

Pareto Analysis

Vital few from the trivial many

Poka-yoke

Japanese term for foolproof

SIPOC

Suppliers, Inputs, Process, Outputs, Customers

Kaizen

Metric - average count of defect parts

Kanban

a ticket-based JIT system that indicates when to reorder inventory

Walter Shewhart

Developed the foundations of statistical quality control (control charts)

Deming Cycle (PDCA)

An approach of continuous improvement.

PDCA cycle

Plan, Do, Check, Act

TAKT time

the cycle time needed to match customer demand for final product

Takt Time Formula

total work time available/units required

Six Sigma Focus

Customer Need

Yellow Belt

Project Specific and devote all their time to provide process & cross functional knowledge

TQM 3 principles

Company, Competition, Customer

Value Stream Mapping

Enables all stakeholders of an organization from the ground up to easily understand the process

Current State Map

can be checked by asking shop floor personnel how product flows

DPMO (defects per million opportunities)

of Observed Defects/

of Opportunities for Defect

X 1,000,000

DPMO (defects per million opportunities)

A metric used to describe the variability of a process.

Gage R&R

also known as measurement system analysis; sources of variability come from repeatability and reproducibility

ANOVA

Compares mean values of a contributes variable for multiple categories/groups

FMEA

Failure Mode and Effects Analysis: process used to identify potential failures before they result with the intent to minimize or eliminate them

SWOT analysis

strengths, weaknesses, opportunities, threats

Gembutsu

the real process / product

Gembutsu

uncomfortable with physical or tangible things like scrap

Joseph Juran

Connected to the Pareto Principle

Believed that the results should fit for use by the customer

Believed in getting top management involved

CTQ (Critical to Quality) Tree

translates broad customer requirements into specific CTQ requirements

COPQ (Cost of Poor Quality)

Costs associated with providing poor quality product or services. These are categorized into 4 categories: Internal Failure Costs, External Failure Costs, Appraisal Costs, Prevention Costs

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

a six sigma process that outlines the steps that should be followed to improve an existing business process

DMAIC Cycle

Define - identify customers and their priorities

Measure - determine how to measure the process and how it is performing

Analyze - determine the most likely causes of defects

Improve - identify means to remove the causes of defects

Control - determine how to maintain the improvements

Bias

The difference between the output of the measurement system and the true value. It is often referred to as accuracy.

RPN

Calculated by multiplying the severity into occurrence into detection.

YX Diagram

A six sigma tool which is mostly used in the DMAIC measure phase. Shows the relationship between Y and X factors.

DPMO of 233 Value

Six sigma level 5

Deming 14 points

Emphasis inspection at the end of the production cycle.

VOC - Voice of the Customer

Direct or Indirect interview method can be used to collect information

JIT (just in time)

Makes use of Kanban

FMEA (Failure Mode and Effects Analysis)

Applies a Bottom up analysis approach

Master Black Belt Six Sigma

Expert Statisticians

Dispersion

The variability around the central tendency.

VSM (Value Stream Mapping)

Customer and Supplier icons are the same

Kaizen

Continuous improvement

Zero Defects

The aim of achieving perfect products every time (continuous improvement)

Gemba Walk

Results in the identification of place of value addition

Direct or Indirect Interview

Method to collect information for the Voice of Customer (VOC)

Data Collector

Must know how the data will be used during data collection.

Six Sigma Black Belt

may operate independently to manage multiple six sigma projects, devote 100% of their time to six sigma initiatives

VSM

Grouping similar products under VSM happens by having a commonality of 70% or more.

Tangible Effects

Can be measured by the following performance metric & cycle time

Safety Inventory

Inventory type used to address internal problems in a value stream

Flow Chart

The tool ordinarily used to aid in understanding the sequence of events through which a product travels.

Kanban System

a production control approach that uses containers, cards, or visual cues to control the production and movement of goods through the supply chain

Timekeeper & Scribe

Responsible for monitoring and time keeping of six sigma meetings.

Type 1 error

Rejecting null hypothesis when it is true

Control Chart Types

Interpretation

Gage R&R (Repeatability And Reproducibility)

A measurement systems analysis technique that uses an analysis of variances (ANOVA) random effects model to assess a measurement system.

FMEA (Failure Mode and Effects Analysis)

Assists in reviewing as many components, assemblies and sub-systems as possible to identify failure modes and their causes and effects.

Mean

The total of all data values divided by the number of data points. The arithmetic means is the most widely used measure of central tendency.

Balanced Scorecard (BSC)

A strategy performance management tool which involves automation tools & design methods & is useful to keep track of the executive of activities.

Balanced Scorecard Approach

A top-down management system that organizations can use to clarify their vision and strategy and transform them into action

Run Chart

A chart that displays the history and pattern of variation of a process over time

Run Charts (Time series plots)

Are understood by clusters, mixtures, oscillations and trends.

Cause and Effect Diagram (Fishbone)

Diagram that maps out a list of factors that are thought to affect a problem or a desired outcome.

Normal Distribution (bell curve)

A probability distribution that plots all its values in a symmetrical fashion and most of the results are situated around that mean.

Standard Deviation (SD)

A measure of the variability of a data set, calculated as the square root of the variance (V).

Process Mapping

A graphical display of steps, events and operations that constitute a process. It is an ongoing living document used throughout the DMAIC process.

