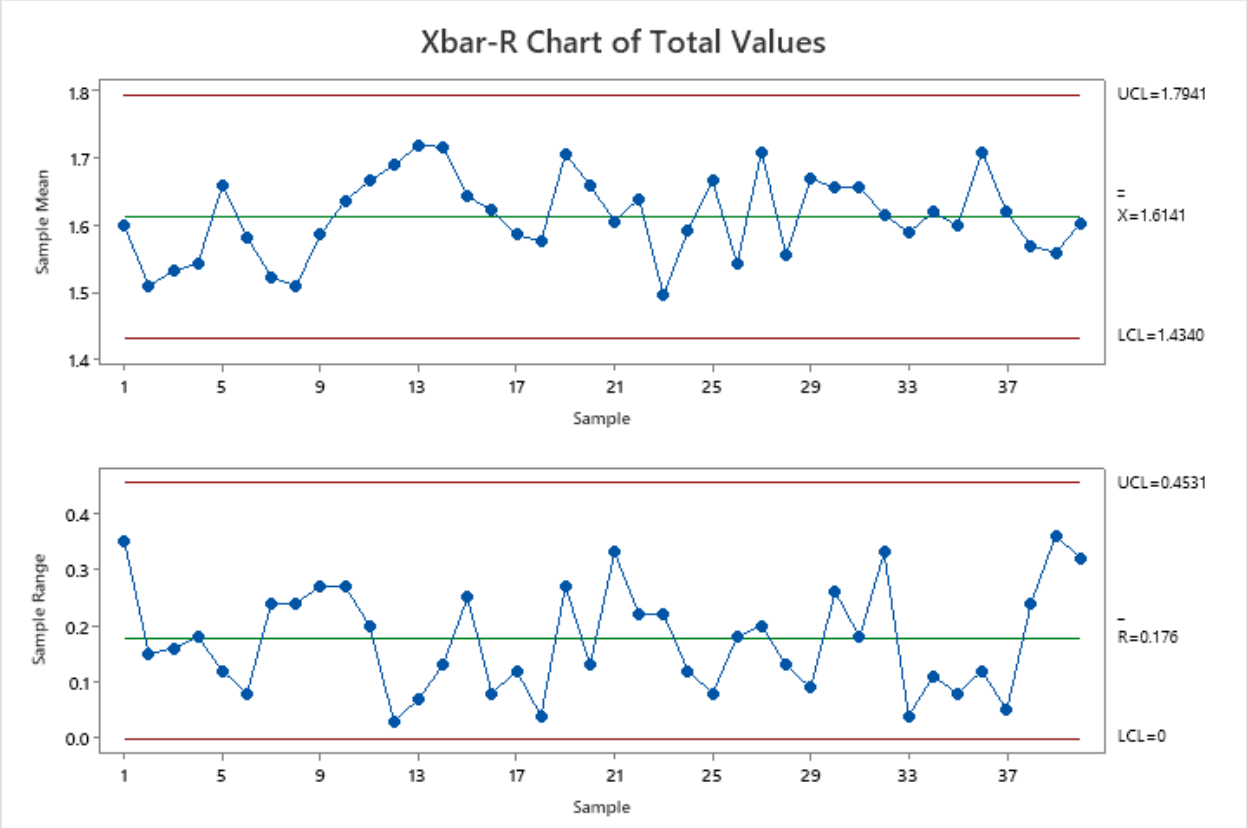
The process control chart is an essential instrument to identify the distinctive causes of variation within the process. Natural variations will always exist as an essential part of all operations. So, by means of a process control study, we can determine the special cause variation from the normal variation. Analyzing control charts represents the way we analyze process control. Additionally, there will be lower and upper bounds on control charts. Any point outside of these control limits is a sign that the process is out of control. Two charts, an X bar chart, and an R chart, are typically included in a process control study. The X-bar chart demonstrates how the mean or average varies across subgroups, whereas the R chart illustrates how the range of the subgroups varies across samples.

For many reasons, this analysis is essential. The first advantage is that it allows organizations to identify opportunities for improvement and implement changes that can boost efficiency, cut down on waste, and improve the level of their output. In addition, companies can reduce the likelihood of output flaws or faults, which may end up in dissatisfied consumers and significant rework, by reducing process variance. Thirdly, process control studies can help organizations in complying with quality standards and laws, which are frequently demanded across multiple industries.

