

Statistical Quality Control

IEng3102

CHAPTER ONE:

INTRODUCTION TO STATISTICAL

PROCESS CONTROL

1.1. Introduction

Quality

Quality has been defined in different ways by various authors.

- **Crosby (1979)**

Quality is conformance to requirements or specifications

- **Juran (1974)**

Quality is fitness for use or purpose

Support services: Quality defined in terms of the support provided after the product or service is purchased/sale

- Garvin (1984) divides the definition of quality in to five categories

1. Transcendent Quality

- ✓ Judgmental perspective of —goodness of a product.
- ✓ absolute and universally recognizable, a mark of uncompromising standards and high achievement (Shewhart's transcendental definition of quality)

2. Product-Based Quality:-

- ✓ The presence or absence of a given product attribute.

3. User-Based Quality

- ✓ its ability to meet the user's expectations.

4. Manufacturing-Based Quality

- ✓ How well the product conforms to its design specification or blueprint.

5. Value-Based Quality

- ✓ How much value each customer separately attributes to the product in calculating their personal cost-benefit ratio.

- **Quality is meeting or exceeding customers' expectations and requirements** that are determined or modified through continuous communication between customers, front-line associates, and management (Deming,1986;1939).

The formal definition of quality as stated in ISO

(International Organization for Standardization) 9000 :

2000 is :-

- ✓ Ability of a set of inherent characteristics of a product, system or process to fulfill requirements of customers and other interested parties.

- Main concerns of manufacturers and customers in any industry are:

Manufacturer

- Quality
- Cost
- Productivity

Customer

- Quality
- Price
- Availability

- Quality is the only common concern and it is the most significant factor in determining the long range success or failure of an organization

Good quality of product and service can provide:

- Competitive edge
- Reduce cost due to returns, reworks, and scrap
- Productivity and profits
- Generates satisfied customers:

The Evolution of Quality Concept

The four stage of quality evolution:

1. Inspection (1856-1924 Tylor)

- measure the characteristics of a product and compare them with its specifications;
- The goal here is the fitness of standards. This is the passive "inspecting" attitude.

2. Quality Control (1924-1950 Shewhart)

- inspection performed by the workers themselves with a feedback loop to the production line;
- "quality control" by statistical methods is outlined and characterized by applying statistical control techniques.
- Here we avoid the "inspector" effect and allow some learning to take place.

3. Quality Assurance(Deming, Feigenbaum, Juran.)

- set of (implemented) predefined and systematic activities necessary to give confidence in the process quality;
- One step further. Quality procedures are designed and planned as a whole to ensure that no bad products be delivered. We do not just rely on everybody's work and control. This introduces the notion of a coherent set of quality procedures/tests.
- The given confidence (in the definition of QA) is important both for the producer and for the customer.

4. Total Quality Management:(many gurus)

- management centered on quality and based on the participation of everybody which aims at the customer satisfaction and at the improvement of the company's personnel, of the company and of the society.
- The ultimate step. A quality assurance plan is operational but the management, the workers and the customers continuously interact to review / improve this plan.

Quality perspectives

❖ Typical points about the definition of quality include:

1.Perfection

2.Consistency

3.Eliminating waste

4.Speed of delivery

5.Compliance with policies and procedures

6.Doing it right the first time

7.Delighting or pleasing customers

8.Total customer satisfaction and service

Dimensions of product Quality

- *Conformance* - meeting pre-established standards
- *Performance* —basic operating characteristics eg. acceleration of a vehicle
- *Reliability* — that the product will function as expected without failure
- *features*—the extras that are included beyond the basic characteristics;
- *Durability* - expected operational life of the product
- *Serviceability* - ease of getting repairs, speed & competence of repairs
- *Aesthetics* - look, feel, sound, smell or taste
- *Safety* - freedom from injury or harm

Dimensions of service Quality

- Reading Assignment

Quality Characteristics

- **Physical** - length, weight, voltage, viscosity
- **Sensory** - taste, appearance, color
- **Time Orientation** - reliability, durability, serviceability
 - ❖ Nominal or target value
 - ❖ Upper Specification Limit (USL)
 - ❖ Lower Specification Limit (LSL)

Management quality problems

- Quality become a question only at the final assembly, rather than at the early design stage
- The employees in the organization lack understanding of customer requirements
- Quality issues fail to gain much attention until problems developed
- Management seemed willing to sacrifice quality when it conflicts with cost and schedule

- Operators lacked sufficient training in their work and in quality issues
- Suppliers contribute to the quality problem of the producer
- High quality costs are common (cost of poor quality)
- Employee-employer and producer-supplier are always blaming each other