Accuracy

An unbiased true value and is normally reported as the difference between the average of several measurements and the true value. Checking a micrometer with a gauge block is an example of an accuracy check.

Six Sigma quality control

Consists of a disciplined, statistics-based system aimed at producing not more than 3.4 defects per million iterations for any business process.

X -R control chart

Is used to determine whether a process is in control or out

Program Evaluation Review Technique (PERT)

statistical tool, used in project management, which was designed to analyze and represent the tasks involved in completing a given project

Gantt Chart

Tie scaled activity chart

Activity Network Diagram (AND)

graphically displays interdependent relationships between groups, steps, and tasks as they all impact a project. Bubbles, boxes, and arrows are used to depict these activities and the links between them. This is also known as a flow chart, project network, or process map

Affinity Diagram

- Organize ideas under a problem statement
- used throughout DMAIC process
- organizes data
- group effort

- stimulates creativity

Matrix Diagram

- shows a relationship between items
- T shape/Y shape/C shape
- used for assigning project tasks, combine tree diagrams, look at cause and effect
- used during define and improve stage of DMAIC

Relations Chart

- causal relationship between factors
- explore root cause of problem
- discover influencing factors

Tollgate review

- checkpoint process to meet objectives
- validate that you are on track
- evaluate milestone, goals, metrics

measuring central tendency: descriptive data

- #'s used to summarize data
- inductive
- aim to summarize a sample, rather than use the data to learn about the population that the sample of data is thought to represent

measuring central tendency: inferential data

- deductive
- infer from the sample data what the population might think. Or, we use inferential statistics to make judgments of the probability that an observed difference between groups is a dependable one or one that might have happened by chance in this study.
- hypothesis testing

central tendency

most common measure is the mean

mean

average number in a data set

median

-# in the middle of a data set

- determines midpoint of data, can skew data

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See More

mode

most common or repeated number in a data set

Dispersion

How far data strays from central point

68-95-99.7 rule

-empirical rule

- represents normal distribution

variance

measure of variation, goal is to reduce this to create a tighter bell curve

confidence intervals

a variety of uncertainty, the probability that the population mean falls within a certain value range

data types: continuous

- scaled
- can be broken into smaller units
- time/height/weight/temp/cost

data types: discrete

- can not be broken down
- attributes
- color/size (s/m/l)/gender/pass or fail/ yes or no

Hierarchy of scale: Nominal data

no ordering/discrete data

- value assigned by name
- attributes can only be named

Hierarchy of scale: Ordinal data

- help order data by numbers to create a rank
- example: age
- attributes can only be ordered

hierarchy of scale: interval data

- understand difference between values
- distance is meaningful
- distance between attributes does have meaning
- scale values

-example: distance from 30-40 is same as distance from 70-80. The interval between values is interpretable.

hierarchy of scale: ratio

- most informative data type
- can have a fixed zero point (absolute zero)
- example: time/mass/length

measurement and measurement systems: accuracy

- correct data
- attribute of measurement tool
- measure true value of a variable
- average of all variables

measurement and measurement systems: precision

- consistent data
- minimal variation
- measured using same variable and same device
- attribute of measurement system

Types of accuracy errors in data measurement

- bias
- linearity errors
- precision errors

Types of precision errors in data measurement

- repeatability
- reproducibility

Data measurement: Bias

- constant bias is horizontal
- (average - reference)

data measurement: total process variation

- measured as a percent
- (bias)/total process variation X 100

data measurement: linearity

- bias over operating range
- $L = b(V_p)$
- $x = \text{slope} * \text{variation of process}$

data measurement: stability

- bias over time, same result for same sample over time

what does instability indicate in data measurement?

device deterioration, drifting calibration in measurement tools

measurement system variation: repeatability

- equipment variation (EV)
- same operator
- same part

- same device

- ^ used multiple times

measurement system variation: reproducibility

- Appraiser variation (AV)

- different operators

- same parts

- same device

- ^used multiple times

GR study (Gauge repeatability)

gauge repeatability to access precision

repeatability formula

$R/d2$

- range average/constant based on sample size

reproducibility formula

$R - x(\bar{x} \text{ on top})/d2$

- range of total averages/ constant based on sample

Linearity definition

accuracy of measuring device across a range of measurements

stability definition

degree in which you can repeat measurements for the same item

a horizontal line on a graph indicates what

no slope = constant bias

Lean Tools 5s

sort

straighten

scrub

standardize

sustain

Lean Tools: value analysis

identify and determine value in order to eliminate waste

Lean tool: 8 Wastes

Transportation

Inventory

Motion

waiting

over processing

overproducing

defects

skills (underutilized)

TOM WOODS

FMEA: failure mode and effects analysis

rank possible failures

emphasis on prevention

measured by Severity, occurrence, detection

RPN: risk priority number

Severity x occurrence x detection

RPN improvement percentage

$(\text{RPN original} - \text{RPN new}) / \text{RPN original} \times 100$

Probability Distribution: continuous data

binomial distribution = 2 possible outcomes or events are independent

Probability distribution: discrete data

normal distribution - single peak

distributed around the mean

Variations in control charts: common cause

fluctuation caused by unknown factors resulting in a steady but random distribution of output around the average of the data

- machine wear and tear

- operator fatigue

variation in control charts: special cause

shift in output caused by a specific factor such as environmental conditions or process input parameters. It can be accounted for directly and potentially removed and is a measure of process control.

