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Statistical and Planning Uses of Six Sigma

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Abstract

In order to reach the main goal in implementing the strategy based on - measurement, which focuses on improving the development process and reducing spatial variation through the application of improvement projects in a statistical form, relying on the Six Sigma methodology at work, which is one of the modern statistical methods with multiple application, where The statistical representation of this method describes in practical terms how the process is performed. So that the Mean of the quality of the developmental process moves away from the threshold of quality by six standard deviations. Whitney's descriptive method has been used in the research to describe the research phenomenon related to the SS method at the present time to find out its characteristics and fields, as well as the interrelationships between them, trying to extrapolate the applied future. For the phenomenon, by defining the required parameters and boundaries, with the aim of reaching to give an idea of the most important statistical planning methods used in the Six Sigma method in a coherent manner, in order to facilitate the complexity of the problem of developing programs and setting priorities, and perhaps the most prominent and important of these aspects are:

- Rationalize the use of available and limited resources.
- Recruitment of material resources, human and natural resources in an economical way in development programs and projects.
- Establishing a schedule of priorities that seek and directly affect the development process, in its social and economic aspects

Keywords: statistical uses in planning, Six Sigma, SPC, Control Chart, DMAIC, DMAIC, TQM.

Introduction: With the increase in the need for spatial planning, forecasting processes and methods of calculating statistical estimates for them to determine or know development needs and capabilities, the serious interest in statistics as a science and as an indispensable element in achieving development programs without gaps began. As it helps in describing and analyzing data in order to reach sound planning decisions for the purpose of setting visions or expectations for development plans and projects. Statistics in this case is the basic training course, and if the phrase “no development without statistics” is correct and compatible with professional rules and principles, then adding the phrase “no development without planning”

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means the same importance and need. Statistics and planning are two terms that are inseparable from the development process.

1- Definition of Six Sigma

It is a business management strategy in general that was first implemented by Motorella, which today has pervasive application in several sectors. The Six Sigma look for improving product quality for the procedure by recognizing and eliminating the reasons of flaws (errors) and variances in work and manufacturing processes (1). Six Sigma develops a network of internal specialists in these approaches (black belts, etc.) and applies a set of quality management techniques, including statistical techniques. Each Six Sigma project is implemented within an organization that follows a specific sequence of steps and has complementary financial goals (reducing costs or increasing profits).

The term “Six Sigma is derived from The capacity of industrial processes to create a significant portion of the product is the subject of a discipline of statistics called Process Capability Studies within the specifications of operations working with the quality of Six Sigma in a short term that is supposed to create defective levels in the long term Less than 3.4 defects per million opportunities (DPMO) (Defects Per Million Opportunities) (2). The implicit objectives of SS is to optimize entire processes to this level of quality or better. A defect in the SS is defined as anything outside the customer's specification, while the opportunity is the total amount of chances (the defect). The Six Sigma process can be calculated easily by using the SS calculator.

Origin and terminology of Six Sigma Process

The word Sigma (expressed by the Greek letter σ) is the eighteenth letter in the Greek alphabet and its symbol is σ , and statisticians have used it to indicate the standard deviation. The standard deviation is a statistical method and indicator to describe the deviation, variance, dispersion or inconsistency in the implementation processes in relation to the planning objectives.(3)

3.4 DPMO (Defects Per Million Opportunities) yields six standard deviations of the procedure for a procedure with just one specification restriction (upper or lower limitation). (i.e. Sigma 6), but with a two-binomial process (higher and lower), this number translates to less. A bit of six standard deviations of the process and every single limit is specified that the entire flaw rate matches the compatible six standard deviations of the process (4). Figure (1).

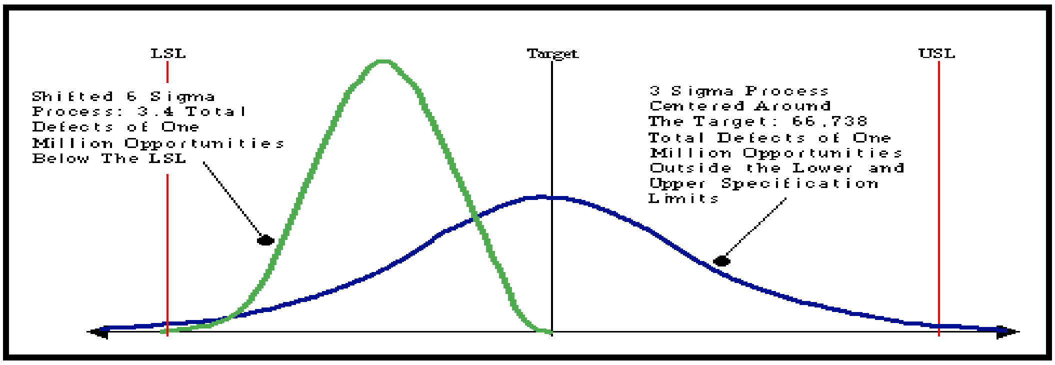

Figure (1) Standard boundaries of the process

Source; Baas, 2005

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Many operations are liable to be affected by distinct and / or identifiable reasons that affect the entire performance of the planning process , meaning that the overall performance of our process may be equal to 3.4 defects per million opportunities (DPMO) (identical to remote performance) The range is (σ 4.5)), however, our process may really be able to produce a process close to perfection (short term viability of 6 σ). what the process is, as measured by the interim procedure viability, and the accumulated experience (lasting viability) is identified as the z-shift (z-shift) or the σ-shift (shift).

For a "typical" operation, the displacement value is 1.5, so when a person perceives about "6" inherent in that phrase it means that the interim viability of the process is (6), lasting viability is (4.5) (3.4DPMO-seen by the socity) with an assumed displacement Equal to (1.5), when the σ value of the process rises from 0 to 6, the variance of the practical around the mean value falls down with a sufficiently high value for the practical, so the process approaching zero variance is then notorious as "flawless".

2- The relationship of Six Sigma to TQM

There are several different names such as "Total Quality Management" "Working as One Team" "Quality Rings" "ISO 9000" (5) etc. and also Six Sigma. All of these terms are united by one common concept, but each has a methodology and specificity that differs from the others and a specific application in a specific field. Six Sigma's relationship to quality can be summarized as follows:

a- Quality focused on meeting the needs of the customer at any cost, so it was believed that quality costs a lot of time and effort and money.

b- The emergence of Six Sigma is a natural extension of quality efforts, and the Six Sigma mechanism works by linking the highest quality with the lowest Costs (6) for development investment projects.

c- Six Sigma is a Planning goal and can be applied to every quality component and not to the product as a whole .Therefore, Six Sigma focuses on operations and the quality of process and development outputs.

d- Six Sigma Quality Management provides the tools and techniques necessary to bring about cultural changes and the development of processes within the department , the first step in calculating Six Sigma is to define the expectations and requirements of the society , which are known as the characteristics Quality Critical and Tree of Quality Necessities. (Critical-to- Quality)

5- Six Sigma is not about quality itself, but rather about providing better value to the society , employees and investors (7).

3- Sigma levels

In the following we list the σ levels for the near term according to the dependent (one-side) long-term DPMO values (8).

1σ = 690 000 DPMO = 31% efficiency

2σ = 308 000 DPMO = 69.2% efficiency

3σ = 66 800 DPMO = 93.32% efficiency

4σ = 6210 DPMO = 99.379% efficiency

5σ = 230 DPMO = 99.977% efficiency

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6σ = 3,4 DPMO = 99.9997% efficiency

The above numbers assume that the process Range will shift 1.5σ to the part with the basic feature limit after a period of time from the initial study determining the σ level for the short term, For instance, the given figure of 1 σ assumes that the average far-off process would be 0.5σ below the limit of specification rather than the 1σ within, as it was in the interim study (9).

4- How does Six Sigma work?

Looking at the variance among the-3σ process and the -6σ under the assumption that the distribution is normal for the data, which is a critical assumption with respect to the following calculations (the stability assumption is also a key assumption without which one cannot foretell the operation of the process or provide possibilities). Figure (2) shows the (-3σ) process (which is in the center) and the (-6 σ) process (the shift by 1.5). distributions for both processes are fully featured within the product specification. LSL is defined as the minimum specification limitation and the USL with the upper specification limitation. Objective, T, equals (USL + LSL) / 2 for this instance we selected T = 0, USL = 3σ and LSL = + to facilitate the explanation.

We traditionally operate at the -3 level. When specifying the specification, the process variance (σ) should be tiny enough that the base for normal dissemination corresponds within the specification, once the mean matches the target. This means that the length from (μ -3σ) to (μ + 3σ) is equal to 6σ. Therefore, (USL + LSL / 6) = σ is the largest acceptable variance.

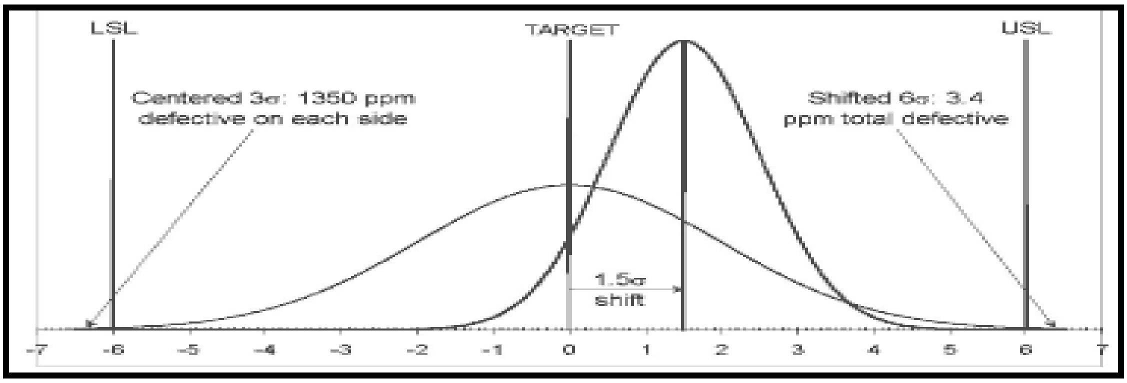

Figure (2): Six Sigma Process With + 1.5σ Shift

Source; Hahn, 1990, P210

Figure (2) illustrates the case with a normal distribution where the mean (μ) equals zero and the variance (σ) equals (2).

5- SS methods:

The main objective of the SS method is the execution of the measurement-based strategy stressing on improving the process and reducing the variance through the application of SS enhancement projects. This is acheived through using the methodologies attached to the SS, namely:

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A- DMAIC: Define, Measure. Analysis. Improve. Control.
B- DMADV: Define. Measure. Analysis. Design. Verify
Both were inspired by the DEMING'S CYCLE course:
(PLAN - DO - CHECK – ACT). (10)

The DMAIC process is an optimization system for existing sub-standard processes looking for incremental optimization. As for the DMADV process, it is an improvement system used to develop new processes or products at the quality levels of the SS, and it can also be used if the current process requires more than incremental improvement. Both operations are carried out by Green Belts and Black Belts, and they are supervised by the Master Black Belts (SS) (11).

A- DMAIC

The key method includes the 5 steps:

1- Defining high-level project objectives and define the existing process.
2- Measuring the basic characteristics of the existing process and gather important data.
3- Analyzing data to establish Cause-and-Effect relationships. Finding what these relationships are, and trying to ensure that all factors are taken into account.
4- Improve or optimize the process based on data analysis by using techniques such as Design Of Experiments.
5- Control to ensure that any deviation from the target is corrected before defects arise. Establishing guidance courses to establish process capacity, move towards production, establish a mechanism for controlling and following up the process on an ongoing basis.

B- DMADV

Is also called DFSS (Design For Six Sigma), which is an abbreviation for (Designing for SS), and the key method includes the subsequent 5 steps:

1- Defining the design objectives that are in harmony with the client's requests, and the strategy of the institution.
2- Measure and determine the CTQ5 critical characteristics, product competences, production process capacity, and perils.
3- Analyzing in order to enhance and form alternatives, make a high-level design and assess the design ability to choose the perfect design.
4- Designing details, optimizing the design, and planning to ensure the design is correct. This stage may require groups.
5- Verify the design, set up extension sessions, implement the production process and hand it over to the process owners.

6- **Quality management tools and methodologies used in SS:**

SS uses a great deal of quality management means employed outside of SS. The following are the main methods used in SS:

1- The Five Whys.
2- Analyzing the Variance.
3- ANOVAs Gunged R and R
4- axiomatic design
5- Business Process Mapping

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6- Catapult Exercise On Variability
7- Cans and Effects Diagram also called Ishikawa diagram.
8- Ch1- Square Test Of Independence And Fits
9- Control chart
10- Correlation
11- Cost-Benefit Analysis
12- CTQ tree
13- Design of Experiments
14- Quantitative Marketing Research by using Enterprise Feedback Management (EFM) Systems
15- Mode Failure and Effect Analysis
16- Model of General Linear
17- Histograms
18- Deployment of Quality Function
19- Pareto Chart
20- Pick Chart
21- Process Capability
22- Regression Analysis
23- Root Cause Analysis
24- Run Chart
25- Stratification
26- (SIPOC) (Supplier, Inputs, Process, Output, Customers(
27- Taguch, Methods
28- Thought Process Map

7-**Statistical Process Control (SPC)**

The statistical process control deals with working on the target that is with the least variance + 6. Statistical process control and control schemes are employed in many and varied ways in the sequence of measurement, improvement, and control. The performance of + σ6 assures that there will be less than 3.4 defects per million chances even if there is an average creep of 1.5 standard deviation.

The SPC is employed to derive Action. An non-suitable action leads to a worse situation. identifying the one in charge for what type of action is one of the main goals of SPC. In SPC there are many various tuning schemes, each one performing best for a specific type of data. Choosing the right plan depends on our learning the basics of Total Quality Management (TQM).

Control schemes used in the (SPC) include:

X bar R control charts
X m R control charts
C control charts
P control charts
NP control charts
U control charts

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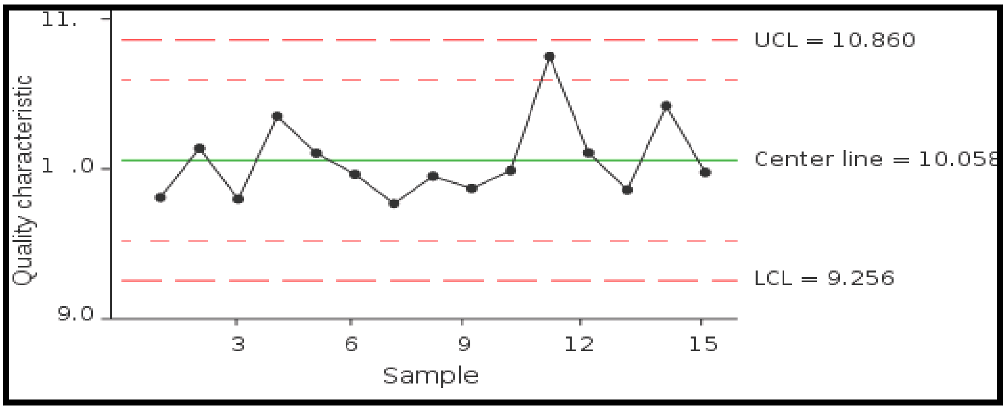
The design of experiments may accelerate the optimization and improvement process in large steps while the SPC and control charts ensure that the gains acquired would not be lost during the continuation of the incremental improvement.

8-**Control Chart:**

A tool used in the statistical process to assess whether the work or manufacturing process is under statistical control is the control chart. The planner could be employed to anticipate the process's performance in the upcoming time with some degree of certainty if it shows that the process is now under control. If the chart shows pursuing the process isn't in a state of control, then the pattern that it shows could assist in finding the source of the variance that must be removed to get the process under control. The control chart is a special type of Run Chart allowing distinguishing the major shift from the Natural Variability of the process (12). Diagram (2).

Control chart is one of the seven basic tools for controlling the quality which are (Histogram, Pareto chart, Check Sheet, Cause and effect diagram, Flow chart, Scatter diagram).

Diagram (2): a tuning scheme



Source; Mandel, 1969, P4

9-**Chart Usage:**

Once the process is in the set state then overall marks will be within the set limitations. Any units outside of boundaries or within Systematic patterns that propose to present a new source of variance, known as special cause variance. As long as the increasing variance means increasing the cost of quality, the control chart indicates the existence of the special reason that needs urgent investigations. This would lead to make control limits a basic aid for decision-making. The aim of the control charts would be allowing the identification of minor incidents which are denotative of the change that is of real process. This simple decision may be hard when the process feature is constantly changing. Statistically, the control chart gives objective standard for change. If the change is worse, its cause must be determined and removed. The aim of adding warning boundaries or dividing the chart into bands is to give early notice if something is wrong. (13)

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10-**Types of control charts:**

The following is a list of the types of tuning charts, showing the characteristics of each chart. Table (1)

Table (1) the most important charts used in the tuning process

Chart	**Process observation**	**Process observations relationships**	**Process observations type**	**shift Size to detect**
X bar R chart	Quality characteristic measurement within one subgroup	Independent	Variables	Large (≥ 1.5σ)
X bar S chart	Quality characteristic measurement within one subgroup	Independent	Variables	Large (≥ 1.5σ)
Shewhart individuals control chart (Im R chart or XmR chart)	Quality characteristic measurement for one observation	Independent	Variables	Large (≥ 1.5σ)
Three-way chart	Quality characteristic measurement within one subgroup	Independent	Variables	Large (≥ 1.5σ)
p-chart	Fraction nonconforming within one subgroup	Independent	Attributes	Large (≥ 1.5σ)
np-chart	Number nonconforming within one subgroup	Independent	Attributes	Large (≥ 1.5σ)
c-chart	Number of nonconformance's within one subgroup	Independent	Attributes	Large (≥ 1.5σ)
u-chart	Nonconformance's per unit within one subgroup	Independent	Attributes	Large (≥ 1.5σ)
EWMA chart	Exponentially	Independent	Attributes or	Small (< 1.5σ)

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	weighted moving average of quality characteristic measurement within one subgroup		variables	
CUSUM chart	Cumulative sum of quality characteristic measurement within one subgroup	Independent	Attributes or variables	Small (< 1.5σ)
Time series model	Quality characteristic measurement within one subgroup	Auto correlated	Variables or Attributes	N/A
Regression Control Chart	Quality characteristic measurement within one subgroup	Dependent of process control variables	Variables	Large (≥ 1.5σ)

Source; Mandel, 1969, P7

11- **Process Capability**

Process definition: An exceptional mixture of tools, materials, methods, and planners responsible for measurable feasibility studies, for example, power lines associated with transportation planning.

Definition of operability: it is a measurable process characteristic of the standard, expressed by the standard process ability index (for example: Cpk, Cpm). The product, typically, is a histogram and calculations showing the number of components that will be generated outside of the standard are used to explain this measurement. (14).

It is known also “the ability to achieve aim when managed via the management of an organization and by the IS0 15504 process definition structures.

The practicability consists of two parts:

1- Measuring The Variability Of The Process.
2- Comparing that Variability With A Proposed Specification Or Product – Tolerance.