Cost of Quality

- *Costs which would disappear if systems, process and products were perfect*
- The cost of ensuring that the job is done right + the cost of not doing the job right
- Cost of quality can mean two things:
 - Cost of attaining quality – conformance costs
 - Cost of poor quality – non-conformance costs

1. Prevention costs: Costs incurred in the process of preventing poor quality from occurring

- ✓ costs of product and process design
- ✓ employee training in quality measurement

- ✓ Quality Planning
- ✓ Customer Surveys
- ✓ Preproduction Reviews
- ✓ Technical Manuals
- ✓ Job Descriptions
- ✓ Process Capability
- ✓ Preventive Maintenance

2.Appraisal costs: Costs incurred in the process of uncovering defects, including:-

- ✓ cost of quality inspections, product testing, and performing audits
- ✓ Process Controls
- ✓ Product Audits
- ✓ Quality Systems Audits
- ✓ Prototype Inspection

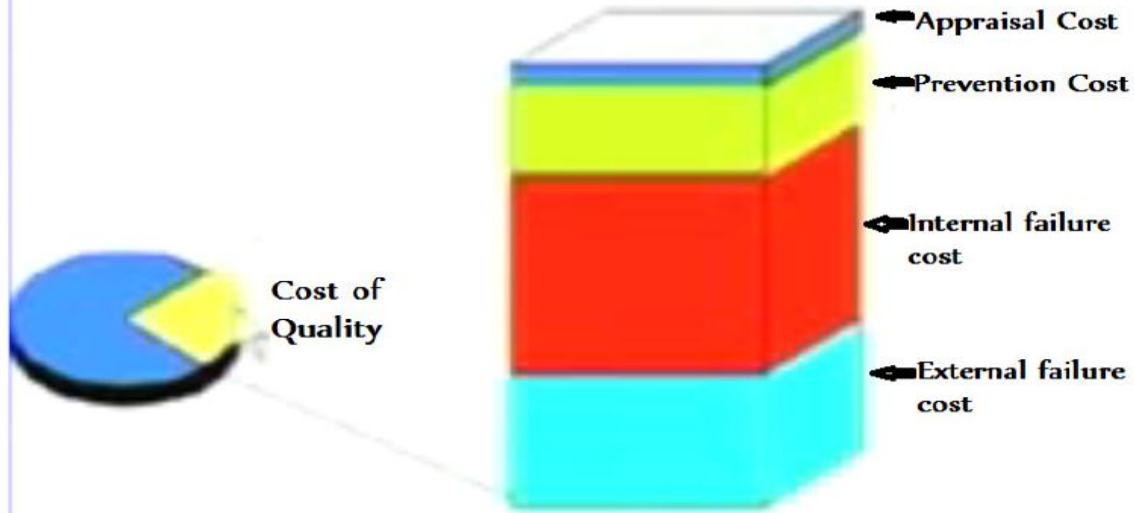
3. Internal failure costs:- costs associated with discovering poor product quality before the product reaches the customer, including:-

- ✓ *Rework* - cost of correcting the defective item
- ✓ *Scrap* - costs material, labor, and machine
- ✓ Re-inspection
- ✓ Redesign/Engineering Change
- ✓ Process Modifications
- ✓ Payroll Errors

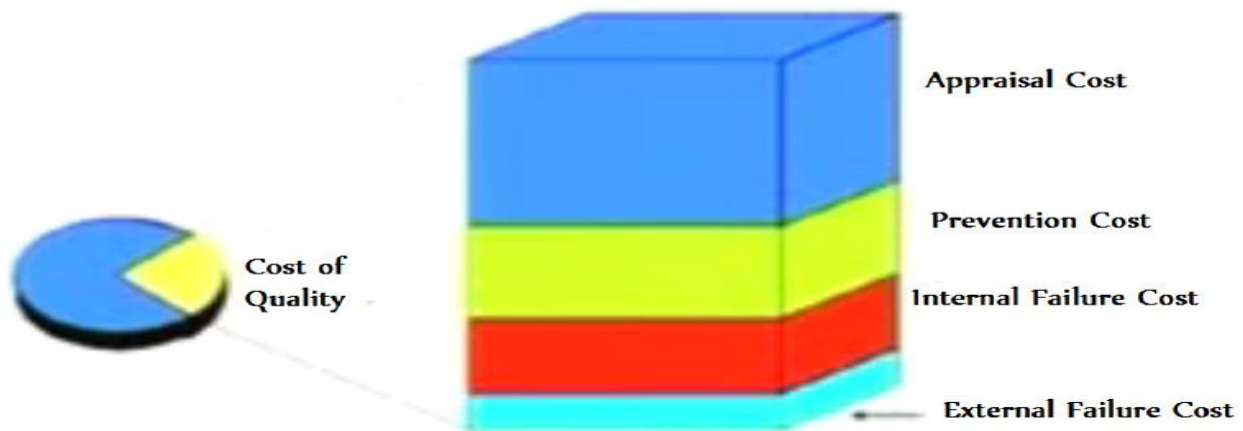
4.External failure costs:- costs associated with quality problems that occur at the customer site