- event driven

- machine malfunction

- operator falls asleep

- outside upper and lower limit

- immediate action needed

RACI chart

who does what or is responsible for what?

responsible

approves

consulted

involved

relational matrix diagram

relationship between KPOV and KPIV

-key process output variable

-key process input variable

assign priority ratings

help find what should be a priority

force field analysis

decision making tool used after root cause analysis

-negative and positive forces

-degree of impact

-visualize pros and cons of one possible action to see if there are more pros or cons

Correlation Analysis: Pearson coefficient

expression of a linear relationship between 1 and -1

weakness: can not distinguish between dependent and independent variables

only works for linear relationships

correlation analysis: causation

- is not correlation (but correlation can point to this)

- is not reversible

- directional

correlation analysis: P-value

measures the significance of a relationship

statistical evidence of a relationship

how well data determines a null hypothesis

if x is high null will fly

if x is low null will go

what is regression analysis

forecast change in dependent variables

relationship between predictor variable (x) and response variable (y)

line of best fit

what is the purpose of hypothesis testing

use data to test a claim about population parameters based on samples

Hypothesis testing: descriptive

what is the variable

-size

-form

-distribution

hypothesis testing: relational

relationship between variables

-positive

-negative

-greater than

-less than

Null hypothesis

any observed difference due to chance

randomness

(in a statistical test) the hypothesis that there is no significant difference between specified populations, any observed difference being due to sampling or experimental error.

alternative hypothesis

observed difference is real and not due to chance or random variation

when would you reject a null hypothesis in favor of an alternative hypothesis

when results are statistically significant

when would you fail to reject a null hypothesis

insufficient evidence to claim a null hypothesis as invalid or the alternative hypothesis as true

Error Type 1

Affects alpha factor

consistent in data

produces risk

- incorrect rejection of a true null hypothesis (a "false positive"),

Error type 2

beta factor risk

is a statistical term used within the context of hypothesis testing that describes the error that occurs when one accepts a null hypothesis that is actually false. The error rejects the alternative hypothesis, even though it does not occur due to chance.

Test tail: actual mean is greater than hypothesis mean results in?

one tailed test to the right

Test tail: actual mean is less than hypothesis mean results in?

one tailed test the left

Statistical power tests are affected by

- sample sizes (more difference more power)

-population difference

-variability (less variable less power)

- alpha levels (lower alpha =lower power)

Types of Kaizen: Super Blitz

1 to 8 hour quick project

Types of Kaizen: blitz

3 to 5 days

use lean to reorganize (5S) manufacturing industry

Types of Kaizen: Kaizen project

2-4 weeks

service industry

Cost benefit Analysis

4 types :

tangible

intangible

unquantifiable

quantifiable

Types of hidden costs

interest

bank fee

taxes

waste

missed opportunities

low morale

Variable data (continuous) control chart type: \bar{X} bar R

Consistent data

sample size under 10

-plots the process mean (\bar{X} bar chart) and process range over time for variables data in subgroups. This combination control chart is widely used to examine the stability of processes in many industries.

-A plastics manufacturer wants to determine whether the production process for a new product is in control. Analysts sample 5 units every hour for 20 hours and assess the strength of the plastic.

Variable data (continuous) control chart type: \bar{X} -S

over 10 sample size

-chart plots the process mean (\bar{X} chart) and process standard deviation over time for variables data in subgroups. This combination control chart is widely used to examine the stability of processes in many industries

-A paint manufacturer wants to assess the stability of the process used to fill paint cans. Analysts collect subgroups of 10 cans every hour and use an \bar{X} -S chart to monitor the mean and variation of the filled paint cans.

Variable data (continuous) control chart type: I-MR

Sample size of 1

-plots individual observations (I chart) and moving ranges (MR chart) over time for variables data. Use this combination chart to monitor process center and variation when it is difficult or impossible to group measurements into subgroups. This occurs when measurements are expensive, production volume is low, or products have a long cycle time.

-A hospital administrator wants to determine whether the time to perform outpatient hernia surgery is stable. Because the data are not collected in subgroups, he uses an I-MR chart to monitor the mean and variation of the surgery times.

Attribute (discrete) data chart type: C chart

defects subgroup

constant sample size

-control chart used to monitor "count"-type data, typically total number of nonconformities per unit. It is also occasionally used to monitor the total number of events occurring in each unit of time.

Attribute (discrete) data chart type: U chart

average # of defects per unit

sample size is not constant

-control chart used to monitor "count"-type data where the sample size is greater than one, typically the average number of nonconformities per unit.

Attribute (discrete) data chart type: NP chart

Defective nonconforming units

constant sample size

-type of control chart used to monitor the number of nonconforming units in a sample.

Attribute (discrete) data chart type: P chart

proportion of satisfied customers

plots proportion of ratio defective units

subgroups not equal

50 or more

-type of control chart used to monitor the proportion of nonconforming units in a sample, where the sample proportion nonconforming is defined as the ratio of the number of nonconforming units to the sample size, n .