12- **Measure the Process**

The entrance to the operation: For an input process, outputs are typically defined using at least one or more quantifiable attributes. When the product data exhibit a normal distribution, they may be statistically examined, and the process can be represented by the process mean

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and standard deviation. To ascertain if the process is "under statistical control," control chart analysis is utilized. The capacity has little significance if the process lacks a statistical control. Therefore practicability includes only public cause variation but not Variation of Special Cause (15).

A set of information must be gotten out of the measured process product. The mean of the process and the standard deviation are taken into account. Via a normal distribution, the ends of the curve "Tails" can be extended behind the positive and negative values of 3 standard deviations, but such interval must include nearly 99.73% of the output of Planning Process. Therefore, for normally distributed data, operability is often defined as the correlation among the 6 standard deviations and the vital feature.

13- Capability Study:

The input to the process is likely to meet the society requirements, attributes, or product acceptance. Engineering could study the viability of a process to assess how well the process can live up to these expectations.

The ability of a process to meet the specifications can be expressed as a single number using the standard process ability index, or it can be divided using control charts.

Both cases require the implementation of the process in order to obtain a net measurable product so that the engineering is sure that the process is reliable and that it may be used to accurately assess the mean and variability of the process.. Statistical Process Control (SPC) determines the techniques to correctly distinguish among stable processes and deviated processes. Standard operability indicators are meaningful only for established operations (in the case of statistical control). As to IT, ISO 15504 sets out a processability framework of measurement for evaluating practicability. Such a framework is comprised of (0.5 + 5.5) levels of operability levels from zero scalability (CL 0) to the optimum operational level (CL5).

14- Design of Experiment

Experiment design" is used for all Data-Collecting exercises where contrast is available, whether or not under complete control.

(The last case is typically known as a study for observation (perhaps the planner is looking forward to influencing some processes or innovating (treatment) on some things (experimental units)) it could be people, parts of people, groups of people .... etc.

Therefore, this kind of design is a disciplined system is of a wide application over the entire social and natural sciences and is characterized by the following:

A- **Principles of Experiment Design (**16)

A methodology for experiment design has been proposed by Ronald A. Fisher in his creative book called "Experimental Design" as an example: He described how to test the hypothesis that a woman can distinguish by flavor only what milk or tea was first placed in the cup. Although this application may seem trivial, it permitted him to explain the key thoughts of experimental design, namely:

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- Comparison

In some domains of research it is difficult to find fully measured findings. Contrasts among treatments could likely produce results. Maybe one of us is comparing against a standard or doing a conventional treatment that works as a base line.

- Randomization

There is a wide range of mathematical theories that explore the results of making the assignment of units, especially the processors, through some random mechanisms like tables of arbitrary numbers, or using random tools like playing cards or the button. When the sample size is appropriate, the perils related with haphazard allocation (like failure to get a representative sample in the survey, or a significant imbalance in a basic feature among the treatment group and the control group) are computable. Hence, it can be maintained to a satisfactory level.

- Replication

Measurements are typically dependent on variance, both among reiterated measures and among repetitive terms or processes. Multiple measures of repeated vocabulary are necessary and thus variance can be evaluated.

- Gathering

Grouping is the organization of experimental units according to groups which are alike. Aggregation reduces recognized sources of variance and therefore permits for more accuracy in estimating the source of variance under study.

- Orthogonality

Orthogonality relates to forms of (Oppositeness) that could be executed efficiently and rationally. If the data is normal, contrast could be exemplified by vectors and a collection of unconnected, independently distributed orthogonal oppositions. Each orthogonal process provides a separate piece of information to the others because of their independence. If (n) treatments and (n-1) orthogonal opposites are present. The collection of oppositions contains all the knowledge that may be gained from the experiment.

Factorial Experiments

Here, these Experiments are used instead of the One - Factor - At-A - Time method. Factorial experiments are effective in estimating the effects and potential interactions of many factors (independent variables). The experimental design analysis is based on the analysis of variance of a set of models in which the measured variance is broken down into components of different causes that are estimated and / or tested.

Example: This example is ascribed to Harold Hoteling.

It bears the flavor of such characteristics of a topic which includes Combinatorial Designs. Weights for 8 objects should be under measurement making use of a double-shouldered scale and a set of standard weights. In every single weighing operation, the weight variance between the objects put on the left cuff versus anything placed on the right cuff is measured by cuffing the lighter with measured weights until the scale is balanced. Random error exists in each measurement. The standard deviations of the probability distribution of mistakes on the various weighing procedures are the identical number, the error rate is set to zero, and the errors on the various weighing processes are independent.

Symbolized the real weights 1ϴ ----- 8ϴ

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By examining two various experiments:

1- Weigh everything on one pan, leaving the other empty.

Suppose Xi expresses the measured weight of ith, where i is from (1) -------- (8)

2- We perform the eight weighing operations according to the following table,

Suppose Yi represents the measured difference where .i is from (1) --------- (8).

Weights	Left cuff	Right cuff
First weight	87654321	Empty
= Second	8321	7654
= The third	8541	7632
= The fourth	8761	5432
= Fifth	8642	7531
= Sixth	8752	6431
= Seventh	8743	6521
= The eighth	8653	7421

Then the estimated value for weight 1 is:

$$\check{O}1 = \frac{Y1 + Y2 + Y3 + Y4 - Y5 - Y6 - Y7 - Y8}{8}$$

Similar estimations may be obtained for other words' weights, such as:

$$\check{O}2 = \frac{Y1 + Y2 - Y3 - Y4 + Y5 + Y6 - Y7 - Y8}{8}$$

The question for designing experiences is: Which one is the best?

The estimated variance of x1 from Ɵ1 is (σ^2) if we apply the initial test. However, if we do the second test, the variance of the above-mentioned estimation is ($\sigma^2/8$). Therefore, the second experiment provides us eight times greater accuracy for estimating the single item, and evaluates the whole terms at the same time, with the same accuracy.

What was achieved in the eight weighing process in the second experiment could lack to 64 weighing operations if the items were weighed individually. Though, we note that the estimates for the vocabulary gotten in the second experiment are of errors that are associated with each of them. Many of the experimental design problems contain overlay designs, as in this instance.

B- **A step-by-step procedure in effective experiment design** (17)

StepByStep Procedure in the Effective Design of an Experiment

The following steps include:

1- Select Problem
2- Finding Determining Dependent Variables
3- Determining Independent Variables
4- Finding the number of levels for the independent variables.
5- Specifying the Probable Combination
6- Specifying The Number Of Observations
7- Re-design
8- Randomization
9- Institutional Review Board

10- Mathematical Model
11- Data Collection
12- Data Reduction
13- Data Verification

15- **Optimal Design**

Optimal designs give three more benefits than near-optimized experimental designs (18):

A- Optimal designs reduce experimentation costs by letting statistical models to be valued with a small number of experimental implementation.