- ✓ damaging customer faith and loyalty
- ✓ can be difficult to regain customers back
- ✓ customer complaints
- ✓ product returns and repairs
- ✓ warranty claims and recalls

Normal Cost of Quality Distribution when Quality System is Not in Place



Optimum Cost of Quality Distribution when Quality System is in Place



Advantages of Using Quality Costs for Management

- Reducing the cost of poor quality is one of the best ways to increase a company's profit.
- Provides manageable entity and a single overview of quality.
- Aligns quality and goals.
- Prioritizes problems and provides a means to measure improvement.
- Promotes the effective use of resources.
- Provides incentives for doing the job right every time.

1.2 Statistical Process Control

- Statistical Process Control (SPC) can be thought of as the application of statistical methods for the purposes of quality control and improvement.
- A methodology for monitoring a process to identify special causes of variation and signal the need to take corrective action when appropriate.

- Strategy that focuses on quantifying, classifying, and reducing variability in the process
- Based on the philosophy that making the right product in the first place is better than trying to rework the wrong product
- Quality Improvement is perhaps foremost among all areas in business for application of statistical methods.

Quality Control vs. Process Control

- Traditional quality control focuses on the product
 - Monitor product quality
 - Rework or scrap off-spec product
- Statistical process control focuses on the process
 - Monitor process behavior (including product quality)
 - Adjust the process to eliminate off-spec production

- Traditional quality control focuses on the values
 - A value outside specifications is a signal that the product must be reworked or scrapped

- Statistical process control focuses on the variability
 - Variation outside usual limits in any process measurement is a signal that the process should be adjusted to prevent production of unacceptable product

1.3. Quantifying Variation

Manufacturing process variations are of two types:

- i. Common cause (Random)** - Random, so its effect on the product is predictable. If only common cause variability is present, then product quality will only vary within a specified range ,they are:
 - Always present, even when process operation is consistent
 - Can be quantified with summary statistics that are consistent over time
 - Cannot be reduced by adjusting the existing process, only by changing it

e.g.

- Precision limits of instrumentation
 - ✓ Buy better instruments
- Changes in ambient conditions
 - ✓ Relocate process to climate-controlled building

ii. Special cause (Assignable) - Non-random, so its effect on the product is Unpredictable until you identify the special cause. When special cause variability is present, but the cause has not been identified, product quality can change in any direction at any time. They are:

- Response to some inconsistency in process operation (purposefully adjusting that factor would give a predictable response)
- Causes summary statistics that are not consistent over time
- Can be reduced by adjusting the existing process

e.g.

- Each operator has his own “style”
 - ✓ Retrain operators
- Raw materials purchased from different suppliers have different properties
 - ✓ Stick with one supplier; buy higher-grade supplies
- Equipment wear causes drift over time
 - ✓ Increase maintenance frequency

Causes of Variation

Natural Causes	Assignable Causes
<ul style="list-style-type: none">❑ Inherent to process❑ Random❑ Cannot be controlled❑ Cannot be prevented❑ Examples<ul style="list-style-type: none">• weather• accuracy of measurements• capability of machine	<ul style="list-style-type: none">❑ Exogenous to process❑ Not random❑ Controllable❑ Preventable❑ Examples<ul style="list-style-type: none">• tool wear• “Monday” effect• poor maintenance

1.4. Approaches to Continuous Improvement

- Represents continual improvement of all processes
- Involves all operations and work centers including supplier and customers
- People, Equipment, Materials, Procedures interface,
 - Basis-Every aspect can be improved towards perfection

The aim of TQM is to achieve higher quality at lower cost

❖ Both Higher quality and lower cost should be achieved through:

1. Internal Quality Improvements

2. External Quality Improvements.

❖ The main aim of internal quality improvements is to make the internal processes 'Cleaner', i.e. to prevent defects and problems in the internal processes which will lead to lower costs.