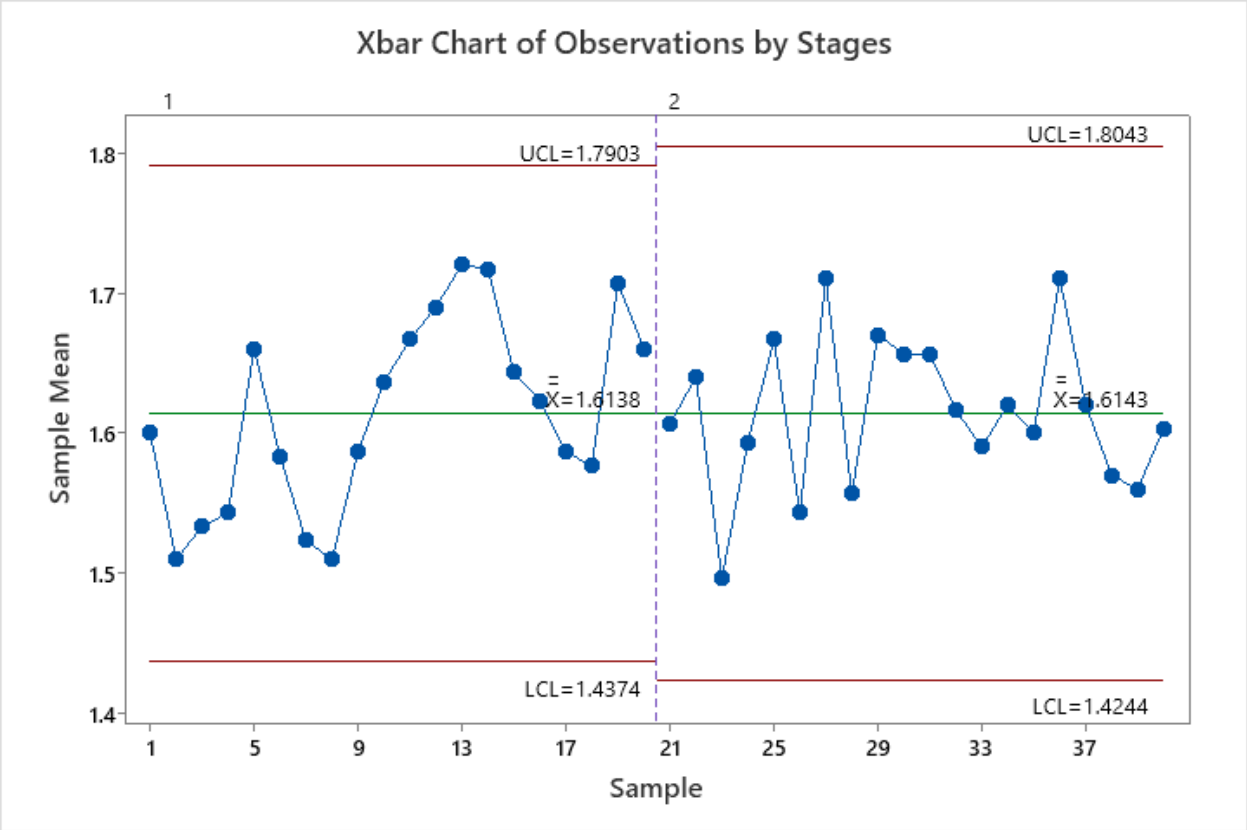
2. Provide a complete interpretation of your process-control results in your own words. Comment and interpret on all figures, findings, and observations made during the data collection activity. If there were differences in the calculated control limits between the first and last 60 plot points, hypothesize why this might be.

