LOVELY PROFESSIONAL UNIVERSITY

TOTAL QUALITY MANAGEMENT

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SYLLABUS

Total Quality Management

Objectives:

- This course is designed to enable the students to organize an internal team to lead the quality improvement efforts and to create awareness about the philosophy of Total Quality Management.
- To identify the problems relating to quality through Customer Satisfaction, Employee Involvement, Failure mode and Effect Analysis, etc.
- Students would be designing and installing best practices for quality improvement through Benchmarking, Process Improvement and adherence to International Quality Standards.

Sr. No.	Description
1.	TQM Framework, Historical Review, Gurus of TQM, Obstacles and Benefits of TQM.
2.	Leadership for TQM, 7 Habits, The Deming Philosophy, Quality Council, Core Values.
3.	Customer Satisfaction, Perception of Quality, Service Quality, Customer Retention.
4.	Employee Involvement, Surveys, Empowerment, Suggestion System, Performance Appraisal.
5.	Continuous Process Improvement, Improvement Strategies, PDSA Cycle, Kaizen, Re-Engineering, Six Sigma.
6.	Benchmarking (Bench Marking Reason, Process, Current Performance and Studying Other Issues).
7.	Quality Management Systems, Benefits of ISO Registration, ISO 9000 Series of Registration, ISO 9001 Requirements, Documentation, Registration, Management Systems, ISO 14000 Series Standards.
8.	Quality Function Deployment, The QFD Framework, QFD Team, House of Quality.
9.	Failure Mode and Effect Analysis, Total Productive Maintenance.
10.	Statistical Process Control, Experimental Design.

CONTENT

Unit 1:	Total Quality Management An Introduction *Neha Tikoo, Lovely Professional University*	1
Unit 2:	Gurus of Quality Management *Dilfraz Singh, Lovely Professional University*	12
Unit 3:	Concept of Quality Management *Navneet Kaur, Lovely Professional University*	30
Unit 4:	Leadership for TQM *Neha Tikoo, Lovely Professional University*	45
Unit 5:	Customer Satisfaction *Neha Tikoo, Lovely Professional University*	57
Unit 6:	Customer Retention *Neha Khosla, Lovely Professional University*	73
Unit 7:	Employee Involvement *Dilfraz Singh, Lovely Professional University*	87
Unit 8;	Continuous Process Improvement *Karan Arora, Lovely Professional University*	102
Unit 9:	Benchmarking *Neha Tikoo, Lovely Professional University*	122
Unit 10:	Quality Management System *Dilfraz Singh, Lovely Professional University*	138
Unit 11:	Quality Function Deployment *Ginni Nijhawan, Lovely Professional University*	152
Unit 12:	Failure Mode and Effect Analysis *Ashwani Panesar, Lovely Professional University*	169
Unit 13:	Total Productive Maintenance *Ginni Nijhawan, Lovely Professional University*	187
Unit 14:	Statistical Process Control *Neha Tikoo, Lovely Professional University*	199

Unit 1: Total Quality Management: An Introduction

Notes

CONTENTS

Objectives

Introduction

1.1 Definition of TQM

1.2 Origin and Evolution of Quality Management

1.3 Meaning and Definition of Quality

1.3.1 Integrating Perspectives on Quality

1.4 Terminologies Related to Quality Management

1.5 Summary

1.6 Keywords

1.7 Review Questions

1.8 Further Readings

Objectives

After studying this unit, you will be able to:

- Explain the Meaning of Total Quality Management
- Discuss the Origin and Evolution of Quality Management
- Explain about the Development of TQM in India Post-independence
- Explain the Contributions of TQM Gurus

Introduction

Total Quality Management (TQM), a buzzword phrase of the 1980's, has been killed and resurrected on a number of occasions. The concept and principles, though simple seem to be creeping back into existence by "bits and pieces" through the evolution of the ISO9001 Management Quality System standard.

"Total Quality Control" was the key concept of Armand Feigenbaum's 1951 book, *Quality Control: Principles, Practice, and Administration*, in a chapter titled "Total Quality Control". Feigenbaum grabs on to an idea that sparked many scholars interest in the following decades that would later be catapulted from Total Quality Control to Total Quality Management.

Total Quality Management (TQM) is a management strategy aimed at embedding awareness of quality in all organizational processes. TQM has been widely used in manufacturing, education, government, and service industries, as well as NASA space and science programs.

1.1 Definition of TQM

According to International Organization for Standardization (ISO):

"TQM is a management approach for an organization, centred on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction, and benefits to all members of the organization and to society."

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One major aim is to reduce variation from every process so that greater consistency of effort is obtained.

TQM is composed of three Paradigms:

- ***Total:*** Involving the entire organization, supply chain, and/or product life cycle
- ***Quality:*** With its usual Definitions, with all its complexities
- ***Management:*** The system of managing with steps like Plan, Organize, Control, Lead, Staff, provisioning and the likes.

TQM is defined as both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization. It is the application of quantitative methods and human resources to improve all the processes within an organization and exceed customer needs now and in the future. TQM integrates fundamental management techniques, existing improvement efforts, and technical tools under a disciplined approach.

Note Companies who have implemented TQM include Ford Motor Company, Phillips Semiconductor, SGL Carbon, Motorola and Toyota Motor Company.

Self Assessment

Fill in the blanks:

1. W. Edwards Deming, Joseph Juran, Philip B. Crosby, and Kaoru Ishikawa, known as the ……..
2. …… is a management strategy aimed at embedding awareness of quality in all organizational processes.
3. TQM is the application of …… and …… to improve all the processes within an organization and exceed customer needs now and in the future.
4. TQM integrates fundamental management techniques, existing improvement efforts, and technical tools under a ……..

1.2 Origin and Evolution of Quality Management

The roots of Total Quality Management (TQM) can be traced back to early 1920s when statistical theory was first applied to product quality control. This concept was further developed in Japan in the 40s led by Americans.

Example: Deming, Juran and Feigenbaum.

The focus widened from quality of products to quality of all issues within an organization – the start of TQM.

The following shows the history of Total Quality Management, from inspection to business excellence.

1. ***Inspection:*** Inspection involves measuring, examining, and testing products, process and services against specified requirements to determine conformity.

   During the early years of manufacturing, inspection was used to decide whether a worker's job or a product met the requirements; therefore, acceptable. It was not done in a systematic

Notes

way, but worked well when the volume of production was reasonably low. However, as organizations became larger, the need for more effective operations became apparent.

In 1911, Frederick W. Taylor helped to satisfy this need. He published 'The Principles of Scientific Management' which provided a framework for the effective use of people in industrial organizations.

Inspection still has an important role in modern quality practices. However, it is no longer seen as the answer to all quality problems. Rather, it is one tool within a wider array.

2. ***Statistical Quality Control:*** Statistical Quality Control focuses on product and the detection and control of quality problems. It involves testing samples and statistically infers compliance of all products. It is carried out at stages through the production process; and it relies on trained production personnel and quality control professionals.

Did u know? The first to apply the newly discovered statistical methods to the problem of quality control was Walter A. Shewhart of the Bell Telephone Laboratories. He issued a memorandum on May 16, 1924 that featured a sketch of a modern control chart.

Shewart's work was later developed by Deming, Dodge and Roming. However, manufacturing companies did not fully utilize these techniques until the late 1940s.

3. ***Quality in Japan:*** In the 1940s, Japanese products were perceived as cheap, shoddy imitations. Japanese industrial leaders recognized this problem and aimed to produce innovative high quality products. They invited a few quality gurus, such as Deming, Juran, and Feigenbaum to learn how to achieve this aim.

In the 1950s, quality control and management developed quickly and became a main theme of Japanese management.

A by-product of quality circles was employee motivation. Workers felt that they were involved and heard. Another by-product was the idea of improving not only quality of the products, but also every aspect of organizational issues. This probably was the start of the idea, total quality.

4. ***Total Quality:*** The term 'total quality' was used for the first time in a paper by Feigenbaum at the first international conference on quality control in Tokyo in 1969. The term referred to wider issues within an organization.

Ishikawa also discussed 'total quality control' in Japan, which is different from the western idea of total quality. According to his explanation, it means 'company-wide quality control' that involves all employees, from top management to the workers, in quality control.

5. ***Total Quality Management:*** In the 1980s to the 1990s, a new phase of quality control and management began. This became known as Total Quality Management (TQM). Having observed Japan's success of employing quality issues, western companies started to introduce their own quality initiatives.

A typical definition of TQM includes phrases such as: customer focus, the involvement of all employees, continuous improvement and the integration of quality management into the total organization.

6. ***Quality Awards and Excellence Models:*** In 1988 a major step forward in quality management was made with the development of the Malcolm Baldrige Award in the United States. The model, on which the award was based, represented the first clearly defined and internationally recognized TQM model. It was developed by the United States government to encourage companies to adopt the model and improve their competitiveness.

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In response to this, a similar model was developed by the European Foundation of Quality Management in 1992. This EFQM Excellence Model is the framework for the European Quality Award.

7. ***Business Excellence:*** TQM models are often called Business Excellence Models. Also, TQM itself is now often called Business Excellence. This is to distinguish the "new TQM" from the past work on TQM.

   Business Excellence is really the same as TQM, but with a more clearly defined approach.

Caselet

Total Quality Management

Total quality management (TQM) is the idea that controlling quality is not something that is left exclusively to the "quality controller", a person who stands at the end of a production line checking final output. It is (or it should be) something that permeates an organization from the moment its raw materials arrive to the moment its finished products leave.

TQM is a process-oriented system built on the belief that quality is a matter of conforming to a customer's requirements. These requirements can be measured, and deviations from them can then be prevented by means of process improvements or redesigns.

The European Foundation for Quality Management (EFQM) said that TQM strategies are characterized by the following:

- The excellence of all managerial, operational and administrative processes.
- A culture of continuous improvement in all aspects of the business.
- An understanding that quality improvement results in cost advantages and better profit potential.
- The creation of more intensive relationships with customers and suppliers.
- The involvement of all personnel.
- Market-oriented organizational practices.

Total quality management was developed by a number of Japanese firms in the 1950s and 1960s. But it was built largely on the teachings of W. Edwards Deming and Joseph Juran, two Americans who had quietly developed the principles in the aftermath of the second world war. With the help of books and articles such as David Garvin's 1983 description in *Harvard Business Review* of the way in which TQM and other techniques were putting Japanese companies streets ahead of their foreign competitors, the idea was later reclaimed by the United States and widely adopted by American business.

Europe, which has at times looked left out of this game of American-Japanese ping-pong, has also made occasional claims to be the fount of total quality. Raymond Levy, chairman of Renault, a French car company, said in the early 1990s:

"Quality is representative of a culture which we Europeans have no reason to let others monopolize. The Europe of Descartes; the Europe of the Age of Reason and the Enlightenment; the Europe of the industrial and technological revolution of the last two centuries holds within itself all the elements of method and exactitude conveyed by the term total quality."

Contd...

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In the late 1990s there was something of a backlash against the implications of TQM, especially in the United States. Florida Power & Light, for example, the first American company to win the prestigious Deming Prize for quality management, cut its TQM program because of its employees' complaints about the excessive amount of paperwork that it required. Douglas Aircraft, a subsidiary of McDonnell Douglas, cut its program to next to nothing. *Newsweek* colourfully described the aircraft company's action: "At Douglas, TQM appeared to be just one more hothouse Japanese flower never meant to grow on rocky American ground."

Self Assessment

Fill in the blanks:

5. ..... involves measuring, examining, and testing products, process and services against specified requirements to determine conformity.
6. The first to apply the newly discovered statistical methods to the problem of quality control was ..... of the Bell Telephone Laboratories.
7. ..... focuses on product and the detection and control of quality problems.
8. A by-product of quality circles was .....
9. The term ..... referred to wider issues within an organization.
10. EFQM Excellence Model is the framework for the .....
11. TQM models are often called .....

1.3 Meaning and Definition of Quality

Quality is a complex phenomenon based on perceptions by individuals with different perspectives on products and services. These perceptions have been built up through the past experience of individuals and consumption in various contexts. Consequently, quality encapsulates time and other contextual dimensions that add to the complexity of what is essentially a subjective evaluation of the quality of good and/or service by the consumer.

There are varied definitions of quality. Few of these are:

- "Quality is conformance to specifications."

  —British Defense Industries Quality Assurance Panel

- "Quality is conformance to requirements."

  —Philip Crosby

- "Quality is fitness for purpose."

  —Dr Juran

- "Quality is synonymous with customer needs and expectations."

  —R J Mortiboys

- "Quality is a predictable degree of uniformity and dependability, at low cost and suited to the market."

  —Dr Edward Deming

Notes

- "Quality is meeting the (stated) requirements of the customer – now and in the future."

  —*Mike Robinson*

- "Quality is the total composite product and service characteristics of marketing, engineering, manufacturing and maintenance through which the product and service in use will meet the expectations by the customer. "

  —*Armand Feigenbaum*

1.3.1 Integrating Perspectives on Quality

Eight principal quality dimensions defined by Garvin are:

- ***Performance:*** This refers to the primary operating characteristics of the product or service; they are usually measurable, e.g., miles per gallon, time for 0 to 60 miles for a car; number of rooms, baths, etc. in a house.
- ***Features:*** These are additional characteristics that enhance the product/services appeal to the user, e.g., deleaded ink used for newspapers, glare reducing coatings on bulbs, etc.
- ***Reliability:*** Is the precision with which the product or service meets the specified standards. Approaches such as using pre-specified tolerance limits, Taguchi's quality loss function, Motorola's 6S (six sigma) limits.
- ***Conformance:*** Garvin (1988) came up with eight dimensions of quality to link customer requirements to engineering design.
- ***Durability:*** Durability measures the length of a product's life, e.g., light bulbs, car mufflers. When a product can be repaired, estimating durability is more complicated.
- ***Serviceability:*** Serviceability is the speed with which the product can be put into service when it breaks down, as well as the competence and behaviour of the service person. The speed of service can be measured by response time and mean time to repair (MTTR).
- ***Aesthetics:*** Aesthetics is the subjective dimension indicating the kind of response a user has to a product. It represents the individual's personal preference – the ways an individual responds to the look, feel, sound, taste and smell.
- ***Perceived Quality:*** This is also a subjective dimension. It is the quality attributed to a good or service based on indirect measures, for example, inferring the quality of an airline by the cleanliness of the flip-down tray. Well maintained tools and an immaculate workplace may indicate a good workman.

On the basis of these quality dimensions and the varied definitions, we look below and the Quality Policies of a few companies from the Manufacturing Sector, and the Service Sector.

1. ***Life Insurance Corporation of India Ltd.***

   Quality Mission: To explore and enhance the quality of life through financial security by providing products and services of aspired attributes with competitive returns.

2. ***Sony Music:*** Their Quality Policy is as under:

   "***Improve:*** We will lead in the use of advanced technologies development and processes.

   Surpass: Every one of us is totally dedicated to exceeding our artists and customers expectations by striving to deliver the highest quality music and media careers.

   Optimize: As a team we expect the best because we are committed to being the best."

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3. ***Airtel Quality Statement:*** We will deliver error free "Mobile Communication Services" through Customer Services, attitude, employee empowerment, speed, creativity and continuous improvement.

4. ***Mitsubishi Hi Tech***

   Quality Policy: Continuous fulfillment of customer requirement and specification.

   The company principles for ensuring consumer satisfaction are stated as:

   - Comprehensive customer support before and after sales.
   - Customer-oriented delivery periods for all grades and maximum quality.
   - Continuous improvement of product and process considering both economic and ecological procedure.
   - Employment of highly motivated and well trained and flexible staff.
   - Economics and quality, ensuring cooperation with supplier.
   - Development of new products and improvement of existing ones.

5. ***Oberoi Hotels and Resorts:*** OHRs are relentlessly committed to quality through consistency and dedication to guest satisfaction and unparalleled standard of service. Quality means providing the right blend of service, luxury and efficiency.

Task Make a report on the development of TQM in India since last 20 years.

Self Assessment

Fill in the blanks:

12. Quality is getting more and more relevant as India is …… its economy and is …… itself with the world system.

13. It is universally recognized that …… and …… contribute to customer loyalty.

1.4 Terminologies Related to Quality Management

Quality Control

Quality control refers to all those functions or activities that must be performed to fulfill the company's objectives.

It is systematic control of all those variables which affects the quality of a product.

It aims at prevention of defects.

Inspection

Inspection is the process of comparing actual quality characteristics of a product with a predetermined or specified set of standards in order to segregate good products from bad products.

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Quality Assurance

Quality Assurance is any action directed toward providing customers with goods and services of appropriate quality.

It relies on comprehensive system of planning, documentation, statistical process control and certification of product.

Total Quality Control (TQC)

TQC can be defined as an effort of continuous quality improvement of all processes, products and services through universal participation that results in increased customer satisfaction, loyalty, and improved business results.

TQM is the foundation for activities, which include:

- Commitment by senior management and all employees
- Meeting customer requirements
- Reducing development cycle times
- Just in Time/Demand Flow Manufacturing
- Improvement teams
- Reducing product and service costs
- Systems to facilitate improvement
- Line Management ownership
- Employee involvement and empowerment
- Recognition and celebration
- Challenging quantified goals and benchmarking
- Focus on processes/improvement plans
- Specific incorporation in strategic planning

This shows that TQM must be practiced in all activities, by all personnel, in Manufacturing, Marketing, Engineering, R&D, Sales, Purchasing, HR, etc.

It focuses on total satisfaction of customer through continuous improvement.

Self Assessment

Fill in the blanks:

14. ..... refers to all those functions or activities that must be performed to fulfill the company's objectives.
15. Quality control aims at ..... of defects.
16. ..... is any action directed toward providing customers with goods and services of appropriate quality.
17. TQM focuses on total satisfaction of customer through .....

Notes

Case Study

Toyota Contract Workers

While life-time employment has been the norm for a portion of the workers in Japan, recessionary economic systems have made this trend difficult if not impossible for some corporations. In an effort to eliminate the costly life-time employment contract while at the same time avoiding lay-offs, organizations led by Toyota Motor Corporation have created a new category of temporary professional workers for labour force in Japan.

These temporary workers will have limited of one year contracts. Employees like automotive designers will not be offered customary life time employment. The company will pay these employees a salary based on individual merit rather than the past pay practice of linking pay to seniority and overall company performance.

According to Toyota "As business conditions surrounding Japanese Corporations underwent radical change, it was inevitable that the rigid organizational structure of past would impose limits on the corporate growth".

Toyota President, Tatsuro Toyoda plans to gradually increase the number of white collar contract workers in Japan. Other Japanese organization may follow Toyota's trend. The number of white collar contract employees in increasing and this class of workers is easier to terminate than life time workers. Contract workers in blue and white collar segments increased from 14 percent in 1989 to 19 percent in 1993. These temporary workers will be the safety valve during the cyclical economic conditions. The practices will reduce the number of white collar workers blamed for many corporate earning declines. According to a leading Japanese organization, executives agree Japan "must thoroughly revise the life time employment system".

Questions

1. Make a brief presentation of the case.
2. What do you think the Japanese revising their employment trend?
3. What are the advantages and disadvantages of the new employment practice?
4. Are Japanese attempting to adopt an American style employment and evaluation policy?
5. Would the former lifetime employment system work for US companies? Why?

1.5 Summary

- "Total Quality Control" was the key concept of Armand Feigenbaum's 1951 book, Quality Control: Principles, Practice, and Administration, in a chapter titled "Total Quality Control".
- Total Quality Management (TQM) is a management strategy aimed at embedding awareness of quality in all organizational processes.
- TQM is defined as both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organization.
- During the early years of manufacturing, inspection was used to decide whether a worker's job or a product met the requirements.

Notes

- Statistical Quality Control is carried out at stages through the production process; and it relies on trained production personnel and quality control professionals.
- In the 1950s, quality control and management developed quickly and became a main theme of Japanese management.
- In 1988 a major step forward in quality management was made with the development of the Malcolm Baldrige Award in the United States.
- Eight principal quality dimensions defined by Garvin are: performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality.
- Quality Mission of Life Insurance Corporation of India Ltd. is to explore and enhance the quality of life through financial security by providing products and services of aspired attributes with competitive returns.
- Quality Policy of Mitsubishi Hi Tech is continuous fulfillment of customer requirement and specification.

1.6 Keywords

Business Excellence: Business excellence is the systematic use of quality management principles and tools in business management.

Conformance: Conformance refers to certification or confirmation that a good, service, or conduct meets the requirements of legislation, accepted practices, prescribed rules and regulations, specified standards, or terms of a contract.

Customer Focus: The orientation of an organization toward serving its clients' needs is called as customer focus.

Inspection: The testing of a part to ensure that it meets its design specifications is known as inspection.

ISO 9001: ISO 9001 is one of the standards within the range of ISO 9000 standards which addresses various aspects of quality management.

Malcolm Baldrige Award: The Malcolm Baldrige National Quality Award (MBNQA) is presented annually by the President of the United States to organizations that demonstrate quality and performance excellence.

Quality Control: Quality control is a process that is used to ensure a certain level of quality in a product or service.

Restructuring: It means a significant modification made to the debt, operations or structure of a company.

Statistical Quality Control: Statistical Quality Control (SQC) is the term used to describe the set of statistical tools used by quality professionals. SQC is used to analyze the quality problems and solve them.

Total Quality Management: Total quality management is a management system for a customer-focused organization that involves all employees in continual improvement.

1.7 Review Questions

1. Explain the concept of Total Quality Management.
2. Define TQM.
3. Write a note on the evolution of TQM from inspection to business excellence.

Notes

4. Explain the philosophy of Joseph Juran.
5. Explain in detail the history of Total Quality Management.
6. What are the eight principal quality dimensions defined by Garvin? Explain.
7. "TQM is here to stay." Explain in Indian context.
8. Give their quality mission:
   (a) Sony Music
   (b) LIC India Ltd.
   (c) Airtel
   (d) Infosys
   (e) Oberoi Hotels and Resorts

Answers: Self Assessment

1.	Big four	2.	Total Quality Management
3.	Quantitative methods; human resources	4.	Disciplined approach
5.	Inspection	6.	Walter A. Shewhart
7.	Statistical Quality Control	8.	Employee motivation
9.	Total quality	10.	European Quality Award
11.	Business Excellence Models	12.	Deregulating; integrating
13.	Quality, Reliability	14.	Quality control
15.	Prevention	16.	Quality Assurance
17.	Continuous improvement		

1.8 Further Readings

Books

Besterfield. Dale H. (2011), *Total Quality Management,* Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management,* Pearson Education, India

Mukherjee N.P. (2006), *Total Quality Management,* PHI Learning Pvt. Ltd.

Nigam, Shailendra (2009), *Total Quality Management,* Excel Books, India

Online links

http://asq.org/learn-about-quality/total-quality-management/overview/overview.html

http://www.businessballs.com/dtiresources/total_quality_management_TQM.pdf

http://www.scribd.com/doc/19494376/Chap-1-Historical-Development-of-TQM

http://www.wiley.com/college/sc/reid/chap5.pdf

Notes

Unit 2: Gurus of Quality Management

CONTENTS

Objectives

Introduction

2.1 TQM Guru: An Introduction

2.2 W. Edwards Deming

2.2.1 Management Responsibility

2.3 Joseph M. Juran

2.3.1 Quality is Fitness to Use

2.3.2 Juran's Quality Trilogy

2.4 Philip B. Crosby

2.4.1 Crosby's Four Absolutes of Quality

2.4.2 Crosby's Six C's

2.5 Armand V. Feigenbaum

2.5.1 Stages of Industrial Cycle

2.6 Kaoru Ishikawa

2.6.1 Ishikawa's Statistical Techniques to CWQC

2.7 Genichi Taguchi

2.8 Summary

2.9 Keywords

2.10 Review Questions

2.11 Further Readings

Objectives

After studying this unit, you will be able to:

- Explain the Contribution of Various TQM Gurus
- Discuss and Differentiate the Philosophies of the TQM Gurus

Introduction

Previous unit gave you an insight on the meaning of total quality management and its development over the years. In this unit, you will study about the different TQM gurus and their contribution in this field.

2.1 TQM Guru: An Introduction

A TQM Guru is an expert thinker who communicates his thoughts through verbal and written expressions and thus contributes to the field of TQM. Starting just after World War II a number

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of philosophers and thinkers have made their contributions to the movement of "Total Quality Management". In the summer of 1985 the name "Total Quality Management" was first suggested by Nancy Warren, a behavioural scientist in the US Navy, according to Marry Walton (1990). Thereafter, a number of TQM Gurus have made their significant contributions. Many of the TQM Gurus are Americans and a very few of them significant contributors.

Did u know? Some of the major contributors towards the thought of TQM are: (i) M. Edwards Deming, (ii) Joseph M. Juran, (iii) Philip B. Crosby, (iv) Armand V. Feigenbaum (v) Bill Conway, (vi) Kauru Ishikawa (vii) Genichi Taguchi, (Viii) Shigeo Shingo (ix) W.G. Ouchi, (x) Vilfredo Pareto, (xi) Tom Peters, (xii) S.R. Udpa, (Xiii) Stephen Covey, and (xiv) J.S. Oakland.

Self Assessment

Fill in the blanks:

1. A …… is an expert thinker who communicates his thoughts through verbal and written expressions and thus contributes to the field of TQM.
2. The name "Total Quality Management" was first suggested by …….

2.2 W. Edwards Deming

Dr. W. Edwards Deming was born on 14 October, 1990. He was awarded his doctorate in mathematical physics in 1928. He then worked in the US Government census for many years, particularly in statistical sampling techniques. In 1943 he published a technical book – *Statistical Adjustment of Data*.

Deming is regarded as "the quality Guru who never gave up," writes John A. Byrne while remembering Edwards who taught American managers that quality matters described Deming at the age of 93 years as a frail figure in three piece pinstripes, with bifocals, hearing aids in both ears and thin white hair. He said, "My experience with Deming was pleasant one when I interviewed him. "He described Deming as a Cranky, obstinate, and obscure. He asked as many questions as he volunteered answers. He spoke in waspy staccato, in short declarative sentences, many of them followed by awkward pauses. Deming by then was concerned that he had run out of time. Despite success stories of Xerox, Motorola and many other companies that embraced his teachings, Deming felt he was a prophet without honour in his own country. Deming achieved credibility in the US only late in his long career, despite his status as Japan's great American censor. The former Census Bureau statistician visited Japan in 1947, as a consultant to help in the work of rebuilding the nation. Year after year he returned to lecture the leading business executives on how to use statistics and to determine how consumers define quality.

Beneficial effects of Deming's programs were seen such as reductions in scrap and rework. However, these advances did not have a lasting effect after the war. In the home market anything that was produced was sold with or without statistical or quality control. A second factor had a strong bearing on Deming's later success. To quote him: "the courses were well-received by engineers but management paid no attention to them. Management did not understand that they had to get behind improvement of quality and carry out their obligations from the top down. Any instability can help to point out specific local problems. Once these local problems are removed, there is process that will continue until someone changes it. Changing the process is management's responsibility and we failed to teach them that."

After the World War II, Deming was invited by Japan as an Adviser to the Japanese Census. He became involved with the Japanese Union of Scientists and Engineers (JUSE) after its formation in 1946.

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Notes In 1956, Deming was awarded the Shewhart Medal by the American Society for Quality Control. Four years later in 1960, Deming's teachings were widely known in Japan and the Emperor awarded him the Second Order of the Sacred Treasure.

Deming encouraged Japanese managers and engineers to go beyond the utilization of statistics and strive for continuous improvement. The Shewhart Cycle of "Plan-Do-Check-Act" was revised by Deming to include "Study" rather than PDSA Cycle (Plan, Do, Study and Act). He said: "One has to analyze and think at study stage of the cycle and then act." Deming convinced Japanese managements that the purpose of using quality management techniques was to help companies stay in business.

2.2.1 Management Responsibility

Deming strongly believed that quality improvement had to be management led. He saw management responsibility in two main areas:

(i) To create a positive climate for quality improvement, and

(ii) To emphasize knowledge of workers rather than rigid systems.

To create a positive climate for quality improvement, it is management's responsibility to make sure that work is fund and the workers must enjoy it and do it for a purpose as of their self-esteem. Deming stressed the importance of what he calls intrinsic motivation (self-esteem as the individual responsibility for what he or she does) rather than extrinsic motivation (accept once the material rewards for work carried out). Deming believed that the present work culture in Western countries has "destroyed workers' by depriving them of enjoying what they do and by placing emphasis on merit system based on results.

To emphasize knowledge of workers rather than rigid system, Dr. Deming was of the opinion that our job is to increase the knowledge and skills of the worker. Deming said you must develop the "human being" in worker by improving his/her brainpower through continuous training and education. Rigidity does not solve any problem. It is flexibility which creates humility and values and thus finds solution to all sorts of problems. He laid special emphasis on the knowledge and skills development of workers. Deming claimed that many errors which occur in organizations were caused by existing systems which were impractical, too right and inaccurate rather than the system work by trying to reduce costs and make money for their organizations. Questioning figures to achieve good results can only make things worse rather than better.

Self Assessment

Fill in the blanks:

3. …… is regarded as "the quality Guru who never gave up," writes John A. Byrne.
4. Any …… can help to point out specific local problems.
5. In 1956, Deming was awarded the …… by the American Society for Quality Control.
6. Deming encouraged Japanese managers and engineers to go beyond the …… and strive for continuous improvement.

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7. It is ..... which creates humility and values and thus finds solution to all sorts of problems.

8. ..... thinking defeats constancy of purpose to stay in business with long-term growth.

Caselet

What Deming Taught Toyota – Every 21st Century Manager Needs to Know

Dr. W. Edwards Deming's principles support the global success of Toyota, Proctor & Gamble, Ritz Carlton, Harley-Davidson, and many other leading organizations. His teachings are essential for the effective application of Six Sigma, Lean Manufacturing, and Loyalty/Net Promoter and other quality improvement, customer retention and business growth methods.

Dr. Deming's profound, yet simple; success strategies offer your organization a proven system to achieve lasting growth and success. The principles apply universally to business, healthcare, education—in fact, to any enterprise—and to you personally.

Ironically, this American prophet—still unknown to most of his countrymen—created the theory behind today's successful business practices. He is a national hero in Japan. The highest award for quality in Japan—a Nobel Prize for business success—is the Deming Prize, awarded with great fanfare every year. Dr. Deming helped Toyota—and other leading Japanese exporting companies—develop the vital management philosophy and practices that enabled them to become market leaders around the world. Dr. Shoichiro Toyoda, Chairman and former President (1982-1999) of Toyota, said:

Every day, "I think about what he meant to us. Deming is the core of our management".

In 2005, accepting the American Society for Quality's Deming Medal, Dr. Toyoda elaborated:

"…Dr. Deming came to Japan following World War II in order to teach industry leaders methods of statistical quality control, as well as to impart the significance of quality control in management and his overall management philosophy. He was an invaluable teacher…, playing an indispensable role in the development and revitalization of post-war Japan.

Industrialists as well as academics earnestly began to study and implement Dr. Deming's theories and philosophy. Dr. Deming soon became widely known not only as a brilliant theorist, but also as a kind and modest man. In 1951, the Deming Prize was founded in order to promote the widespread practice of quality control based on Dr. Deming's philosophy.

We at Toyota Motor Corporation introduced TQC in 1961, and in 1965 were awarded the Deming Application Prize…. As we continued to implement Dr. Deming's teachings, we were able to both raise the level of quality of our products as well as enhance our operations on the corporate level. I believe that TMC today is a result of our continued efforts to implement positive change in pursuit of the Deming Prize…

Now, we are faced with rapid global restructuring of both society and business. In the midst of these overwhelming changes, corporations faced with the challenge of providing value to a wide range of shareholders have begun to focus on quality innovations such as completely customer-oriented management practices, environmental preservation, and the upholding of corporate ethics.