Control Chart Trends: process shift

shift above or below the center line

Control Chart Trends: freaks

outlier data point by itself

Control Chart Trends: process drift

steady increase or decrease

Control Chart Trends: stratification

constantly below or above center line

Control Chart Trends: recurring cycles

visible recurring patterns

Types of control documents: policy manual

overall quality system

-flowcharts/personal responsibility for system/reporting instructions/system accessibility

Types of control documents: procedures

description of process/ people who do it/locations

-what?who?when?where

-SOPS

Types of control documents: work instruction

how to do work

-drawings

Types of control documents: records

evidence

documentation of performance over time

Team Norms

This term describes the principles of conduct on how a team should function

DMAIC

This acronym identifies the 5 steps of problem solving

Total Employee Engagement

This one of the three important principles of continuous improvement; some would say the most important principle

Strategic, Improvement, Daily

These are the three "types of work" carried out in organizations/businesses

Plan, Do, Check, Act

These are the 4 steps identified in the Deming Wheel

Poor Quality, Bureaucracy, Wasted Time

These are 3 types of non-value added work

SIPOC Diagram

This is a tool to help identify an improvement project's customer(s)

Coach

It is the role of this person to help the champion prepare for reviews

Champion

It is this person's role to control the budget

PAL

When running a meeting you should have these three things: purpose, agenda, time limit

Run Chart

this a tool for tracking results over a period

Benchmarking

This is one way to set goals

Pareto Chart

This tool separates the vital few from the trivial many (80/20 rule)

Fishbone diagram

This is a tool used to identify the root cause of problems

flow charts

identify key steps of a process and who is responsible at each step; it also identifies key 'hand offs' and decision points in the process. This chart allows for a value stream analysis

affinity diagram

This technique allows large numbers of ideas to be sorted into groups for review and analysis.

operational definition

a statement of the procedures used to define research variables; this makes a definition as clear as possible

discrete data

Data that can only take certain values (examples: Yes/no; male/female).

continuous data

Data that can take any value (examples: pounds, height)

The question, "Why?"

You should ask this question several times in a root cause analysis

Affinity Diagram

A technique for organizing individual pieces of information into groups or broader categories.

ANOVA

Analysis of Variance - A statistical test for identifying significant differences between process or system treatments or conditions. It is done by comparing the variances around the means of the conditions being compared.

Attribute Data

Data which on one of a set of discrete values such as pass or fail, yes or no.

Average

Also called the mean, it is the arithmetic average of all the sample values. It is calculated by adding all the sample values together and dividing by the number of elements (n) in the sample.

Bar Chart

A graphical method which depicts how data fall into different categories.

Black Belt

An individual who receives approximately four weeks training in DMAIC, analytical problem solving, and change management methods. A Black Belt is a full time six sigma team leader solving problems under the direction of a Champion.

Breakthrough Improvement

A rate of improvement at or near 70% over baseline performance of the as-is process characteristic.

Capability

A comparison of the required operation width of a process or system to its actual performance width. Expressed as a percentage (yield), a defect rate (dpm, dpmo,), an index (Cp, Cpk, Pp, Ppk), or as a sigma score (Z).

Cause and Effect Diagram

aka Fishbone Diagram - A pictorial diagram in the shape of a fishbone showing all possible variables that could affect a given process output measure.

Central Tendency

A measure of the point about which a group of values is clustered; two measures of central tendency are the mean, and the median.

Champion

A Champion recognizes, defines, assigns and supports the successful completion of six sigma projects; they are accountable for the results of the project and the business roadmap to achieve six sigma within their span of control.

Characteristic

A process input or output which can be measured and monitored.

Common Causes of Variation

Those sources of variability in a process which are truly random, i.e., inherent in the process itself.

Complexity

The level of difficulty to build, solve or understand something based on the number of inputs, interactions and uncertainty involved.

Control Chart

The most powerful tool of statistical process control. It consists of a run chart, together with statistically determined upper and lower control limits and a centerline.

Control Limits

Upper and lower bounds in a control chart that are determined by the process itself. They can be used to detect special or common causes of variation. They are usually set at ± 3 standard deviations from the central tendency.

Correlation Coefficient

A measure of the linear relationship between two variables.

Cost of Poor Quality (COPQ)

The costs associated with any activity that is not doing the right thing right the first time. It is the financial qualification any waste that is not integral to the product or service which your company provides.

CP

A capability measure defined as the ratio of the specification width to short-term process performance width.

Cpk

An adjusted short-term capability index that reduces the capability score in proportion to the offset of the process center from the specification target.

Critical to Quality (CTQ)

Any characteristic that is critical to the perceived quality of the product, process or system. See Significant Y.

Critical X

An input to a process or system that exerts a significant influence on any one or all the key outputs of a process.

Customer

Anyone who uses or consumes a product or service, whether internal or external to the providing organization or provider.

Cycle Time

The total amount of elapsed time expended from the time a task, product or service is started until it is completed.

Defect

initiative within a company.

An output of a process that does not meet a defined specification, requirement or desire such as time, length, color, finish, quantity, temperature etc.

Defective

A unit of product or service that contains at least one defect.

Deployment (Six Sigma)

The planning, launch, training and implementation management of a six sigma initiative within a company.

Design of Experiments (DOE)

Generally, it is the discipline of using an efficient, structured, and proven approach to interrogating a process or system for the purpose of maximizing the gain in process or system knowledge.

Design for Six Sigma (DFSS)

The use of six sigma thinking, tools and methods applied to the design of products and services to improve the initial release performance, ongoing reliability, and life-cycle cost.

DMAIC

The acronym for core phases of the six sigma methodology used to solve process and business problems through data and analytical methods. See define, measure, analyze, improve and control.

DPMO

Defects per million opportunities - The total number of defects observed divided by the total number of opportunities, expressed in parts per million. Sometimes called Defects per Million (DPM).

DPU

The total number of defects detected in some number of units divided by the total number of those units.

Entitlement

The best demonstrated performance for an existing configuration of a process or system. It is an empirical demonstration of what level of improvement can potentially be reached.

Epsilon

ϵ - Greek symbol used to represent residual error.

Experimental Design

See Design of Experiments.

Failure Mode and Effects Analysis (FMEA)

A procedure used to identify, assess, and mitigate risks associated with potential product, system, or process failure modes.

Finance Representative

An individual who provides an independent evaluation of a six sigma project in terms of hard and/or soft savings. They are a project support resource to both Champions and Project Leaders.

Fishbone Diagram

See cause and effect diagram.

Flowchart

A graphic model of the flow of activities, material, and/or information that occurs during a process.

Gage R&R

Quantitative assessment of how much variation (repeatability and reproducibility) is in a measurement system compared to the total variation of the process or system.

Green Belt

An individual who receives approximately two weeks of training in DMAIC, analytical problem solving, and change management methods. A Green Belt is a part time six sigma position that applies six sigma to their local area, doing smaller-scoped projects and providing support to Black Belt projects.

Hidden Factory or Operation

Corrective and non-value-added work required to produce a unit of output that is generally not recognized as an unnecessary generator of waste in form of resources, materials and cost.

Histogram

A bar chart that depicts the frequencies (by the height of the plotted bars) of numerical or measurement categories.

Implementation Team

A cross-functional executive team representing various areas of the company . Its charter is to drive the implementation of six sigma by defining and documenting practices, methods and operating policies.

Input

A resource consumed, utilized, or added to a process or system. Synonymous with X, characteristic, and input variable.

Input-Process-Output (IPO) Diagram

A visual representation of a process or system where inputs are represented by input arrows to a box (representing the process or system) and outputs are shown using arrows emanating out of the box.

Ishikawa Diagram

See cause and effect diagram and fishbone diagram.

Least Squares

A method of curve-fitting that defines the best fit as the one that minimizes the sum of the squared deviations of the data points from the fitted curve.

Long-term Variation

The observed variation of an input or output characteristic which has had the opportunity to experience most of the variation effects that influence it.

Lower Control Limit (LCL)

For control charts: the limit above which the subgroup statistics must remain for the process to be in control. Typically, 3 standard deviations below the central tendency.

Lower Specification Limit (LSL)

The lowest value of a characteristic which is acceptable.

Master Black Belt

An individual who has received training beyond a Black Belt. The technical, go-to expert regarding technical and project issues in six sigma. Master Black Belts teach and mentor other six sigma Belts, their projects and support Champions.

Mean

See average.

Measurement

The act of obtaining knowledge about an event or characteristic through measured quantification or assignment to categories.

Measurement Accuracy

For a repeated measurement, it is a comparison of the average of the measurements compare to some known standard.

Measurement Precision

For a repeated measurement, it is the amount of variation that exists in the measured values.

Measurement Systems Analysis (MSA)

An assessment of the accuracy and precision of a method of obtaining measurements. See also Gage R&R.

Median

Median - The middle value of a data set when the values are arranged in either ascending or descending order.

Metric

A measure that is considered objectives and carefully monitored.

Natural Tolerances of a Process

See Control Limits.

Nominal Group Technique

A structured method that a team can use to generate and rank a list of ideas or items.

Non-Value Added (NVA)

Any activity performed in producing a product or delivering a service that does not add value, where value is defined as changing the form, fit or function of the product or service and is something for which the customer is willing to pay.

Normal Distribution

The distribution characterized by the smooth, bell- shaped curve. Synonymous with Gaussian Distribution.

Objective Statement

A succinct statement of the goals, timing and expectations of a six sigma improvement project.

Opportunities

The number of characteristics, parameters or features of a product or service that can be classified as acceptable or unacceptable.

Out of Control

A process is said to be out of control if it exhibits variations larger than its control limits or shows a pattern of variation.

Output

A resource or item or characteristic that is the product of a process or system. See also Y, CTQ.

Pareto Chart

A bar chart for attribute (or categorical) data categories are presented in descending order of frequency.

Pareto Principle

The general principle originally proposed by Vilfredo Pareto (1848-1923) that most of the influence on an outcome is exerted by a minority of input factors.

Poka-Yoke

A translation of a Japanese term meaning to mistake-proof.

Probability

The likelihood of an event or circumstance occurring.

Problem Statement

A succinct statement of a business situation which is used to bound and describe the problem the six sigma project is attempting to solve.

Process

A set of activities and material and/or information flow which transforms a set of inputs into outputs for the purpose of producing a product, providing a service or performing a task.

Process Characterization

The act of thoroughly understanding a process, including the specific relationship(s) between its outputs and the inputs, and its performance and capability.

Process Certification

Establishing documented evidence that a process will consistently produce required outcome or meet required specifications.

Process Flow Diagram

See flowchart.

Process Member

An individual who performs activities within a process to deliver a process output, a product or a service to a customer.

Process Owner

Individuals that have responsibility for process performance and resources. They provide support, resources and functional expertise to six sigma projects. They are accountable for implementing developed six sigma solutions into their process.

Quality Function Deployment (QFD)

A systematic process used to integrate customer requirements into every aspect of the design and delivery of products and services.

Range

A measure of the variability in a data set. It is the difference between the largest and smallest values in a data set.

Regression Analysis

A statistical technique for determining the mathematical relation between a measured quantity and the variables it depends on. Includes Simple and Multiple Linear Regression.

Repeatability (of a Measurement)

The extent to which repeated measurements of a object with a particular instrument produce the same value. See also Gage R&R.

Reproducibility (of a Measurement)

The extent to which repeated measurements of a object with a particular individual produce the same value. See also Gage R&R.

Rework

Activity required to correct defects produced by a process.

Risk Priority Number (RPN)

In Failure Mode Effects Analysis -- the aggregate score of a failure mode including its severity, frequency of occurrence, and ability to be detected.

Rolled Throughput Yield (RTY)

The probability of a unit going through all process steps or system characteristics with zero defects.

R.U.M.B.A

An acronym used to describe a method to determine the validity of customer requirements. It stands for Reasonable, Understandable, Measurable, Believable, and Achievable.

Run Chart

A basic graphical tool that charts a characteristic's performance over time.

Scatter Plot

A chart in which one variable is plotted against another to determine the relationship, if any, between the two.

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Significant Y

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Data which is continuous, which can be meaningfully subdivided, i.e. can have decimal subdivisions.

Variance

A specifically defined mathematical measure of variability in a data set or population. It is the square of the standard deviation.

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See variability.

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See Sigma Score.

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Nested Designs

Each part is measured by only one operator. This is since after destructive testing, the measured characteristic is different after the measurement process than it was at the beginning.

Precision

The variability in the measured value; is quantified like all variation by using the standard deviation of the distribution of measurements.

Linearity

The difference in Bias values throughout the measurement range in which the gauge is intended to be used.

Affinity Diagram

A technique for organizing individual pieces of information into groups or broader categories.

ANOVA

Analysis of Variance - A statistical test for identifying significant differences between process or system treatments or conditions. It is done by comparing the variances around the means of the conditions being compared.

Attribute Data

Data which on one of a set of discrete values such as pass or fail, yes or no.

Average

Also called the mean, it is the arithmetic average of all the sample values. It is calculated by adding all the sample values together and dividing by the number of elements (n) in the sample.

Bar Chart

A graphical method which depicts how data fall into different categories.

Black Belt

An individual who receives approximately four weeks training in DMAIC, analytical problem solving, and change management methods. A Black Belt is a full time six sigma team leader solving problems under the direction of a Champion.

Breakthrough Improvement

A rate of improvement at or near 70% over baseline performance of the as-is process characteristic.

Capability

A comparison of the required operation width of a process or system to its actual performance width. Expressed as a percentage (yield), a defect rate (dpm, dpmo), an index (Cp, Cpk, Pp, Pak), or as a sigma score (Z).

Cause and Effect Diagram

aka Fishbone Diagram - A pictorial diagram in the shape of a fishbone showing all possible variables that could affect a given process output measure.

Central Tendency

A measure of the point about which a group of values is clustered; two measures of central tendency are the mean, and the median.

Champion

A Champion recognizes, defines, assigns and supports the successful completion of six sigma projects; they are accountable for the results of the project and the business roadmap to achieve six sigma within their span of control.

Characteristic

A process input or output which can be measured and monitored.

Common Causes of Variation

Those sources of variability in a process which are truly random, i.e., inherent in the process itself.

Complexity

The level of difficulty to build, solve or understand something based on the number of inputs, interactions and uncertainty involved.

Control Chart

The most powerful tool of statistical process control. It consists of a run chart, together with statistically determined upper and lower control limits and a centerline.

Control Limits

Upper and lower bounds in a control chart that are determined by the process itself. They can be used to detect special or common causes of variation. They are usually set at ± 3 standard deviations from the central tendency.

Correlation Coefficient

A measure of the linear relationship between two variables.

Cost of Poor Quality (COPQ)

The costs associated with any activity that is not doing the right thing right the first time. It is the financial qualification any waste that is not integral to the product or service which your company provides.

CP

A capability measure defined as the ratio of the specification width to short-term process performance width.

Cpk

An adjusted short-term capability index that reduces the capability score in proportion to the offset of the process center from the specification target.

Critical to Quality (CTQ)

Any characteristic that is critical to the perceived quality of the product, process or system. See Significant Y.

Critical X

An input to a process or system that exerts a significant influence on any one or all the key outputs of a process.

Customer

Anyone who uses or consumes a product or service, whether internal or external to the providing organization or provider.

Cycle Time

The total amount of elapsed time expended from the time a task, product or service is started until it is completed.

Defect

initiative within a company.

An output of a process that does not meet a defined specification, requirement or desire such as time, length, color, finish, quantity, temperature etc.

Defective

A unit of product or service that contains at least one defect.

Deployment (Six Sigma)

The planning, launch, training and implementation management of a six sigma initiative within a company.

Design of Experiments (DOE)

Generally, it is the discipline of using an efficient, structured, and proven approach to interrogating a process or system for the purpose of maximizing the gain in process or system knowledge.

Design for Six Sigma (DFSS)

The use of six sigma thinking, tools and methods applied to the design of products and services to improve the initial release performance, ongoing reliability, and life-cycle cost.