Answer –

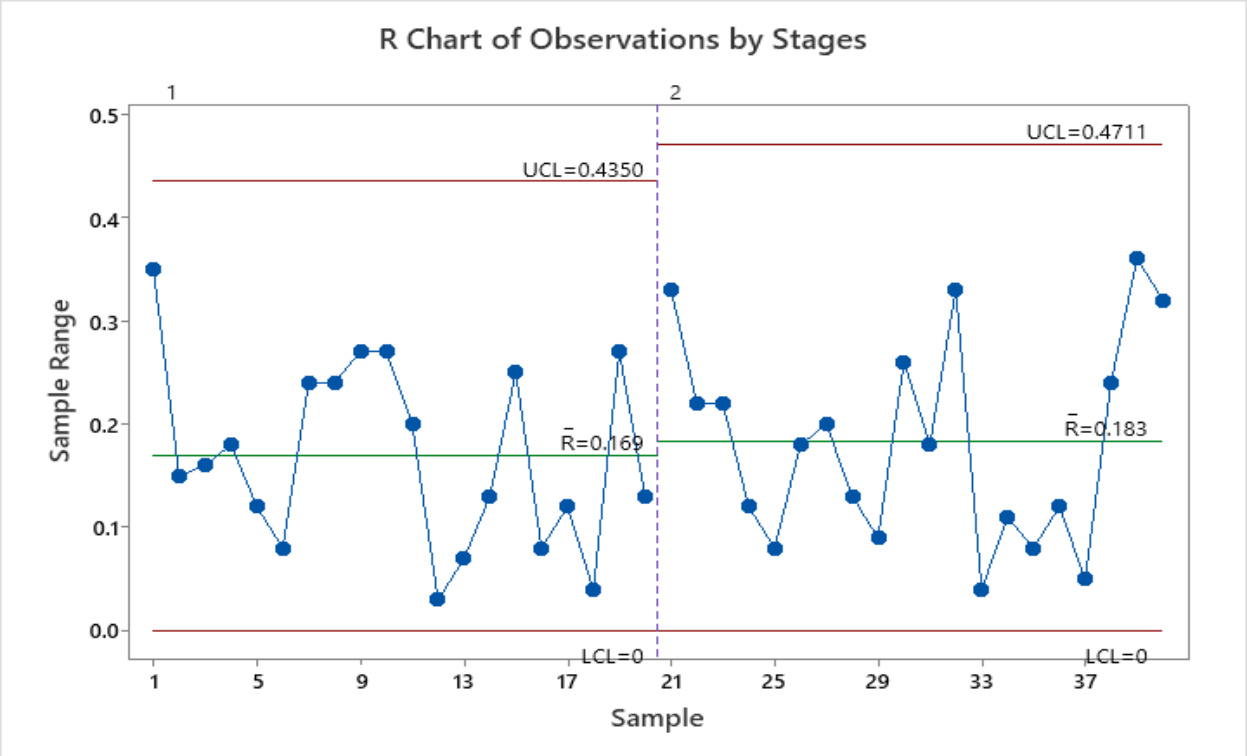
Operators A and B were chosen to release the helicopters from a height of 200 cm, a pair of people were selected to monitor the flight durations, and one person was chosen to enter data into Minitab. In addition, the study measured the amount of time spent flying utilizing an iPhone timer. The helicopter was dropped 60 times by Operator A, then 60 times by Operator B. The helicopter was built to comply with the exact requirements of the Mini project 1 version. The experiment took place on the same day in the exact same room. The dropper dropped the helicopter and measured using a stopwatch throughout the procedure using the same procedures.



On the R chart, the subgroup ranges are displayed. The centerline is created by averaging all the subgroup ranges. The R chart's control limits, which are located 3 standard deviations above and below the center line, demonstrate the amount of variation that can be expected in the subgroup ranges. Checking for any areas on the chart that seem out of control we determined from our examination that none of the points are out of control. R Chart illustrates the variability within the sample. It is a useful measure of short-term variability since it indicates variability within the sample.



In the Xbar chart, the average of the measurements for each subgroup is presented. The center line is created by the total of the averages for each of the subgroups. The control boundaries on the X-bar chart are located three standard deviations from and below the center line, which means they act as an indication of the range for potential variability in the subgroup averages. There are certainly not any points that are out of control on the X bar chart. It means that it has no long-term variability associated with it. Overall, we can assert that the process remains under control. Assuming that the process is under control, we can assess its capability. Process capability is only effective when the process is stable because we are unable to anticipate the outcome of an unstable process.



The two sets of data, which were collected by two separate Measure/Dropper pairings, were combined. The control limit for both data sets was successfully fixed using the Minitab functionality. For both sets of data, the conditions were the same. On the same day and at the same location, we collected both sets of data. All the helicopter and the stopwatch were identical. The techniques utilized to start and stop the stopwatches were the same. To preserve the same setting throughout the test, the process concluded as rapidly as feasible. Consequently, we determined that two separate operators were ultimately responsible for the alteration in control limits. Both operators are going to encounter some natural variation when taking the measurement, although the fact that the conditions and steps are the same. In our research, the second operator who assessed the flight time did so for a longer period than operator 1. We can deduce that operator 1 is better in terms of short-term variability since its sample range average, which is 0.169, is less than operator 2, which is 0.183. For the X bar chart, operator 2 has larger sample mean values than operator 1, even if both operator values are in the control. (1.6143 and 1.6138).