Source: http://www.managementwisdom.com/weddechofqua.html

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2.3 Joseph M. Juran

Dr. Joseph M. Juran has also contributed a lot to the movement of total quality. He raised pertinent questions on the contribution of quality in reducing costs and improving standards in his book titled: *Quality Control Handbook* in 1951 which has subsequently become an essential reference book on quality. Juran's work started later than Deming after the World War II during rebuilding of Japanese economy. Juran was an engineer by profession working in the USA. He was invited Japanese in 1954 to contribute to the rebuilding of Japanese economy and speak on planning, organizing and managing quality programs. Juran is the founder Chairman of the Juran Institute. He is also the author of many books and hundreds of research papers and articles related to subjects to quality. He has acted as consultant to many major industrial organizations and governments. He is still in great demand as an international speaker. He has been awarded over thirty medals, fellowships, and honorary memberships in more than twelve countries. He was awarded the Second Order of Sacred Treasure by the Emperor of Japan, the highest decoration given to a non-Japanese citizen for helping the development of quality control in Japan. Juran is known for his development of the concepts of determining the avoidable and unavoidable costs of quality, company-wide quality management and quality Trilogy.

Juran's approach to quality control and its management is two-sided:

(i) ***Companies Mission in Terms of Fitness of Use:*** This is done by providing products and service which conform to customer specifications plus issues of reliability, availability, maintainability, customer service, etc.

(ii) ***The role of Senior Managers in Providing Leadership:*** This is for managing the required resources in encouraging awareness and participation and in developing systems of policy, goals, plans, measures and controls for quality.

2.3.1 Quality is Fitness to Use

Juran has said that one of the chief obstacles to achieving is disagreement over the meaning of quality and the key words associated with it. He defines quality as, "fitness to use" which breaks into the two components.

(i) ***Quality Consists of those Product Features that meet Customer Need:*** Product features provide customer satisfaction. The product is output of any process and includes goods and services. The customer is any one affected by the goods or services and can be internal or external.

(ii) ***Quality Consists of Freedom from Deficiencies:*** Measures of deficiency are calculated by dividing the frequency of deficiencies by the number of chances for deficiencies. The evaluation process begins with asking the customers how they evaluate quality. To further clarify the meaning of quality, Juran points out that product satisfaction and dissatisfaction are not opposites. "Product satisfaction has its origin in product features and that is why clients buy the products. Product dissatisfaction has its origin in non-conformance and that is why customers complain."

Fitness for use is achieved by a process which reflects the interplay between the various stages of organizational activities before meeting customer demands and Juran terms this process as "the spiral of progress". The spiral of progress reflects the chain of user–supplier relationships at various stages of the process.

Caution Quality has to be controlled at each stage of the processes but should not be implemented just as a mechanical process.

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It should be aimed at controlling two aspects.

- Sporadic problems or avoidable costs (defects, product failure, scrapped materials, labour wasted in usage for rework, repair, dealing with customer complaints).
- Unavoidable costs dealing with chronic problems (prevention and control).

The first category of the problems is easily solved by using quality control techniques such as tolerance review, fool proofing, standard statistical techniques, charts and diagrams. The second category, however, requires the introduction of a new culture which is intended to change attitudes and increase companywide knowledge. The long-term health of business is determined by a structured approach to quality which is planned, implemented and controlled according to the mission of the business concerned.

2.3.2 Juran's Quality Trilogy

Juran proposes three managerial processes under his Quality Trilogy which he thinks are necessary for the structured implementation of a total quality program. These three managerial processes are: (i) Planning (ii) Improvement and (iii) Control. Juran argues that the planning process is crucial for improvement to become a continuous activity. Planning therefore, has to be conducted with a long-term view rather than a on a project by project basis.

Juran's project by project improvement approach is very popular among Indian companies as well.

Example: Punjab Tractors Limited, Mohali (Punjab) has started implementing this approach for improving its overall effectiveness. They have achieved very encouraging results with the help of this approach.

Many more Indian companies have started using Juran's project by project improvement approach in their plants for improving effectiveness. But ultimately they have to drain the swamp, that is, implement total quality management.

Juran developed a quality trilogy to assist management in the implementation of strategic quality planning.

Table 2.1: Juran's Quality Trilogy

Quality Planning	Quality Control	Quality Improvement
Identify the customers.	Quality Control	Prove need for improvement
Determine the customer's needs.	Choose control subjects	Identify specific projects for improvement
Develop product features.	Choose units of measurement	Guide the projects
Establish quality goods.	Establish measurement	Diagnose for discovery of causes
Develop a process.	Establish standards of performance	Diagnose to find the causes
Prove process capability.	Measure actual performance	Provide remedies
	Interpret the difference	Prove that remedies are effective under the operating conditions
	Take action on the difference	Provide for control to hold gains.

Juran, trilogy comprises the three stages of quality planning, quality control and quality improvement. Juran suggested that most organizations placed too much emphasis on control and paid insufficient attention to the aspects of planning and improvement. The seven

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management tools support the quality planning process in assisting the identification and management of quality improvement opportunity. In terms of improvement process, Juran proposed a six-stage methodology.

Self Assessment

Fill in the blanks:

9. Juran was a/an ..... by profession working in the USA.
10. Juran defines quality as .....
11. The spiral of progress reflects the chain of ..... relationships at various stages of the process.
12. Juran's ..... improvement approach is very popular among Indian companies as well.
13. Juran developed a ..... to assist management in the implementation of strategic quality planning.

2.4 Philip B. Crosby

Philip B. Crosby was a former Corporate Vice-President for Quality at ITT. He is the founder of the Crosby Quality College where over 15,000 senior managers have attended courses and seminars on quality. Crosby is perhaps best known for his more vocational style and popular programs such as: zero defects (ZD), conformance to requirements and quality is free. He is also the author of many books, amongst which "*Quality is Free: The Art of Making Quality Certain*" is a universally adopted book. His one other book is: **"***Quality Without Tears***".**

The essence of Crosby's quality drive is prevention. He argues that quality should be "Zero Defect (ZD)". Acceptable Quality Levels (AQL) should be forbidden because they compromise the commitment towards the achievement of Zero Defects. According to Crosby there are two major problems which are the causes of poor quality in industry.

(i) Those which are due to employee's poor awareness and knowledge, and

(ii) Others which are due to carelessness and lack of attention. The former can be easily identified, measured, and solved but the latter need long term management effort in changing culture and attitudes.

Crosby explains that if managements are serious about achieving ZD, they have to be serious about prevention. He proposes some guidelines for managers which he calls the four absolutes of quality management. He has also put forward a 14-point program for quality management. Crosby refers to the four absolutes of quality management as: "The concept that forms the foundation for improvement". They must be ingrained in the mind and fabric of an organization. These must also be implemented continually if success is to be complete and permanent.

2.4.1 Crosby's Four Absolutes of Quality

1. ***Quality means conformance to requirements:*** The setting of requirements is management's responsibility as are the communication devices and their effectiveness. Crosby argues that if management wants people to "do things right the first time", they have to tell everyone clearly what that is.
2. ***Quality comes from prevention:*** Vaccination is the way to prevent disease. The first absolute was to understand the process by which various processes are involved in producing

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products/services. The second is about identifying and eliminating all chances of error to occur. Appraisal and inspections are expensive and unreliable methods of attaining quality. Organizations have to adopt prevention as the way of life as Crosby notes, "The error that does not exist cannot be missed. " The secret to prevention is: observing the process, identifying possibilities for error, and eliminating the causes of problem. His observation concerning service and manufacturing organizations is: "The only difference between the two is that the waste in service companies goes out in baskets and in manufacturing companies in barrels."

3. ***Quality performance standard is zero defects:*** "This is conformance to requirements and should be the personal performance standard of everyone in the organization, and will come from a change in attitudes" according to Crosby. Crosby believes errors are a function of the importance the organization and individual place on specific things. People will perform the standard they are given if they truly understand it. And that the standard must be zero defect.

4. ***Quality measurement is the price of non-conformance:*** According to Crosby manufacturing companies spend 25 percent of sales doing things wrong and service companies spend about 40 percent of their operating costs on the same wasteful actions. Crosby explains that cost of quality consists of two areas of performances: Price of non-conformance and price of conformance. The price of non-conformance is all the expenses involved doing things wrong. The price of conformance is what is spent to make things come out right Tracking this data serves to act as a way to determine where promising improvement opportunities lie and a way to track the improvement.

Similarly to the arguments raised by Deming and Juran, Crosby thinks that companies' performance is reflected by their management attitudes to quality. To achieve great improvements, management has to believe in the following points:

- The conviction by senior managers that they have had enough of quality being a problem and wanting to turn it into an asset.
- The commitment that they will understand and implement the four absolutes of quality management.
- The conversion to that way of thinking from the conventional wisdom that caused the problem in the first place.

Crosby points out that it takes a long time to transfer from conviction to conversion but that as soon as the transfer process begins it is a positive sign that improvement starts to take place.

2.4.2 Crosby's Six C's

A Key to the improvement process is education beginning with management and flowing down to all employees. Crosby summarizes the education process in the six C's as follows:

1. ***Comprehension:*** Understanding what is necessary and the abandonment of the conventional way of thinking.
2. ***Commitment:*** Expression of dedication first by management and everyone else soon after.
3. ***Competence:*** Implementation of the improvement process in a methodical way.
4. ***Correction:*** Elimination of possibilities for error by identifying current problems and tracking them back to their basic cause.
5. ***Communication:*** Complete understanding and support of all people in the process including suppliers and customers.

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6. ***Continuance:*** Unyielding remembrance of how things used to be and how they are going to be.

Self Assessment

Fill in the blanks:

14. Philip B. Crosby was a former …… for Quality at ITT.

15. The essence of Crosby's quality drive is …….

2.5 Armand V. Feigenbaum

Armand V. Feigenbaum became known to the Japanese at the same time as Deming and Juran. As head of quality at General Electric (USA) he had extensive contacts with Japanese companies such as Hitachi and Toshiba. But it is really through his book titled: *Total Quality Control* that he became best known. He was the first to argue that quality should be considered at all the various stages of the process and not just within the manufacturing function. Feigenbaum argued that the contribution of the manufacturing function in isolation is not enough for the production of high quality products. He concludes.

"The underlying principle of the total quality view and its basic difference from all other concepts is that to provide genuine effectiveness. Control must start with identification of customer quality requirements and end only when the product has been placed in the hands of a customer who remains satisfied. Total Quality Control guides the coordinated actions of people, machines, and information to achieve this goal. The first principle to recognize is that quality is everybody's job."

From a quality consideration, Feigenbaum argues that new products progress in the factory through smaller stages of what he terms the industrial cycle. He refers to three categories of stages of the industrial cycle.

2.5.1 Stages of Industrial Cycle

1. New design control
2. Incoming material control
3. Product or shop-floor control

He also made a major contribution by studying quality costs. He identified the various costs in what he called the 'hidden plant'. This is the proportion of the total plant capacity which specifically deals with rework and corrections. He considered that the size of the hidden plant can vary from 15 to 40 per cent of the total plant capacity.

Deming, Juran and Crosby are the main pioneers in the area of Total Quality Management. Their thoughts on TQM have some conflicts but there are more similarities than conflicts. So their contributions to TQM are also regarded as three paths, one journey.

Task Present a detailed report highlighting the clashes and commonalties in the philosophies of W. Edwards Deming, Philip B. Crosby and Joseph M. Juran.

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Self Assessment

Fill in the blanks:

16. …… was the first to argue that quality should be considered at all the various stages of the process and not just within the manufacturing function.

17. The underlying principle of the total quality view and its basic difference from all other concepts is that to provide …….

2.6 Kaoru Ishikawa

Kaoru Ishikawa is considered as Japan's leading figure in the area of Total Quality Management. His inspiration came from the work of Deming and Juran and to a lesser extent, from that of Feigenbaum. He is more respected for the following contributions.

Ishikawa's main contributions to TQM are given below:

(i) ***Quality control circles:*** He was the first to introduce this concept and to have put it into practice successfully.

(ii) He is the originator of fishbone diagrams or Ishikawa diagrams which are now used worldwide for problem solving and continuous improvement through cause-effect analysis.

(iii) Ishikawa has commented that Feigenbaum's approach to Total Quality Control includes many non-specialists and therefore, the input on quality problem solving may be limited. He argues that Company Wide Quality Control (CWQC) has to rely on the wide use of statistical techniques. He has classified statistical techniques in three categories as given below. Ishikawa argues that nearly 90-95 per cent of the problems can be solved using the elementary statistical techniques which do not require specialized knowledge.

2.6.1 Ishikawa's Statistical Techniques to CWQC

1. Elementary statistical techniques
   - (i) Pareto analysis (vital few *versus* trivial many)
   - (ii) Cause and effect diagram (not a true statistical technique)
   - (iii) Stratification
   - (iv) Checklist (tally sheet)
   - (v) Histogram
   - (vi) Scatter diagram
   - (vii) Graphs and Shewhart control chart
2. Intermediate statistical methods
   - (i) Theory of sampling surveys
   - (ii) Statistical sampling techniques
   - (iii) Various methods of statistical estimation and hypothesis testing
   - (iv) Methods of utilizing sensory tests
   - (v) Methods of experimental design

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3. Advanced statistical methods (using computers)
   (i) Advanced experimental design
   (ii) Multivariate analysis
   (iii) Operations research methods.

Self Assessment

Fill in the blanks:

18. …… was the first to introduce the concept of quality control circles.
19. Kaoru Ishikawa argues that …… has to rely on the wide use of statistical techniques.

2.7 Genichi Taguchi

Genichi Taguchi worked as Director of the Japanese Academy of Quality between 1978 and 1982. He was awarded the Deming Prize in 1960 for his contribution in developing techniques for industrial optimization. He has developed methods for on-line and off-line quality control which form the basis for his approach towards total quality control assurance in 1989. Taguchi received MITI's Pourle Ribbon Award from the Emperor of Japan for his contribution to Japanese industrial standards. He is known as international consultant in quality control and assurance.

Taguchi's methods incorporate the use of statistical techniques. They are primarily intended for designers and engineers to optimize the setting so that products are robust. These statistical methods are intended as a troubleshooting/problem-solving tool in the early stages of the product development cycle. Besides control variables which are dealt with by SPC, Taguchi methods enable engineers/designers to identify 'noise variables' which if not controlled can affect product manufacture and performance.

Taguchi defines the quality of a product as the loss imparted by the product to the society from the time the products is shipped. The loss may include various things such as customer complaints, added warranty costs, damage to company reputation and loss of market lead amongst others.

Taguchi argues that product does not start causing losses until it is out of specification but more importantly when there is deviation from the target value.

Taguchi methods emerged because of his disagreement with the use of zero defects as a principle to produce quality products. The zero defect principle is that the robustness derives from consistency. Provided that there is a consistency in deviations, it will be quite possible to make adjustments in the target. Zero Defect does not permit scattered deviations within specifications.

Taguchi argues that product robustness comes from having consistent deviation which them makes the task of elimination much easier. He proposed the list of quality imperatives as guidelines to quality improvement.

Table 2.2: Taguchi's Quality Imperatives

Sl No.	Quality Imperatives
1.	Quality losses result from product failure after sale. Product robustness is more a function of product design than on-line control, however, stringent be the manufacturing processes.
2.	Robust products deliver a strong 'signal' regardless of external 'noise' and with a minimum of internal 'noises'. Any strengthening of a design, that is, any market increase in the signal-to-noise ratios of component parts will simultaneously improve the robustness of the product as a whole.

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3.	To set targets at maximum signal-to-noise ratios, develop a system of trials that allows you to analyse change in overall system performance according to the average effect of change in component parts, that is, when you subject parts to varying values, stresses, and experimental conditions. In new products, average effects may be most efficiently discerned by means of "arthogonal arrays".
4.	To build robust products, set ideal target values for components and then minimize the average of the square of deviations for combined components, averaged over the various customer-user conditions.
5.	Before products go on to manufacturing tolerances are set. Overall quality loss then increases by the square of deviation from the target value, that is, by the quadratic formula L= D^C, where the constant C, is determined by the cost of the counter measure that might be employed in the factory. This is the "quality loss function".
6.	Virtually nothing is gained in shipping a product that just barely satisfied the corporate standards over a product that just fails. Get on target, don't just try to stay in specification.
7.	Work relentlessly to achieve designs that can be produced consistently: demand deviation outside. Where deviation from target is consistent, adjustment to the target is possible.
8.	A concerted effort to reduce product failure in the field will simultaneously reduce the number of defectives in the factory. Strive to reduce variances in the components of the product and variance will be reduced in the production system as a whole.
9.	Competing proposals for capital equipment or competing proposals for on-line interventions may be compared by adding the cost of each proposal to the average quality loss, that is, the deviations expected from it.

Self Assessment

Fill in the blanks:

20. Taguchi received MITI's …… from the Emperor of Japan for his contribution to Japanese industrial standards.

21. Taguchi is known as …… in quality control and assurance.

Case Study

What Makes Sundaram-Clayton's Win the Deming Prize

The historic story of how Sundaram-Clayton beat the world to win the Deming Prize.

—By R Sridharan

They are the demigods. From the mud has sprung the lotus. From the quagmire of quality that India Inc. has become has emerged a flagbearer of global class. From the disdain for Total Quality Management (TQM) has come forth India's – and Asia's – first-ever winner of the Deming Prize for Overseas Companies: Sundaram-Clayton, the Chennai-based manufacturer of air-brake systems and castings, every rupee of whose turnover of ₹ 139.37 crore now carries the watermark of quality that is world-class, organization-wide, and fault-proof. In short, unbeatable.

For, the Deming Prize is, quite simply, the last word in the world on quality. Instituted by the country that gave quality to the world – Japan – to honour the man who gave quality to the world, W. Edwards Deming, it is an acknowledgement of the fact that Sundaram-Clayton, led by its CEO Venu Srinivasan, 45, has risen above the countrywide contempt for total quality to be counted up there among an exclusively small global elite.

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So small that it consists of only three other companies: the $6.51-billion Florida Power & Light, which won the Deming Prize in 1989; the $53.26-billion AT&T's Power Systems Division in 1994, and the $38.05-billion Philips' Taiwan unit.

So small that even the great TQM corporations of the world, like the $48.88-billion Honda, the $55.03-billion Sony, and the $190.84-billion General Electric, do not belong to it.

So small that, in the 38 long years since the Deming Prize was instituted – and the 15 years since a separate Prize was offered to companies outside Japan – for 5 different categories, only 163 CEOs and managers have ever strode up to receive the coveted medal on the dais at the Union of Japanese Scientists & Engineers' (a.k.a. JUSE) Centre Hall in downtown Tokyo.

When Srinivasan joined their ranks on November 14, 1998 – tellingly, Children's Day – it was a small step for him to the podium, but a truly giant step for India Inc. What makes Sundaram-Clayton's winning the Deming Prize for total quality – Company-Wide Quality Control (or CWQC, in JUSE-speak) – an extraordinary feat is the fact that no global award for quality makes more demands of both the body and the soul of the winning corporation. The Malcolm Baldrige Award for quality in the US is comprehensive in its coverage of quality-related parameters too, but even its ruthless objectiveness excludes the fanatical obsession with statistical quality-control and performance that the Deming Prize displays. The European Quality Model Award is ingenious in its linkage of the enablers and results of quality, but cannot match the depth of the Deming Prize's probes. For, there is no transaction, no speck of dust on the floor, no tightening of a nut, no disaffected worker that escapes the scrutiny of the examination team.

In fact, the JUSE's rigorous quality audit tests a company on not 2 or 3, but 10 parameters which, between them, envelop each and every activity of a company. The one relentless theme that is tested across every operation: the ability of a company to use statistics-driven quality-control mechanisms to produce – consistently, economically, and reliably – a product or service that meets the customer's requirement in every possible manner – not just once, not just sporadically, not just over a specified period, but time and again. Explains Suresh Krishna, 61, the CEO of the ₹ 326.18 crore Sundram Fasteners, and a fellow-traveller on the road to total quality: "The Deming Prize is not just a recognition of product quality. It is recognition of the organization itself. Clearly, Sundaram-Clayton meets the requirements of a world-class company."

Ask a Deming Prize winner, though, and he will say – not from the public pulpit, but as a statement of his intensely personal religion – that quality is a journey, not a destination. That's why Sundaram-Clayton will never rest on its laurels. Says CEO Srinivasan, a man whose energy is only matched by the intensity of his compulsive pursuit of excellence: "Internally, we are pleased. But everybody recognizes that we have a long way to go before we become world-class manufacturers." Those, of course, are words of wisdom, gleaned from the teaching of Sundaram-Clayton's Japanese gurus, the JUSE's Yoshikasu Tsuda and the late Y. Washio, who brought Buddha and best-in-class in equal proportions into the company. Argues Ashish Basu, 34, COO, Institute of Quality Ltd (IQL) says, "The Deming Prize is a good energiser, but it should not be the end-all goal." At Sundaram-Clayton, there are no fears of that happening.

Its climb to the top of TQM started way back in 1979, when Srinivasan took over from his father, T.S. Srinivasan, as CEO after his return from Purdue University (US) in 1977, after his MBA. The SWOT analysis he conducted, applying his B-school learning, revealed, to the company's horror, that a 90-per cent market share was no insulation against top-class competition. Concluding that short-term tactics or defensive strategies would not deliver what a long-term transition to excellence could, Srinivasan set his company off on Quality Street.

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In quick succession, Sundaram-Clayton's managers were exposed to the quality practices of global leaders, trained in modern manufacturing techniques, and taught about TQC, first by Yoshio Kondo in a watershed workshop at the National Institute For Quality & Reliability in 1986, and, from 1989 onwards, under the tutelage of Washio and Tsuda. And to walk the talk, Srinivasan set up a core taskforce to baptise Sundaram-Clayton in the new religion of TQC. Recalls quality consultant C.S. Nath, 62, the former general manager (quality) at Sundaram-Clayton: "Srinivasan laid the foundation for TQC in just a few years. When I look back, I am amazed at how focused he has been."

That wasn't all. To provide a big bang bull's eye to aim for – a magnet for the quality practices, as it were – he decided to set external targets, starting with the national quality awards. Sweeping those was easy given Sundaram-Clayton's head-start and commitment: in 1989, for instance, it won the Confederation of Indian Industry's (CII) Quality Circle award, followed by the Quality Circle Federation of India awards in the following years. Despite this raising of the bar, it was evident to Srinivasan that continuous quality improvement had been hardwired into the organisation by the 1990s. And, as it often happens even with the best of companies, the movement faced the threat of petering out if not kept up relentlessly. Concurs S.D. Kulkarni, 64, the CEO of the ₹ 5,841 crore Larsen & Toubro: "In the early years, quality goes through pockets of excellence, but it must be translated into a culture that touches every employee. The vision and momentum must not be lost." So, in 1995, Srinivasan threw a huge challenge to his team: beat the world by winning the Deming Prize. The organizational sub-conscious had been aware that its objective was world-class quality – and the Deming Prize was whispered about in the gangways of the shop floor – but it now became a focused goal. Points out Suresh Lulla, 54, CEO, Qimpro Consultants: "Such goals help inculcate a sense of pride and purposefulness in people."

The results of Sundaram-Clayton's total quality movement are written not just on the medal that was put around Srinivasan's neck, but also on the company's books. Its financial indicators in the 5 years between 1992-93 and 1997-98 tell a tale of top-level performances. Being a vendor to the auto-makers, its top line, of course, is tied to those of its customers: the ₹ 2,048-crore Ashok Leyland and the ₹ 7,450-crore Tata Engineering & Locomotives Co. for air-brake systems, and the ₹ 7,842-crore Maruti Udyog and Hyundai Motors India for castings. Thus, sales grew at an average rate of 35 per cent per annum between 1992-93 and 1996-97 although it shrank by 25 per cent in 1997-98 on account of the recession in the automobile industry. Likewise, the average growth in net profits in those 4 years was a stunning 83 per cent per annum – a glowing tribute to quality-led cost management – although it fell back by 35 per cent in 1997-98. But, internally, its performance improved consistently despite the recession, with turnover per employee rising by an average of 18 per cent a year, and gross value added climbing by an average of 12 per cent per annum.

Make no mistake, merely working towards an award – and developing the requisite mindset of competitiveness – is not enough. What Sundaram-Clayton's progress reveals is the all-important alignment of the quality imperatives of the company with the parameters used by an assessment framework, such as the one applied by the JUSE for the Deming Prize. The Deming Prize Committee defines quality as "a system of activities to ensure the quality of products and services, in which products and services of the quality required by customers are produced and delivered economically." Sundaram-Clayton's quality coup: integrating Deming's 10 parameters into the four streams of its quality practices, which flow around policies, people, processes and products, respectively. Its TQC model puts employees at the base of the pyramid, daily management on top of it, and erects five pillars resting on these two: Total Employee Involvement, Policy Deployment, Standardisation, Kaizen, and Training. In short, everyone everywhere in the company is

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a custodian of quality. Says IQL's Basu: "Most companies, when they have set a quality goal, will sub-contract the monitoring to the quality department. But that's not what Deming Prize winners do." BT offers a guided tour through today's Deming Prize winner's systems for tomorrow's Deming Prize aspirants.

TQM and Policy

The TQM Corporation ensures that quality is everyone's job for every moment that they are on the job. But only the Deming company articulates this ownership as a policy. Nor is the policy limited to ownership; every activity in the company must conform to the master-list of guidelines on quality. Sundaram-Clayton's strategy: it uses its policy to dovetail the Deming definition of what quality means into the requirement for involving everyone in it. Explains Srinivasan: "Quality is a multi-faceted body. It has to encompass the entire organisation." In fact, Sundaram-Clayton actually has a Quality Policy room, where the company's top managers meet once a week for a review.

At Sundaram-Clayton, the Quality Policy exists in the form of an elaborate statement, which reads: "Sundaram-Clayton will deliver a level of quality that totally meets customer expectations. This customer satisfaction will be obtained by supplying products of the right quality, at the right time, and at the right place. Total employee involvement and continuous improvement in every sphere of activity will be the twin supports on which Sundaram-Clayton quality will stand." Thus, policy deployment spreads across the entire organizational value-chain, including marketing, operations, product development, finance, and personnel. That is especially crucial in the context of the Deming Prize, which grades the performance of every department and function separately – including the CEO himself. Explains Sarita Nagpal, 44, TQM Counsellor, CII: "At Sundaram-Clayton, transformation is truly everybody's job – just as Deming wanted it to be." Adds C. Narasimhan, 58, President, Sundaram-Clayton: "It is the clarity about the company's strategic position in its industry and its long-term goals that has enabled the organization to align itself with the larger objective of becoming a world-class manufacturer."

Questions

1. Explain why winning the Deming Prize is considered prestigious for an Indian organization.
2. Explain the factors that led to winning the Deming Prize by Sundaram Layton.
3. Explain the quality policy of Sundaram Clayton.
4. Explain how Company Wide Quality Control (CWQC) was practiced at Sundaram Clayton.

Source: http://www.india-today.com/btoday/22111998/cover.html

2.8 Summary

- A TQM Guru is an expert thinker who communicates his thoughts through verbal and written expressions and thus contributes to the field of TQM.
- Dr. W. Edwards Deming was awarded his doctorate in mathematical physics in 1928.
- Despite success stories of Xerox, Motorola and many other companies that embraced his teachings, Deming felt he was a prophet without honour in his own country.
- After the World War II, Deming was invited by Japan as an Adviser to the Japanese Census. He became involved with the Japanese Union of Scientists and Engineers (JUSE) after its formation in 1946.

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- In 1951, Japan instituted the much-cherished Deming Prize for corporate quality in the honour of Dr. Deming. In 1956 only, Deming was awarded the Shewhart Medal by the American Society for Quality Control.
- Deming stressed the importance of what he calls intrinsic motivation rather than extrinsic motivation.
- Quality according to Juran has to be controlled at each stage of the processes but should not be implemented just as a mechanical process.
- The long-term health of business is determined by a structured approach to quality which is planned, implemented and controlled according to the mission of the business concerned.
- Juran's project by project improvement approach is very popular among Indian companies as well.
- Juran developed a quality trilogy to assist management in the implementation of strategic quality planning which comprises of quality planning, quality control and quality improvement.
- Philip B. Crosby was a former Corporate Vice-President for Quality at ITT.
- The essence of Crosby's quality drive is prevention.
- Genichi Taguchi worked as Director of the Japanese Academy of Quality during 1978-82. He was awarded the Deming Prize in 1960 for his contribution in developing techniques for industrial optimization.
- Taguchi's methods incorporate the use of statistical techniques.

2.9 Keywords

***American Society for Quality Control*:** ASQC, is the leading quality improvement organization in the United States, with more than 130,000 individual and 1,000 sustaining members worldwide.

***Behavioural Science*:** A scientific discipline, such as sociology, anthropology, or psychology, in which the actions and reactions of humans and animals are studied through observational and experimental methods.

Company Wide Quality Control: Methodological principles and intervention techniques for step-by-step improvement.

***Japanese Union of Scientists and Engineers*:** JUSE was established in May 1946 and authorized as the foundation of a juridical body by the Science and Technology Agency of Japanese Government.

Jidoka: The term *Jidoka* used in the TPS (Toyota Production System) can be defined as "automation with a human touch."

Management by Wandering Around: A face-to-face communication technique in which a manager walks around a work area and talks informally with employees about issues and concerns.

Management Commitment: Direct participation by the highest level executives in a specific and critically important aspect or program of an organization.

Piece-rate Wage System: A piece-rate wage system is a system where compensation is based upon the number of units of work produced by an individual or distinct work team.

Poka-yoke: It employs visual signals that make mistakes clearly stand out from the rest, or devices that stop an assembly line or process if a part or step is missed.

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Quality Control: Quality control is a process that is used to ensure a certain level of quality in a product or service.

Quality Trilogy: Juran's Quality Trilogy consists of quality planning, quality control, and quality improvement.

Theory Z: This theory deals with employee loyalty and the safety of the employees.

Zero Defects: Defect prevention level where all output is within specification limits.

2.10 Review Questions

1. Mention the names of some of the TQM gurus.
2. Why is Deming known as the quality guru who never gave up? Explain his contributions.
3. Explain the contribution of Joseph M. Juran with special emphasis on quality trilogy.
4. What are Crosby's 4 absolutes of quality? Explain.
5. Explain the 6 C's of Crosby.
6. Explain the contribution of Armand V. Feigenbaum.
7. List various contributors who have contributed towards the literature of quality improvement. Describe the thoughts of Genichi Taguchi in evaluation of quality, loss function, noise and variation, experimental design and orthogonal arrays.
8. Mention the main contributions of Ishikawa.

Answers: Self Assessment

1. TQM Guru
2. Nancy Warren
3. Deming
4. Instability
5. Shewhart Medal
6. Utilization of statistics
7. Flexibility
8. Short-term
9. Engineer
10. Fitness to use
11. User- supplier
12. Project by project
13. Quality trilogy
14. Corporate Vice-President
15. Prevention
16. Armand V. Feigenbaum
17. Genuine effectiveness
18. Kaoru Ishikawa
19. Company Wide Quality Control
20. Pourle Ribbon Award
21. International consultant

2.11 Further Readings

Notes

Books

Besterfield, Dale H. (2011), *Total Quality Management*, Pearson Education, India

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http://www.slideshare.net/ritikagauba/tqm-gurus

Notes

Unit 3: Concept of Quality Management

CONTENTS

Objectives

Introduction

3.1 Concept of Quality

3.2 Principles of TQM

3.2.1 Customer Focus

3.2.2 Participation and Team Work

3.2.3 Employee Involvement and Empowerment

3.2.4 Continuous Improvement and Learning

3.3 TQM Framework

3.4 Obstacles and Benefits of TQM

3.4.1 Obstacles of TQM

3.4.2 Benefits of TQM

3.5 Summary

3.6 Keywords

3.7 Review Questions

3.8 Further Readings

Objectives

After studying this unit, you will be able to:

- Explain the Concept of Quality
- Explain the Principles of TQM and Its Framework
- Explain the Obstacles and Benefits of TQM

Introduction

Previous unit gave you an insight on the meaning of Total Quality Management and its development over the years. In this unit, you will study about the TQM framework, its principles and the various obstacles and benefits of TQM.