DMAIC

The acronym for core phases of the six sigma methodology used to solve process and business problems through data and analytical methods. See define, measure, analyze, improve and control.

DPMO

Defects per million opportunities - The total number of defects observed divided by the total number of opportunities, expressed in parts per million. Sometimes called Defects per Million (DPM).

DPU

The total number of defects detected in some number of units divided by the total number of those units.

Entitlement

The best demonstrated performance for an existing configuration of a process or system. It is an empirical demonstration of what level of improvement can potentially be reached.

Epsilon

ϵ - Greek symbol used to represent residual error.

Experimental Design

See Design of Experiments.

Failure Mode and Effects Analysis (FMEA)

A procedure used to identify, assess, and mitigate risks associated with potential product, system, or process failure modes.

Finance Representative

An individual who provides an independent evaluation of a six sigma project in terms of hard and/or soft savings. They are a project support resource to both Champions and Project Leaders.

Fishbone Diagram

See cause and effect diagram.

Flowchart

A graphic model of the flow of activities, material, and/or information that occurs during a process.

Gage R&R

Quantitative assessment of how much variation (repeatability and reproducibility) is in a measurement system compared to the total variation of the process or system.

Green Belt

An individual who receives approximately two weeks of training in DMAIC, analytical problem solving, and change management methods. A Green Belt is a part time six sigma position that applies six sigma to their local area, doing smaller-scoped projects and providing support to Black Belt projects.

Hidden Factory or Operation

Corrective and non-value-added work required to produce a unit of output that is generally not recognized as an unnecessary generator of waste in form of resources, materials and cost.

Histogram

A bar chart that depicts the frequencies (by the height of the plotted bars) of numerical or measurement categories.

Implementation Team

A cross-functional executive team representing various areas of the company . Its charter is to drive the implementation of six sigma by defining and documenting practices, methods and operating policies.

Input

A resource consumed, utilized, or added to a process or system. Synonymous with X, characteristic, and input variable.

Input-Process-Output (IPO) Diagram

A visual representation of a process or system where inputs are represented by input arrows to a box (representing the process or system) and outputs are shown using arrows emanating out of the box.

Ishikawa Diagram

See cause and effect diagram and fishbone diagram.

Least Squares

A method of curve-fitting that defines the best fit as the one that minimizes the sum of the squared deviations of the data points from the fitted curve.

Long-term Variation

The observed variation of an input or output characteristic which has had the opportunity to experience most of the variation effects that influence it.

Lower Control Limit (LCL)

For control charts: the limit above which the subgroup statistics must remain for the process to be in control. Typically, 3 standard deviations below the central tendency.

Lower Specification Limit (LSL)

The lowest value of a characteristic which is acceptable.

Master Black Belt

An individual who has received training beyond a Black Belt. The technical, go-to expert regarding technical and project issues in six sigma. Master Black Belts teach and mentor other six sigma Belts, their projects and support Champions.

Mean

See average.

Measurement

The act of obtaining knowledge about an event or characteristic through measured quantification or assignment to categories.

Measurement Accuracy

For a repeated measurement, it is a comparison of the average of the measurements compare to some known standard.

Measurement Precision

For a repeated measurement, it is the amount of variation that exists in the measured values.

Measurement Systems Analysis (MSA)

An assessment of the accuracy and precision of a method of obtaining measurements. See also Gage R&R.

Median

Median - The middle value of a data set when the values are arranged in either ascending or descending order.

Metric

A measure that is considered objectives and carefully monitored.

Natural Tolerances of a Process

See Control Limits.

Nominal Group Technique

A structured method that a team can use to generate and rank a list of ideas or items.

Non-Value Added (NVA)

Any activity performed in producing a product or delivering a service that does not add value, where value is defined as changing the form, fit or function of the product or service and is something for which the customer is willing to pay.

Normal Distribution

The distribution characterized by the smooth, bell- shaped curve. Synonymous with Gaussian Distribution.

Objective Statement

A succinct statement of the goals, timing and expectations of a six sigma improvement project.

Opportunities

The number of characteristics, parameters or features of a product or service that can be classified as acceptable or unacceptable.

Out of Control

A process is said to be out of control if it exhibits variations larger than its control limits or shows a pattern of variation.

Output

A resource or item or characteristic that is the product of a process or system. See also Y, CTQ.

Pareto Chart

A bar chart for attribute (or categorical) data categories are presented in descending order of frequency.

Pareto Principle

The general principle originally proposed by Vilfredo Pareto (1848-1923) that most of the influence on an outcome is exerted by a minority of input factors.

Poka-Yoke

A translation of a Japanese term meaning to mistake-proof.

Probability

The likelihood of an event or circumstance occurring.

Problem Statement

A succinct statement of a business situation which is used to bound and describe the problem the six sigma project is attempting to solve.

Process

A set of activities and material and/or information flow which transforms a set of inputs into outputs for the purpose of producing a product, providing a service or performing a task.

Process Characterization

The act of thoroughly understanding a process, including the specific relationship(s) between its outputs and the inputs, and its performance and capability.

Process Certification

Establishing documented evidence that a process will consistently produce required outcome or meet required specifications.

Process Flow Diagram

See flowchart.

Process Member

An individual who performs activities within a process to deliver a process output, a product or a service to a customer.