B- Optimum designs can accommodate various kinds of factors, like: process, combination, and discrete agents.

C- Designs may be adjusted even when the design space is constrained, for as when Factor-Settings are included in the mathematical process space, which means the possibility of controlling and fixing worker choices.

The following consideration can be followed and taken into consideration in the optimal design:

(A) finding the optimal designs

The main statistical systems such as the SAS system and the R system have processes for adjusting the design based upon the user specification. The experimenter must define a design model and standard-optimization before calculating the optimal design by the method (19).

Practical Considerations

1-Model Dependence & Robustness

As long as the optimization criterion for lots of optimal designs is dependent on many functions of the Matrix Information, the optimization for a given design is Model Dependent: although an optimized design is better for that model, its performance may be detrimental to other models. In other optimization models, it may be good or bad in comparison to a non-optimal design. Thus, it is crucial to evaluate the effectiveness of designs using various criteria and alternative designs. (20).

2- Flexible Optimality Criteria & Convexity

All conventional optimization criteria are convex (or concave) functions. Thus, optimized designs that submit to the mathematical theory of convex analysis and calculations may employ special methods of convex minimization methods.

The expert does not lack to choose only one conventional standard-fitness, but he can define a standard based on the customer's request. In practice, the expert can determine the convex criterion by using the upper point of the convex optimization criterion and the convex combinations of the convex optimization criterion. For the convex optimization criterion, the Kiefer - Wolfowitz equivalent theory allows the expert to confirm that the design is universally optimal.

B- Model Uncertainty & Bayesian Approaches:

When experts need to take into account multiple models, they can determine the measurement-of-likelihood on the models and then choose which design maximizes the predictable value of this experiment. These optimization designs are based on-likelihood are

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called Bessian's optimal designs. These Bisian designs are used specifically for generalized linear models (where the response follows a specific family-exponential distribution) (20).

C- Iterave Experimentation

Practical experimentation is a process of iteration, and statisticians have developed many methods of optimizing design with successive experiments

D- Sequential analysis:

A statistical analysis in which the sample size is not beforehand determined is known as a sequential analysis, also known as a sequential hypothesis. Instead, data is assessed as it is gathered, and subsequent sampling is halted in accordance with a predetermined Rule Stopping rule as soon as noteworthy findings are observed. Therefore, when translating lower and/or human costs, a result may occasionally be reached earlier than is achievable with a traditional estimate or hypothesis test. The notion of optimum decisions is connected to the best experimental design.

E- Response - Surface Methodology

Early optimized designs were enhanced to evaluate parameters of continuous variable models of regression. Circle designs for the surface - the multivariate response were suggested by George. E. P.Box. Box designs possess a small number of optimization characteristics, Box - Behnken design needs an excessive number of experimental implementations when several variables is more than three (20).

F: Design For System Identification, & Stochastic Approximation

The optimization of sequential approximation has been studied in stochastic programming and in systems and settings. Familiar methods including random approximation and other methods of stochastic optimization have been related with the sub discipline of system determination. In computational optimization, Boris Polyak described more efficient methods of (Armigo-style), and the rules of volume - the step provided by Box in a surface-response methodology. The designs adopted are employed in clinical trials.

G- Discretizing probability - measure design

An ideal design can be a probability measurement based on an unlimited number of observational locations in the mathematical theory of optimal experiments. Measurement Designs - This optimum probability solves a mathematical issue that has been neglected to determine the cost of releases and experimental implementation. However, these probability-measurement designs may be separated to find approximate optimal designs. (20) In certain events, a final set of sites - views is sufficient to backup an optimal design. That result was demonstrated by Kono & Kiefer in their work on Surface-Response Designs for Quadratic Models.

16- Ishikawa Diagram

The Ishikawa scheme was introduced by Kaoru Ishikawa (21) in 1960 who was at the forefront in Kawasaki's quality management processes as well as in the processes that became pioneers in modern management and planning. It was used in the 1960's and was considered among the seven essentials in quality management tools and with (Histogram, Pareto Chart, Check Sheet, Control Chart, Flowchart, And Scatter Diagram(.

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It is also defined as a fishbone diagram since it resembles a side view of the fish's skeleton. Ishikawa diagram formed by fish bone shows the vectors: for tools, people, species, environment as well as management and planning process, and all these vectors that affect all the studied problem, small arrows are related to the sub-cause and to the main cause as in figure(4):

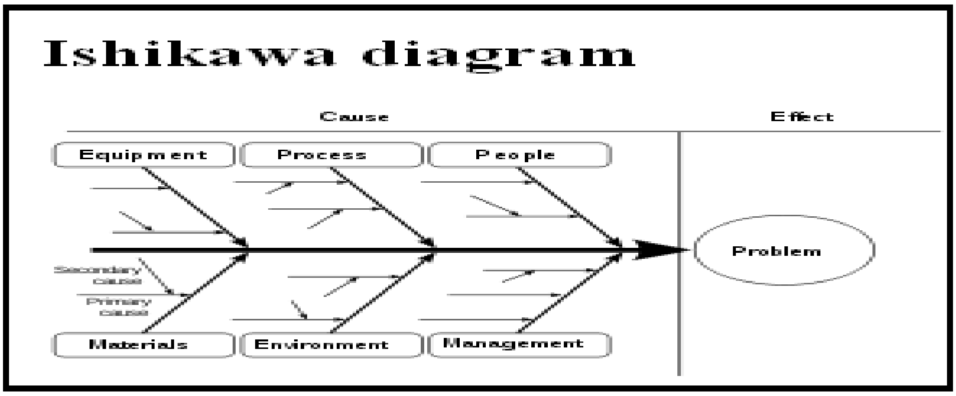

Figure (4) Ishikawa Diagram

Source; Hankins, 2001, P43

Ishikawa diagrams are also called cause-and-effect, and these maps also show the cause of certain and specific events and are generally used in designing experiments .

Causes:

Causes in this Diagram are mainly in the group (6 M's) Reason - and - The effect and the Diagram is the key to the relationship between the various variables, as well as the possible causes that are equipped for addition in the behavior of operations.

Causes need to be led by a rational cycle, after which it is necessary to classify causes on the basis of affinity - grouping in order to bring together similar ideas.

After that, these groups are given the name (Labeled) on the basis of the (Fishbone) group, and they are considered from the traditional groups adopted in the applications and tools for specific, measured and controlled reasons.