3.1 Concept of Quality

Quality is defined as meeting or exceeding the needs and expectations of the customer. It is necessary to give customers what they want, but customers may not be willing to pay the price for features that vastly exceed their needs.

Quality can be defined as the degree to which a product is fit for the specific use. It can be defined as products and services beyond present needs and expectations of customers.

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Quality is defined as the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs.

'Quality is the ongoing process of building and sustaining relationships by assessing, anticipating, and fulfilling stated and implied needs.'

The quality of a product is determined by how well it suits one's needs in terms of reliability, durability, safety, maintainability & cost.

Self Assessment

Fill in the blanks:

1. …… is defined as meeting or exceeding the needs and expectations of the customer.
2. Quality can be defined as the …… to which a product is fit for the specific use.

Caselet

Managers Do Not See Immediate Need to Improve Quality

Like any country that opens its economy, India has in the last 12 years seen much change in the way business and industries as a whole are now dealing with consumer demand and expectation with regard to quality of service, and quality of goods being sold, this is especially evident in the retail and food sectors.

The healthcare sector too has been bitten by the same bug. There has been a slow but sure shift in the way healthcare delivery is being perceived, by both providers and patients. Growing proliferation of the Internet and media vehicles is leading to awareness about health among people which is fuelling their desire to remain healthy. Patients are demanding better quality of healthcare delivery; this, irrespective of in-patient services, outpatient services or even preventive care.

Yet the one question that remains unanswered is: what is quality in healthcare? How does a provider know they are providing the best quality of care at an affordable price? At the same time, how does a patient/consumer know they are getting value for money when it comes to treatment?

In the US, healthcare practitioners realized, as early as in the 1950s, that managing healthcare is going to be a Herculean task. Who was going to monitor the way treatment was being provided to patients? Who was going to monitor medical malpractice, patient safety, and who was going to translate this into financial costs, not the patient. Hence, there have, over the last few decades, been very significant developments and changes that have been implemented to highlight the quality of healthcare that countries are providing, and how healthcare providers can actually improve and aggressively assure quality in the way they deliver healthcare.

Several theories have been proposed and have been implemented, as to what quality in healthcare pertains to. Yet the easiest and most practical theory was given by Adeis Donabedian, the late quality healthcare guru in the US.

According to him, quality in healthcare encompassed and critical attributes: (1) Structure (2) Process (3) Outcome

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Structure: This pertains to the "physical" aspects of healthcare delivery, including infrastructure, equipment, and human resources, for example, Equipment requirements as per services being offered and accessibility of facility.

Process: This pertains to the procedures and protocols that all healthcare personnel, clinical and non-clinical have to conform to, so as to ensure appropriate and adequate delivery of healthcare services. E.g. Infection control procedures, protocols for patient case management.

Outcome: This specifically pertains to the well-being of the patient after delivery of healthcare provision. E.g. Mortality rates and case specific morbidity rates.

Taking a more detailed perspective, quality in Healthcare can also be divided into two specific parts: (1) Clinical (2) Non-clinical. Clinical – Looking at the specific clinical aspects that go into delivery of quality healthcare, such as:

1. Clinical credentialing
2. Clinical audit
3. Clinical risk management (Including Infection Control)
4. Clinical outcome measurement
5. Clinical care pathways

Non-clinical – Looking at service quality aspects that go into delivery of healthcare, such as:

1. Infrastructure and facilities management
2. Equipment management
3. Supplies and consumable management
4. IT Infrastructure and management
5. Hospitality management
6. Patient satisfaction

Apart from this, there are other specific areas such as non-clinical risk management, and accreditation. Why should any healthcare organization think of improving their quality?

As part of the KSA-Technopak "Healthcare Outlook" study, senior managers from the country's top healthcare providers were quizzed over this, with an overwhelming majority saying that "with an occupancy rate of 85-100 per cent, we do not feel there is an immediate need to improve quality; patients come to us because we are already providing good quality services". However, the customer's point of view was a more contrasting picture, as 54 per cent of those surveyed said they were satisfied with the quality of care, 32 per cent stated that services provided were below expectations and 14 per cent stated they were extremely happy with services provided. In the West, implementation of risk management systems in healthcare has lead to the revelation of some startling facts.

Medical errors are one of America's leading causes of death and injury. It is estimated that as many as 44,000 to 98,000* people die in US hospitals each year as the result of medical errors. This means that more people die from medical errors than from motor vehicle accidents, breast cancer, or AIDS. In the UK there are approximately 5,000 deaths/year due to hospital acquired infections (HAI). Hospital admissions up to 7.8 per cent and 15,000 deaths/year are partially attributed to the HAI and cost the NHS approximately 1000 million pounds a year in extended hospital stay and treatment.

In the US, there are approximately 700,000 needle stick injury cases reported per year – 86 per cent of occupational-related infectious disease transmissions result from needle stick

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injuries. Going by trends in developed healthcare markets, it is imperative that Indian healthcare providers woke up to the need for quality in the delivery of healthcare services, irrespective of the level at which healthcare is provided and the type of services provided.

Sources: Dr Vivek Sahi, Express Healthcare.

3.2 Principles of TQM

The core principles of total quality are as follows:

(i) A focus on the customer

(ii) Participation and team work

(iii) Employee involvement and empowerment

(iv) Continuous improvement and learning.

3.2.1 Customer Focus

The modern definition of quality centers on meeting or exceeding customer expectations. Thus, the customer is the principle judge of quality. Perceptions of value and satisfaction are influenced by many factors throughout the customer's overall purchase, ownership and service experiences. Companies must focus on all product and service attributes that contribute to perceived value to the customer and lead to customer satisfaction. To accomplish this task, a company's efforts need to extend well beyond merely meeting specifications, reducing defects and errors on eliminating complaints. They must include both designing new products that truly delight the customers and responding rapidly to changing consumer and market demands.

A firm also must recognize that internal customers are as important in assuring quality as are external customers. Employees who view themselves as both customers of and suppliers to other employees understand how their work links to the final product.

Customer focus extends beyond the consumers and internal relationship to the society which represents an important customer of business. Business ethics, public health and safety, environment and the sharing of quality – related information in the company's business and geographic communities are necessary activities of a world-class company.

3.2.2 Participation and Team Work

When managers give employees the tools to make good decisions and the freedom and encouragement to make contributions individually or in teams, they virtually guarantee that better quality products and production processes will result. In any organization the person who performs a job is the person who best understands the job and how to improve both the product and the process. By training employees to think creatively and rewarding good suggestions, managers can develop employee loyalty and trust.

Note Managers must formulate systems and procedures and put them in places to ensure that participation becomes a part of the work culture.

Participation: Participation of employees can be encouraged by implementing suggestion systems or schemes that act quickly, provide feedback and reward good suggestions.

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These systems should also facilitate the following:

(i) Recognize team and individual accomplishment.

(ii) Share success stories throughout the organization.

(iii) Encourage risk taking by removing the fear of failure.

(iv) Promote the formation of employee involvement teams.

(v) Provide financial and technical support to develop their ideas.

Team work: Team work is another important element of total quality attention on customer – supplier relationships among the employee and encourages the involvement of the total work force in attacking systemic problems, particularly those that cross functional boundaries. Success of team work needs managers' acceptance of workers' suggestions. The "quality circles" implemented in Japan in 1962 achieved dramatic results. Today, the use of self-directed or self-managed teams is growing. These teams combine team work and empowerment into a powerful method of "employee involvement".

An important type of team is the cross-function team. This type of team facilitates horizontal co-ordination between organizational units which is essential for achieving total quality. Partnerships are an additional way of promoting team work. Partnerships between a company and organized labor and between customers and suppliers are useful for practicing total quality.

Did u know? General Motors (GM) tries to eliminate the practice of completing internally and instead promotes team work. To counter internal competition, GM developed a system called "Quality Network" made up of a joint union management, Quality Councils at the corporate, division and plant levels. The heart of the Quality Network is a customer satisfaction model that encourages team work and co-operation.

3.2.3 Employee Involvement and Empowerment

Employee involvement involves changing organizational culture, fostering individual development through training, establishment awards and incentives and encouraging team work.

Employee empowerment means involving employees in every step of the production process. It means enlarging employee jobs so that the added responsibility and authority is moved to the lowest possible in the organization.

Techniques for building employee empowerment include:

(i) Building communication networks that include employees.

(ii) Moving responsibility from managers to production employees.

(iii) Building high employee morale in the organizations.

(iv) Creating such formal organization structures as team and quality circles.

3.2.4 Continuous Improvement and Learning

Continuous improvement refers to both incremental (i.e. small and gradual) and breakthrough (i.e. large and rapid) improvement.

Improvements may take any one of several forms:

(i) Enhancing value to the customer through new and improved products and services.

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(ii) Reducing errors, defects, waste and related costs.

(iii) Improving productivity and effectiveness in the use of all resources.

(iv) Improving responsiveness and cycle time performance.

Caution Continuous improvement and learning should be an integral part of the management of all systems and processes.

Learning refers to adapting to change, leading to new goals and approaches. Learning takes place via feedback between practices and results.

Four stages of a learning cycle are as follows:

(i) Planning

(ii) Execution of plans

(iii) Assessment of progress

(iv) Revision of plans based upon assessment findings.

Peter Senge, a professor at the MIT. USA, defines the learning organization as "an organization that is continually expanding its capacity to create its future. For such an organization, it is not enough, merely to survive. "Survival learning" or what is more often termed "adaptive learning" is important – indeed it is necessary. But for a learning organization, "adaptive learning" must be joined by "generating learning", learning that enhances our capacity to create. Senge often points out, "over the long run, superior performance depends on superior learning".

Example: The plants hold periodic corporate analysis meetings during which entire plants shutdown operations briefly for thorough audits of the quality system. The plant-level work team and workers focus on ways to improve quality and productivity.

Self Assessment

Fill in the blanks:

3. The modern definition of quality centers on meeting or exceeding …….

4. …… extends beyond the consumers and internal relationship to the society which represents an important customer of business.

5. Managers must formulate …… and put them in places to ensure that participation becomes a part of the work culture.

6. The heart of the Quality Network is a …… that encourages team work and co-operation.

7. …… means involving employees in every step of the production process.

8. …… refers to adapting to change, leading to new goals and approaches.

3.3 TQM Framework

It begins with the knowledge provided by gurus of quality: Shewhart, Deming, Juran, Figenbaum, Ishikawa, Crosby, and Taguchi. They contributed to the development of principles and practices and/or the tools and techniques. Some of these tools and techniques are used in product and/or service realization activity. Feedback from internal/external customers or interested parties provides information to continually improve the organizations system, product and/or service.

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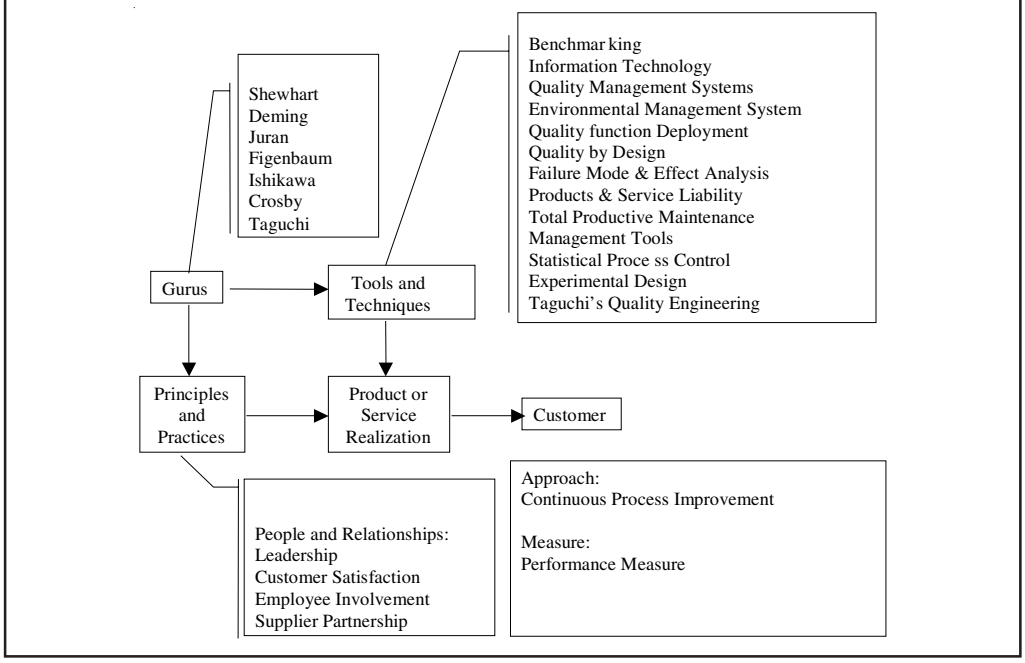
Total Quality Management is a management approach aimed at satisfying all customer requirements, needs and expectations using a Continuous Improvement approach.

Figure 3.1: TQM Framework



The TQM principles can be grouped into the following practical and common sense concepts:

- Customer focus (internal and external customers).
- Leadership (management role changes to active leadership).
- Teamwork (multi-disciplinary teams, including involvement of customers and suppliers).
- Continuous improvement of processes.
- Measurement (the improvement process is based on quantitative and qualitative metrics).
- Benchmarking (as a driver to improvement in a competitive environment).

Leadership

Concept: management should demonstrate leadership by:

- Recognizing IQ as a strategic issue.
- Allocating the appropriate resources to IQ improvement – capital, management attention, vision and priorities.
- Setting an example as the first to require, use or provide better quality information. This role is the responsibility of all management levels, from the company president down to team leaders.

Customer Focus

The modern quality paradigms emphasise the importance of customer satisfaction as a driver to the improvement process. IQ improvement efforts should focus on the identification of users, specification of their true IQ needs, and fulfilment of these requirements.

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Caution The "voice of the customer" should lead the entire improvement process.

Teamwork

Specification of IQ needs and metrics, as well as fulfilment control are based on teamwork operation. All stakeholders are included in the team. A typical team hosts representatives from the information users' group, information providers, information solutions' suppliers, information organization and other relevant parties. A certain level of management participation is required as well. All the above functions are responsible for higher quality of information.

Measurement

IQ metrics are used to translate the information user needs into measurable specifications. These specifications should be designed into the information solution. Once the solution is provided, IQ metrics are used to assess the solution's actual performance against the requirements, and effectively against user needs due to the special importance of this concept to the InfoQual methodology.

Benchmarking

In order to achieve "world class" IQ, it is necessary to explore what IQ levels are achieved in the "external world". We refer here to other functions in your organization, other organizations in your industry or even other industries and professional domains. Benchmarking supports the IQ improvement team in setting high but realistic targets that energise the process. Benchmarking is also a useful tool to discover new and practicable metrics and methods to measure IQ.

Continuous Improvement

In the field of IQ, quality improvement efforts are not a onetime effort. There are two aspects to this concept: cultural and methodological.

1. ***Cultural aspect:*** In a culture that promotes IQ continuous improvement, each member deals with the following questions: What is the meaning of high quality information? How is it defined and measured? Do I require, obtain and use high quality information? Do I provide such information? What must I do in order to get or provide better information?

2. ***Methodology aspect:*** The cultural aspects of IQ are beyond this paper's scope. However, it should be noted that IQ culture cannot be achieved by having the company president stating, "Information is critical, let's improve it continuously." Rather, it should be deployed via a series of practicable improvement activities. Implementing a methodology such as InfoQual can help create the common language and behavioral habits of an IQ culture. The InfoQual methodology is based on the PDCA (Plan Do Check Act) cycle, a popular model to organize the improvement process (Hari, 1995). The cycle is based on four phases:

   - *Plan:* Improvement objectives are identified, scope is agreed, metrics are specified and targets are set.
   - *Do:* Here the actual improvement activities are conducted (e.g. introduction of a new information solution)
   - *Check:* The performance of the new solution (i.e. the quality of information) is checked against the pre-defined metrics.

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- *Act:* The actions required to close the gaps between the required and actual IQ performance are designed and conducted.

Once completed, the cycle is reiterated in order to achieve further improvements.

Self Assessment

Fill in the blanks:

9. …… is a management approach aimed at satisfying all customer requirements.
10. The modern quality paradigms emphasise the importance of …… as a driver to the improvement process.
11. …… supports the IQ improvement team in setting high but realistic targets that energise the process.
12. The InfoQual methodology is based on the ……, a popular model to organize the improvement process.

3.4 Obstacles and Benefits of TQM

3.4.1 Obstacles of TQM

TQM is not just another fashionable management theory. It is not a quick fix to solve the problems overnight. There are many barriers to implementing Total Quality Management. They show themselves in all business sectors-manufacturing, services, government and even education.

Therefore, it is important for all organizations to understand and avoid these barriers both before and during TQM implementation. It takes a long time to build the appropriate emphasis and techniques into the culture. Overemphasis on short-term results and profits has to be avoided.

These barriers can be divided into two categories:

1. Organizational barriers
2. Behavioral barriers

Organizational Barriers

These are the most visible barriers of TQM implementation and are spread all over organization.

1. ***Lack of Commitment by Top Management:*** The primary responsibility of TQM rests with the top management. Therefore, there must be substantial commitment by top management for TQM. This commitment must be manifest by the management time and organizational resources they keep for implementation of TQM. In some organizations, the quality initiative is delegated to an outside expert. When top management commitment is missing, it passes on to other levels easily. All such organizations experience employee participation and interest in TQM programs.
2. ***Lack of continuous Training and Education:*** Lack of training is the next most important obstacle. This gives rise to confusion about the various aspects of the program. This is like building walls and ceiling without laying the foundation. Naturally, such a structure would collapse. Training and education is an ongoing process for everyone in the organization. When senior management conducts the training on the principles of TQM, its effectiveness increases. Needs must be determined and a plan must be developed to

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achieve those needs. They could be a lack of training in group discussion and communication techniques, quality improvement skills, problem identification, for problem solving affects implementation of TQM.

3. ***Improper Planning:*** Planning accounts for more than 50% of the job. Planning works well when all the concerned people are involved. TQM is no exception. TQM is about empowerment of people and participative management. All constituents of the organization should be the goal. Financial or sales goals take a back seat.

4. ***Inadequate use of empowerment and teamwork:*** TQM is all about teamwork, participative management and empowerment of employees. However, working in teams is an approach that has to be learned. The Team members need to have proper training. Supervision must learn how to be effective coaches. Further employees need to be empowered to take decisions that affect the efficiency of their process. The lacks of these result in frustration.

5. ***Inability to change organizational culture:*** The organization must undergo cultural change before teamwork can succeed. Individuals resist change. The resistance has to be overcome. It is very difficult to change an organization's culture and it takes time. It may take around five years for individuals to unlearn the old ways and learn the new ways. Once they are accustomed to doing a particular process it becomes the preferred way.

   People change only when they want to and only to meet their own needs. Nobody would change for the organization unless adequate reason is given and accepted by him or her. Management must understand and utilize these basic concepts of change. Further people must be moved from a state of fear to trust for accepting a change.

   Lack of effective communication and emphasis on short-term results are the main reasons for this. Sufficient time has to be spent by organizations for planning for the cultural aspects of implementing a TQM program.

6. ***Incompatible Organizational Structure and Isolated Individuals and Departments:*** More often, the organizational structure may not be conducive to team building. It can create differences between various departments and between individuals. These differences may create implementation problems. Use of multifunctional terms can help to rectify this. The whole organization has to be made customer oriented to make it more responsive to customer needs. The organization will have to be structured for the same.

7. ***Ineffective Measurement Techniques and Lack of Access to Data and Results:*** Effective Measurement acts as a booster to the improvements made. It would also inspire and encourage the participants to achieve more on the hand and to rectify and improve on the other hand. It is equally important that the progress is known within a reasonable period of time. Otherwise people lose interest and become frustrated. Access to relevant and quick retrieval is necessary for this. Effective decisions cannot be made in their absence.

8. ***Paying inadequate attention to internal and external Customers:*** The needs and expectations of customers will be changing over time. There are internal suppliers and internal customers. If we want to take care of the ultimate external customer, it is essential that the internal customer's en route have to be properly attended to. Organization needs to understand this through effective feedback mechanisms.

9. ***Failure to Continually Improve:*** One of the cardinal principles of TQM is continuous improvement. This continuous improvement is a journey and not a destination. A lack of continuous improvements of the process, product, and/or service is bound to make the implementation a failure.

10. ***Apparent lack of business experience and knowledge:*** This aspect of continuous improvement in all the activities of an organization implies continuous learning and

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improving knowledge and experience. Every mistake is a valuable lesson in experience. People have to upgrade not only their knowledge about the product and process but also about customer's perception changes.

11. ***Taking narrow dogmatic approach:*** Some organizations are determined to follow the Deming approach or Juran approach or Crosby approach, etc. It must be remembered that the each of the quality gurus and other experts have made valuable contribution. For TQM to be successful, it is imperative that organization has to assimilate from all these philosophies and create a blue print for their success.

Behavioral Barriers

Some people do not want the implementation of TQM in the organization. This arises due to:

1. Individual values, attitudes, perception, personality, etc.
2. Lack of training, & learning opportunities
3. Management styles viz. autocratic, democratic or laissez-faire
4. Level of success
5. Organizational structure itself doesn't permit the implementation of TQM

3.4.2 Benefits of TQM

Various total quality management benefits are as follows:

1. Reduction of defects because TQM promotes quality awareness and participation of all members of the organization, not just the QA or QC department. It means quality at the source.
2. Total quality management system leads to ease of problem solving. Through measurements such as SPC and other techniques such as failure analysis, defects and failures (even potential failures) can be identified and addressed.
3. TQM also leads to continuous improvement of processes and products. TQM system should also improve the efficiency of people and machine.
4. TQM leads to quality products which leads to customer satisfaction.
5. And finally, by reducing defects and improving machine and personnel efficiency, TQM should lead to cost savings and profitability improvement (bottom line).
6. A philosophy that improves business from top to bottom.
7. A focused, systematic and structured approach to enhancing customer's satisfaction.
8. Process improvement methods that reduce or eliminate problems i.e. non-conformance costs.
9. Tools and techniques for improvement – quality operating system.
10. Delivering what the customer wants in terms of service, product and the whole experience.
11. Intrinsic motivation and improved attitudes throughout the workforce.
12. Workforce is proactive – prevention-orientated.
13. Enhanced communication.
14. Reduction in waste and rework.

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15. Increase in process ownership – employee involvement and empowerment.
16. Everyone from top to bottom educated.
17. Improved customer/supplier relationships (internally & externally).
18. Market competitiveness.
19. Quality based management system for ISO 9001:2000 certification.

Self Assessment

Fill in the blanks:

13. The primary responsibility of TQM rests with the …… management.
14. …… and education is an ongoing process for everyone in the organization.
15. …… is about empowerment of people and participative management.
16. …… measurement acts as a booster to the improvements made.
17. Total quality management system leads to ease of …….
18. TQM leads to continuous …… of processes and products.

Case Study

RPG Enterprises, India

TQM Saves Millions of Dollars in Quality Costs

In 1996, the management of RPG Enterprises, a large business house in India, determined that quality management was to be the major competitive tool to take the company to global leadership. To facilitate, encourage and motivate staff towards quality excellence throughout the group the company initiated the RPG Quality Awards. The awards' criteria and system measured results in terms of customer satisfaction, employee satisfaction, business results and impact on society. As a result of their implementation, the following results occurred:

1. Increased quality awareness among the group's companies and made TQM an important topic within the group. Staff started talking about the awards, their eligibility, the criteria, the application and selection process, the winners and their achievements.
2. Generated healthy competition among the group companies.
3. Provided direction and created a uniform TQM culture throughout the group.
4. Recognised contributions made by individual units and motivated managements and employees to work towards improvements on a continuing basis.
5. Improved performance of the company in both financial and non-financial areas.
6. Improved business results which enhanced the competitive position among domestic and global players.
7. The award criteria provided checklists that helped group companies focus their attention on items they might not have otherwise thought of.

Contd...

Notes

8. The award criteria provided benchmarks for measuring company performance and individual performance.
9. The advantages of corporate quality awards were increasingly recognised by management within the group.
10. Contributed to greater improvement efforts all round and helped RPG's TQM initiative; in 1996 the company saved US$ 0.2 million in poor quality costs from 52 successful TQM projects. In 2000, the company saved US$ 24.4 million in poor quality costs from 2520 successful TQM projects.

Questions

1. Explain the need for introducing quality award by the RPG. Do you think an award within the company can contribute to quality improvement? How?
2. What principles of TQM were incorporated into the quality award introduced by the company?
3. Discuss how the company was able to reduce costs.

Source: http://www.bpir.com/total-quality-management-bpir.com/menu-id-72/example-cases.html

3.5 Summary

- Quality can be defined as the degree to which a product is fit for the specific use. It can be defined as products and services beyond present needs and expectations of customers.
- The quality of a product is determined by how well it suits one's needs in terms of reliability, durability, safety, maintainability & cost.
- The modern definition of quality centers on meeting or exceeding customer expectations. Thus, the customer is the principle judge of quality.
- Customer focus extends beyond the consumers and internal relationship to the society which represents an important customer of business.
- Participation of employees can be encouraged by implementing suggestion systems or schemes that act quickly, provide feedback and reward good suggestions.
- Employee involvement involves changing organizational culture, fostering individual development through training, establishment awards and incentives and encouraging team work.
- Learning refers to adapting to change, leading to new goals and approaches. Learning takes place via feedback between practices and results.
- Shewhart, Deming, Juran, Figenbaum, Ishikawa, Crosby, and Taguchi contributed to the development of principles and practices and/or the tools and techniques.
- Total Quality Management is a management approach aimed at satisfying all customer requirements, needs and expectations using a Continuous Improvement approach.
- Benchmarking supports the IQ improvement team in setting high but realistic targets that energise the process.

3.6 Keywords

Atarimae Hinshitsu: The idea that things will work as they are supposed to is referred to as Atarimae Hinshitsu.

Notes

Continuous Improvement: It refers to the concept that continuous focus on improving an organization's performance – from assembly line to the CEO – is a permanent objective.

Employee Involvement: Giving employees input and allowing them an impact on decisions affecting their jobs is known as employee involvement.

Just in Time: The principle of production and inventory control in which goods arrive when needed for production or use is called as just in time.

Kaizen: Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership.

Miryokuteki Hinshitsu: The idea that things should have an aesthetic quality is known as Miryokuteki Hinshitsu.

Quality: Quality is defined as the totality of characteristics of an entity that bear on its ability to satisfy stated or implied needs.

Systems Thinking: Systems thinking is a way of understanding reality that emphasizes the relationships among a system's parts, rather than the parts themselves.

Value Sharing: Value sharing is a universal paradigm that provides a foundation for a complete quality system.

3.7 Review Questions

1. Explain the concept & dimensions of quality.
2. Discuss the principles of TQM.
3. Explain TQM framework with special reference to continuous improvement and customer focus.
4. Mention the obstacles and benefits of TQM.
5. What are the two types of barriers? Differentiate between them.
6. Why we need quality management? Explain.
7. Briefly explain the concept of continuous improvement.
8. Discuss the role of top management in total quality management.

Answers: Self Assessment

1.	Quality	2.	Degree
3.	Customer expectations	4.	Customer focus
5.	Systems and procedures	6.	Customer satisfaction model
7.	Employee empowerment	8.	Learning
9.	Total Quality Management	10.	Customer satisfaction
11.	Benchmarking	12.	PDCA cycle
13.	Top	14.	Training
15.	TQM	16.	Effective
17.	Problem solving	18.	Improvement

Notes

3.8 Further Readings

Books

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Unit 4: Leadership for TQM

Notes

CONTENTS

Objectives

Introduction

4.1 Leadership

4.2 Characteristics of Quality Leaders

4.3 Role of TQM Leaders

4.4 Attitudes and Involvement of Top Management

4.4.1 Nature of Attitudes and Their Dimensions

4.4.2 Types of Attitudes

4.5 Leadership Concepts

4.5.1 Seven Habits

4.5.2 Deming Philosophy

4.6 Quality Council

4.6.1 Core Values

4.7 Summary

4.8 Keywords

4.9 Review Questions

4.10 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Leadership
- Discuss the Characteristics of Quality Leaders
- Explain the Various Roles of TQM Leaders

Introduction

In previous unit, we dealt with the concept of quality, the process steps in TQM, its principles, framework and the basic elements of TQM. We also discussed some of the barriers and benefits of TQM. This unit will help you to understand the importance of leadership in TQM.

There is no universal definition of leadership and indeed many books have been devoted to the topic of leadership. James MacGregor Burns, in his book Leadership, describes a leader as one who instills purposes, not one who controls by brute force. A leader strengthens and inspires the followers to accomplish shared goals. Leaders shape the organization's values, promote the organization's values, protect the organization's values and exemplify the organization's values. Ultimately, Burns says, "Leaders and followers raise one another to higher levels of motivation

Notes

and morality. Leadership becomes moral in that it raises the level of human conduct and ethical aspiration of both the leader and the led, and thus has a transforming effect on both." Similarly, Daimler Chrysler's CEO Bob Eaton defines a leader as "someone who can be a group of people to a place they don't think they can go." "Leadership is we, not me; mission, not my show; vision, not division; and community, not domicile." As the above illustrates, leadership is difficult to define in anything other than lofty words.

4.1 Leadership

The Malcolm Baldrige National Quality Award has a more grounded definition of leadership in its core values. As stated in its core values and concepts, visionary leadership is:

"An organization's senior leaders should set directions and create a customer focus, clear and visible values, and high expectations. The directions, values, and expectations, should balance the needs of all your stakeholders. Your leaders should ensure the creation of strategies, systems, and methods for achieving excellence, stimulating innovation, and building knowledge and capabilities. The values and strategies should help guide all activities and decisions of your organization. Senior leaders should inspire and motivate your entire workface and should encourage all employees to contribute, to develop and learn, to be innovative, and to be creative. Senior leaders should serve as role models through their ethical behavior and their personal involvement in planning, communications, coaching, development of future leaders, review of organizational performance, and employee recognition. As role models, they can reinforce values and expectations while building leadership, commitment, and initiative throughout your organization."

Self Assessment

Fill in the blanks:

1. A leader strengthens and inspires the followers to accomplish …….
2. ……. CEO Bob Eaton defines a leader as "someone who can be a group of people to a place they don't think they can go."

4.2 Characteristics of Quality Leaders

The main behaviors or characteristics that successful quality leaders demonstrate:

- They give priority attention to external and internal customers and their needs. Leaders place themselves in the customers' shoes and service their needs from that perspective. They continually evaluate the customers' changing requirements.
- They empower, rather than control, subordinates. Leaders have trust and confidence in the performance of their subordinates. They provide the resources, training, and work environment to help subordinates do their jobs. However, the decision to accept responsibility lies with the individual.
- They emphasize improvement rather than maintenance. Leader use the phrase "If it isn't perfect, improves it" rather than "If it ain't broke, don't fix it." There is always room for improvement, ever if the improvement is small. Major breakthroughs sometimes happen, but it's the little ones that keep the continuous process improvement on a positive track.
- They emphasize prevention. "An ounce of prevention is worth a pound of cure" is certainly true. It is also true that perfection can be the enemy of creativity. We can't always wait until we have created the perfect process or product.