Process Owner

Individuals that have responsibility for process performance and resources. They provide support, resources and functional expertise to six sigma projects. They are accountable for implementing developed six sigma solutions into their process.

Quality Function Deployment (QFD)

A systematic process used to integrate customer requirements into every aspect of the design and delivery of products and services.

Range

A measure of the variability in a data set. It is the difference between the largest and smallest values in a data set.

Regression Analysis

A statistical technique for determining the mathematical relation between a measured quantity and the variables it depends on. Includes Simple and Multiple Linear Regression.

Repeatability (of a Measurement)

The extent to which repeated measurements of a object with a particular instrument produce the same value. See also Gage R&R.

Reproducibility (of a Measurement)

The extent to which repeated measurements of a object with a particular individual produce the same value. See also Gage R&R.

Rework

Activity required to correct defects produced by a process.

Risk Priority Number (RPN)

In Failure Mode Effects Analysis -- the aggregate score of a failure mode including its severity, frequency of occurrence, and ability to be detected.

Rolled Throughput Yield (RTY)

The probability of a unit going through all process steps or system characteristics with zero defects.

R.U.M.B.A

An acronym used to describe a method to determine the validity of customer requirements. It stands for Reasonable, Understandable, Measurable, Believable, and Achievable.

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What is Six Sigma?

A defined and disciplined business methodology to increase customer satisfaction and profitability by streamlining operations, improving quality and eliminating defects in every organization-wide process.

What is Quality?

Meeting customer expectations.

What is the Hidden Factory?

The set of activities in the process that result in reduction of quality or efficiency of a business process or manufacturing department, and is not known to managers or others seeking to improve the process. Six Sigma focuses on identifying "hidden factory" activities to eliminate the root-causes.

What are the Process Excellence/Process Documentation points?

Helps the project team to define, measure and control the business processes. Six Sigma and Lean tools are used for both Process Excellence and Process Documentation.

Process Excellence and Process Documentation ensures:

Standardization across different processes in the same organization/department.

Allows business continuity in case of non-availability of Key Subject Matter Experts (SME's).

Helps to understand the current state of the process and to measure the performance of the future state of the project.

What does Six Sigma stand for?

6 standard deviations (6σ) between average and acceptable limits.

What is the focus of Six Sigma?

Identifying causes and mitigating them. The Result will automatically improve if the causes are dealt correctly.

What is DMAIC?

A Six Sigma methodology which helps in achieving process improvements by reducing variation.

What does DMAIC stand for?

Define, Measure, Analyze, Improve and Control.

What is Business Process Reengineering (BPR)?

BPR is process of streamlining the processes by challenging the each step of the current process.

What is Statistics?

Statistics is a tool for creating new understanding from a set of numbers.

What is Descriptive Statistics?

A method of organizing, summarizing, and presenting data in a convenient and informative way.

What is Inferential Statistics?

Inferential statistics is also a set of methods used to draw conclusions or inferences about characteristics of populations based on data from a sample.

Accuracy vs Precision

Processes may have a problem of Low Accuracy and/or Low Precision. The processes and their associated measurements need to have High Precision and High Accuracy in order produce the expected business outcomes.

What is KANO Analysis?

KANO Analysis is about prioritizing customer requirements once they are established. Requirements are prioritized as:

Basic Requirements

Performance Requirements

Delighter Requirements

Indifferent Requirements

Reverse Requirements

What is CTQ Drilldown Tree?

A tool that can be used to effectively convert customer's needs and requirements to measurable product/service characteristics, to establish linkage between Project "Y" & Business "Y" and to bound the project or to make the project manageable.

What is Voice of Customer?

The customer's voice, expectations, preferences, comments, of a product or service in discussion. It is the statement made by the customer on a product or service.

What is CAP?

Change Acceleration Process (CAP)

What is the Change Acceleration Process?

The process of moving the Current State of the Process/Service/Product to an Improved State by catalyzing (speeding up) the Transition State.

What is the ARMI model?

Approver, Resource, Member, Interested Party

Facts about ARMI model

ARMI model is a CAP tool used to assess each person's role in the project during various phases of the project.

ARMI is an acronym of:

A - Approval of team decisions

R - Resource of the team, one whose expertise/ skills may be needed

M - Member of team, with the authorities and boundaries of the charter

I - Interested Party, one who will need to keep informed on direction and findings

What does SIPOC stand for?

Suppliers, Inputs, Processes, Outputs and Customer.

What is SIPOC?

SIPOC as a tool displays a cross-functional set of activities in a single and simple diagram which helps us identify process inputs (Xs) and outputs (Ys), identify process owner, customers & suppliers and identify & establish boundaries for the process.

What are the elements of SIPOC?

The five key elements of SIPOC are:

Supplier - Whoever provides the input to your process

Input - The product or data that a process does something to or with to deliver the required output

Process - The activities you must perform to satisfy your customer's requirements and deliver the output

Output - The product or data that results from the successful operation of a process

Customer - Whoever receives the output of your process

What is an Operational Definition?

A clear, understandable description of what is to be observed and measured, such that different people taking or interpreting the data will do so consistently.

What is a Process Control?

A control mechanism that ensures that the process performance be maintained are at level that satisfies the customer's need and drive the ongoing improvement of process performance.

What are the key elements of Process Control?

The key elements that constitute a process control system are:

Documentation of the process

Develop process metrics

Monitor the process based on the defined metrics