The Causes in the regular scheme are naturally based on the ordered and major groups, and they are :

The Original (6 M's):	Machine.
Method.	Materials.
Maintenance.	Man.
Mother Nature (Environment).	
A Modern Selection Of Categories :	**The modern selected groups are:**
Process.	Equipment
Materials.	People.
Management.	Environment.

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Appearance:

Generally, the Ishikawa chart appears red and causes blue as accidents. Most of the charts contain a box on the right side of the tested and written events. The main part of the body of the chart is horizontal, which indicates the reasons represented as the "bones", which are drawn to the left of the paper, and each one of them has a name with the reasons for verification.

Each large bone is extinguished and it is possible that the small bones will remain lit and more specific for the specific expected reasons. Sometimes there is a third level of bones or more (branches), and you can know through the technique (5 Why's) when all the causes of the problems are known. As in figure(5):

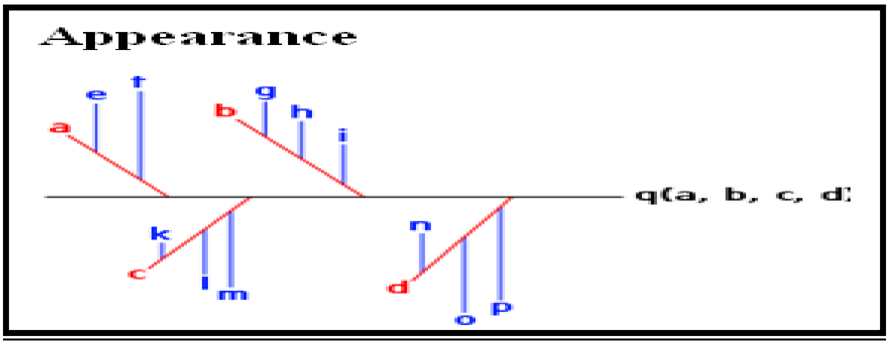

Figure (5) appearing
Source: Hankins, 2001, P45

Additional chart analyzes are also addressed with Pareto charts. Ishikawa diagrams can be prepared as Documentented reports and Analyzed reports in Matrix Format.

17- 5 whys

5 whys is a question-asking method used to unravel the cause / effect relationships of a specific basic problem. Ultimately, the goal of applying this method is to determine the root cause of a defect or problem. (22)

18- Critical - To - Quality Tree (CTQ Tree)

The Critical-to-Quality tree is used to replace broad society requirements with more easily requirements. The CTQ tree is often used in SS methodology. The CTQ is derived from the society needs. People delight may be added to the Add-on tree when the Critical-to-Quality parameters are derived. With regard to cost considerations, we may keep the focus on customer needs at the primary level (23).

The CTQ is the main measurable characteristics (The key) of a product or process for which the performance criteria or specification limits must meet these characteristics in order to satisfy the sosiety

It directs design and improvement efforts in line with society requirements. The CTQ represents the product or service characteristics defined by the people (internal or external). It may include the upper or lower specification limits or any other factors related to the product or service. The CTQ should normally be translated from descriptive people statements into an actionable quantitative job specification.

19- Histogram

Statistically, a histogram is a graphic representation of tabular frequencies revealed in the form of rectangular bars, and these bars must not be identical one on top of the other and must be adjacent, usually of the same width. Histograms are used to plot densities of data and perhaps to estimate density: estimate the probability density function of the primary variable. The total area of the histogram is always equal to one. There are two types of histograms (24), normal and cumulative as shown in Figure (6).

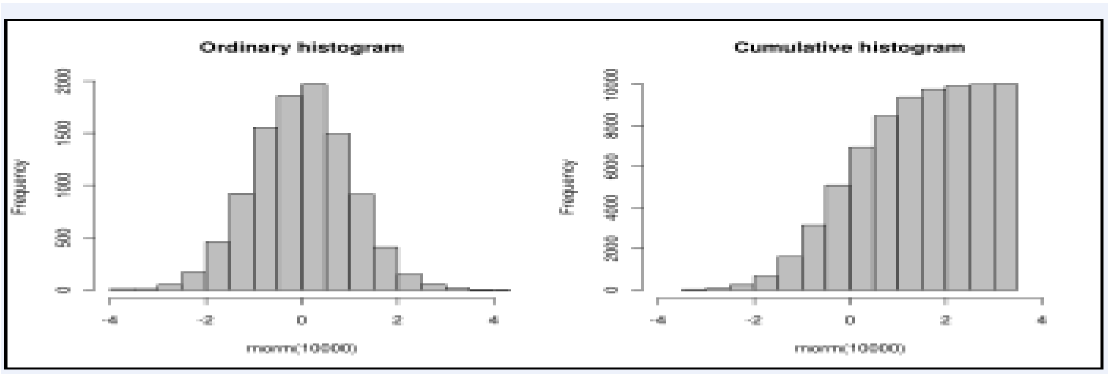

Figure (6), the two types of histograms

Source: Sturges, H.A. (1926)

The histogram is used to find out whether the data is normally distributed or not, and if the data is not normally distributed, the central limit theorem is used for processing.

- Central Limit Theorem

This is the second fundamental theory in the probability theory, and it states that in the circumstances under which the sum of several independent random variables, each one of them with finite variance and mean, will be roughly distributed normally. Since the quantities in the real world are often the balanced sum of many unnoticed random occurrences, this theory gives a partial explanation for the propagation of a normal probability distribution. This theory justifies the approximation of the statistics of the large sample to the normal distribution in controlled experiments. Here we will explain the classical central limit theorem.

Suppose $X_1 + X_2 + \ldots\ldots\ldots + X_n$ expresses a sequence of (n) independently distributed random variables symmetrically and each one has finite values of expectation (μ) and variance of $\sigma^2 > 0$.

According to this theory, regardless of the form of the initial distribution, the distribution of the sample rate for these random variables achieves a normal distribution with a mean (μ) and a variance of n / 2 as the sample size (n) grows. Let the total of the random variables (n) equal Sn to represent the theory in a more generic fashion.

where:

$S\,n = X1 + X2 + \ldots\ldots\ldots + X\,n$

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Then, define the new variable

$$z_n = \frac{s_n - n\mu}{\sigma\sqrt{n}}$$

The distribution for z_n approaches toward the standard normal distribution N(0,1) when (n) reaches ∞ (this convergence in the distribution and the result is the Asymptotic distribution) .This may be `written as follows:

$$\frac{\sqrt{n} \;\; \bar{x}_n - \mu}{\sigma} \longrightarrow N(0,1),$$

$X_n = S_n / n = (X1 + \ldots + X_n) / n$

This means, when φ (z) is the cumulative distribution function of N(0.1)
then for any real number (z)
We will have

$$\lim_{n\to\infty} p(z_n \le z) = \varphi(z)$$

$$\lim_{n\to\infty} p(\frac{\bar{x}_n - \mu}{\sigma/\sqrt{n}} \le z) = \varphi(z)$$

20- Chi Square Test

The chi-square test is the abbreviation of the Pearson's Kai square test, symbolized by ($\aleph^2$), and it is a test of the statistical hypothesis where the sample distribution is of the chi-square, and when the null hypothesis is correct, the variance of a normally distributed population has a given value based on the variance of the sample and that the sample size is large enough to give correct results.

Some examples of choosing a chi-square when the chi-square distribution is only approximate:

1- Pearson's Chi-Square Test, also known as The Chi-Square Goodness-Of-Fit Test
2- The Yates chi square test is defined as the continuous correction test.
3- Mantel - Haenszel Chi Square Test
4- Linear - By - Linear Association Chi - Square Test
5- The Portmanteau Test In Time - Series Analysis, Testing For The Presence Of Autocorrelation.
6- Likelihood - Ratio Tests In General Statistical Modeling

- Chi-square test for variance in a normal population:

If we have a sample size (n) taken out of people with a normal distribution, then there will be identified results that allow a test to be performed even if the variance of the population has a previously extracted value.

Example: A producing process may be under stable conditions for a long time letting the variance value to be extracted basically without errors. Suppose the variance of the process is verified.

Give height to a small sample of the product items for which the variance is to be tested. The T-test in this case is the sum of squares about the sample mean divided by the exponential value of the variance.

Then (T) has a chi-square distribution with a degree of freedom equal to (n-1). For example: if the sample size is (21) then the acceptance area for (T) with a significance level of 5% is in the period 9.59 to 34.17.

21- The concept and philosophy of the human dimension in total quality applications

The concept of total quality management is one of the modern administrative concepts that aim to continuously improve and develop performance by responding to people's requirements. Total quality management is defined as "the management strategy achieving lasting success by pleasing service users. Total quality management focuses on the engagement of all members of the business in improving procedures, goods, and services, as well as the workplace culture. Both the organization's employees and the community gain from total quality management.

First: definitions of quality

Many people understand quality as (good quality) and it means quality, the opposite of quantity, which means number, and quality management is the process of controlling, documenting, controlling and improving the various operations of the facility in order to ensure their compliance with quality standards, and these standards are either defined by the institution , or defined by the international quality management bodies, quality in short is the pursuit to ensure the good quality of the services , no matter how different the conditions or elements of operation, quality management also includes a basic principle, which is the principle of continuous improvement. It should be mentioned that since each person has a unique idea of quality, it is quite challenging to provide an appropriate description. Accordingly, quality is (Entrepreneurship and excellence in doing things).

Entrepreneurship: It means being ahead of the curve in responding to people's needs.

Excellence: means perfection (adjustment, accuracy, and perfection) in work.

Second: Definitions of Total Quality Management

The contrast of the concepts and ideas of total quality management according to the angle of view by the researchers was clearly reflected in the lack of a general definition agreed upon by them, but there are some definitions that showed a general perception of the concept of TQM. Researchers vary in defining it, and it is unsurprising that the quality leader, Dr. Daimana, was asked about it, and he replied that he did not know, and this is evidence of the comprehensiveness of its meaning. Thus, each of us has his opinion in understanding it and harvesting its results.

From the British point of view: "It is the management philosophy of the organization through which it realizes the achievement of both consumer needs, as well as the achievement of ".project goals together

As for the American viewpoint, TQM defines: "Total Quality Management is a philosophy, guidelines and principles that guide the organization to achieve continuous development. It is quantitative methods in addition to human resources that improve the use of available resources as well as services so that all operations within the organization seek to achieve the satisfaction of the needs of current and prospective consumers ". We note through the first definition (of the Quality Organization from the British point of view) that It places a strong emphasis on the project's efficiency and effectiveness, which safeguards the organization and propels it toward excellence by assisting in the fulfillment of the objectives of the organization or project.

In the second (American) definition, it affirms that it is a philosophy and principles that result in continuous development and that all operations look forward to achieving existing and future consumer needs. Accordingly, the comprehensive definition of the concept of Total Quality Management TQM:

It is the ongoing improvement of administrative procedures through their review, analysis, and search for methods and means to improve their level of performance and shorten the time it takes to complete them by eliminating all pointless and unnecessary tasks and functions for people or the procedure in order to reduce cost and improve quality based at all stages of development on the needs and requirements of individuals). Depending on the total quality approach, TQM takes three dimensions:

(1) The human dimension (the quality of human technology), skills, capabilities, knowledge
(2) The logical dimension (the quality of environmental technology): the work environment and the health of systems, regulations, laws, policies, procedures, activities and
(3) The technical dimension (physical technology quality) machines and equipment as in Figure (7). In our opinion, the first dimension is the most important, although it is the less visible dimension in TQM

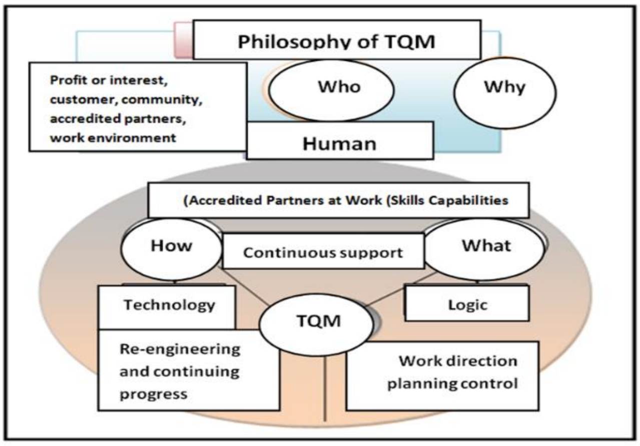

Figure 7. Three dimensions in TQM

Source;N,Kelada,'Comprendre realiser quality total'2ⁿed (Dollard Ormeaus,Qubee,Canada,Editions,1992,p55

22- Six Sigma basic applied principles

-Tools & Methods

Although the methods and tools of SS contain many statistical tools used in other quality issues, they are used in a systematic, project-oriented manner via the cycle of definition, measurement, analysis, improvement and control (DMAIC) in addition to That is, scientific progress that facilitates the application of these tools has occurred over time. Enable all users to use Lshikawa's Seven Quality Tools to create a workforce able to address several issues, as we learned through TQM. The use of such tools in conjunction with other statistical methods typified in the scientific method and the availability of modern statistical software that provide us with graphical output cuts short of hard work and assists statistically oriented staff to make better use of their craft. It makes problem solvers critical in leading their team to enhance quality, reduce Cost and reduce distribution time at the same time.

The statistical methods used in SS differ fundamentally from those learned in engineering or statistical software. The SS emphasizes observational and experimental methods in a practical scientific context.

For example: experiments with two-level expansion are standard, and graphing methods are widely used to analyze these experiments.

Example 1: A case study using the Np . diagram

Mr. Sedrlate, Quality Manager at Long Run Hospital, was worried about the future of his organization, and in particular his future - Mr. Sedrlate had learned to manage the hospital's quality systems, but only through the ingenuity of his Statistical Process Control (SPC) team, who worked Non-stop data analysis. Mr. Sedert has found that the highly visible project that he is able to supervise lies in the number of treatments that are either incomplete or inaccurate when distributed from the pharmacy. So he has made arrangements for pharmacists to collect data on missing treatments, Mr. Sedret knows he will have a great deal of data in this area. He estimated that the data should be identical in the characteristic as long as he will measure nonconforming vocabulary, and define it as the treatments that fail to distribute it in the specified time. Moreover, Mr. Sdrthet believed that the NP scheme is the appropriate method for analyzing the data as long as he will test the number of distributions with errors. Mr. Sdrthe has developed the following scheme based on the data processed by the pharmacists. As shown in Figure (8).

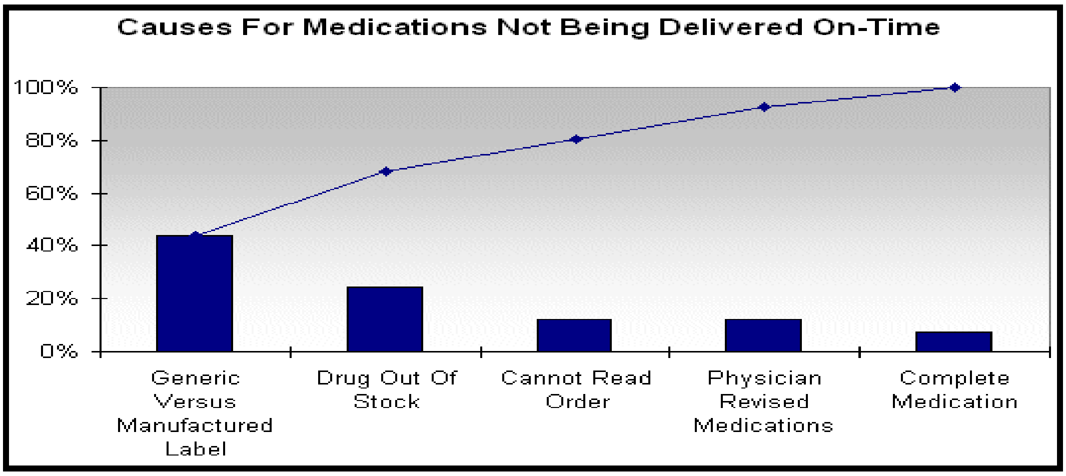

Figure (8) Testing data at specific times

Mr. Sedret saw that the pharmacy process gave him a large number of opportunities to improve quality. The issue was not only to identify cases that were out of control, but to improve the process. The NP diagram reflects that the process now generates an average of (10.2) mismatches per week. With the use of cause-and-effect analysis of transient episodes of insanity, the Pareto chart and other problem-solving and data-analysis tools can thus further identify ways to reduce the number of natural prescriptions missing.

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Example 2: Case study: Business identification using SS. (Six Sigma DMAIC Project .Portfolio Selections Discover Sim)

Randomization is used to identify development projects that are expected to achieve the best economic savings.

Objective: To identify development projects that achieve the maximum expected total savings (N20) subject to a total resource constraint (Ø24) <= 20.

Management needs minimum total project savings of US$1 million (LSL = $1,000K). Cost savings are determined with the triangular distribution. The chance of success is modeled using a Bernoulli distribution (yes/no). The resources required are identified for each project. Discover Sim uses (discrete) input controls to 'select' the project (0,1). Expected savings are calculated as the sum of the project: cost savings * probability of success (if the project is selected) or (if the project is not specified). The Sigma XL program for that, as shown below.

DMAIC Project Name	Project Cost Savings - Minimum $K	Project Cost Savings - Most Likely (Mode) $K	Project Cost Savings - Maximum $K	Cost Savings Input Distribution Name	DiscoverSim Input Distribution - Cost Savings	Probability of Success	Probability of Success Input Distribution Name	DiscoverSim Input Distribution - Success (0/1)	Resources Required	Input Control Name	DiscoverSim Input Control - Project Selected (0/1)	Expected Project Savings
Project_A	100	125	150	Project_A_CS		0.9	Project_A_Pr		1	Project_A_Select		0
Project_B	50	100	150	Project_B_CS		0.8	Project_B_Pr		2	Project_B_Select		0
Project_C	500	600	700	Project_C_CS		0.8	Project_C_Pr		5	Project_C_Select		0
Project_D	100	150	200	Project_D_CS		0.9	Project_D_Pr		2	Project_D_Select		0
Project_E	1500	2000	2500	Project_E_CS		0.5	Project_E_Pr		10	Project_E_Select		0
Project_F	200	250	300	Project_F_CS		0.8	Project_F_Pr		2	Project_F_Select		0
Project_G	300	400	500	Project_G_CS		0.8	Project_G_Pr		4	Project_G_Select		0
Project_H	700	750	800	Project_H_CS		0.7	Project_H_Pr		5	Project_H_Select		0
Project_I	300	350	400	Project_I_CS		0.8	Project_I_Pr		3	Project_I_Select		0

Total Resources for Selected Projects:	0
0	DiscoverSim Output: Total Expected Savings
DiscoverSim Constraint: Total Resources <= 20	

It is clear from the results after implementation, that there are minimum and upper limits in the selection of projects according to the priorities of the chances of success and the available resources (material and human), whether the selection is made or not, based on the savings and cost (real and expected) in a very accurate manner for the process (inputs - operations - outputs) separately.

Conclusion

There are many statistical and planning methods that are interconnected with each other and applied in Six Sigma, which aim to make the procedures for implementing projects, whether (productive or developmental planning), statistically controlled in order to reach the desired goal of using them in the implementation of the strategy based on measurement.

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