Notes

Note There must be a balance between preventing problems and developing better, but no perfect, processes.

- They encourage collaboration rather than competition. When functional areas, departments, or work groups are in competition, they may find subtle ways of working against each other or withholding information. Instead, there must be collaboration among and within units.
- They train and coach, rather than direct and supervise. Leaders know that the development of the human resource is a necessity. As coaches, they help their subordinates learn to do a better job.
- They learn from problems. When a problem exists, it is treated as an opportunity rather than something to be minimized or covered up. "What caused it?" and "How can we prevent it in the future?" are the questions quality leaders ask.
- They continually try to improve communications. Leaders continually disseminate information about the TQM effort. They make it evident that TQM is not just a slogan. Communication is two ways—ideas will be generated by people when leaders encourage them and act upon them. Communication is the glue that holds a TQM organization together.

Example: On the eve of Desert Storm, General Colin Powell solicited enlisted men and women for advice on winning the war.

- They continually demonstrate their commitment to quality. Leaders walk their talk—their actions, rather than their words, communicate their level of commitment. They let the quality statements be their decision-making guide.
- They choose suppliers on the basis of quality, not price. Suppliers are encouraged to participate on project teams and become involved. Leaders know that quality begins with quality materials and the true measure is the life-cycle cost.
- They establish organizational systems to support the quality effort. At the senior management level a quality council is provided, and at the first-line supervisor level, work groups and project teams are organized to improve the process.
- They encourage and recognize team effort. They encourage, provide recognition, and reward individuals and teams. Leaders know that people like to know that their contributions are appreciated and important. This action is one of the leader's most powerful tools.

Self Assessment

Fill in the blanks:

3. Leaders have trust and confidence in the performance of their …….
4. …… continually disseminate information about the TQM effort.

4.3 Role of TQM Leaders

Everyone is responsible for quality, especially senior management and the CEO; however, only the latter can provide the leadership system to achieve results. For instance, in the 1980's,

Notes

General Electric's CEO, Jack Welch, instituted leadership training courses at all levels of the organization. The General Electric training courses taught leadership approaches and models and provided the opportunity for teams to develop solutions to real business problems. Many of the solutions the teams developed were implemented. Jack Welch supported the development of a leadership system whereby quality control leaders were developed at all levels in all functions of the organization, including research, marketing, manufacturing, sales, finance, and human resources. Senior managers need to be provided with the skills to implement quality control techniques and actively participate in the quality council.

Senior management has numerous responsibilities.

Note Senior management must practice the philosophy of Management by Wandering Around (MBWA).

Management should get out of the office and visit customers, suppliers, departments within the organization, and plants within the organization. That way, managers learn what is happening with particular customer, supplier, or project. MBWA can substantially reduce paperwork. Encourage subordinates to write only important message that need to be part of the permanent record.

Example: Kinko's executives perform normal operating duties for two or three days at one location.

This approach is an excellent technique for gaining firsthand information.

The idea is to let employees think for themselves. Senior management's role is no longer to make the final decision, but to make sure the team's decision is aligned with the quality statements of the organization. Push problem solving and decision making to the lowest appropriate level by delegating authority and responsibility.

Caution Senior managers must stay informed on the topic of quality improvement by reading books and articles, attending seminars, and talking to other TQM leaders. The leader sends a strong message to subordinates when that leader asks if they have read a particular book or article.

The needed resources must be provided to train employees in the TQM tools and techniques, the technical requirements of the job, and safety. Resources in the form of the appropriate equipment to do the job must also be provided.

Senior managers must find time to celebrate the success of their organization's quality efforts by personally participating in award and recognition ceremonies. This activity is an excellent opportunity to reinforce the importance of the effort and to promote TQM.

Did u know? A phone call or handshake combined with a sincere "thank you for a job well done" is a powerful form of recognition and reward.

One of the duties of the quality council is to establish or revise the recognition and reward system. In particular, senior management's incentive compensation must include quality improvement performance. Also, provisions must be made to reward teams as well as creative individuals.

Notes

Senior managers must be visible and actively engaged in the quality effort by serving on teams, coaching teams, and teaching seminars. They should lead by demonstrating, communicating, and reinforcing the quality statement. As a rule of thumb, they should spend about one-third of their time on quality.

A very important role of senior managers is listening to internal and external customers and suppliers through visits, focus groups, and surveys. This information is translated into core values and process improvement projects.

Another very important role is communication. The objective is to create awareness of the importance of TQM and provide TQM results in an ongoing manner. The TQM message must be "sold" to personnel, for if they don't but it, TQM will never happen. In addition to internal efforts, there must be external activities with customers and suppliers, the media, advertising in trade magazines, and interaction with the quality community.

By following the preceding suggestions, senior managers should be able to drive fear out of the organization, break down barriers, remove system roadblocks, anticipate and minimize resistance to change, and, in general, change the culture. Only with the involvement of senior management can TQM be a success.

Caselet

How One Company Successfully Implemented Continuous Improvement?

As an illustration of quality management in action, one construction company procedure was enacted by establishing a daily foreman's meeting that usually lasts one hour. Although an hour may have appeared to be a long time, the company and its people believe it to be worthwhile. Every person in the company has an opportunity to relate the status of his or her task in the work cycle.

Included among the benefits from conducting this daily foreman's meeting are the elimination of conflicts between crews and crafts at jobsites, work crews not occupying the same space at the same time, and the entire working staff becoming and remaining knowledgeable about all phases and problems which exist at the jobsite. Additional benefits include improved coordination with other trades, increased problem solving, and improved morale and efforts as a result of the ability to directly air concerns.

Self Assessment

Fill in the blanks:

5. …… supported the development of a leadership system whereby quality control leaders were developed at all levels in all functions of the organization.
6. Senior management must practice the philosophy of …….
7. One of the duties of the …… is to establish or revise the recognition and reward system.

4.4 Attitudes and Involvement of Top Management

Attitudes can be simply referred to as evaluative statements, which may be either favorable, regarding people, objects or events. Attitudes reflect how one feels about something. For instance, if you say "I like my work," then you are merely expressing your attitude about your work.

Notes

Attitudes and values are not similar, though they are inter-related. So now let us look at attitudes in depth.

4.4.1 Nature of Attitudes and Their Dimensions

Attitude is often used in describing people and in explaining their behavior. What then is an attitude? Let us understand this with a simple example. If someone says" I like his attitude" or that "our employees produce quality products, because of positive attitude." The person is clearly referring to attitude. Now let us define an attitude. An attitude can be defined as a continuous tendency to feel and behave in a specific way toward some object.

Example: If we say that Shilpa hates working overtime. This means that Shilpa has a negative attitude towards overtime.

Attitudes being subtle cognitive process, they can be characterized in three ways. The first important thing is that they tend to continue until and unless something is done to change them. For instance, if Shilpa gets compensatory time-off after an overtime assignment or if she gets paid for overtime, she may change her attitude towards overtime. Secondly, attitudes generally fall anywhere between extremely favorable and extremely unfavorable. Maybe at the moment Shilpa's attitude is moderately unfavorable, but when she is given compensatory off or is given extra payment, her attitude may turn to extremely positive. Thirdly, attitudes are aimed at some object about which the person has some associated feelings, (which is sometime referred to as affect") and beliefs. In Shilpa's case, it is "overtime". Now let us look at the different types and components of attitudes in order to understand them better.

4.4.2 Types of Attitudes

An individual can have several attitudes, but in Organizational Behavior we are only concerned with job-related attitudes. These job-related attitudes explore the positive or negative evaluations that employees possess about aspects of their work environment. In OB, there are three very important work related attitudes: job satisfaction, job involvement and organizational commitment.

Example: If somebody does not like traveling on work, he has a negative attitude towards a particular aspect of his work.

Self Assessment

Fill in the blanks:

8. …… is often used in describing people and in explaining their behavior.
9. The …… component refers to a person's feelings or affect about an object.

4.5 Leadership Concepts

The various concepts of leadership are:

4.5.1 Seven Habits

Stephen R. Covey, in his book "The 7 habits of highly effective people", talked about the 7 habits which are required in a leader.

Notes

1. ***Be Proactive:*** Proactive people think beforehand and are ready to face a situation. Reactive people react as per the situation and react on whims and emotions. A proactive person can plan beforehand for an eventuality. If you are well prepared then you can face a situation or solve a problem more efficiently.
2. ***Begin with the end in Mind:*** "If you don't know where to go then you will reach nowhere" goes an old saying. Start a task with set goals. Goals are important as they tell you where to go. They help in focusing your approach as well. Remember the famous incident from Mahabharata where Guru Dronacharya asks his disciple about what they could see during target practice. Arjuna gives the most perfect answer as he was focusing on the target. Because of his focused approach Arjuna became one of the best archers of his time.
3. ***Put First Things First:*** Because of multitude of tasks and assignments one needs to prioritize. This helps in giving more attention to more important things at hand.
4. ***Think win-win:*** Think about mutual benefits rather than your own benefit alone. Everybody wants to have an upper hand in life and in business dealings. But this is practically not possible. So best way is to find is the middle of the road.
5. ***Seek first to understand, then to be understood:*** First give other people ample time to express themselves. This will help on many fronts. The other person gets enough opportunity to say what he wants to say. You get an opportunity to understand other's perspective. You get enough time to strategize accordingly.
6. ***Synergy:*** The best example of team work can be learnt from a pleasant orchestra or 'jugalbandi' in Indian classical music. Especially in Indian classical music you will observe how maestros bury their egos and come out with astounding performances.
7. ***Sharpen the Saw:*** Skill building or practice is very important. Nobody is perfect and perfection is a thing which can never be achieved in one's lifetime. Moreover, it always pays to practice as much as you can.

4.5.2 Deming Philosophy

Known as the father of quality, Deming was a statistics professor at New York University during the 40s. He studied for several years with Walter Shewhart and was involved in assisting Japanese companies to reborn from their own ashes. His contribution was in improving quality, by setting a 14-point principle which should be the foundation for achieving quality improvements. Japanese companies applied extensively these principles. Today's power of Japan and quality of their products has a strong root in this matter. Deming emphasized on the role of management in achieving quality.

Deming's 14 principles are:

1. Create constancy of purpose (short-term reactions has to be replaced by long-term planning),
2. Adopt the new philosophy (management should adopt his philosophy, rather than to expect the employees to do that),
3. Cease dependence on inspection (it concerns to variation. In other words, if there is no variation, no inspection is needed because no product shows any defects),
4. Move towards a single supplier for any one item (working with several suppliers, automatically involves variation in raw materials),
5. Improve constantly and forever (it refers to decreasing variation, as a key to better quality),

Notes

6. Institute training on the job (another source of variation is the lack of training of workers; train them properly to do a certain job, and they will do it with far less variation),
7. Institute leadership (distinction between leadership and supervising),
8. Drive out fear (eliminate fear at worker's level to get their support for improvements. Fear is counter-productive),
9. Break down barriers between departments (here comes the concept of "internal customer" which is found in TQM; a department is a supplier for next one. The second one is the client for the first one),
10. Eliminate slogans (usually, it's not the employee who did it wrong, but it's the system who allowed that. No need to create tension on worker, as long as the system fails to prevent problems),
11. Eliminate management by objectives (as long as workers had to achieve an established production level, quality will be a secondary target),
12. Remove barriers to pride of workmanship (bringing problems all the time to worker's ears, will create a discomfort for them. Lower satisfaction of workers equals a lower interest for doing good items),
13. Institute education and self improvement (education is an asset. Everyone has to improve themselves),
14. Transformation is everyone's job (improvement exists at every level).

Task Make a presentation on the similarities and differences between the concepts of leadership.

4.6 Quality Council

A quality council is established to provide overall direction. The council is composed of:

- Chief Executive Officer
- Senior Managers
- Coordinator or Consultant
- A representative from the Union

Duties of the council are:

1. Develop the core values, vision statement, mission statement and quality policy statement
2. Develop the strategic long-term plan with goals and Annual Quality Improvement Program with objectives
3. Create the total education and training plan
4. Determine and monitor the cost of poor quality
5. Determine the performance measures

Notes

6. Determine projects those improve the process
7. Establish multifunctional project and work group teams
8. Revise the recognition and rewards system

A typical meeting agenda will have the following items:

- Progress report on teams
- Customer satisfaction report
- Progress on meeting goals
- New project teams
- Benchmarking report

Within three to five years, the quality council activities will become ingrained in the culture of the organization.

4.6.1 Core Values

Core values foster TQM behaviour and define the culture.

Some examples from Malcolm Baldrige National Quality Award:

- Visionary leadership
- Customer driven excellence
- Organizational and personal learning
- Valuing employees and partners
- Agility
- Focus on the future
- Managing for innovation
- Management by fact
- Public responsibility and citizenship
- Focus on results and creating value.
- Systems perspective

Self Assessment

Fill in the blanks:

10. ..... people think beforehand and are ready to face a situation.
11. ..... are important as they help in focusing your approach.
12. ..... is known as the father of quality.
13. Deming emphasized on the role of management in achieving .....
14. A ..... is established to provide overall direction.

Notes

Case Study

Chrysler's Transmission Problem

Chrysler pioneered its immensely popular mini van in 1984, which quickly became the best selling product the company had ever built. Within five years, Chrysler held more than 50% of market share of mini vans. In 1989 Chrysler offered a new automatic transmission as an option in some of it's to models of mini vans and luxury automobiles. The new transmission immediately ran into trouble when many customers reported serious problems.

Claiming that it had made improvement to reduce the initial problem, Chrysler continued to use transmission. Meanwhile the centre of auto safety, a consumer group that monitors the auto industry charged that Chrysler had not tested the transmission before introducing it. The group's claim was supported by data on owner complaints and frequency of repairs. During the first years of ownership itself, about 20% of the owners were reporting problems with the new transmission.

For the 1991 model, Chrysler extensively modified the design of the vehicle but continued to use the same problematic transmission as standard equipment, with most of the large engines in high demand.

As a result, the Chrysler which was placed at the top in magazine "Consumer reports" for many years, dropped to bottom of the list in 1991, citing the transmission in particular as well as other signs of deteriorating quality. A new Toyota model captured the top spot of the year.

Questions

1. Make the brief presentation of the case.
2. To what factors might you attribute Chrysler's failure to maintain market leadership?
3. How might a stronger focus on quality have helped Chrysler?
4. What might have Chrysler done differently? Give suggestions.

4.7 Summary

- James MacGregor Burns, in his book Leadership, describes a leader as one who instills purposes, not one who controls by brute force.
- Quality leaders give priority attention to external and internal customers and their needs.
- Everyone is responsible for quality, especially senior management and the CEO; however, only the latter can provide the leadership system to achieve results.
- Senior managers need to be provided with the skills to implement quality control techniques and actively participate in the quality council.
- Senior management must practice the philosophy of Management by Wandering Around (MBWA).
- Senior managers must be visible and actively engaged in the quality effort by serving on teams, coaching teams, and teaching seminars.
- A very important role of senior managers is listening to internal and external customers and suppliers through visits, focus groups, and surveys. This information is translated into core values and process improvement projects.

Notes

- Attitudes can be simply referred to as evaluative statements, which may be either favorable, regarding people, objects or events.
- Attitude is often used in describing people and in explaining their behavior.
- An attitude can be defined as a continuous tendency to feel and behave in a specific way toward some object.
- In OB, there are three very important work related attitudes: job satisfaction, job involvement and organizational commitment.
- A quality council is established to provide overall direction. Core values foster TQM behaviour and define the culture.
- Technological advances coupled with business incertitude are turning organizations into more proactive entities. Downsizing and VRS are common features of the corporate scenario today.

4.8 Keywords

Attitude: A settled way of thinking or feeling, typically reflected in a person's behavior.

Cognitive Process: Cognitive processes are the mental processes used by an individual to learn and retain information.

Core Values: A principle that guides an organization's internal conduct as well as its relationship with the external world.

Employee Recognition: Employee recognition is one of the most effective and affordable ways to reduce turnover, curb absenteeism, increase productivity, and keep employees engaged with their work.

Job Satisfaction: The extent to which you are content with the work you do and the conditions which you work under.

Leadership: The action of leading a group of people or an organization.

Organizational Behavior: Organizational behavior the systematic study and careful application of knowledge about how people – as individuals and as groups – act within organizations.

Organizational Strategies: An expression of how an organization needs to evolve over time to meet its objectives along with a detailed assessment of what needs to be done.

4.9 Review Questions

1. What do you understand by leadership? Explain.
2. Mention any ten characteristics of leaders.
3. Write a short note on the role of the TQM leaders with special emphasis on the role of senior management.
4. Explain attitude. What are the different types of attitude? How does the involvement of top management affect the attitude of employees?
5. Mention the 7 habits given by Stephen Covey.
6. What do you understand by Deming philosophy?
7. Briefly describe the 14 principles of Deming's philosophy.
8. Who are the members of quality council and what are their duties?

Notes

9. What do you understand by core values?
10. What, in your opinion, is required to be done by the organizations so as to maintain a healthy and positive attitude?

Answers: Self Assessment

1.	Shared goals	2.	Daimler Chrysler
3.	Subordinates	4.	Leaders
5.	Jack Welch	6.	Management by Wandering Around
7.	Quality council	8.	Attitude
9.	Emotional	10.	Proactive
11.	Goals	12.	Deming
13.	Quality	14.	Quality council

4.10 Further Readings

Books

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Notes

Unit 5: Customer Satisfaction

CONTENTS

Objectives

Introduction

5.1 Customer Satisfaction

5.2 Customer Perception of Quality

5.2.1 Feedback

5.2.2 Customer Satisfaction Index

5.3 Service Quality

5.3.1 Kano Model

5.4 Summary

5.5 Keywords

5.6 Review Questions

5.7 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Customer Satisfaction and Their Perception of Quality
- Discuss Various Methods of Feedback
- Explain Customer Satisfaction Index
- Explain Service Quality

Introduction

Previous unit dealt with leadership in TQM, quality council and core values. It also discussed the various leadership concepts, viz. 7 habits and Deming philosophy.

This unit will give you an insight on the concept of customer satisfaction and their perception of quality.

There are two distinct types of customers i.e. external and internal. Internal customers are within the company-the colleagues working together for delivering a service or product for the external customer. An external customer may be an individual or an enterprise that hires or purchases the product(s) or service(s) from another person or business in exchange of money.

One of the most important factors for the success of an enterprise is its customers. Without them, a business cannot exist.

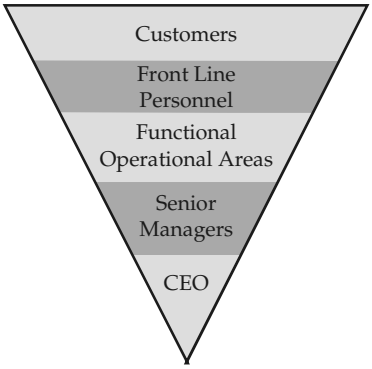
To capture customers, a business must try to find out what people want, how much and how often they will buy and how their post-purchase satisfaction will be ensured.

Notes

5.1 Customer Satisfaction

Customer satisfaction, a business term, is a measure of how products and services supplied by a company meet or surpass customer expectation. Customer satisfaction is not an objective statistics but more of a feeling or attitude. If a customer is happy with a product or a service it has hired or purchase they will pay their bills promptly, which greatly improves cash flow-the lifeblood of any organization. Customers that are satisfied will increase in number, buy more, and buy more frequently.

Figure 5.1: Customer Satisfaction Organizational Diagram



This inverted pyramid is a good way to depict the importance of customers. He is at the top of the pyramid and the CEO is at the bottom. This shows the relative importance of people at the bottom of the hierarchy. A company never makes a product for its top management people, rather it is meant for the customer. As front line employees are in direct contact with people so they are in a better position to understand a customer's needs and problems.

Caution Every effort should be taken by the organization to seek opinion from front line employees. Even in case of empowerment it is front line employee who should be having more empowerment which will enable him to solve customer problem on the spot.

Self Assessment

Fill in the blanks:

1. One of the most important factors for the success of an enterprise is its ……..
2. …… is a measure of how products and services supplied by a company meet or surpass customer expectation.
3. Every effort should be taken by the organization to seek opinion from …… employees.

5.2 Customer Perception of Quality

The American Society for Quality (ASQ) survey on the user perceptions of important factors that influenced purchases showed the following ranking:

1. Performance
2. Features

Notes

3. Service
4. Warranty
5. Price
6. Reputation and goodwill

Performance: Performance involves "fitness for use" – a phrase that indicates that the product and service is ready for the customer's use at the time of sale. Other considerations are:

1. Availability, which is the probability that a product will operate when needed;
2. Reliability, which is freedom from failure over time;
3. Maintainability, which is the case of keeping the product operable.

Features: Identifiable features or attributes of a product or service are psychological, time oriented, contractual, ethical, and technological. Features are secondary characteristics of the product or service.

Service: An emphasis on customer service is emerging as a method for organization to give the customer-added value. However, customer service is intangible- it is made up of many small things, all geared to change the customer's perception. Intangible characteristics are those traits that are not quantifiable, yet contribute greatly to customer satisfaction. Providing excellent customer service is different from and more difficult to achieve than excellent product quality.

Warranty: The product warranty represents an organization's public promise of a quality product backed up by a guarantee of customer satisfaction. Ideally, it also represents a public commitment to guarantee a level of service sufficient to satisfy the customer.

Price: Today's customer is willing to pay a higher price to obtain value. Customers are constantly evaluating one organization's products and services against those of its competitors to determine who provides the greatest value. However, in our highly-competitive environment, each customer's concept of value is continually changing.

Reputation: Most of us find ourselves rating organizations by our overall experience with them. Total customer satisfaction is based on the entire experience with the organization, not just the product.

Did u know? Good experiences are repeated to six people and bad experiences are repeated to 15 people; therefore, it is more difficult to create a favorable reputation.

5.2.1 Feedback

Customers continually change. They change their minds, their expectations, and their suppliers.

Note Customer feedback must be continually solicited and monitored.

Customer feedback is not a one-time effort; it is an ongoing and active probing of the customers' mind. Feedback enables the organization to:

- Discover customer dissatisfaction.
- Discover relative priorities of quality.
- Compare performance with the competition.

Notes

- Identify customers' needs
- Determine opportunities for improvement.

Comment Card: A low-cost method of obtaining feedback from customers involves a comment card, which can be attached to the warranty card and included with the product at the time of purchase. The intent of the card is to get simple information, such as name, address, age, occupation, and what influenced the customer's decision to buy the product. However, there is very little incentive for buyers to respond to this type of card, and the quality of the response may not provide a true measure of customer's feelings.

Customer Questionnaire: A customer questionnaire is a popular tool for obtaining opinions and perceptions about an organization and its products and services. However, they can be costly and time-consuming.

To make surveys more useful, it is best to remember eight points.

1. Client and customers are not the same.
2. Surveys raise customers' expectations.
3. How you ask a question will determine how the question is answered.
4. The more specific the question, the better the answer.
5. You have only one chance and only 15 minutes.
6. The more time you spend in survey development, the less time you will spend in data analysis and interpretation.
7. Who you ask is as important as what you ask.
8. Before the data are collected, you should know how you want to analyze and use the data.

When writing a survey, it is best to remember that more multiple choice questions can be answered in 15 minutes than open-ended questions. To illustrate this point, compare the following multiple-choice question to the open ended question.

How many times do you dine out in a mouth?

(a) 1 - 2 times

(b) 3 - 5 times

(c) 6 -10 times

(d) More than 10 times

Focus Group: Customer focus groups are a popular way to obtain feedback, but they too can be very expensive. These groups are very effective for gathering information on customer expectations and requirements.

Surveying a focus group is a research method used to final out what customers are really thinking. A group of customers is assembled in a meeting room to answer a series of questions. These carefully structured questions are asked by a skilled moderator, who probes into the participants' thoughts, ideas, perceptions, or comments.

Toll-Free Telephone Number: Toll-free (800/888) telephone numbers are an effective technique for receiving complaint feedback. Organizations can respond faster and more cheaply to the complaint. Such a number does not, however, reach those who decided not to buy the product or those who discovered some likable feature on a competitor's product. Toll-free numbers are in use by at least 50% of all organizations with sales of at least $10 million.

Notes

Customer Visits: Visits to a customer's place of business provide another way to gather information. An organization can proactively monitor its product's performance while it is in the use and thereby identify and specific or recurring problems. Senior managers should be involved in these visits and not delegate them to someone else. However, it is a good idea to take along operating personnel so they can see firsthand how the product is performing.

Report Card: Another very effective information-gathering tool is the report card.

The Internet Computers: Some managers are beginning to monitor discussions that take place on the internet to find out what customers are saying about their products. Internet users frequently seek advice regarding their everyday activities or activities related to specific interests, hobbies, or sports. Newsgroups, electronic bulletin boards, and mailing list can be scanned using keyword searches if one knows that a company's is of interest to participants in certain activities, hobbies, or profession.

Employee Feedback: Employees are often an untapped source of information. Companies are listening more to the external customer but still are not listening to employee. Employees can offer insight into conditions that inhibit service quality in the organization. Employee groups can brainstorm ideas to come up with solutions to problems that customers have identified.

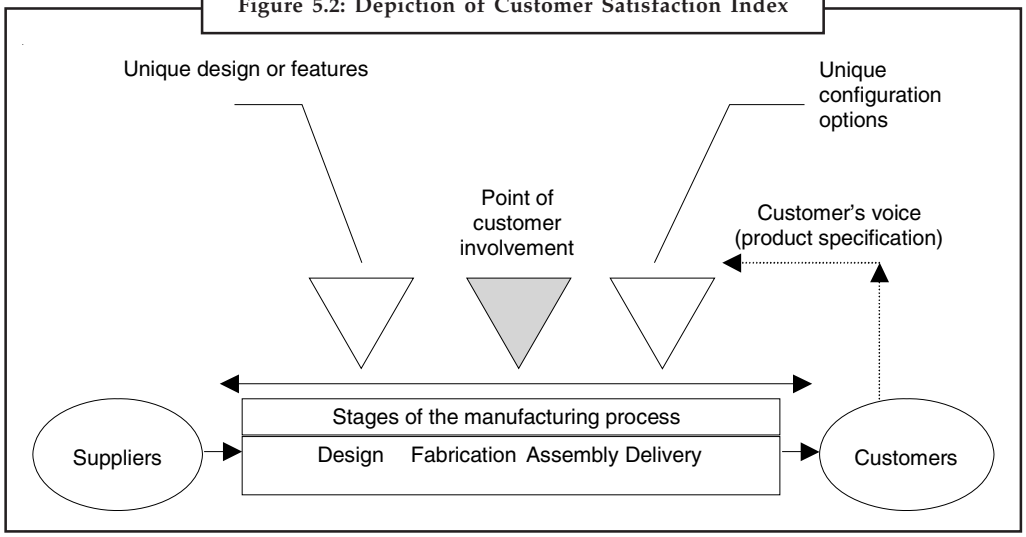
Mass Customization: The ultimate in customer satisfaction is giving customers exactly what they want. In the past, the price tag for this was prohibitive, but mass customization is a way to provide variety at an affordable cost.

Task Prepare a report on the customer feedback on their experience in a public sector bank.

5.2.2 Customer Satisfaction Index

The American Customer Satisfaction Index (ACSI), established in 1994 as a joint project between the University of Michigan and the American Society of Quality, quantifies quality and customer satisfaction and relates them to firm's financial performance.

Figure 5.2: Depiction of Customer Satisfaction Index



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The index measures eight sectors of the economy, which include more than 40 industries and more than 200 individuals companies and agencies. The eight sectors of the economy are:

1. Manufacturing (non durables)
2. Manufacturing (Durables)
3. Retail
4. Transportation, communication and utilities
5. Finance and Insurance
6. Services
7. Public administration and government
8. E-commerce (adopted in 2000)

Caselet

Use TQM to Improve Customer Satisfaction

A primary focus of TQM and most Quality Management Systems is to improve customer satisfaction by having a customer focus and consistently meeting customer expectations. Customers are almost always satisfied when their expectations are met. When they expect a certain product or service, and you deliver it without problems and at a fair price, you've built a solid customer relationship. Happy, satisfied customers become repeat customers and they provide word-of-mouth marketing – the most powerful kind.

There are three Total Quality Management components that work toward achieving customer satisfaction:

1. It requires that your business understand what customers typically expect in a field, industry, or product line.
2. It ensures your business has the expertise and the resources to consistently deliver the expected product or service.
3. It emphasizes the need for your business to clearly communicate to the customers exactly what you will deliver to avoid misunderstandings.

TQM provides the quality assurance that customers will get what they expect, as well as a process for managing unsatisfied customers, make needed corrections and prevent similar reoccurrences.

Every business owner and manager knows the importance of satisfied customers, and how expensive it is to find new customers compared to keeping current customers. Business research clearly shows that there is a direct correlation between satisfied customers and revenue. If your business doesn't have a clear path to creating satisfied customers, then it can benefit from TQM.

TQM Improves Business Efficiency and Effectiveness

While focusing on the customer is critical to success, it isn't the only factor. A business can go broke sparing no expense to make customers happy. So not only does a business need to satisfy customers, but it needs to do it in a way that is. A business also has to look within

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and understand its own operations, another important role of a quality management system.

Total Quality Management places a focus on internal processes, including:

- How processes align to produce desired outcomes to satisfy customers
- How consistently processes deliver desired outcomes (effectiveness)
- The productivity of a process compared the resources used (efficiency)

Being able to consistently produce desired outcomes without wasting resources like time, material and money is critical for a business to make it over the long haul.

Self Assessment

Fill in the blanks:

4. ..... is the probability that a product will operate when needed.
5. ..... is the case of keeping the product operable.
6. ..... characteristics are those traits that are not quantifiable, yet contribute greatly to customer satisfaction.
7. ..... feedback must be continually solicited and monitored.
8. ..... are very effective for gathering information on customer expectations and requirements.
9. Through ..... organizations can respond faster and more cheaply to the complaint.
10. Companies are listening more to the ..... but still are not listening to .....

5.3 Service Quality

Customer service quality elements are as follows:

Organization

1. Identify each market segment
2. Write down the requirements
3. Communicate the requirements
4. Organize processes
5. Organize physical spaces

Customer Care

1. Meet the customer's expectations
2. Get the customer's point of view
3. Deliver what is promised
4. Make the customer feel valued

Notes

5. Respond to all complaints
6. Over-respond to the customer
7. Provide a clean and comfortable customer reception area

Communication

1. Optimize the trade-off between time and personal attention
2. Minimize the number of contact points
3. Provide pleasant, knowledgeable and enthusiastic employees
4. Write documents in customer-friendly language

Front-line People

1. Hire people who like people
2. Challenge them to develop better methods
3. Give them the authority to solve problems
4. Serve them as internal customers
5. Be sure they are adequately trained
6. Recognize and reward performance

Leadership

1. Lead by example
2. Listen to the front-line people
3. Strive for continuous process improvement

Customer Care

Code of ethics is to:

1. Keep promises to customers.
2. Return calls to customers in an expedient manner.
3. Give customers assistance with their concerns, referring an appropriate staff member for problem-solving action when necessary.
4. Treat our customers with respect, courtesy and professionalism at all times.
5. Remain aware and evaluate customer satisfaction regularly.
6. Continually search for customer-related improvements.
7. Deliver service and products quickly and efficiently.
8. Give every customer involved and personal attention.
9. Maintain a clean and neat appearance, including the workplace, at all times.
10. Review and implement customer feedback and suggestions into current procedure when appropriate.