- ❖ external quality improvements are aimed at
 - ✓ the **external customer**, the aim being to increase customer satisfaction and thereby achieve a bigger market share and with it, higher earnings.
 - ✓ Education and training for employees
 - ✓ A leadership style that appreciate and motivate ideas for continuous improvement

TQM Writers

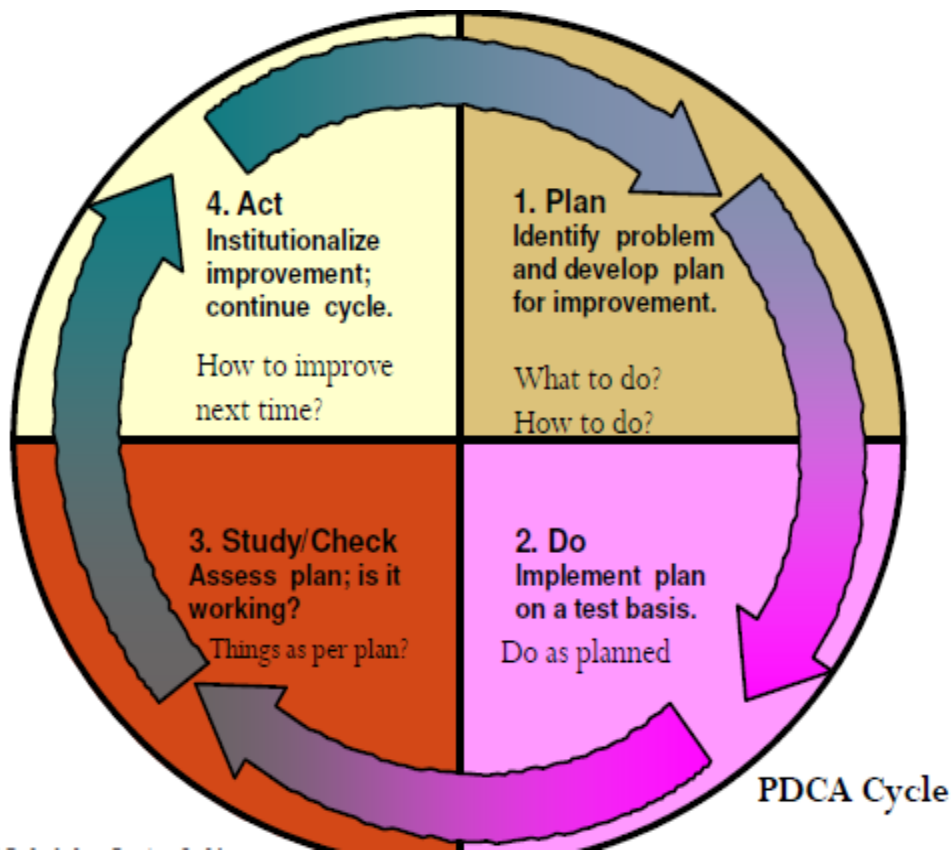
The most influential quality practitioners who have made significant contribution to the development of the philosophy are;