Q3. In your own words, explain the purpose of a process capability study. Why is this analysis important?

A process capability study is a statistical method used to assess a process' performance by determining its capacity to create output that adheres to the requirements for a good or service. This analysis's goals are to find any process variability and ascertain whether the process is capable of consistently producing the required results.

Statistical techniques can be helpful throughout the product cycle, including development activities prior to manufacturing, in quantifying process variability, in analyzing this variability relative to product requirements or specifications, and in assisting development and manufacturing in eliminating or greatly reducing this variability. This general activity is called process capability analysis.

Process capability studies can also assist businesses in meeting regulatory requirements and customer expectations by demonstrating how dependable and stable their internal procedures are. This study can be used to create quality goals, develop performance benchmarks, and track process performance over time.

Process capability analysis is a vital part of an overall quality-improvement program.

A program for general quality improvement must include process capacity analysis.

The following are some of the main applications for data from a process capacity analysis:

1. Predicting how well the procedure will maintain the tolerances.

2. Aiding product developers and designers in choosing or changing a process.

3. Assisting in determining the time between samplings for process monitoring.

4. Outlining performance standards for new equipment.

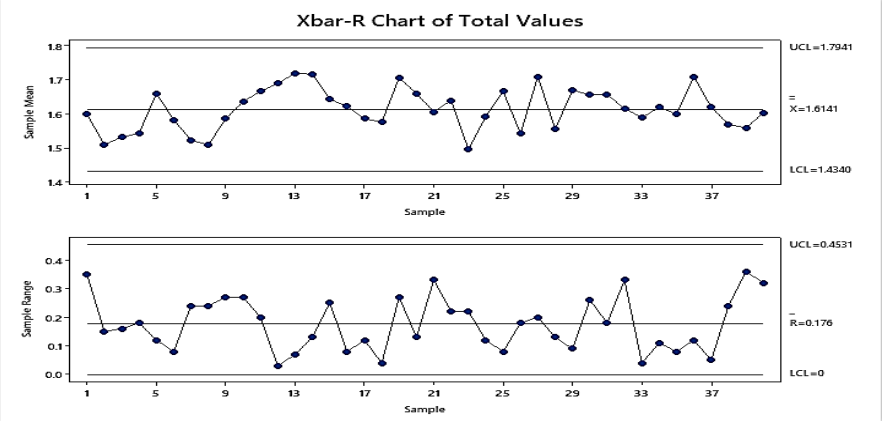
5. Making decisions on other supply chain management tasks and rival suppliers.

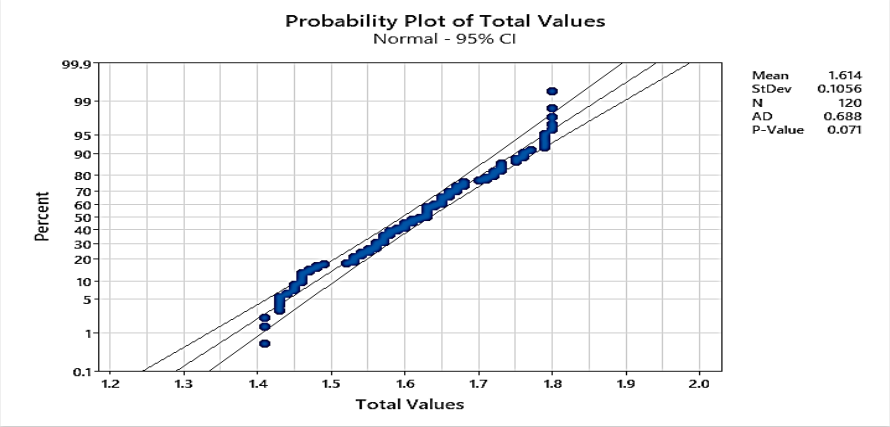
6. Arranging the order of production processes when processes interact with tolerances.