Notes

11. Engage in any training or education that will enhance our job performance and our commitment to customer care.
12. Treat every customer just as we would want to be treated ourselves.

Additional Comments

Many organizations emphasize traditional or reactive service after the sale.

Examples:

(a) Preventive maintenance (service provided according to a prescribed timetable)

(b) Service contract (service provided as required)

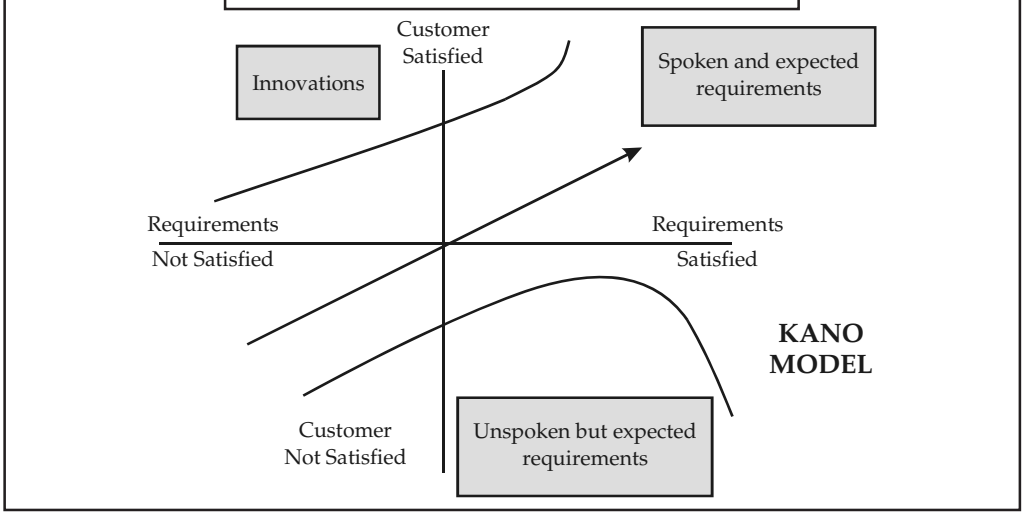
(c) No service contract (service requires labor and material billing)

(d) Combinations of the above

5.3.1 Kano Model

Kano model shows us how an unsatisfied customer can be converted to a satisfied customer by implementing quality goals.

Figure 5.3: Kano Model of Customer Satisfaction



The bottom left quadrant shows the most unsatisfied customer. This can be because of many reasons. Maybe the product isn't fulfilling the consumer's need or the product is not matching his expectations. When the customer moves to the bottom right quadrant then he is just a mute buyer of the product. He may be buying the product just because it is his necessity. The product is just fulfilling his some basic needs.

Example: When Bajaj scooter was the only major brand available in the Indian market, people had to choose from some very basic models like Bajaj Chetak, Rajdoot and Yezdi. Then, came the onslaught of 100 cc bike. This gave more convenience to customers.

In the late nineties many models arrived on the scene and some of them gave real customer delight taking the customer to the top left quadrant of the Kano model and then to the top right quadrant where the customers have their say in the products.

Notes

Self Assessment

Fill in the blanks:

11. ..... shows us how an unsatisfied customer can be converted to a satisfied customer by implementing quality goals.

12. In Kano model, the bottom left quadrant shows the most ..... customer.

Case Study

Hewlett-Packard Company

Have you ever sat down with other people at your company to look for a better way to meet customers' quality needs, only to have been disappointed with the results? The reason for your disappointment may be that one important element was missing from the equation: your customers themselves. Listening to them is what provides real insight into meeting their quality requirements.

While Hewlett-Packard Company's Northwest Integrated Circuit Division (Corvallis, OR) is in business to sell chips to other divisions inside Hewlett Packard (HP), it also serves customers outside of HP. The problem that it faced about five years ago, however, was that many employees either didn't know who their customers were or actually believed that the customers were interfering with them as they performed their work.

Fortunately, management saw the obvious need to address these problems. "We wanted our people to become very familiar with our customers and realise that they were here to serve those customers," says Casey Collett, Ph.D., Total Quality Control manager. "Our goal was to become so responsive to our customers that we would be the only supplier with which they would want to do business."

A Four-step Process

To meet that goal, the Division launched its Total Quality Control effort in 1983. Collett says it involves four steps:

Step 1: On your own, identify what you feel your major business processes are.

Step 2: On your own, determine how you are being measured by your customer.

Step 3: Go out and verify these two perceptions with your major customers.

Step 4: Develop a programme to improve these processes.

To execute these four steps, division management created a small group of TQC experts, who currently report directly to the division manager and work closely with a steering committee of top managers. TQC members have expertise in manufacturing, teaching, statistics, and group facilitation. Together, the division quality and TQC departments attack customer satisfaction and internal process improvement issues, respectively.

The Division has also created a three-point TQC model, which has expanded to a seven-point model over the years. (See Figure 1)

Process improvements occur through quality leadership and teamwork. Reducing complexity, setting data-based (meaningful) standards, and using appropriate statistical methods are the tools used to achieve the process improvements

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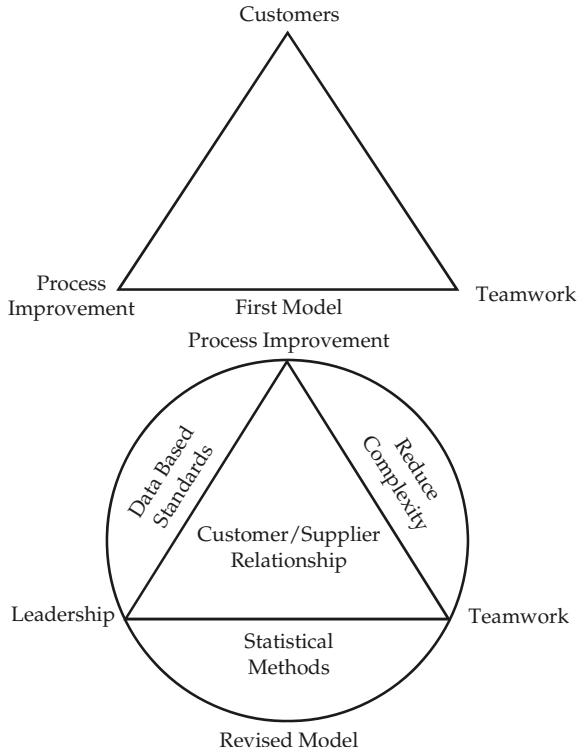
Figure 1: The Customer/Supplier Relationship is Central to the Model



HP's 10-step Planning Process

The key to achieving TQC from the customer's point of view at HP is a 10-step business planning process pioneered by planning expert Scott Feamster. This process requires the division to understand and analyse each of the following:

1. Purpose
2. Objectives
3. Customers and distribution channels
4. Competition
5. Necessary products and services
6. Plans for necessary products and services (research, manufacturing, financial, and marketing plans)
7. Financial analysis
8. Potential problem analysis
9. Recommendations
10. Next year's tactical plan

The 10-step business planning process, then, is a systematic way of:

- Understanding the business you're proposing to be in;
- Understanding your customers' needs;

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- Understanding the market and competitive environment you're entering, and as a result of these understandings;
- Making solid, well-thought-out plans to meet your objectives.

"When you have developed your strategy, you should have an objective, methodical business plan that looks at what customers need and what you are going to do about those needs," says Collett. "Then you can take this document back to the customer and verify its accuracy."

A crucial element of making the 10-step business planning process work is what John Doyle, HP executive vice president for Systems Technology, calls "Imaginative Understanding of Users' Needs" (IUUN). "IUUN is becoming an" integral part of how HP does business," Collett reports, adding that the philosophy of IUUN is to hear what customers say their needs are, and apply the creativity and knowledge you have to create solutions for customers.

Quality Function Deployment

While IUUN is critical to the success of the business planning process, Quality Function Deployment (QFD) is critical to the success of IUUN. QFD is the philosophy of designing your processes in response to customer needs.

"Before QFD, we didn't always realise the importance of understanding customer needs," says Collett. "As a result, we often invented products that we thought people such as ourselves would want, instead of asking our customers what they wanted."

Currently, the Division uses QFD in its R&D and marketing areas. "It helps us find out what our customers need so that we can build these needs into the next generation of our products."

QFD's Planning Matrix

One of the most important tools in QFD is the Planning Matrix. Once you know what your customers' requirements are, the next step is to translate these data into product development plans. The Planning Matrix plots customer requirements on one axis and business processes and their measures or product features on the other axis. The idea is to be able to determine the fit between customer needs and product features. "The Planning Matrix puts a lot more objectivity into the product development process," notes Collett.

Here's How it Works

Down the left side of the matrix are rows of user needs. Across the top of the matrix are columns of product features. With the matrix, you can see where a row intersects with a column and in that cell, ask yourself if there is a strong relationship, a weak relationship, or no relationship between what the customer requires and what your company is doing.

If you find no relationship on a highly rated need as ranked by the customer, then you need to look at your product design plan and address problem, since the customer considers it important. Conversely, if you are building in steps in the design process that have no bearing on customer needs, you may be able to eliminate them. For example, you may be doing test procedures on something that the customer doesn't care about.

R&D then creates another matrix of customer needs by process control characteristics (or internal manufacturing control characteristics) that will have to be met in order to give customers the features that they want. In short, the system translates raw customer data into focused activities for helping Marketing, R&D, Manufacturing, and Quality to make the desired product a reality.

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Two More Tools for Success

HP uses two other tools to ensure that it is responding to the quality requirements of customers.

Customer Quality Engineers are electrical engineers who work with Marketing to gather customer data and with R&D and Manufacturing to make sure customer issues are addressed. The task is not always easy. "Clients ask questions in their own terms," says Collett. Customer quality engineers thus need to translate these terms so that answers to their real, often unarticulated problems can be found. Then they need to translate the solutions developed by the division back into language that the customers will be able to understand and utilize.

Process Improvement Teams attack customer issues throughout the Division's team concept. "A few of these teams interface so closely with customer divisions that they ask the customers to be on one of our teams," says Collett. "This certainly gives teams direct feedback from customers."

The teams solve customer problems and then return to customer locations to show them what they have accomplished. "The concept works well, because customers essentially drive the improvement process," she adds.

Focus on the Future

Things have been improving. "Our quality is better, our planning processes are improving, and teams are busy with improvement projects," says Collett. "Sales are up, but we never take customer satisfaction for granted. On an annual basis, we verify with our customers that our processes and the way we are measuring ourselves reflect customer satisfaction. We refine the measures more and more over time to make sure that they accurately reflect what the customer wants."

Questions

1. Why is it important to understand a company's basic business processes in order to deliver Customer satisfaction? Illustrate your answer.
2. How do you determine customers' perceptions of your product or service?
3. What are the basic differences between the first model and the revised model in Figure 1?
4. Explain the necessity for steps 3 and 4 of Hewlett-Packard's 10-step planning process.
5. How would you verify that customers are satisfied? What key result indicators might be used?

Source: Shailendra Nigam, *Total Quality Management*, Excel Books, New Delhi.

5.4 Summary

- There are two distinct types of customers i.e. external and internal.
- One of the most important factors for the success of an enterprise is its customers.
- Customer satisfaction is a measure of how products and services supplied by a company meet or surpass customer expectation.
- As front line employees are in direct contact with people so they are in a better position to understand a customer's needs and problems.

Notes

- Performance involves "fitness for use" – a phrase that indicates that the product and service is ready for the customer's use at the time of sale.
- An emphasis on customer service is emerging as a method for organization to give the customer-added value.
- The product warranty represents an organization's public promise of a quality product backed up by a guarantee of customer satisfaction.
- Customers are constantly evaluating one organization's products and services against those of its competitors to determine who provides the greatest value.
- Customer feedback must be continually solicited and monitored.
- Some managers monitor the discussions that take place on the internet to find out what customers are saying about their products.
- The American Customer Satisfaction Index (ACSI), established in 1994 as a joint project between the University of Michigan and the American Society of Quality quantifies quality and customer satisfaction and relates them to firm's financial performance.
- The index measures eight sectors of the economy, which include more than 40 industries and more than 200 individuals companies and agencies.
- Customer service quality elements are: Organization, Customer Care, Communication, Front-line people, Leadership.
- Kano model shows us how an unsatisfied customer can be converted to a satisfied customer by implementing quality goals.

5.5 Keywords

***Comment Card*:** Comment card is sent out at the completion of each job. This gives us immediate feedback as to the satisfaction of our work.

***Customer Satisfaction Index*:** It is the overall satisfaction rating for the retailers that covers all the key players' individual performances on the satisfaction scale.

***Customer Satisfaction*:** Customer satisfaction means customer's perception of the degree to which the customer's requirements have been fulfilled.

***Employee feedback*:** Employee feedback is to know opinions of employee about things which happened or not happen in organization.

***Feedback*:** Information about reactions to a product, a person's performance of a task, etc., used as a basis for improvement is known as feedback.

***Focus Groups*:** A demographically diverse group of people assembled to participate in a guided discussion about a particular product before it is launched, or to provide ongoing feedback on a political campaign, television series, etc is known as focus group.

***Front Line Employee*:** Any employee with direct contact with customers and/or with direct involvement with the money making process in their respective company.

***Mass Customization*:** A process whereby small lots of individualized parts or products are produced. The opposite of mass production whereby large numbers of identical parts or products are produced is referred to as mass customization.

***Perceived Quality*:** Perceived quality refers to the consumer's opinion of a product's (or a brand's) ability to fulfill his or her expectations.

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***Service Quality*:** Service quality refers to a number of inter-related factors including the way in which individuals are treated by providers, the scope of services and contraceptives available to clients, the quality of the information provided to the clients and quality of the counseling skills, the promotion of individual choice, the technical competence of providers, and the accessibility and continuity of services.

***Warranty*:** A written guarantee is issued to the purchaser of an article by its manufacturer, promising to repair or replace it if necessary within a specified period of time.

5.6 Review Questions

1. Write a short note on:
   (a) customer satisfaction
   (b) customer perception of quality
   (c) feedback
   (d) customer satisfaction index
   (e) service quality
2. Explain customer satisfaction with the help of a diagram.
3. What are the important factors that influence purchases according to American Society for Quality? Explain them briefly.
4. Briefly explain comment card and customer questionnaire. Which one, in your opinion is the better way of getting feedback?
5. Mention the points which should be kept in mind while making the customer questionnaires.
6. Which is the cheapest methods of getting customer feedback and why? Explain with examples.
7. Why do you think that employee feedback is necessary in organizations?
8. Discuss customer satisfaction index.
9. What do you understand by service quality? Explain its elements.
10. Describe Kano model.

Answers: Self Assessment

1.	Customers	2.	Customer satisfaction
3.	Front line	4.	Availability
5.	Maintainability	6.	Intangible
7.	Customer	8.	Focus groups
9.	Toll-free telephone numbers	10.	External customer; employee
11.	Kano model	12.	Unsatisfied

Notes

5.7 Further Readings

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Notes

Unit 6: Customer Retention

CONTENTS

Objectives
Introduction
6.1 Different Types of Customers
6.2 Customer Retention Strategies
6.2.1 Negative Retention Strategies
6.2.2 Positive Retention Strategies
6.3 Trends in Customer Retention
6.4 Keys for Customer Retention
6.5 Customer Loyalty
6.6 Summary
6.7 Keywords
6.8 Review Questions
6.9 Further Readings

Objectives

After studying this unit, you will be able to:

- Identify the Different Types of Customer and Discuss Its Strategies
- Define Customer Retention
- Discuss Trends in Customer Retention
- Explain the Key Techniques used for Customer Retention
- Explain Customer Loyalty

Introduction

Customer retention is the key to any organization's effectiveness. Customer centric approach to marketing program helps retain customers and win back lost customers. An organization needs to study the needs of the various market segments and design the marketing programs tailor made to suit the segments. Customer anticipates several things from the company in addition to the product; which the firm has to study well to bridge the gaps between customer expectations and firm's delivery. Emergence of competitive environment resulted in a series of customer focused (quality centered) management approaches. Thus the quality and productivity have become synonymous and the employee-centered (internal customer) focus on change management such as QC, Kaizen, TQM, Zero defects, etc., have come into play.

6.1 Different Types of Customers

Customers play the most significant part in business. In fact the customer is the actual boss in a deal and is responsible for the actually profit for the organization. Customer is the one who uses

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the products and services and judges the quality of those products and services. Hence it's important for an organization to retain customers or make new customers and flourish business. To manage customers, organizations should follow some sort of approaches like segmentation or division of customers into groups because each customer has to be considered valuable and profitable.

Customers can be of following types:

1. ***Loyal Customers:*** These types of customers are less in numbers but promote more sales and profit as compared to other customers as these are the ones which are completely satisfied. These customers revisit the organization over times hence it is crucial to interact and keep in touch with them on a regular basis and invest much time and effort with them. Loyal customers want individual attention and that demands polite and respectful responses from supplier.
2. ***Discount Customers:*** Discount customers are also frequent visitors but they are only a part of business when offered with discounts on regular products and brands or they buy only low cost products. More is the discount the more they tend towards buying. These customers are mostly related to small industries or the industries that focus on low or marginal investments on products. Focus on these types of customers is also important as they also promote distinguished part of profit into business.
3. ***Impulsive Customers:*** These customers are difficult to convince as they want to do the business in urge or caprice. They don't have any specific item into their product list but urge to buy what they find good and productive at that point of time. Handling these customers is a challenge as they are not particularly looking for a product and want the supplier to display all the useful products they have in their tally in front of them so that they can buy what they like from that display. If impulsive customers are treated accordingly then there is high probability that these customers could be a responsible for high percentage of selling.
4. ***Need-based Customers:*** These customers are product specific and only tend to buy items only to which they are habitual or have a specific need for them. These are frequent customers but do not become a part of buying most of the times so it is difficult to satisfy them. These customers should be handled positively by showing them ways and reasons to switch to other similar products and brands and initiating them to buy these. These customers could possibly be lost if not tackled efficiently with positive interaction.
5. ***Wandering Customers:*** These are the least profitable customers as sometimes they themselves are not sure what to buy. These customers are normally new in industry and most of the times visit suppliers only for confirming their needs on products. They investigate features of most prominent products in the market but do not buy any of those or show least interest in buying. To grab such customers they should be properly informed about the various positive features of the products so that they develop a sense of interest.

An organization should always focus on loyal customers and should expand or multiply the product range to leverage impulsive customers. For other types of customers strategies should be renovated and enhanced for turning out these customers to satisfy their needs and modify these types of customers to let them fall under loyal and impulsive category.

6.2 Customer Retention Strategies

The dynamics of the business ecosystem have changed the way in which companies do business both in relationship management and the streamlining of their operations. Relationship marketing is emerging as the core marketing activity for businesses operating in fiercely competitive environments.

Notes

Did u know? On an average, businesses spend six times more to acquire new customers than to keep them. Therefore, many firms are now paying more attention to their relationships with existing customers to retain them and increase their share of customer's purchases.

The practice of relationship marketing also has the potential to improve marketing productivity through improved marketing efficiencies and effectiveness.

Customer Retention is the activity that a selling organization undertakes in order to reduce customer defections. Successful customer retention starts with the first contact an organization has with a customer and continues throughout the entire lifetime of a relationship. A company's ability to attract and retain new customers, is not only related to its product or services, but strongly related to the way it services its existing customers and the reputation it creates within and across the marketplace.

Customer retention is more than giving the customer what they expect; it's about exceeding their expectations so that they become loyal advocates for your brand. Creating customer loyalty puts 'customer value rather than maximizing profits and shareholder value at the center of business strategy'. The key differentiator in a competitive environment is more often than not the delivery of a consistently high standard of customer service.

An important distinction can be made between strategies that lock the customer in by penalizing their exit from a relationship, and strategies that reward a customer for remaining in a relationship. The former are generally considered negative, and the latter positive customer retention strategies.

6.2.1 Negative Retention Strategies

Negative customer retention strategies impose high switching costs on customers, discouraging defection.

In a B2C context, mortgage companies have commonly recruited new customers with attractive discounted interest rates. When the honeymoon period is over, these customers may want to switch to another provider, only to discover that they will be hit with early redemption and exit penalties. Customers wishing to switch retail banks find that it is less simple than anticipated: direct debits and standing orders have to be reorganized. In a B2B context, a customer may have agreed a deal to purchase a given volume of raw material at a quoted price. Some way through the contract a lower cost supplier makes a better offer. The customer wants to switch but finds that there are penalty clauses in the contract. The new supplier is unwilling to buy the customer out of the contract by paying the penalties.

Some customers find that these switching costs are so high that they remain customers although unwillingly. The danger from CRM practitioners is that negative customer retention strategies produced customers who feel trapped. They are likely to agitate to be freed from their obligations, taking up much management time. Also, they may utter negative word-of-mouth. They are unlikely to do further business with that supplier. Companies that pursue these strategies argue that customers need to be aware of what they are buying and the contracts they sign. The Total Cost of Ownership (TCO) of a mortgage can include early redemption costs.

When presented with a dissatisfied customer who is complaining about high relationship exit costs, companies have a choice. They can either enforce the terms and conditions, or not. The latter path is more attractive when the customer is strategically significant particularly if the company can make an offer that matches that of the prospective new supplier.

Notes

In the following section we look at a number of positive customer retention strategies, including meeting and exceeding customer expectations, finding ways to add value, creating social and structural bonds, and building commitment.

6.2.2 Positive Retention Strategies

It is very difficult to build long-term relationships with customers if their needs and expectations are not understood and well met. It is a fundamental precept of modern customer management that companies should understand customers, then acquire and deploy resources to ensure their satisfaction and retention. Customers that you are not positioned to serve may be better served by your competitors.

Exceeding customer expectations means going beyond what would normally satisfy the customer. This does not necessarily mean being world-class or best-in-class. It does mean being aware of what it usually takes to satisfy the customer and what it might take to delight or pleasantly surprise the customer. You cannot really strategize to delight the customer if you do not understand the customer's fundamental expectations. You may stumble onto attributes of your performance that do delight the customer, but you cannot consistent efforts to delight customers show your commitments to the relationship. Commitment builds trust. Trust begets relationship longevity.

Customer delight occurs when the customer's perception of their experience of doing business with you exceeds their expectation. In formulaic terms:

Customer delight = P > E

Where P = perception and E = expectation.

This formula implies that customer delight can be influenced in two ways: by managing expectations or by managing performance. In most commercial contexts customers expectations are ahead of perceptions. In other words, customers generally can find cause for dissatisfaction. You might think that this would encourage companies to attempt to manage customer expectation down to levels that can be delivered. However, competitors may well be improving their performance in an attempt to meet customer expectations. If your strategy is to manage expectations down, you may well lose customers to the better performing company. This is particularly so if you fail to meet customer expectations on important attributes.

Customers have expectations of many attributes.

Example: Product quality, service responsiveness, price stability, and the physical appearance of your people and vehicles.

These are unlikely to be equally important. It is important to meet customer expectations on attributes that are important to the customer. Online Customers, for example, look for rapid and accurate order fulfillment good price, high levels of customer service and website functionality. Dell Computers believes that Customer retention is the outcome of their performance against three variables: order fulfillment on time, in full, no error, product performance and after sales service. The comments in parentheses are the metrics that Dell uses.

Kano has developed a product quality model that distinguishes between three forms of quality. Basic qualities are those that the customer routinely expects in the product. These expectations are often unexpressed until the product fails.

Notes

Caselet

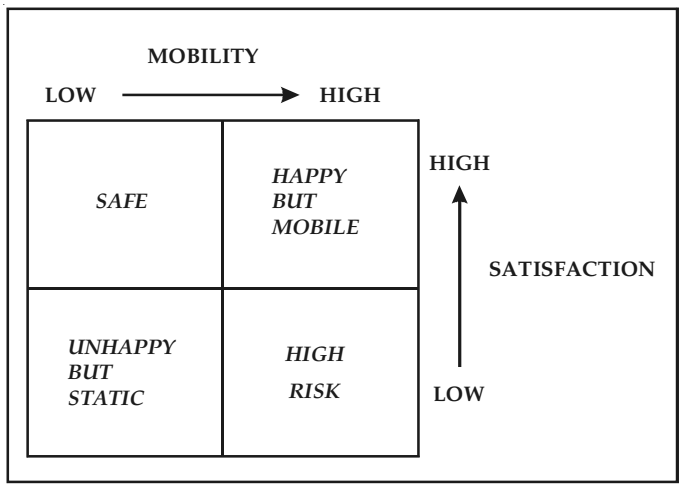
Rockbridge: A New Paradigm for Understanding Customer Retention

A common paradigm that has emerged from the TQM movement is that the ultimate path to retaining customers is to satisfy their needs. The theory holds that by identifying what customers expect, and then meeting and exceeding these expectations, customers will be far less likely to seek the services of competitors. Over the past few years, analyses of different satisfaction data bases have validated this theory. Customer satisfaction is indeed a strong correlate of retention and loyalty. However, the level of satisfaction with a service does not completely explain loyalty. In one study of a mass market service, it is discovered that when all the effects of satisfaction were controlled, the strongest predictor of brand loyalty became the number of years the customer had used their current brand.

The analysis suggested a new hypothesis about customer retention: some customers will not change their brand of service even if they are dissatisfied, while others will switch or try new alternatives even when they are completely satisfied. Other more comprehensive analyses of the determinants of loyalty and retention have suggested several factors, beyond satisfaction, that drive retention. These include:

- Past behavior
- Attitudes about purchasing, such as openness to new services
- Perceptions about the loss or gain of switching brands
- Demographics

In some cases, a company's high customer attrition rate may have as much to do with the type of customer as with the quality of service. Such companies may rely heavily on aggressive marketing. Customers who are responsive to solicitation are also more likely to be brand switchers.



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To help clients more intelligently, Rockbridge manage their customer retention, and has developed scales to measure two constructs that together more fully explain loyalty – satisfaction and mobility. Existing customer satisfaction surveys often contain enough information to develop both of these measures. The satisfaction and mobility scales have a great deal of independence, meaning that a person who is "highly satisfied" can be either "highly mobile" (i.e., willing to switch to a competitor) or "static" (i.e., unlikely to change brands).

Customers can be classified by where they fall on each of the two characteristics:

- "Safe" customers are considered such because they are not only satisfied, but tend not to change services even when their satisfaction drops.
- "High risk" customers are both unhappy and more likely than other customers to move on; management might consider writing off this segment, since even if they could be satisfied, they would still be prone to leaving.
- Attention needs to be focused on the "unhappy but static" customers. Every company has customers like these. Whether it is due to laziness or fear of inertia, they are likely to remain customers despite their lower satisfaction. Companies should still seek to correct these customers' problems. Even though their odds of leaving are less, they may still change brands, and a satisfied relationship will move them into the "safe zone."
- "Happy but mobile" customers are satisfied, but are in danger of switching brands, perhaps because they like to shop for new deals or are receptive to marketing pressure. The strategy for retaining these types of customers is akin to "watching the chickens in the henhouse." They need to be monitored more closely for switching cues. Companies should also structure pricing and programs to make sticking around economically rewarding.

Customer retention depends on much more than a process of continually improving satisfaction. It also requires dealing with attrition as an environmental circumstance that occurs even when the best service is in place.

Source: http://www.rockresearch.com/a-new-paradigm-for-understanding-customer-retention

Self Assessment

Fill in the blanks:

1. Customer …… is the key to any organization's effectiveness.
2. …… marketing is emerging as the core marketing activity for businesses operating in fiercely competitive environments.
3. Customer Retention is the activity that a selling organization undertakes in order to reduce customer …….
4. …… customer retention strategies impose high switching costs on customers, discouraging defection.

6.3 Trends in Customer Retention

Retaining and developing customers has long been a critical success factor for businesses. In that sense, Customer Relationship Management is not new, previously falling under the guise of customer satisfaction. Worldwide, service organizations have been pioneers in developing cause retention strategies.

Notes

1. ***Innovative Measures:*** Banks have relationship managers for selected customers, airlines have frequent flyer programs to reward loyal customers, credit card companies offer redeemable bonus points for increased card usage, telecom service operators provide customized services to their heavy users, and hotels have personalized services for their regular guests. It is, however, with the rapid rise of new entrants into the market place and increased competition that companies in other sectors have recognized the business potential within a captured base.

2. ***Improved Operating Performance:*** Sluggish growth rates, intensifying competition and technological developments businesses induced to reduce costs and improve their effectiveness. Business process re-engineering, automation and downsizing reduced the manpower costs. Financial restructuring and efficient fund management reduced the financial costs. Production and operation costs have been reduced trough Total Quality Management (TQM), Just in Time (JIT) inventory, Flexible Manufacturing Systems (FMS) and efficient Supply Chain Management (SCM).

3. ***Increased Focus:*** However, reduction in costs alone is no longer enough or is necessarily an effective strategy. In facing the competitive threats, such as new entrants, pricing pressures, technology along with the related costs and also including the time lags in procuring, maintaining and strengthening one's market, more and more organizations are realizing that the traditional marketing model is no longer effective. With a flood of new entrants offering quality products and services at lower prices, many sectors have been turned into commodity markets. In a market place where loyalty has plummeted and the cost of acquiring new customers is prohibitive, companies have turned to their current customers in an attempt not only to retain them but also to exploit the potential within. This has enabled them not only to respond to the threats in their market place but also positioned the strategically to take advantage of the opportunities available.

6.4 Keys for Customer Retention

Some of the techniques used in organizations to retain their customers are:

1. ***SFA (Sales Force Automation):*** CRM also incorporates enhanced sales force automation (SFA) functionality. SFA puts account information directly in the hands of field sales staff, making them responsible for maintaining it and thus helps them to be more productive. Now, as part of CRM, SFA is also focused on cultivating customer relationships and improving customer satisfaction.

2. ***TQM (Total Quality Management):*** TQM has been another driving force. TQM is aimed at improving quality and reducing costs. The TQM philosophy has been prevalent in many companies, which find it necessary to involve both suppliers and customers for implementing TQM at all levels of the value chain. Companies like IBM, Motorola, General Motors, Xerox, Ford and Toyota are consistent users of TQM and hence also of CRM. Other programs like JIT supply and MRP (Material Resource Planning) have also made for the use of interdependent relationship between supplier and customer.

3. ***SSA (Systems Selling Approach):*** SSA is yet another factor which has become more common with the advent of digital technology and complex products. The systems selling approach involves the integration of parts, supplies and the sale of services along with a particular capital equipment. In the capital goods market, customers appreciate the idea of system integration. Sellers have been able to sell augmented products and services. This has also been extended to consumer packaged goods and services sector.

4. ***KAM (Key Account Management):*** Another offshoot of CRM has been the development of key Account Management Program as some companies insisted upon new purchasing

Notes

approaches like national contracts and master purchasing agreements to be adopted by vendors.

5. ***SCM (Supply Chain Management):*** Regarding suppliers' loyalty, again it has been observed that it pays more to develop closer relations with a few suppliers than to deal with more vendors. More often marketers find it beneficial to retain existing customers for life rather than making a one-time sale to several new customers.

6. ***GAMP (Global Account Management Programs):*** An extension of CRM is reflected in the emerging trend of large internationally oriented companies to become global. For this purpose, such companies are seeking the assistance of vendor's co-operating and collaborating solutions for global operations. This has made it obligatory for markets interested in the business of global companies, to adopt CRM programs, particularly global account management programs.

7. ***KM (Knowledge Management):*** Knowledge about customers is a pre-requisite for CRM. Indeed, in depth knowledge of the customer's habits, desires, needs and the analysis of their cognitive effective behavior and attributes need to be applied through CRM to develop and design marketing strategies as well as to develop ad cultivate interaction and relationship with customers for mutual benefit.