1. W. Edwards Deming

W. E. Deming, who was a statistician during 1940s, is regarded as the father of the TQM revolution.

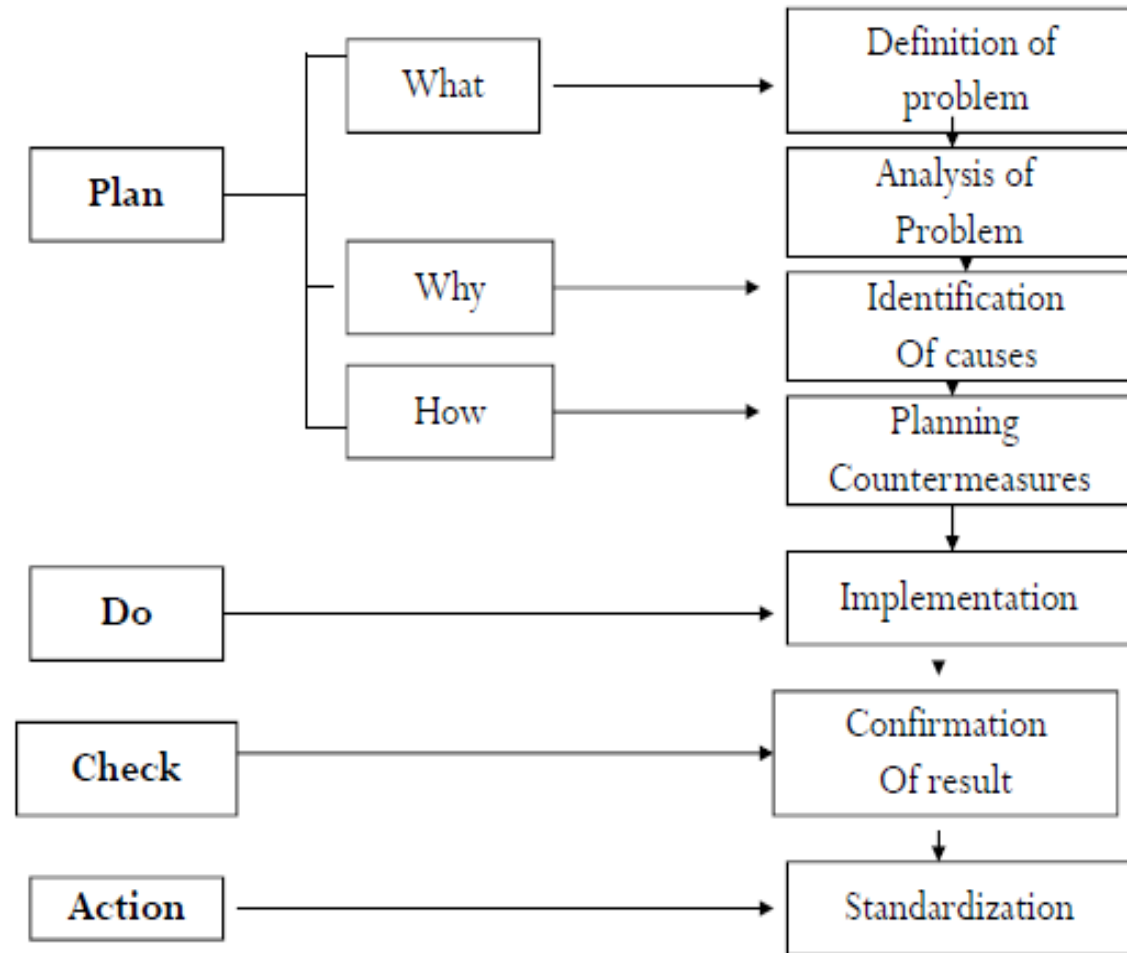
Continuous improvement cycle (PDCA) or Deming cycle

The key to any process improvement program is the PDSA cycle



Problem Solving Cycle

- PDCA for problem solving



Deming's fourteen points are:

1. Create consistency of purpose toward improvement of product and service, with the aim to become competitive and thus to stay in business and to provide jobs.
2. Adopt the new philosophy of the need for higher quality.
3. Cease dependence on mass inspection to achieve quality.
4. End the practice of awarding business on the basis of price tag alone.
5. Improve consistently and forever every process for planning, production and service.

6. Institute modern methods of training and education on the job, including management.
7. Adopt and institute leadership.
8. Drive out fear, so that every one may work effectively for the economy.
9. Break down barriers between staff areas.
10. Eliminate slogans and exhortations asking the work force for unrealistic targets.

11. Eliminate numerical quotas for the work force and numerical goals for management.
12. Remove barriers that rob people of pride of workmanship.
13. Institute a vigorous program of education and self-improvement for everyone.
14. Put everyone in the company to work to accomplish the transformation.

2. Juran

His concept of “fitness for use” reflects meeting customer needs and is based on the following five quality characteristics, as outlined by him:

1. Technological (strength)
2. Psychological (beauty)
3. Time-oriented (reliability)
4. Contractual (guarantee)
5. Ethical (sales staff courtesy)

- There are two types of costs: these are:
 - **Unavoidable Costs:** preventing defects (inspection, sampling, sorting, QC) and
 - **Avoidable Costs:** defects and product failures (scrapped materials, labour for re-work, complaint processing, losses from unhappy customers)

Juran trilogy

❖ Quality Planning

Establish quality goals

Identify customer needs

Translate needs into our language
(that can be manufactured)

Develop a product for these needs

Optimize product features for
these needs

❖ Quality Control

Prove the process can
produce under operating
conditions

Transfer process to operation

❖ Quality Improvement

Seek to optimize the process
via tools of diagnosis

In order to set about improving quality, Juran has formulated ten steps which companies can follow:

- 1) Build awareness of the need and opportunity for improvement
- 2) Set goals for improvement
- 3) Organize to reach goals
- 4) Provide training
- 5) Carry out projects to solve problems
- 6) Report progress
- 7) Give recognition
- 8) Communicate results
- 9) Keep scores achieved on quality improvement
- 10) Maintain momentum by making annual improvement

Juran was also the first to point out that the Pareto Principle could be used to quality improvements. The basis is to distinguish the important vital few from the trivial many.

Assignment 1.

Prepare a brief note on the history, basic tents and approaches to quality management of the following Quality Gurus.

1. Armand V. Feigenbaum
2. Philip B. Crosby
3. Kaoru Ishikawa
4. Genichi Taguchi
5. David A. Garvin

Individual assignment

Submission date: