

Statistical Tools for Process Improvement

A

ANOVA (Analysis of Variance)

An important statistical tool used in process improvement to compare means of three or more groups to determine if there are statistically significant differences between them. ANOVA helps identify the sources of variation within a process and is commonly used to assess the impact of different factors on process performance.

Attribute Data

Data that can be categorized into distinct groups or categories. Attribute data is qualitative in nature and is often measured in terms of counts or proportions, such as the number of defects in a product or the percentage of on-time deliveries.

Availability

A key performance indicator that measures the percentage of time a process, machine, or system is available to perform its intended function. Availability is calculated as the ratio of actual operating time to total planned production time.

B

Baseline

A reference point or starting measurement that is used to compare the effectiveness of process improvement efforts. Establishing a baseline helps organizations track progress, measure success, and identify areas for further improvement.

Box Plot

A graphical representation of data that displays the distribution, central tendency, and variability of a dataset. Box plots are useful for identifying outliers, comparing multiple datasets, and gaining insights into the shape of the data distribution.

C

Capability Analysis

A statistical method used to assess the ability of a process to meet customer specifications. Capability analysis involves calculating process capability indices such as Cp, Cpk, Pp, and Ppk to determine if a process is capable of producing products within the desired quality limits.

Cause-and-Effect Diagram

Also known as a Fishbone diagram or Ishikawa diagram, a cause-and-effect diagram is a visual tool used to identify and organize potential causes of a problem or quality issue. The diagram helps teams brainstorm

possible root causes and understand the relationships between different factors affecting a process.

Control Chart

A graphical tool used to monitor process performance over time and detect variation in a process. Control charts display data points plotted against control limits to determine if a process is in a state of statistical control or if special causes of variation are present.

D

Data Collection Plan

A structured approach to collecting data for process improvement projects. A data collection plan outlines the type of data to be collected, the methods of data collection, the frequency of data collection, and the responsibilities of team members involved in collecting and recording data.

Defect

Any deviation from the customer's requirements or specifications in a product or process. Defects can result in poor quality, rework, scrap, and customer dissatisfaction. Identifying and eliminating defects is a key focus of process improvement initiatives.

Design of Experiments (DOE)

A systematic method for investigating and optimizing process parameters to achieve desired outcomes. DOE involves planning, conducting, and analyzing controlled experiments to identify the most influential factors affecting a process and optimize process performance.

E

Efficiency

A measure of how well resources are utilized in a process to produce outputs. Efficiency is calculated as the ratio of actual output to standard output or the ratio of actual cycle time to theoretical cycle time. Improving efficiency can lead to cost savings and increased productivity.

Error Proofing

Also known as Poka-Yoke, error proofing is a technique used to prevent errors or defects from occurring in a process. Error-proofing devices or methods are designed to make it impossible for mistakes to happen or to quickly detect and correct errors before they result in defects.

F

Failure Mode and Effects Analysis (FMEA)

A systematic method for identifying and prioritizing potential failure modes in a process, product, or system. FMEA helps teams anticipate and prevent failures by analyzing the effects of failures, their causes, and the likelihood of occurrence. It is used to proactively improve processes and reduce risks.

Five Whys

A problem-solving technique that involves repeatedly asking "why" to uncover the root cause of a problem. By asking "why" five times or more, teams can delve deeper into the underlying causes of issues and

identify effective solutions to address them.

G

Gage R&R (Gage Repeatability and Reproducibility)

A method for evaluating the measurement system variation in a process. Gage R&R assesses the repeatability (consistency) and reproducibility (reliability) of measurement systems to ensure that measurement errors are minimized and reliable data is obtained for process improvement analysis.

H

Histogram

A graphical representation of the distribution of data points in a dataset. Histograms display the frequency or count of data values within predefined intervals or bins, allowing teams to visualize patterns, trends, and outliers in the data.

Hypothesis Testing

A statistical method used to evaluate the validity of a claim or hypothesis about a process. Hypothesis testing involves formulating null and alternative hypotheses, collecting data, conducting statistical tests, and making decisions based on the evidence to determine if there is enough support to reject or accept the null hypothesis.

I

Improvement Project

A structured initiative aimed at enhancing process performance, reducing waste, increasing efficiency, and delivering value to customers. Improvement projects typically follow a defined methodology such as DMAIC (Define, Measure, Analyze, Improve, Control) or DMADV (Define, Measure, Analyze, Design, Verify) to achieve measurable and sustainable results.

Interrelationship Digraph

A visual tool used to analyze the relationships between different factors, causes, or elements influencing a process or problem. Interrelationship digraphs help teams identify key drivers, dependencies, and interactions among variables to prioritize improvement efforts and make informed decisions.

J

Just-In-Time (JIT)

A lean manufacturing concept that emphasizes producing and delivering products or services at the right time, in the right quantity, and with the right quality. JIT aims to minimize inventory, reduce lead times, and eliminate waste by synchronizing production processes with customer demand.

K

Kaizen

A Japanese term that means continuous improvement or change for the better. Kaizen involves making

small, incremental improvements to processes, products, or systems on a regular basis to achieve higher levels of quality, efficiency, and customer satisfaction. Kaizen is a core principle of lean thinking.

Kanban

A visual signaling system used to manage and control workflow in production or service environments. Kanban boards or cards help teams visualize work, limit work in progress, and optimize the flow of tasks through the system. Kanban is a key tool in lean and agile methodologies.