Task Take any organization of your choice. Research on the various techniques implemented by them to retain their customers and to what degree have they succeeded in that.

Finally, it is recognizable that customers' expectations have changed significantly in recent years. With the advent of new technology and increased availability of new and advanced product features and services, consumers are least prepared to compromise their preferences for quality of products/services. Cross selling and up selling are possible to a greater extent for customers, if they are loyal and committed to the firm and its offerings.

Self Assessment

Fill in the blanks:

5. Business process re-engineering, automation and downsizing reduced the …… costs.
6. SFA puts …… directly in the hands of field sales staff.
7. The …… approach involves the integration of parts, supplies and the sale of services along with a particular capital equipment.
8. Knowledge about customers is a pre-requisite for …….

6.5 Customer Loyalty

Building customer loyalty is the basic platform of relationship formation. In a highly competitive and challenging business environment, organizations are really blessed if they are fortunate to have loyal customers in their customer inventory. With the backup of loyal customers, the organization could enjoy a number of advantages. In short, having loyal customers will serve as a sustainable competitive edge to the organization concerned in the present day context. Therefore, organizations should keep "building customer loyalty" as their prime agenda.

Notes

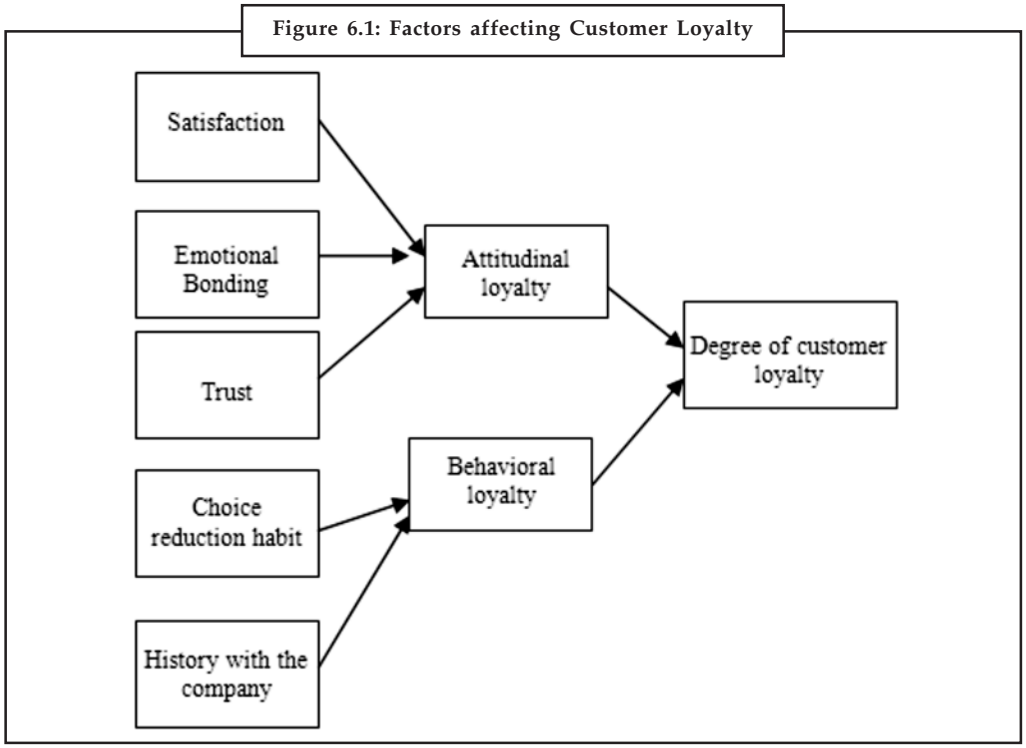
Customer loyalty is a company's ability to retain satisfied customers. Maintaining customer loyalty is one of the toughest challenges for any marketing department in a business enterprise, since the wants of a customer are modified at much faster rate than their needs. It requires a business enterprise to follow a pro-active approach that includes formulating strategies for brand consolidation, researching and continuing with new product development, following TQM (Total Quality Management), implementing CRM systems, and also, working out Pipeline Management tactics.

A customer loyalty program is based on a simple premise: as a company develops stronger relationships with their best customers, those customers will stay with the company longer and become more profitable.

Since every marketer wants customers, a logical question to ask is "what affects customer loyalty". The factors that affect the customer loyalty are:

- Customer satisfaction
- Emotional bonding
- Trust
- Choice reduction and habit
- History with the company

Figure 6.1: Factors affecting Customer Loyalty



For most organizations, the goal is to measure and manage customer satisfaction with the cumulative experiences customers have with the brand, product, organization, or location. Over time customer loyalty requires emotional bonding. Customers have a positive brand affect, which is an affinity with the brand, or they have a company attachment, which means they like the company.

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Example: Many customers identify with Polo Ralph Lauren. They identify with the brand because the brand identifies them and their friends. From a consumer's perspective the brand equity associated with Polo leads to customer loyalty.

Notes CRM must reach beyond the idea of the rational consumer and strive to establish feeling of closeness, affection, and trust as true emotional bonding is often based on trust and respect.

Trust exist when one party has confidence that he or she can rely on the other exchange partner. People feel comfortable with familiar brands and well known situations that have been rewarding. With simple repetition we become familiar with a brand, store, company, Web site, or search engine. We develop habits that result in continuity. One's history with the company influences one's habits.

Example: Wal-Mart is known for everyday low prices while another department store, such as Nordstrom, may be known for excellent customer service.

Thus, perceptions of the company's historical image can impact customer intentions, loyalty and likelihood of buying.

Self Assessment

Fill in the blanks:

9. Building customer …… is the basic platform of relationship formation.
10. …… try to understand if the discrepancy between expectations and performance is large or small.

Case Study

The AXA Way: Improving Quality of Services

"If you want to innovate, you must always do so in a cost-effective, predictable way, and for that you must master your processes. Excellent manufacturers know how to do this. We will, too"

—Claude Brunet, Member, AXA Management Board in 2005

"This (AXA Way) is a powerful tool that harnesses all of the internal energies we have to mobilize in order to step up the pace of our quest for operational excellence."

—Henri de Castries, Chairman, Management Board, AXA Group in 2003

The case discusses the implementation of process improvement technique called 'The AXA Way' in AXA, a France based insurance and wealth Management Company. In a span of two decades, AXA went in for several mergers and acquisitions and gained global presence. In order to improve the quality of its services, the company launched 'AXA Way,' which involved the application of DMAIC principles. The AXA Way was a continuous

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improvement program that focused on improving the existing processes and making them more customer-oriented. The case also describes the benefits reaped by AXA after implementing the program including cost reduction and customer retention.

Improving Customer Satisfaction

France based insurance and investment management conglomerate; AXA Group3's operations were spread across the world. In the year 2001, the company's German operations had some difficulty in retaining customers.

The company conducted a survey and found that although most customers wanted to obtain accurate information about the loss and claims processes, in writing, only 22% of the company's customers were actually receiving such information. The customers also expected to receive such information within the span of one week. However, in most cases, AXA Germany was unable to provide the information in the specified time frame.

The main reason was that the processing of claims in the company was geared to the needs and ease of operations of those working in the company, rather than the needs and preferences of the customers. To overcome this problem, a team from the company took feedback from customers on claims-related services being provided to them. Having understood their requirements, the team devised a specimen letter, which informed the customers about how their claim was being settled, the details of the employee from AXA who was looking into the matter and how to go about settling their claims.

Letters on these lines were, from then on, dispatched to all the customers who filed for claims. The result of these efforts was instantaneous. The number of calls the customer service center received about claims-related information reduced by half. The retention rate increased, and customers came back to AXA. The change in the company's outlook towards its customers could be attributed to 'the AXA Way,' a continuous improvement program launched by AXA in 2002, to achieve operational excellence and bring about changes in its business processes based on customer feedback.

The parent company of AXA, Mutuelle Contre de l'Assurance contre l'incendie (MCI), was founded in 1816 by Jacques-Théodore le Carpentier and 17 other entrepreneurs. The company was located at Rouen and was established as a fire insurance company. For a period of five years, every shareholder in the company was both insurer and insured party. This was the beginning of a mutual company, where the company was owned by insured parties. With growing competition from companies like La Providence (founded in 1838) and La Paternelle (founded in 1843), MCI decided to diversify and develop its activities.

For this purpose two companies were created, Mutualité Immobiliére and Mutualité Mobiliére for insuring movable risks; these companies started operating in 1847. In the 1850s, the companies expanded their activities across France and started covering real estate risks. In 1881, the companies merged under the name Ancienne Mutuelle (AM).

In 1922, AM began offering automobile insurance under the name – AM Accidents. During the Second World War, in 1944, the company's offices were bombed by US forces. The accident and life insurance divisions were not severely affected by the war, but tighter controls became necessary. This led to constitution of Groupe AM in 1946, under the leadership of André Sahut d'Izarn. The company's first merger, with AM du Calvados, took place in 1946. In the following decade, AM acquired Mutuelle d'Orléans, Mutualité Gérale life insurance company and La Participation. In 1955, AM ventured overseas, starting its operations in Quebec, Canada. In 1958, Claude Bébéar (Bébéar) joined the group as a senior manager.

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Bébéar was sent to Canada on an assignment and he developed the Canadian subsidiary of AM named Provinces Unies. After the death of André Sahut d'Izarn in 1972, the company went through a turbulent period. In 1974, activities at AM were paralyzed for over two months, owing to a strike in the company. Bébéar's successful resolution of the strike impressed the board members and he was brought in as Chairman in 1975. Bébéar brought in several changes beginning with a change in name of the company. AM was renamed Mutuelles Unies (MU) in 1978. In the same year, MU acquired another French company, Compagnie Parisienne de Garantie.

The Problems

The late 1990s and early 2000s presented many challenges for the global insurance industry. Major events that affected the global economy were the oil price hikes in 1999 and 2000, and the burst of the speculative bubble in technology stocks. The year 2001 witnessed a global economic slowdown, which resulted in a decline in corporate earnings. The insurance industry was among the worst hit and underperformed the general indices. Lower equity returns, low interest and high default rates – all had a negative effect on the industry. The September 11, 2001 terrorist attacks in the US resulted in total insurance claims of over US$ 70 billion.

The AXA Way

AXA had set priorities which included strengthening the group's businesses in most developed and high potential markets like Western Europe, North America and in selected countries in the Asia Pacific region. Another priority was to achieve operational excellence in each market by leveraging organic growth and improving quality and productivity. In 2002, when AXA measured its customer satisfaction, the score was 53, with defaults at about 20%, thus presenting great scope for improvement.

Reaping the Benefits

By the first half of the year 2005, AXA had more than 400 Black Belts and 10,000 employees had been sensitized to the AXA Way. By then, the AXA Way had been launched in 23 of its companies which accounted for 90% of the group's revenues. The implementation of the AXA Way helped in improving customer satisfaction at AXA. This was revealed through the Scope survey on customers conducted in 16 countries, which accounted for 94% of group's revenues. Customer satisfaction on servicing had increased to 69% during the first half of 2005 as compared to 64% in the corresponding half of the year 2004.

Questions

1. Find out the systems employed by AXA to improve the quality of its services.
2. What are the benefits of process improvement and making services customer-oriented?

Source: http://www.icmrindia.org/casestudies/catalogue/Operations/AXA%20Way-Quality%20of%20Services-Operations%20Case%20Studies.htm

6.6 Summary

- Customer retention is the key to any organization's effectiveness. Customer centric approach to marketing program helps retain customers and win back lost customers.
- Relationship marketing is emerging as the core marketing activity for businesses operating in fiercely competitive environments.
- Customer Retention is the activity that a selling organization undertakes in order to reduce customer defections.

Notes

- A company's ability to attract and retain new customers, is not only related to its product or services, but strongly related to the way it services its existing customers and the reputation it creates within and across the marketplace.
- Negative customer retention strategies impose high switching costs on customers, discouraging defection.
- It is a fundamental precept of modern customer management that companies should understand customers, then acquire and deploy resources to ensure their satisfaction and retention.
- Retaining and developing customers has long been a critical success factor for businesses.
- In facing the competitive threats, such as new entrants, pricing pressures, technology along with the related costs and also including the time lags in procuring, maintaining and strengthening one's market, more and more organizations are realizing that the traditional marketing model is no longer effective.
- TQM is aimed at improving quality and reducing costs. The TQM philosophy has been prevalent in many companies, which find it necessary to involve both suppliers and customers for implementing TQM at all levels of the value chain.
- Building customer loyalty is the basic platform of relationship formation. Customer loyalty is a company's ability to retain satisfied customers.
- A customer loyalty program is based on a simple premise: as a company develops stronger relationships with their best customers, those customers will stay with the company longer and become more profitable.

6.7 Keywords

Customer Delight: The result of delivering a product or service that exceeds customer expectations is known as customer delight.

Customer Loyalty: A customer's feeling or attitude of attachment to the company is referred to as customer loyalty.

Customer Retention: The act of keeping your customers and not losing them to competitors, usually by performing a valuable service is known as customer retention.

Exit Penalties: This is the charge applied by a financial institution when you cash in an investment within a set number of years or before a specific maturity date.

Relationship Marketing: Relationship marketing refers to the benefits that ongoing relationships with key customers can bring to an organization.

Standing Orders: Standing order is an order or rule governing the procedures of a society, council, or other deliberative body.

Total Cost of Ownership: In addition to the initial cost of a purchase, all long-term and indirect costs resulting from that purchase is referred to as total cost of ownership.

Zero Defects: Zero defects is a quality philosophy based on the idea that a level of perfect quality, as in zero defects, is achievable and should be a company-wide goal.

6.8 Review Questions

1. What do you mean by customer retention strategy?
2. What are the different types of customers?

Notes

3. Differentiate between positive customer retention strategy & negative customer retention strategy.
4. Explain the concept of customer delight.
5. Describe the keys of customer retention.
6. What do you understand by customer loyalty? Have you ever been loyal to a particular brand? Give reasons for it.
7. Briefly explain the trends in customer retention.
8. Write short note on factors that affect customer loyalty.

Answers: Self Assessment

1.	Retention	2.	Relationship
3.	Defections	4.	Negative
5.	Manpower	6.	Account information
7.	Systems selling	8.	CRM
9.	Loyalty	10.	Effective marketers

6.9 Further Readings

Books

Besterfield. Dale H. (2011), *Total Quality Management,* Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management.* Pearson Education, India

Mukherjee, N.P. (2006), *Total Quality Management,* PHI Learning Pvt. Ltd.

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Online links

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http://totalqualitymanagement.wordpress.com/tag/customer-retention/

http://www.pulseplm.com/wp-content/pdf/crm4pp.pdf

http://www.scribd.com/doc/91797946/Total-Quality-Management

Unit 7: Employee Involvement

Notes

CONTENTS

Objectives

Introduction

7.1 Motivation

7.1.1 Maslow's Hierarchy of Needs

7.1.2 Herzberg's Two-Factor Theory

7.2 Employee Surveys

7.3 Employee Empowerment

7.3.1 Teams

7.4 Suggestion System

7.5 Performance Appraisal

7.5.1 Importance of Performance Appraisals

7.6 Summary

7.7 Keywords

7.8 Review Questions

7.9 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Motivation
- Discuss Maslow's Hierarchy of Needs
- Explain Herzberg's Two-Factor Theory
- Elaborate on Employee Surveys
- Explain Employee Empowerment and Suggestion System

Introduction

In previous unit, we dealt with the importance of customer satisfaction, their perception of quality and service quality. We also discussed on customer feedback methods and customer retention.

This unit will help you to understand employee involvement and their empowerment the various sections and sub-sections will also summarize the suggestion system and performance appraisal methods.

Employee involvement is one approach to improving quality and productivity. Its use is credited for contributing to the success enjoyed by the Japanese in the world marketplace. Employee involvement is not a replacement for management nor is it the final word in quality improvement. It is a means to better meet the organization's goals for quality and productivity at all levels of an organization.

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7.1 Motivation

Knowledge of motivation helps us to understand the utilization of employee involvement to achieve process improvement.

7.1.1 Maslow's Hierarchy of Needs

One of the first popular motivational theories was developed by Abraham Maslow. He stated that motivation could best be explained in terms of hierarchy of needs and that there were five levels. These levels are survival, security, social, esteem, and self-actualization. Once a given level is satisfied, it can no longer motivate a person.

Relating these needs to motivation, we know that Level 1 (survival) means food, clothing, and shelter, which is usually provided by a job. In the workplace, Level 1 needs include proper lighting, heating/air conditioning, ventilation, phone system, data/voice access, and computer information system. Level 2 (security) can mean a safe place to Work and job security, which are very important to employees.

Self actualization
Esteem
Social
Security
Survival

When the organization demonstrates an interest in the personal well-being of employees, it is a motivating factor. A threat of losing one's job certainly does not enhance motivation. Level 2 is not limited to job security. It also includes having privacy on the job such as being able to lock one's office door or having lockable storage for personal items, as well as having a safe work environment that may include ergonomic adjustable furniture.

Did u know? Maslow's theory has been elaborated by some researchers and an 8-step hierarchy of needs pyramid has been developed. These 8 needs are: (1) physiological needs, (2) Safety needs, (3) social needs, (4) Esteem needs, (5) Cognitive needs, (6) Aesthetic needs, (7) Self-actualization needs, (8) Transcendence needs.

Level 3 (social) relates to our need to belong. It has been said that cutting someone out of the group is devastating to that individual. Isolation is an effective punishment. Conversely, giving an individual the opportunity to be part of the group by feeling important and needed will motivate that person. If possible, employees should be provided with both formal social areas such as a cafeteria and conference rooms and informal areas such as water coolers and bulletin boards. Being a member of a team is a good way to bring employees into the group. Level 4 (esteem) relates to pride and self worth. Everyone, regardless of position or job assignment, wants to be recognized as a person of value to the organization. Where possible, employees should be given offices or personal spaces with aesthetics. Business cards, workspace size, and office protocols also provide employees with a certain level of self-esteem within an organization. Seeking advice or input into business or production processes is a good way of telling employees that they are of value. This activity requires giving employees control and freedom of their jobs by providing trust. Level 5 (self-actualization) says that individuals must be given the opportunity to go as far as their abilities will take them. Many organizations have a policy of promoting from within. It is that some employees do not want to move up the corporate ladder, which is understandable. However, those who do want to move up know that it is possible.

Notes

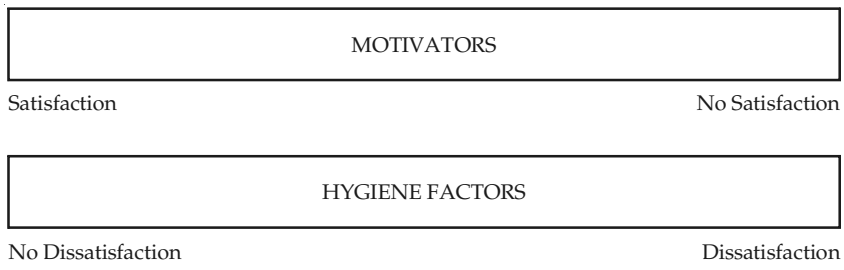
It is important to note that as employees move up the hierarchy, they will immediately revert back to the previous level if they feel threatened.

Example: If an employee is satisfied in Level 3, a rumor of downsizing may cause an immediate return to Level 2.

7.1.2 Herzberg's Two-Factor Theory

In 1959, Frederick Herzberg, a behavioural scientist proposed a two-factor theory or the motivator-hygiene theory. According to Herzberg, there are some job factors that result in satisfaction while there are other job factors that prevent dissatisfaction. According to Herzberg, the opposite of "Satisfaction" is "No satisfaction" and the opposite of "Dissatisfaction" is "No Dissatisfaction".

Figure 7.1: Herzberg's View of Satisfaction and Dissatisfaction



Source: http://www.managementstudyguide.com/herzbergs-theory-motivation.htm

The following table presents the top six factors causing dissatisfaction and the top six factors causing satisfaction, listed in the order of higher to lower importance.

Table 7.1: Factors Affecting Job Attitudes

Leading to Dissatisfaction	Leading to Satisfaction
Company policy	Achievement
Supervision	Recognition
Relationship with Boss	Work itself
Work conditions	Responsibility
Salary	Advancement
Relationship with Peers	Growth

Herzberg classified these job factors into two categories:

1. ***Hygiene Factors:*** Hygiene factors are those job factors which are essential for existence of motivation at workplace. These do not lead to positive satisfaction for long-term. But if these factors are absent/if these factors are non-existant at workplace, then they lead to dissatisfaction. In other words, hygiene factors are those factors which when adequate/reasonable in a job, pacify the employees and do not make them dissatisfied. These factors are extrinsic to work. Hygiene factors are also called as dissatisfiers or maintenance factors as they are required to avoid dissatisfaction. These factors describe the job environment/scenario. The hygiene factors symbolized the physiological needs which the individuals wanted and expected to be fulfilled. Hygiene factors include:

Notes

- *Pay:* The pay or salary structure should be appropriate and reasonable. It must be equal and competitive to those in the same industry in the same domain.
- *Company Policies and Administrative Policies:* The company policies should not be too rigid. They should be fair and clear. It should include flexible working hours, dress code, breaks, vacation, etc.
- *Fringe Benefits:* The employees should be offered health care plans (mediclaim), benefits for the family members, employee help programmes, etc.
- *Physical Working Conditions:* The working conditions should be safe, clean and hygienic.

Caution The work equipment's should be updated and well-maintained.

- *Status:* The employees' status within the organization should be familiar and retained.
- *Interpersonal Relations:* The relationship of the employees with his peers, superiors and subordinates should be appropriate and acceptable. There should be no conflict or humiliation element present.
- *Job Security:* The organization must provide job security to the employees.

2. ***Motivational Factors:*** According to Herzberg, the hygiene factors cannot be regarded as motivators. The motivational factors yield positive satisfaction. These factors are inherent to work. These factors motivate the employees for a superior performance. These factors are called satisfiers. These are factors involved in performing the job. Employees find these factors intrinsically rewarding. The motivators symbolized the psychological needs that were perceived as an additional benefit. Motivational factors include:

- *Recognition:* The employees should be praised and recognized for their accomplishments by the managers.
- *Sense of Achievement:* The employees must have a sense of achievement. This depends on the job. There must be a fruit of some sort in the job.
- *Growth and Promotional Opportunities:* There must be growth and advancement opportunities in an organization to motivate the employees to perform well.
- *Responsibility:* The employees must hold themselves responsible for the work. The managers should give them ownership of the work.

Caution They should minimize control but retain accountability.

- *Meaningfulness of the work:* The work itself should be meaningful, interesting and challenging for the employee to perform and to get motivated.

Implications of Two-Factor Theory

The Two-Factor theory implies that the managers must stress upon guaranteeing the adequacy of the hygiene factors to avoid employee dissatisfaction. Also, the managers must make sure that the work is stimulating and rewarding so that the employees are motivated to work and perform harder and better. This theory emphasize upon job-enrichment so as to motivate the employees. The job must utilize the employee's skills and competencies to the maximum. Focusing on the motivational factors can improve work-quality.

Notes

Note Herzberg's dissatisfiers are roughly equivalent to Maslow's lower levels, and the motivators are similar to the upper levels.

Employee Wants

While management thinks that good pay is the number one want of the employee, survey results show that this factor is usually in the middle of the ranking. Employee wants tend to follow the theories of Maslow and Herzberg. It is interesting to note that the manager's perceptions are much different. By involving employees through the use of teams in meaningful work and by providing the proper reward and recognition, manager can reap the advantages of greater quality and productivity along with employee satisfaction. If managers are to effectively motivate employees, they must align their actions closer to the motivators. The important parameters are interesting work, appreciation, involvement, job security, good pay, promotion/growth, good working conditions, loyalty to employees, help with personal problems and tactful discipline.

Achieving a Motivated Workforce

Concepts to achieve a motivated workforce are as follows:

1. Know thyself
2. Know your employees
3. Establish a positive attitude
4. Share the goals
5. Monitor progress
6. Develop interesting work
7. Communicate effectively
8. Celebrate success

These eight concepts can be used at all managerial levels of the organization.

Self Assessment

Fill in the blanks:

1. Employee …… is an approach to improving quality and productivity.
2. …… states that motivation could best be explained in terms of a hierarchy of needs and that there were five levels.
3. …… says that individuals must be given the opportunity to go as far as their abilities will take them.
4. …… wants tend to follow the theories of Maslow and Herzberg.

7.2 Employee Surveys

Employee survey teams are created by the quality council. These surveys help the managers assess the current state of employee relations, identify trends, measure the effectiveness of

Notes

program implementation, identify needed improvements, and increased communication effectiveness.

Step 1: The Quality Council to create a multifunctional team.

Step 2: The Team will develop survey instrument. The concepts to be used in formulating the instruments are: personality characteristics, management styles, job attitudes, and the work.

Step 3: Administer the survey (is confidential and by 3rd party).

Step 4: Results are compiled and analyzed (report is circulated in the firm).

Step 5: Determine areas for improvement.

Figure 7.2: Employee Survey Process

7.3 Employee Empowerment

The Manufactures Alliance for Productivity and Innovation stated that "Organizations that empower employees as part of their total management effort are twice as likely as other firms to report significant product or service improvement.

The dictionary definition of empowerment is to invest people with authority; its purpose is to tap the enormous reservoir of potential contribution that lies within every worker.

An operational definition follows:

Empowerment is an environment in which people have the ability, the confidence, and the commitment to take the responsibility and ownership to improve the process and initiate the necessary steps to satisfy customer requirements within well-defined boundaries in order to achieve organizational values and goals.

Empowerment should not be confused with delegation or job enrichment. Delegation refers to distributing and entrusting work to others. Employment requires that the individual is held responsible for accomplishing a whole task. The employee becomes the process owner-thus, the individual is not only responsible but also accountable, and job enrichment aims at expanding the content of an individual's job, whereas empowerment focuses on expanding on the contest of the job such as its interactions and interdependencies to other functions of the organization. In order to create the empowered environment, three conditions are necessary:

1. Everyone must understand the need for change.

Notes

2. The system needs to change to reinforce and motivate individual and group accomplishments.
3. The organization must enable its employees by providing information, education and skill.

7.3.1 Teams

Employee involvement is optimized by the use of teams. However, are not a panacea for solving all quality and productivity problems, but in most instances, they are effective.

A team is defined as a group of people working together to achieve common objectives or goals. Teamwork is the cumulative actions of the team during which each member of the team subordinates his individual interests and opinions to fulfill the objectives or goals of the group, the objective or goal is a need to accomplish something such as solve a problem, improve a process, design a refrigerator, plan a conference, audit a process, or please a customer, it needs to be clearly defined, have milestones set, have resources provided, and use a systematic approach, members of the team will need to focus on how they relate to each other, listen to the suggestions of others, build on previous information, and use conflict creatively, they will need to set standards, maintain discipline, build team spirit, and motivate each other. Each member of the team has their own history of experience to help achieve the objective. They should have a need to see the task completed, but also the needs of companionship, fulfillment of personal growth, and self-respect.

Why Team Work

Teams work because many heads are more knowledgeable than one, each member of the team has special abilities that can be used to solve problems, and many processes are so complex that one person cannot be knowledgeable concerning the entire process; second, the whole is greater than the sum of its members. The interaction within the team produces results that exceed the contributions of each member. Third, team members develop a rapport with each other that allows them to do a better job, finally, teams provide the vehicle for improved communication, thereby increasing the likelihood of a successful solution.

Types of Teams

Quality Circles: The early history suggests that work simplification efforts by management and labor were most likely the first production-oriented teams. However, the development of quality control circles by the Japanese in 1961 is considered to be the beginning of the use of teams to improve quality, quality control circles are groups of people from one work unit who voluntarily meet together on a regular basis to identify, analyze, and focus on quality-of-work-life and health/safety issues rather than on improving work processes. Often they remain in existence over a long period of time, working on project after project. Quality control circles have been quite successful in Japan and enjoyed some initial success in other countries but not as extensive. A major drawback was a lack of middle management support, without managers on teams or directly overseeing the teams as a quality council might, members frequently were not able to persuade management to implement their recommendations.

Outside Japan, the popularity of quality control circles has declined but for few industries. However, this type or team is the progenitor of our present teams, the current types of teams can be divided into four main groups. They may be called by different names and have slightly different characteristics to accommodate a particular organization.

Notes

1. ***Process Improvement Team:*** The members of process improvement team represent each operation of the process or sub-process, usually the scope of the team's activity is limited to the work unit, a team of about six to ten members will come from the work unit and, depending on the location of the sub-process, an external or internal supplier and external or internal customer would be included on the team. During the course of the team's life, additional expertise from other work areas may be added on a permanent or temporary as-needed basis. The life cycle of this type of team is usually temporary-it is disbanded when the objective has been obtained. When the targeted process includes many work units or the entire organization, a cross-functional team may be more appropriate with work unit teams as sub-teams.

2. ***Cross-functional Team:*** A team of about six to ten members will represent a number of different functional areas such as engineering, marketing, accounting, production, quality, and human resources. It may also include the customer and supplier, a design review team is a good example of a cross-functional team. This type of team is usually temporary. An exception would be a product support team, which would be permanent and have as an objective to serve a particular or4ouct line, service activity, or a particular customer, this type of team breaks down functional area boundaries.

3. ***Natural work Teams***: This type of team is not voluntary – it is composed of all the members of the work unit, it differs from quality control circles because a manager is part of the team and the projects to be improved are selected by management, some employees may opt not to work in teams for a variety of reasons, and managers should anticipate this action and be prepared to help employees become comfortable in the team environment or, alternatively, find work in another unit that still performs work as individuals, even though "team work" is technically feasible, there may be such resistance that its introduction should be delayed until there has been substantial turnover.

4. ***Self-directed/self-managed Work Teams:*** They are an extension of natural work teams without the supervisor, thus, they are the epitome of the empowered organization-they not only do the work but also manage it, there is wide discretion to organize their work subject organizational work flow requirements. There is a team coordinator to liaison with senior management that may rotate among members. The team meets daily to plan their activities, and decisions are usually by consensus, additional responsibilities may include; hiring/dismissal, performance evaluation, customer relations supplier relations, recognition/reward, and training, the team must have access to business information in order to plan, control, and improve their processes.

Characteristics of Successful Teams

In order for a team to be effective, it should have certain characteristics, listed below:

- ***Sponsor:*** To have effective liaison with the quality council, preferably the sponsor is a member of the quality council providing organizational support.
- ***Team Charter:*** A team charter is a document that defines the team's mission, boundaries, the background of the problem, the team's authority and duties, and resources.
- ***Team Composition:*** The size of the team should rarely exceed ten people except in the case of natural work teams or self-directed teams.
- ***Training:*** As the need arises, members should be trained in problem-solving techniques, team dynamics, and communication skills.
- ***Ground Rules:*** The team must develop its rules of operation.
- ***Clear Objectives:*** The criteria for success should be agreed on with management.

Notes

- ***Accountability:*** The team is accountable to perform. Periodic status reports should be given to the quality council.
- ***Well-defined Decision Procedures:*** Effective, acceptable, and timely decisions have to be made by the team.
- ***Resources:*** Not only is funding and employee release time for the project important, but also important is access to information, the team cannot be expected to perform successfully without necessary tools.
- ***Trust:*** Management must trust the team to perform the task effectively. There must also be trust among the members and a belief in each other.
- ***Effective Problem Solving:*** Decisions are based on the problem – solving methods discussed later.
- ***Open Communication:*** Members actively listen, without interruption, to other members, speak with clarity and directness, ask questions, and say what they mean.
- ***Appropriate Leadership:*** All teams need leadership – whether imposed by the quality council, or whether someone emerges as a leader figure as the life of the team progresses.
- ***Balanced Participation:*** All members must become involved in the team's activities by voicing their opinions, lending their knowledge, and encouraging other members to take part.
- ***Cohesiveness:*** Members should be comfortable working with each other and act as a single unit, not as individuals or sub-groups.

Common Barriers to Team Progress

- Insufficient training
- Incompatible rewards and compensation
- First-line supervisor resistance
- Lack of planning
- Lack of management support
- Access to information systems
- Lack of union support
- Project scope too large
- Project objectives are not significant
- No clear measures of success
- No time to do improvement work
- Team is too large
- Trapped in group thinking

Task Has your class ever been divided into groups? What kind of group was it? Explain the 4 stages of team development in context of your team. Present an article on it.

Notes

Self Assessment

Fill in the blanks:

5. Employee survey teams are created by the …….
6. Empowerment should not be confused with …… or job enrichment.
7. …… focuses on expanding on the contest of the job such as its interactions and interdependencies to other functions of the organization.
8. Each member of the team has their own history of …… to help achieve the objective.
9. The life cycle of …… type of team is usually temporary-it is disbanded when the objective has been obtained.
10. …… is an extension of natural work teams without the supervisor.
11. …… is a stage that is reserved for temporary teams.

7.4 Suggestion System

Suggestion systems are designed to provide the individual with the opportunity to be involved by contributing to the organization. Most of the ideas for continuous improvement will come from the team approach. However, once the foundation for a TQM organization has been established, a suggestion system can operate effectively and in parallel to the team approach. The key to an effective system is management commitment. Management must make it easy for employees to suggest improvements. Management should then review them promptly and if feasible, implement them.

Stimulating and encouraging employee participation starts the creative process. There are five ground rules:

1. Be progressive by regularly asking your employees for suggestions.
2. Remove fear by focusing on the process and not on the person.
3. Simplify the process so it is easy to participate. Stamp out superfluous paperwork, review, and procedures.
4. Respond quickly to suggestions and within a specific period of time.
5. Reward the idea with published recognition so that everyone knows the value of the contribution.

Caselet

Employee Involvement – A Vital Aspect of Total Quality Management

The importance of employee involvement in the success of any business.

The shrinking global market has led to stiff competition in the business and industrial arena. The entry of a number of new companies, both local and global into various markets has given the customer a wide array of product choices. Many of these new companies are

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able to produce the same or similar products at almost the same or lower costs. Thus customers today have a wide range of products to choose from. These products not only meet their specifications closely, but also their budgets. Competition has extended far beyond the manufacturing or private sector. Today, the service, government and non-profit sectors also face stiff competition.

The need to grow and succeed in an increasingly competitive market has seen the implementation of various quality initiatives in different organisations. Problem-solving and process improvements are two vital aspects of the quality initiatives, and proactive actions are being taken to prevent problems. Total Quality Management (TQM) is a continuous process that strives to increase customer satisfaction, lower costs, and minimise defects and variations in every aspect and every process of the business.

TQM involves a number of catchwords like Just-in-Time, quality circles, employee involvement, continuous process improvement, empowerment, Kaizen, self-directed work groups and world-class quality. Basically, the philosophy of TQM is to involve every employee in the organisation along with its suppliers and distributors to improve product quality and enhance customer satisfaction.

One of the important concepts of TQM is employee involvement. This is a relatively new method, which is a contrast to conventional management practices, wherein management takes all decisions and workers just follow them to accomplish their jobs. This top-down management style is slow and inflexible with little room for competition. Survival in today's time-starved, customer driven market requires rapid response times from manufacturers and other businesses to the ever-changing customer needs.

This article focuses on the importance of employee involvement in any TQM initiative. Employee involvement is a system wherein employees are encouraged to use their expertise and knowledge to suggest methods for improvements in their work areas. These suggestions could pertain to improvements in the job, the product, the work atmosphere or the company as a whole. Many companies have ventured into a participative style of management by involving employees in the problem solving and decision making processes.

When Ford faced continuous threat of competition from Japanese car manufacturers, it ventured to study how the Japanese were excelling in their performance efficiency. It established a task force to study the Japanese manufacturing process.

Results showed that the key to Japanese performance and efficiency was their empowered workforce and the teamwork involved. Employees were given the responsibility and authority to stop a process if the quality failed to meet the standards specified.

Some of the most successful companies are those that have achieved a close relationship between workers and the managers. The policies in these companies fostered teamwork, participation, continuous learning and flexibility. However, the change from conventional management practices to the new style was not achieved overnight. Learning and implementing participative management requires a lot of effort and time. Implementation of employee involvement systems requires many changes in the existing company practices.

The five obstacles that arise when companies try to shift from a traditional management style to a participative one are listed below:

- Resistance to change

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- Mistrust of the management's motives by the workers
- Lack of clear expectations from the workers
- Lack of participative skills among employees
- Lack of executive commitment

While change of any kind is difficult for the workers, when suddenly asked for inputs, they tend to doubt the motives of the management. Similarly, they are unsure of the extent of inputs required and the importance placed by the management on these inputs. Poor experience in participative activities is also a hindrance. Above all, it is vital for the management to remain continuously committed to the cause of TQM and employee involvement.

7.5 Performance Appraisal

The purpose of performance appraisals is to let employees know how they are doing, and provide a basis for promotions, salary increases, counseling, and other purposes related to an employee's future. There should a good relationship between the employee and the appraiser. Employees should be made aware of the appraisal process, what is evaluated, and how often. Employees should be told how they are doing on a continuous basis, not just at appraisal time. The appraisal should point out strengths and weaknesses as well as how performance can be improved.

7.5.1 Importance of Performance Appraisals

1. It is necessary to prevail a good relationship between the employee and the appraiser.
2. Employee should be informed about how they are performing on a continuous basis, not just at appraisal time.
3. The appraisal should highlight strength and weakness and how to improve the performance.
4. Employee should be allowed to comment on the evaluation and protest if necessary.
5. Everyone should understand that the purpose of performance appraisal is to have employee involvement. Errors in performance evaluations should be avoided.
6. Unfair and biased evaluation will render poor rating and hence should be eliminated.

Self Assessment

Fill in the blanks:

12. ..... are designed to provide the individual with the opportunity to be involved by contributing to the organization.
13. The key to an effective suggestion system is .....
14. Stimulating and encouraging employee participation starts the ..... process.
15. There should a ..... between the employee and the appraiser.

Notes

Case Study

Heavy Truck (HT) Corporation

HT Corporation, a manufacturer of heavy trucks had a long, sad and bitter history of employee relations. The company openly practiced "management through terrorism". Engineers and technicians dominated the culture. One of the company's assembly plants devoted major resources to statistical process control. An entire department staffed with engineers justified its existence by keeping control charts. The engineers collected and stored data on a computer and posted the charts in every production department once each week. They also posted lists of problems and defects attributable to each department. Another department kept itself busy with "work design" and assembly line balancing. The plant was highly product focused. Material moved smoothly from one operation to next.

Subassemblies flowed into the assemblies like tributaries of a river, all moving toward the assembly line.

Despite this effort, quality was mediocre at best. HT Corporation devoted more factory space for rework and repair operations than to the original assembly. The individual and social aspects of the system were largely ignored. People lacked interpersonal skills, common goals and trust, and they could not hope to attain qualities under the existing power structure and reward system.

Questions

1. Comment on the human resources management of the HT Corporation.
2. Why quality was mediocre at best?
3. In spite of problems, the production was smooth, comment.
4. If you take over as the chief executive officer of HT Corporation what changes would you make? How would you begin?

Source: Visveswaraya Technological University-MBA Question Paper, Total Quality Management, July 2007

7.6 Summary

- Employee involvement is not a replacement for management nor is it the final word in quality improvement. It is a means to better meet the organization's goals for quality and productivity at all levels of an organization.
- Maslow's Hierarchy of Needs states that that there were five levels. These levels are survival, security, social, esteem, and self-actualization. Once a given level is satisfied, it can no longer motivate a person.
- Frederick Herzberg extended the general work of Maslow by using empirical research to develop his theory on employee motivation.
- The presence of the extrinsic conditions does not necessarily motivate employees; however, their absence results in dissatisfaction among employees.
- If managers are to effectively motivate employees, they must align their actions closer to the motivators.

Notes

- Employee surveys help the managers assess the current state of employee relations, identify trends, measure the effectiveness of program implementation, identify needed improvements, and increased communication effectiveness.
- Empowerment is an environment in which people have the ability, the confidence, and the commitment to take the responsibility and ownership to improve the process and initiate the necessary steps to satisfy customer requirements within well-defined boundaries in order to achieve organizational values and goals.
- A team is defined as a group of people working together to achieve common objectives or goals.
- Cross-functional team is a team of about six to ten members will represent a number of different functional areas such as engineering, marketing, accounting, production, quality, and human resources.

7.7 Keywords

Employee Empowerment: Giving employees the permission and ability to make decisions and act autonomously for the good of the company.

Employee Involvement: Giving employees input and allowing them an impact on decisions affecting their jobs.

Employee Surveys: A method of collecting data from employees. The reliability of a survey's results depends on whether the sample of people from which the information has been collected is free from bias and sufficiently large.

Maslow's Hierarchy of Needs: This theory is based on the assumption that there is a hierarchy of five needs within each individual. The urgency of these needs varies.

Motivation: The general desire or willingness of someone to do something.

Performance Appraisal: The process of setting performance expectations and standards for employees and evaluating (and periodically summarizing) performance against those standards to determine whether performance is unacceptable, fully successful, etc.

Self-actualization: The realization or fulfillment of one's talents and potentialities esp. considered as a drive or need present in everyone.

Suggestion System: A formal method of obtaining employees' advice for improvement in organizational effectiveness; it includes some kind of reward based on the successful application of the idea.

7.8 Review Questions

1. What do you understand by motivation? Explain the two theories of motivation.
2. Elaborate the process of employee surveys.
3. Explain employee empowerment.
4. How do you think does the team help in employee empowerment?
5. How many different types of teams are there? Explain them.
6. What are the stages of a team development? Briefly explain.
7. What are the common barriers to team development?
8. Briefly discuss suggestion system.

Notes

9. Explain performance appraisal and its importance.
10. Write a short note on:
    (a) Maslow's Hierarchy of Needs
    (b) Herzberg's Two-Factor Theory
    (c) Characteristics of Successful Teams

Answers: Self Assessment

1.	Involvement	2.	Maslow's Hierarchy of Needs
3.	Self-actualization	4.	Employee
5.	Quality council	6.	Delegation
7.	Empowerment	8.	Experience
9.	Process improvement	10.	Self-directed teams
11.	Adjourning	12.	Suggestion systems
13.	Management commitment	14.	Creative
15.	Good relationship		

7.9 Further Readings

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Notes

Unit 8: Continuous Process Improvement

CONTENTS

Objectives

Introduction

8.1 Continuous Process Improvement

8.2 The Juran Trilogy

8.3 The PDCA Cycle

8.3.1 Problem Solving Method

8.4 Kaizen

8.5 Re-engineering

8.5.1 Steps to Re-engineer the Process

8.6 Six Sigma Methodology

8.6.1 DMAIC

8.7 Summary

8.8 Keywords

8.9 Review Questions

8.10 Further Readings

Objectives

After studying this unit, you will be able to:

- Define continuous process improvement.
- Explain Juran Trilogy
- Explain PDSA Cycle
- Elaborate Kaizen
- Explain Re-engineering and Six Sigma Methodology
- Discuss DMAIC

Introduction

Previous unit gave you an insight on the employee involvement, various employee surveys carried out and their empowerment. It also talked about the suggestion system and the performance appraisal. In this unit you will study about the concept of continuous process improvement.

Continuous improvement is a very important component of Total Quality Management. As every product or service is the outcome of a process, the effective way to improve quality is to improve the process used to build the product. The corollary of focusing on process is that the focus is not on the results – results are the dependent variable. The results come from whatever process is followed – process drives results. TQM calls this focus on process 'management by process'. It consists of realizing that results come from process, building a process to produce the

desired results, implementing the process so one can later figure out why it produced the results it did, and then feeding this insight back to improve the process next time it is used.

8.1 Continuous Process Improvement

Organizations should strive to achieve perfection by continuously improving the business and production processes. The Goal is to achieve perfection and must continually strive for its attainment.

Improvement is made by:

- Viewing all works as a process, whether it is associated with production or business activities.
- Making all process effective, efficient, and adaptable.
- Anticipating changing customer needs.
- Controlling in-process performance using measures such as scrap reduction, cycle time, control charts, and so forth.
- Maintaining constructive dissatisfaction with the present level of performance.
- Eliminating waste and rework wherever it occurs.
- Investigating activities that do not add value to the product or service, with the aim of eliminating those activities.
- Eliminating nonconformities in all phases of everyone's work, even if the increment of improvement is small.
- Using benchmarking to improve competitive advantage.
- Innovating to achieve breakthroughs.
- Incorporating lessons learned into future activities.
- Using technical tools such as Statistical Process Control (SPC), experimental design, benchmarking, Quality Function Deployment (QFD), and so forth.

Process

Process refers to business and production activities of an organization. Business processes such as purchasing, engineering, accounting, and marketing are areas where non-conformance can present an opportunity for substantial improvement.

There are five basic ways to improve:

1. Reduce resources
2. Reduce errors
3. Meet or exceed expectations of downstream customers
4. Make the process safer
5. Make the process more satisfying to the person doing it

Self Assessment

Fill in the blanks:

1. …… is a very important component of Total Quality Management.
2. …… refers to business and production activities of an organization.

Notes

8.2 The Juran Trilogy

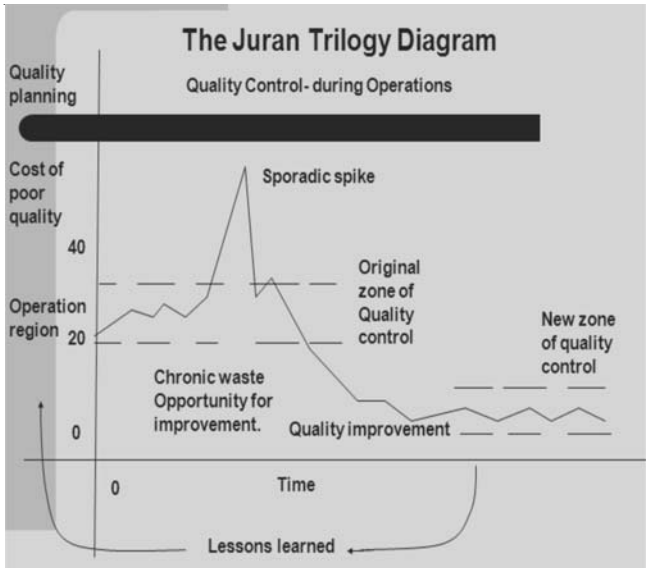
Process improvement involves planning. One of the best approaches is the one developed by Dr. Joseph Juran. It has three components: planning, control, and improvement, and is referred to as the Juran Trilogy. It is based on financial processes such as budgeting (planning), expense measurement (control), and cost reduction (improvement).

Planning: The planning component begins with external customers. Once quality goals are established, marketing determines the external customers, and all organizational personnel (managers, members of multifunctional teams, or work groups) determine the customers. External customers may be quite numerous, as is the case of a bank supply organization, where they include tellers, financial planners, loan officers, auditors, managers, and the bank's customers.

Control: Control is used by operating forces to help meet the product, process, and service requirements. It uses the feedback loop and consists of the following steps:

1. Determine items/subjects to be controlled and their units of measure
2. Set goals for the controls and determine what sensors need to be put in place to make the product, process, or service.
3. Measure actual performance.
4. Compare actual performance to goals.
5. Act on the difference.

Figure 8.1: The Juran Trilogy Diagram



Improvement: The third part of the trilogy aims to attain levels of performance that are significantly higher than current levels. Process improvements begin with the establishment of an effective infrastructure such as quality council.

Self Assessment

Fill in the blanks:

3. Process improvement involves …….
4. The planning component begins with …… customers.

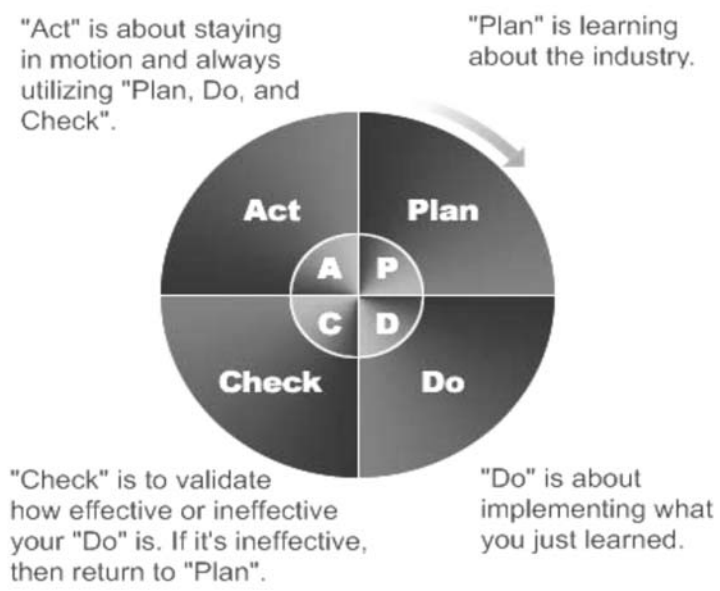
Notes

8.3 The PDCA Cycle

The PDCA (or PDSA) Cycle was originally conceived by Walter Shewhart in 1930's, and later adopted by W. Edwards Deming. The model provides a framework for the improvement of a process or system. It can be used to guide the entire improvement project, or to develop specific projects once target improvement areas have been identified.

The PDCA cycle is designed to be used as a dynamic model. The completion of one turn of the cycle flows into the beginning of the next. Following in the spirit of continuous quality improvement, the process can always be reanalyzed and a new test of change can begin. This continual cycle of change is represented in the ramp of improvement.

Figure 8.2: PDCA Cycle or Deming's Wheel



Plan: A change or a test, aimed at improvement. In this phase, analyze what you intend to improve, looking for areas that hold opportunities for change. The first step is to choose areas that offer the most return for the effort you put in. To identify these areas for change consider using a Flow chart or Pareto chart.

Do: Carry out the change or test (preferably on a small scale). Implement the change you decided on in the plan phase.

Check or Study: The results. What was learned? What went wrong? This is a crucial step in the PDCA cycle.

Note After you have implemented the change for a short time, you must determine how well it is working. Is it really leading to improvement in the way you had hoped?

You must decide on several measures with which you can monitor the level of improvement. Run Charts can be helpful with this measurement.

Act: Adopt the change, abandon it, or run through the cycle again. After planning a change, implementing and then monitoring it, you must decide whether it is worth continuing that

Notes

particular change. If it consumed too much of your time, was difficult to adhere to, or even led to no improvement, you may consider aborting the change and planning a new one. However, if the change led to a desirable improvement or outcome, you may consider expanding the trial to a different area, or slightly increasing your complexity. This sends you back into the Plan phase and can be the beginning of the ramp of improvement.

8.3.1 Problem Solving Method

Identify the Opportunity

1. Identify the Problem.
2. Pareto analysis of external alarm signals.
3. Pareto analysis of internal alarm signals.
4. Proposals from key insiders.
5. Proposals from suggestion schemes.
6. Field study of user's needs.
7. Comments of key people outside the organization.
8. Customer surveys.
9. Employee surveys.
10. Brainstorming by work groups.
11. Form the Team.
12. Team should be selected.
13. Define the Scope.

Criteria for a good problem statement are as follows:

1. It clearly describes the problem.
2. It states the effect.
3. It focuses on what is known, unknown, etc.
4. It emphasizes the impact on the customer.

Analyze the Current Process

The objective is to understand the process and how it is currently performed.

Step 1: The team to develop a process flow diagram.

Step 2: The target performance measures are defined.

Step 3: Collection of all available data and information.

Common items of data and information are:

1. Customer information
2. Design information
3. Process information
4. Statistical information

Notes

5. Quality information
6. Supplier information

Develop the Optimal Solution(s)

This phase has the objective of establishing potential and feasible solutions and recommending the best solution to improve the process.

Creativity plays the major role, and brainstorming is the principal technique.

There are three types of creativity:

- Create new processes
- Combine different processes
- Modify the existing process

Implement Changes

This phase has the objective of preparing the implementation plan, obtaining approval and implementing the process improvements.

- Approval of the quality council.
- Obtain the advice and consent of departments, functional areas, teams, individuals, etc.
- Monitor the activity.

Study the Results

This phase has the objective of monitoring and evaluating the change by tracking and studying the effectiveness of the improvement efforts.

Standardize the Solution

- Institutionalize by positive control of the process.
- The quality peripherals – the system, environment and supervision must be certified.
- Operators must be certified.

Plan for the Future

The objective is to achieve improved level of process performance.

- Regularly conduct reviews of progress by the quality council.
- Establish the systems to identify area for future improvements.
- Track performance with respective internal & external customers.
- TQM tools and techniques are used to improve quality, delivery and cost.

Task Present a descriptive article on PDCA cycle and Juran trilogy with special emphasis on how are the two similar and in which aspects are they different.

Notes

Self Assessment

Fill in the blanks:

5. The PDCA Cycle was originally conceived by …….
6. The objective of plan for the future is to achieve improved level of ……. performance.
7. ……. phase has the objective of monitoring and evaluating the change by tracking and studying the effectiveness of the improvement efforts.
8. Creativity plays the major role, and ……. is the principal technique.

8.4 Kaizen

Kaizen means continuous improvement in personal life, social life and working life. When applied to the workplace, Kaizen means continuing improvement involving everyone, managers and workmen alike.

The essence of Kaizen is simple and straightforward. Kaizen means improvement.

Kaizen and Management: In Japan, management has two major components: maintenance and improvements. Maintenance refers to activities directed towards maintaining current technological, managerial and operating standards and improvement refers to those directed towards improving current standards. Under the maintenance function, management performs the assigned tasks so that everybody in the company can follow the established Standard Operating Procedures (SOP) i.e. policies, rules, directives and procedures. Thus, in any business as employees work to maintain the standards, management helps by providing training and disciple. The improvement refers to improving the standards. The higher up the manager is, the more he is concerned with improvement. At bottom level an unskilled worker working on a machine may spend all his time following instructions. However, as he becomes more proficient at his work, he begins to think about improvement. He begins to contribute in the way his work is done, either through individual suggestions or through group suggestions.

Improving standard means establishing higher standards. Once this is done it is the management's job to see that the new standards are observed. Lasting improvement is achieved only when people work to higher standards. Maintenance and improvement have thus become inseparable for most Japanese managers. The improvement can be broken down between Kaizen and innovation. Kaizen signifies small improvements made in status quo as a result of ongoing efforts. Innovation involves improvement in the status quo as a result of large investment in new technology and/or equipment. In poorly managed companies, which do nothing, but maintenance, there is no internal drive for Kaizen or innovation and change is forced on management by market conditions and competitions.

Kaizen and TQC: The Total Quality Control (TQC) movement in Japan as part of Kaizen movement gives us a clear perspective of Japanese approach. It is important to note that TQC activities in Japan are not concerned solely with QC Japan has developed an elaborate system of Kaizen strategies on management tools with in the TQC movement.

Kaizen and Competition: Western managers who have had some business experience in Japan invariably remark on the intense competition among Japanese companies. This competition is thought to be the driving force of the Japanese companies.

Where profit is not an important criterion for business success, it can be considered that a company could remain unchanged for long time, but in situations as above improvement becomes an ongoing process. Kaizen ensures that there will be continuous improvement for improvement sake. Once the Kaizen movement is started there is no way to reverse the trend.

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Caselet

Real-life Usage of Kaizen

Canon of Japan implemented in 1975 to excel over international competition and expand its operations on a global scale in 6 years. Canon put in place a special matrix management system with numerous small group activities. The purpose was to eliminate wastes, revitalize the workforce, and improve continuously in all business processes. Techniques like Canon Production System, Quality Assurance, Production Assurance, and Personnel Training were introduced. Canon achieved an astonishing 3% per month productivity increase.

Self Assessment

Fill in the blanks:

9. …… means continuous improvement in personal life, social life and working life.
10. …… refers to activities directed towards maintaining current technological, managerial and operating standards.
11. …… refers to those directed towards improving current standards.

8.5 Re-engineering

Business Process Re-engineering (BPR) is an approach aiming at improvements by means of elevating efficiency and effectiveness of the business process that exist within and across organisations. The key to BPR is for organisations to look at their business processes from a "clean slate" perspective and determine how they can best construct these processes to improve how they conduct business.

Business process re-engineering is also known as BPR, Business Process Redesign, Business Transformation, or Business Process Change Management. It is the radical redesign of an organisation's processes, especially its business processes. Rather than organising a firm into functional specialties (like production, accounting, marketing, etc.) and considering the tasks that each function performs; complete processes from materials acquisition, to production, to marketing and distribution should be considered. The firm should be reengineered into a series of processes.

Hammer and Champy (1994) define BPR as "fundamental revision and radical redesign of processes to reach spectacular improvements in critical and contemporary measurements of efficiency, such as costs, quality, service and quickness." Keywords in this BPR definition are:

- ***Fundamental:*** What is the company's basic style of working?
- ***Radical:*** All existing procedures and structures must be forgotten and new styles of working must be discovered. Superficial changes are not useful. Changes must be made at the very root.
- ***Spectacular:*** Spectacular changes must be discovered, not marginal improvements.
- ***Processes:*** Redesign must be fixed on the processes not on the tasks, jobs, people, or structures.

Consequently, a firm must start over, leaving their old procedures behind, testing the work without prejudices, and forgetting systems used up to now. In other words, redesigning is

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changing. Re-engineering is centred in the processes. Davenport and Short (1990) define a process as a set of logically related tasks performed to achieve a defined business outcome. Furthermore, a process is a sequence of activities which, when jointly taken, produce a valuable result for the customer.

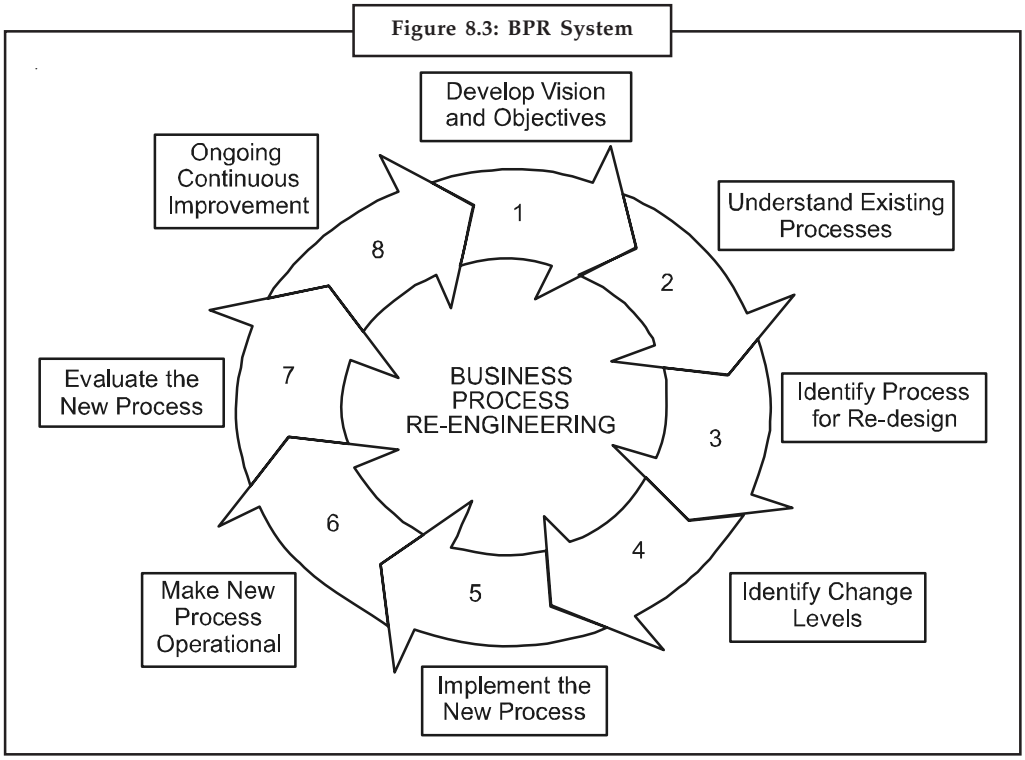
Other methodologies are also centred in the processes, such as continuous improvement or total quality management, and they reorient ate the basic tasks of the company to satisfy customers' needs. However, they can be quite comfortable with their existing processes and they may not want to introduce new ones.

Parker defines BPR as the analysis and redesign of the business and manufacturing processes with a view to eliminating the activities that do not add up value. These definitions enable us to outline the following main characteristics of BPR:

Concentration should be given on fundamental problems and not on departments or other organisational elements.

Concentration should be given on processes and less on activities, functions, people and structures. A process is a total of activities, which take one or several inputs, and creates an output, which is valuable for the client.

Figure 8.3: BPR System



A radical approach which presupposes going to the root of things not only making superficial changes of the existing things but acting by removing what is obsolete and inventing new ways of carrying on the activity.

They are the changes that have a spectacular character that is achieving spectacular results and not simply effecting marginal or gradual improvements.

A strong link of BPR with informatics technologies is a very important characteristic which cannot be seen directly from definitions. The processes introduced through BPR could not exist without applying informatics technologies.

Notes

8.5.1 Steps to Re-engineer the Process

Project phases required for successful BPR:

Phase 1: Begin Organisational Change

Activities

- Assess the current state of the organisation
- Explain the need for change
- Illustrate the desired state
- Create a communications campaign for change

The first step is to take a long, hard look at how the organisation operates. The focus of this examination is on the operating procedures and the bottom-line results that are generated by them. The purpose of performing the analysis described below is to determine whether dramatic change by doing BPR is really necessary. It may be that only marginal change (the result of Continuous Process Improvements, Total Quality Management, and other similar programs) is needed – which would expose the change initiative and the organisation to much less risk.

Aspects of the business that need to be evaluated are: how things are currently done, what changes may be occurring, and what new circumstances exist in our business environment. Next, a look at how certain operating procedures within the organisation has caused or will cause irreparable damage to the company's livelihood. What is the source of the organisation's concern? Maybe the demands of the marketplace are shifting. Perhaps competitors have made significant advancements in products and services. Regardless of the reasons, it should be clear whether or not the organisation, in its current state, is able to meet the needs of the markets it serves.

The consequences of inaction should be identified and well understood. In most cases, these consequences are the loss of jobs by shutting down portions of the business, or perhaps the entire business. Finally, the proper future direction of the organisation should be decided. The future "vision" of how the business must operate will serve as a clear and concise guide with measurable goals for employees to focus on.

If an organisation wishes to change the way it operates, it must turn to its people to make it happen. People are the agents of change. Creating business plans and strategies are important, but they are only tools to guide the actions of people.

In order for change to be embraced, everyone must understand where the organisation is today, why the organisation needs to change, and where the organisation needs to be in order to survive.

Phase 2: Build the Re-engineering Organisation

Activities

- Establish a BPR organisational structure
- Establish the roles for performing BPR
- Choose the personnel who will re-engineer

An infrastructure must be established to support re-engineering efforts. Although this phase consists of only a few tasks, it has a tremendous impact on the success of a BPR endeavour.

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Who are the people that will be chartered to re-engineer the business? What will their responsibilities be? Who will they report to? These are the questions that must be answered as the re-engineering staff is gathered together to communicate, motivate, persuade, educate, destroy, create, rebuild, and implement.