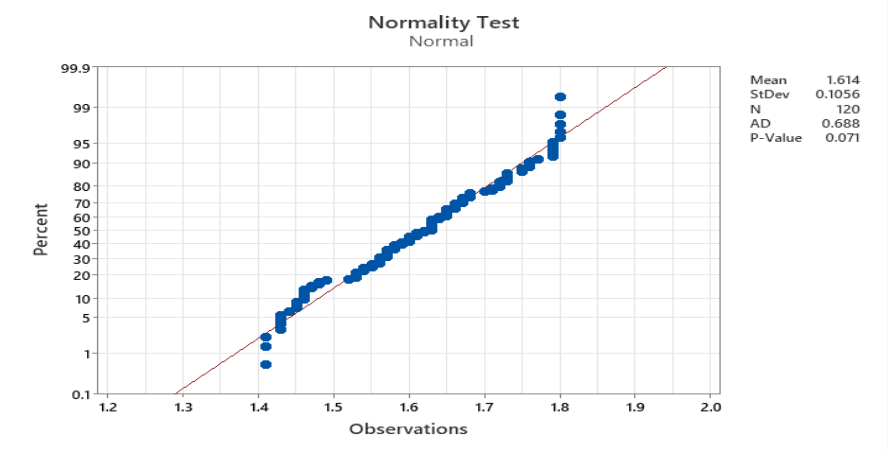
7. Reducing a process' variability

The customer, developer, and designer decide what the specification limit for process capability studies should be. Between capability specification limitations and control limits, there is no quantitative link. Process capability analysis might be of two different forms. They are Cp, or potential capability within subgroups, and OPC, or overall process capability. (Pp). The most significant statistic is the Cp value since it indicates the diversity within the subgroups. A second parameter, Cpk, is included to measure the data's shift from the mean because the Cp value does not take centering into account. Cpk is the minimum (Cpu,Cpl).

Q4. Provide a complete interpretation of your capability analysis in your own words. Comment and interpret on all figures and indexes.







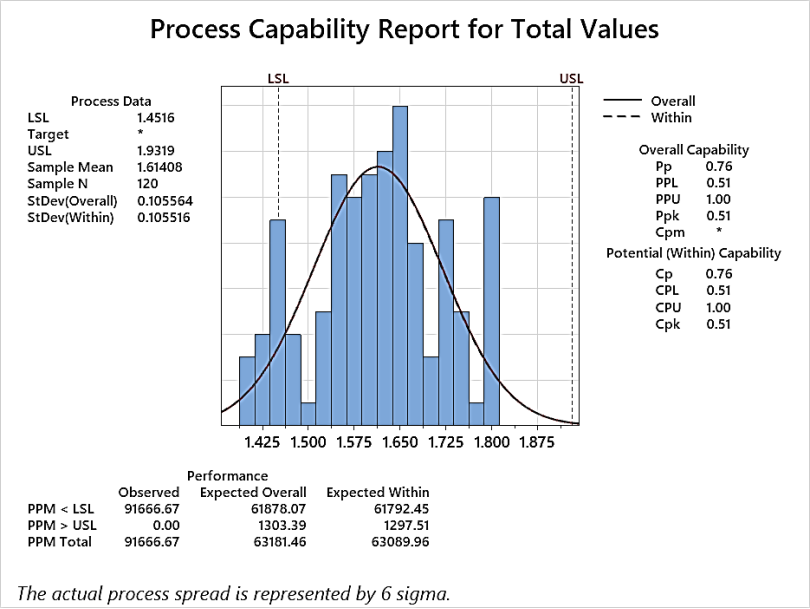
The above figures show the capability analysis for the drop time of a process, which involves assessing whether the process can meet the specified requirements.

Based on the results of the analysis, the report confirms that the process is performing well within the given specification limits, and it is stable. This means that the process is producing consistent and predictable results over time.

The report also mentions the use of X-bar and R control charts, which are statistical tools used for monitoring and controlling variation in a process. The fact that the process-control results show that the process is within control limits is an additional indication that the process is stable and predictable.

Furthermore, the report indicates that a normality test was conducted using the Anderson Darling test. This test assesses whether the data follows a normal distribution, which is important because many statistical methods assume that the data is normally distributed. In this case, the p-value obtained from the test was greater than 0.05(0.071), which means that there is insufficient evidence to reject the null hypothesis that the data follows the specified normal distribution. Therefore, it can be concluded that the data is likely to be normally distributed.

Overall, the report provides evidence that the process can meet the specified requirements, is stable and predictable, and that the data collected for the drop time follows a normal distribution. These findings are important for ensuring the quality and consistency of the process output.



The process performance report, which contains information about the characteristics of a process. In this case, the report includes 120 readings of a process, with a subgroup size of 3. Therefore, there are 40 subgroups in total.