L

Lead Time

The total time required to complete a process from start to finish, including processing time, waiting time, and transportation time. Lead time is a critical metric for evaluating process efficiency, identifying bottlenecks, and improving customer responsiveness. Reducing lead time can lead to faster delivery and increased customer satisfaction.

Lean Six Sigma

An integrated methodology that combines the principles of Lean and Six Sigma to achieve operational excellence and continuous improvement. Lean focuses on eliminating waste and optimizing processes, while Six Sigma aims to reduce variation and improve quality. Lean Six Sigma helps organizations achieve higher performance levels and deliver value to customers.

M

Measurement System Analysis (MSA)

A systematic method for evaluating the reliability, accuracy, and precision of measurement systems used in process monitoring and control. MSA assesses the measurement error, bias, linearity, repeatability, and reproducibility to ensure that data collected for analysis is valid and reliable.

Mean

Also known as the average, the mean is a measure of central tendency that represents the arithmetic average of a dataset. The mean is calculated by summing all data values and dividing by the number of observations. It is commonly used to describe the typical value in a dataset.

N

Normal Distribution

A bell-shaped probability distribution that is symmetric around the mean and characterized by a specific mean and standard deviation. The normal distribution is commonly used in statistical analysis to model continuous data and make inferences about population parameters. Many statistical tools and tests assume that data follow a normal distribution.

O

Overall Equipment Effectiveness (OEE)

A key performance metric that measures the efficiency and effectiveness of equipment or machines in a

production environment. OEE takes into account factors such as availability, performance, and quality to calculate the overall equipment efficiency and identify opportunities for improvement.

P

Process Capability

The ability of a process to consistently produce outputs that meet customer specifications or requirements. Process capability is determined by comparing the natural variation of a process to the specification limits and calculating process capability indices such as Cp, Cpk, Pp, and Ppk. Improving process capability leads to higher quality and customer satisfaction.

Process Mapping

A visual representation of the steps, activities, inputs, outputs, and interactions involved in a process. Process maps help teams understand the flow of work, identify inefficiencies, and optimize processes for better performance. Different types of process maps include SIPOC (Suppliers, Inputs, Process, Outputs, Customers) diagrams, value stream maps, and swimlane diagrams.

Q

Quality Function Deployment (QFD)

A systematic method for translating customer needs and requirements into specific design and process characteristics. QFD captures the voice of the customer, prioritizes customer requirements, and aligns product or service features with customer expectations. QFD helps organizations deliver products and services that meet or exceed customer satisfaction.

R

Root Cause Analysis

A problem-solving technique that focuses on identifying the underlying causes of issues or problems in a process. Root cause analysis helps teams dig deeper into the factors contributing to failures, defects, or deviations from standards. By addressing root causes, organizations can implement effective corrective and preventive actions to improve process performance.

S

Scatter Diagram

A graphical tool used to visualize the relationship between two variables in a dataset. Scatter diagrams plot data points on a graph with one variable on the x-axis and another variable on the y-axis to identify patterns, trends, correlations, or outliers. Scatter diagrams help teams understand the strength and direction of relationships between variables.

SIPOC (Suppliers, Inputs, Process, Outputs, Customers)

A high-level process mapping tool that identifies the suppliers, inputs, process steps, outputs, and customers involved in a process. SIPOC diagrams provide a structured overview of the process flow, key stakeholders, and boundaries to help teams define project scope, understand dependencies, and prioritize

improvement opportunities.

T

Time Series Analysis

A statistical method used to analyze and forecast patterns, trends, and variations in time-ordered data. Time series analysis involves examining historical data, identifying seasonality, trends, and cycles, and making predictions about future values. Time series analysis helps organizations understand and manage time-dependent processes.

U

U-Chart

A control chart used to monitor the number of defects or nonconformities per unit of output. U-charts are designed for attribute data that can be counted as discrete events or occurrences. By tracking defect counts over time, U-charts help teams identify trends, variations, and out-of-control conditions in a process.

V

Variance

A measure of the dispersion or spread of data points around the mean in a dataset. Variance quantifies the variability or inconsistency of data values and is calculated as the average of the squared differences between each data point and the mean. Variance is used in statistical analysis to assess the stability and predictability of processes.

Value Stream Mapping

A lean management tool used to visualize, analyze, and improve the flow of materials and information in a process. Value stream maps show the current state and future state of a process, identify value-added and non-value-added activities, and highlight opportunities for streamlining operations, reducing waste, and enhancing customer value.

W

Work In Progress (WIP)

The inventory or unfinished work that is in process or under production at any given time. WIP includes materials, components, or products that are being processed or moved between workstations in a production system. Managing WIP levels is essential for optimizing flow, reducing lead times, and improving process efficiency.

X

X-Bar Chart

A control chart used to monitor the central tendency or average of a process over time. X-bar charts display the mean of subgroup data points and are used to detect shifts, trends, or patterns in process performance. By analyzing X-bar charts, teams can identify common causes of variation and take corrective actions to maintain process stability.

Y

Yield

The percentage of defect-free or conforming units produced by a process relative to the total number of units attempted. Yield is a key quality metric that measures the effectiveness of a process in meeting customer requirements. Improving yield rates leads to higher productivity, lower costs, and increased customer satisfaction.

This glossary provides a comprehensive overview of key terms, concepts, and tools related to Statistical Tools for Process Improvement in the Postgraduate Certificate in Aerospace Lean Six Sigma program. By understanding and applying these concepts, students can effectively analyze data, identify opportunities for improvement, and drive continuous enhancement in aerospace manufacturing and service processes.