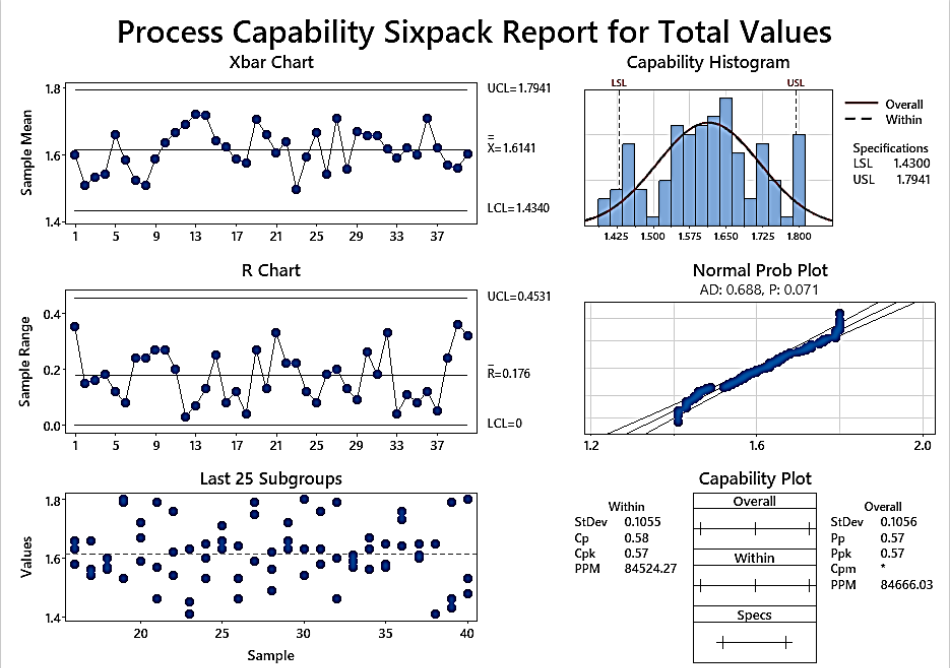
The report states that the mean drop time of the process is 1.61408 seconds, with an overall standard deviation of 0.105564 seconds. This means that the average drop time of the process is 1.61408 seconds, and the readings vary from this mean by an average of 0.105564 seconds.

The standard deviation within subgroups is 0.105516 seconds. This is a measure of how much the readings within each subgroup vary from the subgroup mean. Smaller values of within-subgroup

standard deviations indicate lesser variation within the subgroups, suggesting that the process is more consistent.

To assess the capability of the process, the statement mentions the Overall Process Potential (Pp) statistic. Pp is a measure of the process's ability to produce parts within specification limits, based on the overall spread of the readings. In this case, the Overall Process Potential is calculated to be 0.76, which indicates that the process has some room for improvement to meet specification limits.

However, the process is in control, which means that it is operating within a stable range of variation. Therefore, the focus shifts to the Potential within subgroups, rather than the Overall Process Potential. This allows for a more targeted assessment of the process's capability and potential improvements that can be made.



The actual process spread is represented by 6 sigma.

The report is about the process Capability Sixpack, which gives a summary of the process and checks for the assumptions of data being Normal and the process being in control. The X-bar and R chart is used for process control and the Normal Probability plot is used for Normality check. The report states that the process mean is centered between 1-2 seconds specification limits. The capability Histogram shows that the process spread is large and shifted towards the upper specification limit. Some data lies outside the specification limit. The report suggests checking the Potential Capability within the subgroups to find out the cause.

The upper and lower specification limits used were 1 second and 2 seconds, respectively, since the tolerance is 1.5 +/- 0.5 seconds. The process capability ratio value (Cp) is found to be 0.58, which indicates that the process spread is greater than the specification. The ratio of Cpk, is 0.57, as Cp value does not account for centering, i.e., where the mean is located. The large variation in the process is due to the manual dropping and recording of the flight time, which could cause some data to be calculated beyond the specification limit. The process is off center since Cpk is slightly lesser than Cp value. A Cpk number less than Cp indicates that the process is not consistently meeting the requirements of the customer, which may result in higher expenses, dissatisfied clients, and lower revenue. We must alter the process mean in order to make it such that it is centered between the specification boundaries in order to address a Cpk value that is less than Cp. This may entail altering the process parameters, improving the process inputs, or modifying the process controls.

The expected number of Parts per million that are outside the specification limits within the subgroups (Ppm =84524.27 parts per million), which implies that there are 8.24524% non-conforming parts and 91.5476% conforming parts in the process. The report concludes that the process has acceptable repeatability and reproducibility but has poor capability, and some work needs to be done to improve this process. The report suggests redesigning the process with better methods for dropping and recording the manual flight time, working on a single strategy for both operators to measure the time.