One of the most important members of the re-engineering effort is the executive leader. The leader must be a high-level executive who has the authority to make people listen, and the motivational power to make people follow. Without the commitment of substantial time and effort from executive-level management, most BPR projects cannot overcome the internal forces against them and will never reach implementation.

A process owner is responsible for a specific process and the re-engineering effort focused on it. There should be a process owner for each high-level process being re-engineered. Allocating the responsibility of a process to a specific person ensures that someone is in charge of how that process performs. Process owners are usually appointed by the executive leader.

The process owner convenes a re-engineering team to actually re-engineer his or her process. The team dedicated to the re-engineering of a specific process should be made up of current insiders, who perform the current process and are aware of its strengths and weaknesses, along with outsiders who can provide objective input to spark creative ideas for redesign. The team should be small, usually five to ten people. Since they will be the ones who diagnose the existing process, and oversee the redesign and implementation, they should be credible in their respective areas. This qualification plays an important role in reducing the resistance by company personnel to the new process.

In some BPR initiatives it is helpful to institute a steering committee. Especially in larger or multiple re-engineering projects, a steering committee can control the chaos by developing an overall re-engineering strategy and monitoring its progress.

Lastly, a re-engineering specialist can be an invaluable addition to the overall effort. A re-engineering specialist can assist each of the re-engineering teams by providing tools, techniques, and methods to help them with their re-engineering tasks.

Phase 3: Identify BPR Opportunities

Activities

- Identify the core/high-level processes
- Recognize potential change enablers
- Gather performance metrics within industry
- Gather performance metrics outside industry
- Select processes that should be re-engineered
- Prioritize selected processes
- Evaluate pre-existing business strategies
- Consult with customers for their desires
- Determine customer's actual needs
- Formulate new process performance objectives
- Establish key process characteristics
- Identify potential barriers to implementation

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These processes, usually less than a dozen, are the major or core processes of the organisation. This activity is not a time consuming task, but it is difficult because it requires a shift in how we think of ourselves. One goal here is to identify the process boundaries (where the process begins and where it ends), which will help set the project scope for those processes that are to be re-engineered.

In many cases, seeing the company from the customer's point of view can help identify what these high-level processes might be. At this point, it is helpful to begin thinking about potential change levers which may lead to dramatic changes in the organisation's processes.

Phase 4: Understand the Existing Process

Activities

- Understand why the current steps are performed
- Model the current process
- Understand how technology is currently used
- Understand how information is currently used
- Understand the current organisational structure
- Compare current process with the new objectives

Now that we know which process to re-engineer, we need to take a look at why we currently perform the process the way we do. Understand is a key word here. We may not need to scrutinize every detail of how we are performing the process – this effort has the potential to go on indefinitely, sometimes referred to as analysis paralysis, which can weaken the momentum needed to carry the project all the way to implementation. What we need to do is understand the underlying reasons why the existing process is carried out the way it is, so that we can question those assumptions during our re-engineering sessions later on. When we have the new process objectives clearly defined (in Phase 3), we can measure our existing process in terms of the new objectives to see where we are and how far we have to go.

Modelling the current process is an important part of this phase. It not only helps us to better understand the existing process, but also helps with planning the migration from the old to the new process and executing the physical transformation of personnel, organisational structures, information requirements, and how technology is used. Information that should be included in the models include process inputs (such as task times, data requirements, resources, demand, etc.) and process outputs (such as data outputs, cost, throughput, cycle time, bottlenecks, etc.).

Understanding how and why the current processes use information is also important. Do staff members have access to essential information? Are some business areas wasting time and effort by creating duplicate information when it can be shared across organisational boundaries? Why is technology used to support some tasks and not others? How effective are the current interfaces? Are they easy to use, or are they counter-intuitive and thus inhibit the effectiveness of current tasks? In what way does the existing process take advantage of technology, and in what way has technology imposed artificial restrictions? We need to end up with an estimate of the current cost, robustness, and functional value of each technology and information systems currently being used.

Phase 5: Re-engineer the Process

Activities

- Ensure the diversity of the re-engineering team

Notes

- Question current operating assumptions
- Brainstorm using change levers
- Brainstorm using BPR principles
- Evaluate the impact of new technologies
- Consider the perspectives of stakeholders
- Use customer value as the focal point

During this phase, the actual "re-engineering" begins. We've moved from strategy and analysis phases into the redesign phase. The Re-engineering Team that was formed to take part in the re-engineering sessions should consist of designers and implementers, including people well versed in technology. These team members should come from both inside and outside the existing process.

The "inside" perspective may reveal information about the existing process that was not uncovered in Phase 4. Having people who will be the future process owners or those responsible for the new process are critical components of the Team. Including the future owners will help to ensure that the re-engineered process succeeds once it is implemented.

Equally important is the "outside" perspective of someone who will look at the process with a "fresh eye" and raise questions about operating assumptions that may not be obvious to the insider who might be too close to the process to see this.

Lastly, a technologist will provide insight as to how technology can be applied in new and innovative ways. In other words, the technologist will help to visualize how the process can be performed outside the boundaries of the current implementation. Including both outsiders and technologists on the team will help spark "out-of-box" thinking (thinking creatively above and beyond the current restrictions – the walls of the box).

Phase 6: Blueprint the New Business System

Activities

- Define the new flow of work
- Model the new process steps
- Model the new information requirements
- Document the new organisational structure
- Describe the new technology specifications
- Record the new personnel management systems
- Describe the new values and culture required

Blueprints are detailed plans required to build something in accordance with the designer's intentions. In BPR, blueprints must be created to identify all the necessary details of the newly re-engineered business system and ensure it will be built as intended. This phase of the project takes the re-engineered process developed in the previous phase, and provides the details necessary to actually implement it.

Blueprinting involves modelling the new process flow and the information required to support it. Just as we modelled the "as is" process and information requirements in Phase 4, we need to create "to be" models to illustrate how the workflow will be different. The information models, or data models, will indicate where the new process will use information that is shared across functional areas of the business.

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The blueprints should also contain models of the redesigned organisational structure. Instead of the traditional organisation chart, a different kind of chart is needed. This chart will show the new process flow along with the process team members, the process owners, the case managers, the process facilitators. The chart should also indicate parts of the organisation which interact with the process personnel.

In addition, detailed technology specifications required to support the new process should be defined.

Phase 7: Perform the Transformation

Activities

- Develop a migration strategy
- Create a migration action plan
- Develop metrics for measuring performance during implementation
- Involve the impacted staff
- Implement in an iterative fashion
- Establish the new organisational structures
- Assess current skills and capabilities of workforce
- Map new tasks and skill requirements to staff
- Reallocate workforce
- Develop a training curriculum
- Educate staff about the new process
- Educate the staff about new technology used
- Educate management on facilitation skills
- Decide how new technologies will be introduced
- Transition to the new technologies
- Incorporate process improvement mechanisms

Self Assessment

Fill in the blanks:

12. …… is an approach aiming at improvements by means of elevating efficiency and effectiveness of the business process that exist within and across organisations.
13. Re-engineering can be divided into three related categories: human power, educational power, which and …… power.

8.6 Six Sigma Methodology

Six Sigma at many organizations simply means a measure of quality that strives for near perfection. Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects, driving towards six standard deviations between the mean and the nearest specification limit, in any process- from manufacturing to transactional and from product to service.

Notes

Six Sigma uses a variety of statistics to determine the best practices for any given process. Statisticians and Six Sigma consultants study the existing processes and determine the methods that produce the best overall results. Combinations of these methods will be tested and upon determining that a given combination can improve the process, it will be implemented.

Did u know? Six Sigma stands for "Six Standard deviations from the arithmetic mean".

Six Sigma statistically ensures that 99.9997% of all products produced in a process are of acceptable quality. Six Sigma allows only 3.4 defects per million opportunities. If a given process fails to meet this criterion, it is reanalyzed, altered and tested to find out if there are any improvements. If no improvement is found, the process is reanalyzed, altered and tested again. This cycle is repeated until you see an improvement.

Once an improvement is found, it is documented and the knowledge is spread across other units in the company so they can implement this new process and reduce their defects per million opportunities.

Table 8.1: Cost of Quality at Various Levels of Sigma

Sigma	Defect Rate (PPM)	Cost of Quality	Competitive Level
6	3.4	<10%	World Class
5	233	10-15%	
4	6210	15-20%	Industry Average
3	66807	20-30%	
2	308537	30-40%	Non Competitive
1	6,90000	>40%	

The statistical representation of Six Sigma describes quantitatively how a process is performing. To achieve Six Sigma, a process must not produce more than 3.4 defects per million opportunities. A Six Sigma defect is defined as anything outside of customer specifications. A Six Sigma opportunity is then the total quantity of chances for a defect. Process sigma can easily be calculated using a Six Sigma calculator.

The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects. This is accomplished through the use of two Six Sigma sub-methodologies: DMAIC and DMADV. The six sigma DMAIC Process (define, measure, analyze, improve, control) is an improvement system for existing processes falling below specification and looking for incremental improvement. The Six Sigma DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new processes or products at Six Sigma quality levels. It can also be employed if a current process requires more than just incremental improvement. Both Six Sigma processes are executed by Six Sigma Green Belts and Six Sigma Black Belts, and are overseen by Six Sigma Master Black Belts.

Six Sigma experts (Green Belts and Black Belts) evaluate a business process and determine ways to improve upon the existing process. Six Sigma experts can also design a brand new business process using DFSS (Design for Six Sigma) principles. Typically it is easier to define a new process with DFSS principles than refining an existing process to reduce the defects. Six Sigma incorporates the basic principles and techniques used in Business, Statistics, and Engineering. These three form the core elements of Six Sigma.

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8.6.1 DMAIC

Motorola developed a five phase approach to the Six Sigma process called **DMAIC**.

- Define opportunities
- Measure performance
- Analyze opportunity
- Improve performance
- Control performance

Table 8.2: DMAIC Process

Stage	Phase	Objective
Identification	Identification	Identify key business issues
Characterization	Characterization	Understand current performance levels
Optimization	Optimization	Achieve breakthrough improvement
Institutionalization	Institutionalization	Integrate Six Sigma in day to day functioning

Self Assessment

Fill in the blanks:

14. …… at many organizations simply means a measure of quality that strives for near perfection.
15. The fundamental objective of the Six Sigma methodology is the implementation of a …… strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects.

Case Study

Kaizen Makes Things Work

A leading automotive company launched a three-week campaign where engineers across the organization came up with new ideas that saved the company more than $73 million that year. At an imaging-product organization, an annual exercise of generating 50 ideas per employee has resulted in an increase in productivity of 3 per cent per month.

Cut to 2005—at a leading Business Process Outsourcing (BPO) organization, an employee's idea to route calls directly between the agents telephone to the dialer resulted in reduction of telemarketing sales representatives' hang-up rates in excess of 50 per cent.

It is a revelation how the relatively ancient manufacturing sector has lessons for the so-called sunrise sector of business process outsourcing - or any organization. How at the

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heart of each is the commitment to the Japanese concept of "kaizen" and how both rest on the singular premise that continuous improvement can result if those involved in day-to-day operations can be energized to become stakeholders.

The idea to facilitate employee participation in such a manner traces its history to an old Japanese concept popularly referred to as kaizen (kai meaning change and zen implying good). While Kaizen is a way towards generating operational efficiencies by continuous improvement, the broader aim is to create a company culture that does not tolerate waste. Kaizen efforts typically start on the "gemba", which refers to the place where production takes place or value is added and extend across the entire enterprise.

Kaizen and Outsourcing

The rapid growth of the Indian outsourcing industry is not a simple result of low prices but a passion for quality wherein top-tier companies are continually looking at ways to improve delivery. Taking a page out of the hugely successful kaizen implementations at manufacturing units of the 1990s, Indian BPOs today are realizing that operational efficiency even in a people-oriented industry can result from creating a kaizen approach.

A key facet of kaizen is that it starts ground up. Kaizen necessitates the enthusiasm and contribution of the workforce to bring collective success. The objective is that every organization requires the coordinated effort and participation of its employees to scale new heights.

It is even more amazing to see what happens when the dynamism, youth and creativity of a young workforce is unleashed. We have found that involving our employees to generate new ideas can veritably result in an "idea factory" - a reservoir of ideas/best practices that can be tapped to replicate success stories across the organization.

Of course, ideas can fall in any of the well-documented categories. They could be continuous improvement or kaizen ideas, breakthrough/disruptive ideas and best practices that would help increase productivity and reduce costs. The rationale is to tap the creative potential of every single employee to continuously improve the particular activity, process or atmosphere. Based on the premise that every employee has dozens of ideas on how to improve the work processes and tasks that they are involved in, employees can make these incremental changes themselves, rather than relying on some remote, bureaucratic authority that may be solely looked upon as responsible for innovation or making those changes. With the programme actively involving the idea generator in the implementation phase, this brings a tremendous sense of empowerment and achievement. To say the least, employees who contribute innovative ideas and see them being implemented own the brand and build the organization.

Another aspect of the BPO industry that lends itself to the kaizen culture is the driving need for differentiation. With global delivery models in place, and being completely process driven, it is imperative for Indian BPOs to manage and retain huge scale and size. With not too many differentiators forthcoming, innovation or kaizen can emerge as the most important competitive advantage that enables a company to thrive in today's business environment. Some of the long-term benefits that would accrue as a result would be:

1. An innovative culture encourages people to put their thinking caps in place, make the workplace a healthier set up and control attrition.
2. Long-lasting client relationships that create a differentiating edge for organizations in the global marketplace.
3. Setting industry benchmarks and creating intellectual property creation in a new business era.

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To conclude, kaizen and the Indian BPOs are a seamless match. In a bid to constantly outperform and perfect routine and mundane tasks, organizations must continuously try to discipline and reinvent themselves in the process. Whether it is an auto manufacturer, an imaging-product company or a BPO organization, the rationale is simple – improve, innovate, reinvent – again, again and yet again.

Questions

1. Kaizen is useful in service organizations. Give justification for your answer if positive.
2. Explain the advantages of using Kaizen in knowledge intensive organizations.
3. Kaizen and Indian BPOs are a seamless match. How do you justify this statement?

Source: http://news.zdnet.com/2100-9589_22-144700.html

Raju Venkatraman *President and COO, ICICI OneSource*

8.7 Summary

- Organizations should strive to achieve perfection by continuously improving the business and production processes.
- Process refers to business and production activities of an organization.
- Business processes such as purchasing, engineering, accounting, and marketing are areas where nonconformance can present an opportunity for substantial improvement.
- Juran Trilogy has three components: planning, control, and improvement.
- Control is used by operating forces to help meet the product, process, and service requirements. It uses the feedback loop.
- Process improvements begin with the establishment of an effective infrastructure such as quality council.
- The PDCA model provides a framework for the improvement of a process or system.
- Kaizen means continuous improvement involving everyone, managers and workmen alike.
- Maintenance refers to activities directed towards maintaining current technological, managerial and operating standards and improvement refers to those directed towards improving current standards.
- Lasting improvement is achieved only when people work to higher standards.
- Six Sigma uses a variety of statistics to determine the best practices for any given process.
- Six Sigma stands for "Six Standard deviations from the arithmetic mean".
- The statistical representation of Six Sigma describes quantitatively how a process is performing.
- The fundamental objective of the Six Sigma methodology is the implementation of a measurement-based strategy that focuses on process improvement and variation reduction through the application of Six Sigma improvement projects.
- The Six Sigma DMADV process (define, measure, analyze, design, verify) is an improvement system used to develop new processes or products at Six Sigma quality levels.
- Six Sigma experts (Green Belts and Black Belts) evaluate a business process and determine ways to improve upon the existing process.

Notes

8.8 Keywords

Benchmarking: Benchmarking refers to a standard by which something can be measured or judged.

Continuous Process Improvement: It is a never-ending effort to expose and eliminate root causes of problems; small-step improvement as opposed to big-step improvement.

Experimental Design: Experimental design a research design to investigate cause-and-effect relationships between interventions and outcomes.

Kaizen: Kaizen is a Japanese business philosophy of continuous improvement of working practices, personal efficiency, etc.

PDSA Cycle: It refers to a structured trial of a process change.

Quality Function Deployment: A visual decision-making procedure for multi-skilled project teams which develops a common understanding of the voice of the customer and a consensus on the final engineering specifications of the product that has the commitment of the entire team is known as quality function deployment.

Six Sigma: Six sigma is a quality-improvement performance measurement system that stresses the continual improvement of business processes through reduction of errors.

Statistical Process Control: Statistical process control (SPC) is the application of statistical methods to the monitoring and control of a process to ensure that it operates at its full potential to produce conforming product.

8.9 Review Questions

1. What do you understand by continuous process improvement?
2. What is meant by process? What are the five basic ways of improvement?
3. Briefly describe Juran Trilogy with the help of a suitable diagram.
4. Who formulated the PDCA cycle? Mention its key points.
5. Explain Kaizen with reference to management and TQC.
6. Discuss Six-Sigma methodology. Explain its key elements.
7. What do you understand by DMAIC?
8. Write a short note on:
   (a) Control
   (b) Kaizen and competition
   (c) DMADV
   (d) Proactive improvement

Answers: Self Assessment

1.	Continuous improvement	2.	Process
3.	Planning	4.	External
5.	Walter Shewhart	6.	Process

Notes

7. Study the results
8. Brainstorming
9. Kaizen
10. Maintenance
11. Improvement
12. Business Process Re-engineering (BPR)
13. Technological
14. Six Sigma
15. Measurement-based

8.10 Further Readings

Books

Besterfield, Dale H. (2011), *Total Quality Management*, Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management*, Pearson Education, India

Mukherjee, N.P. (2006), *Total Quality Management*, PHI Learning Pvt. Ltd.

Nigam, Shailendra (2009), *Total Quality Management*, Excel Books, India

Online links

http://www.businessballs.com/dtiresources/total_quality_management_TQM.pdf

http://www.clib.dauniv.ac.in/E-Lecture/TQM.pdf

http://www.ep.liu.se/ecp/026/109/ecp0726109.pdf

http://www.scribd.com/doc/14042732/TQM-Process-Improvement-Tools

Notes

Unit 9: Benchmarking

CONTENTS

Objectives

Introduction

9.1 Definition of Benchmarking

9.2 Levels of Benchmarking

9.2.1 Strategic Benchmarking

9.2.2 Operational Benchmarking

9.3 Types of Benchmarking

9.4 Benefits and Reasons of Benchmarking

9.4.1 Reasons for Benchmarking

9.5 Process of Benchmarking

9.5.1 Xerox Twelve-step Process

9.5.2 Motorola's Five-step Process

9.6 Cost of Benchmarking

9.7 Some Issues of Benchmarking

9.8 Summary

9.9 Keywords

9.10 Review Questions

9.11 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Benchmarking
- Discuss the Reasons for Benchmarking
- Explain the Levels and Types of Benchmarking
- Explain the Benefits of Benchmarking
- Elaborate the Process of Benchmarking
- Discuss the Cost of Benchmarking

Introduction

In the previous unit, we dealt with the concept of continuous process improvement. We also saw the various techniques applied in CPI such as Juran's trilogy, Kaizen, Six Sigma, etc.

In this unit, we will learn about benchmarking, reason for benchmarking and the process for it.

Notes

Organizations need to improve continuously in various areas to keep them in a competitive position. They can learn from various sources for their continuous improvement. Learning can be from both internal and external sources. Many firms choose to compare their performance against that of another firm in order to learn how they are performing in the market place. This can help them measure not only in understanding their current performance, but also help them in best practices in other organizations from which they can learn and improve. Thus benchmarking best industry practices is one of the popular quality management methodology used by organizations all over the world. Xerox was the first organization which initiated benchmarking concept and it went on win Malcolm Baldrige National Quality Award. Xerox basically studied best practices of its competitors to learn and improve its own performance. Since then many other organizations have used benchmarking as tool for quality and productivity improvement.

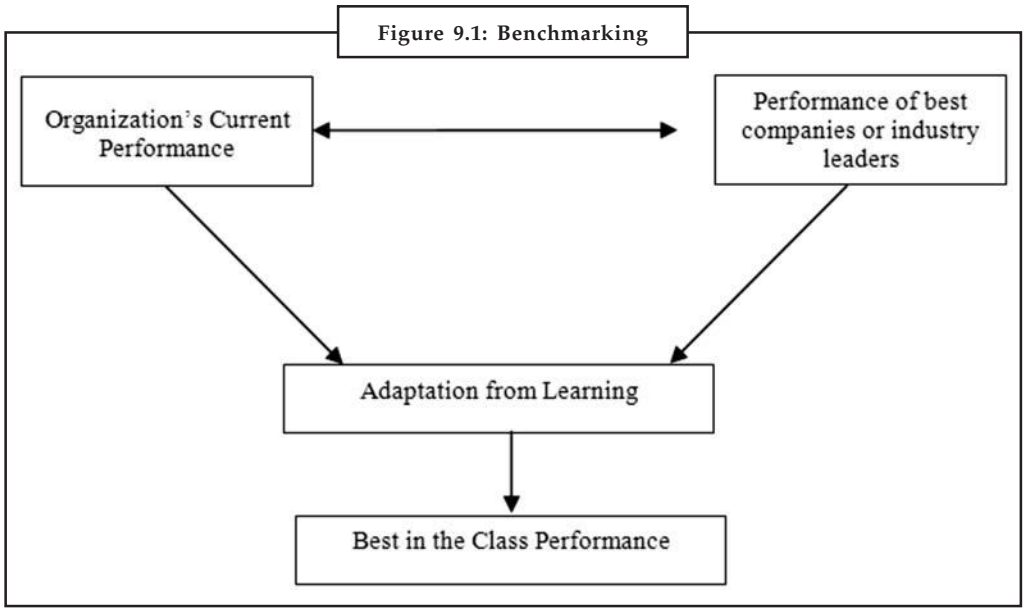
9.1 Definition of Benchmarking

Benchmarking is the systematic and continuous process of determining what the best performances and underlying skills of leading organizations are in their pursuit of excellence, and based on this, of stimulating the organization's own strife for excellent performance at all organizational levels – Camp.

Benchmarking involves management identifying the best firms in their industry, or any other industry where similar processes exist, and comparing the results and processes of those studied (the "targets") to one's own results and processes to learn how well the targets perform and, more importantly, how they do it.

Did u know? The term benchmarking was first used by cobblers to measure people's feet for shoes. They would place someone's foot on a "bench" and mark it out to make the pattern for the shoes.

Figure 9.1: Benchmarking



Benchmarking is most used to measure performance using a specific indicator (cost per unit of measure, productivity per unit of measure, cycle time of x per unit of measure or defects per unit of measure) resulting in a metric of performance that is then compared to others.

Notes

"Benchmarking is a continuous, systematic process of evaluating and comparing the capability of one organization with others normally recognized as industry leaders, for insights for optimizing the organizations processes."

Self Assessment

Fill in the blanks:

1. ..... was the first organization which initiated benchmarking concept.
2. The term ..... was first used by cobblers to measure people's feet for shoes.

9.2 Levels of Benchmarking

Benchmarking is a tool to achieve business and competitive objectives. It can inspire managers and organizations to compete. It is powerful and extremely effective when used for the right reasons and aligned with organization strategy.

The two levels of benchmarking are as follows:

1. Strategic Benchmarking and
2. Operational Benchmarking

9.2.1 Strategic Benchmarking

Strategic benchmarking deals with to management and looks at what strategies the organizations are using to make them successful. It focuses on how companies compete and deals with long-term results. It is using best practices to develop corporate, program, product strategies and results. Most Japanese firms use this technique as they focus on long-term results.

Note Strategic Benchmarking must begin with the assessment of the needs and expectations of the customer.

Strategic Benchmarking involves studying of corporate level strategies of successful organizations and comparing it with the organizational strategy to get the additional insights.

Identifying the process outputs most important to the customers (key quality characteristics) of that process is the first step. This step applies to every organizational function, since each one has outputs and customers. The QFD/customer needs assessment is a natural precursor to benchmarking activities.

Strategic Benchmarking includes:

- The strategic study of the characteristics of effective continuous improvement strategies of public and private organizations, of change processes, of leadership styles, etc. to establish a vision, strategies, leadership competencies, client benefit results;
- Specific studies of the strategies and approaches of high performing organizations;
- Studies of trends and orientations as guide to actions, e.g., technological trends.

Examples of strategic benchmarking studies includes evaluation of options for the design of an organisation's governance structure; assessment of approaches used to implement advanced technology or strategic business issues.

Notes

9.2.2 Operational Benchmarking

Operational Benchmarking is assessing and implementing the best practices of industry or public service leaders to improve processes to the extent possible to meet organizational goals.

Examples of operational benchmarking studies include analysis of invoicing procedures to determine the most productive process, evaluation of productions methods to determine the highest through put methods that deliver lowest cost and least defects; and study of logistics distribution methods that result in both high delivery service performance and low levels of finished goods.

It includes:

- Creating awareness and support at the senior executive level, and establishing dedicated benchmarking resources;
- Building benchmarking into business planning and continuous improvement;
- Establishing operational performance levels to sustain competitive advantages;
- Using a systematic, multi-step benchmarking process to improve business and work processes, and internal and external customer satisfaction.

Self Assessment

Fill in the blanks:

3. ..... is a tool to achieve business and competitive objectives.
4. ..... benchmarking deals with to management and looks at what strategies the organizations are using to make them successful.
5. Strategic Benchmarking involves studying of ..... level strategies of successful organizations and comparing it with the organizational strategy to get the additional insights.
6. ..... Benchmarking is assessing and implementing the best practices of industry or public service leaders to improve processes to the extent possible to meet organizational goals.

9.3 Types of Benchmarking

Benchmarking can be used in several ways. Depending ways of benchmarking or the content of benchmarking; benchmarking can be classified into several categories. Popular methods of benchmarking are discussed below:

1. ***Competitive benchmarking:*** Competitive benchmarking is the process of benchmarking on the products or services of a company's competitor's. For example, Xerox used competitive benchmarking to make itself more competitive.
2. ***Generic benchmarking:*** Generic benchmarking is the process of evaluating processes or business functions against the best companies, regardless of their industry. Thus any organization related any industry can learn from any other organization in different industry certain best practices in different functional areas. For example, an insurance company may benchmark a bank loan application process against its insurance claims process.
3. ***Strategic benchmarking:*** It is the process of improving organization's long-term strategies and general approaches to enable higher performance in various areas like core competencies, products, services, etc. by learning from best in the world.

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4. ***Functional benchmarking:*** It is the process of benchmarking in particular functional (say billing) areas of business to improve organizational performance.

5. ***Internal benchmarking:*** It is the process of learning from within the organization. Any part of Organization can benchmark any process or activity from different departments or business units within the organization. This is very useful for enhancing performance in all business units and departments of an organization. This is very popular in large organizations. For example, shipping and receiving at one plant can be compared with shipping and receiving at another.

6. ***External benchmarking:*** It is the process in which organizations learn from benchmarking with other organizations outside in any area.

7. ***International benchmarking:*** It is the process of benchmarking in which best practices outside the country in any part of the world are identified for an organization's improvement.

8. ***Collaborative Benchmarking:*** Benchmarking, was originally invented as a formal process by Rank Xerox, is usually carried out by individual companies. Sometimes it may be carried out collaboratively by groups of companies (e.g., subsidiaries of a multinational in different countries).

Example: The Dutch municipally-owned water supply companies have carried out a voluntary collaborative benchmarking process since 1997 through their industry association. And the UK construction industry has carried out benchmarking since the late 1990s again through its industry association and with financial support from the UK Government.

Task Make a presentation on the types of benchmarking. Also mention the industries and the companies using these benchmarking methods.

Self Assessment

Fill in the blanks:

7. ..... benchmarking is the process of benchmarking on the products or services of a company's competitor's.

8. ..... is the process of improving organization's long-term strategies and general approaches to enable higher performance in various areas.

9. ..... benchmarking is the process of evaluating processes or business functions against the best companies, regardless of their industry.

10. ..... is the process in which organizations learn from benchmarking with other organizations outside in any area.

11. Product benchmarking is simply comparing the performance, features and customer acceptance of ..... products.

9.4 Benefits and Reasons of Benchmarking

Benchmarking, as we knew is an improvement tool. It is neither a strategy nor a philosophy. The benefits of it, provided used properly are enormous. Some of the main benefits are:

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- Source of innovation.
- Measurable goals & objectives.
- Understanding present performances in measurable terms.
- Awareness about the best practices.
- Accelerate positive change.
- Achievement of standards of excellence.
- Provides SWOT analysis of the company.
- Generates employee involvement.
- Improving organizations bottom line through cost-benefits analysis.
- Improves quality of management through information exchange.

In 2008, a comprehensive survey on benchmarking was commissioned by the Global Benchmarking Network, a network of benchmarking centers representing 22 countries. Over 450 organizations responded from over 40 countries. The results showed that:

1. Mission and Vision Statements and Customer (Client) Surveys are the most used (by 77% of the organisations) of 20 improvement tools, followed by SWOT analysis (72%), and Informal Benchmarking (68%). Performance Benchmarking was used by (49%) and Best Practice Benchmarking by (39%).
2. The tools that are likely to increase in popularity the most over the next three years are Performance Benchmarking, Informal Benchmarking, SWOT, and Best Practice Benchmarking. Over 60% of organizations that are not currently using these tools indicated they are likely to use them in the next three years.

Caselet

Benchmarking: The Politics of Envy

Let's start with a controversial statement: 'envy is a very good thing'. Sounds like a good subject for a business school debate doesn't it? How often have you looked enviously or admiringly at the car someone's driving, or the shoes they're wearing, or the ease with which they carry themselves? Some people might describe that envy as negative, but if it results in you doing something in an improved way, isn't that positive?

Gary Hamel said: "My fundamental belief is that if a company wants to see the future, 80 per cent of what it is going to have to learn will be from outside its own industry." I contend that the motivation for that learning is provided by a feeling of discontent with where you are at present; and that feeling of discontent is something that has to be fostered if complacency isn't to set in.

The conclusions of research carried out by the London Business School on behalf of the CBI in 1997 are as true today as they were then—in essence the research found that the more complacent an organisation, the less effective it is in delivering service. It also found that there is a direct positive correlation between an organisation's service performance and the amount of benchmarking it does. In other words, the more benchmarking you do the better your performance!

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Lawler & Worley, in *Built to Change*, articulated a major temptation for organisations to "institutionalise best practices, freeze them into place, focus on execution, stick to their knitting, increase predictability and get processes under control". These ideas are all premised on stability and consistency as the keys to effective performance. Organisations are positively encouraged through the deployment of models and templates to support enduring values, stable strategies and bureaucratic structures, not to change—in short, to set best practice in aspic!

So how do organisations overcome complacency and inertia? My favoured way is benchmarking, i.e. learning what others do and the appropriate application of that learning to your own organisation in order to improve performance. A simple definition is: benchmarking = comparative analysis + improvement action.

Benchmarking activities are either informal or formal. The former, most of us do unconsciously and is the constant comparing and learning from the behaviour and practices of others. This learning can come from talking to peers within your own organisations, consulting with experts, online and face-to-face networking with people from other organisations, or using online databases that share benchmarking information.

Informal benchmarking remains extremely popular for effective performance improvement. Recent research among the Best Practice Club's membership indicated common key areas of focus in operational efficiency, cost management, employee engagement in difficult times, and the environment. All respondents stated they would be carrying out benchmarking in the next 12 months to help them address those areas of focus and the vast majority of that benchmarking would be informal. In a typical year the Club receives around 150 benchmarking requests of all types and well over 90 per cent of all delegates attending Club workshops state they will make changes to their organisations as a direct result of their attendance. I suggest that in today's challenging economic climate, such cost effective methods of performance improvement will be even more popular.

As for formal benchmarking, there are two types: performance and best practice. In the vernacular, the first is about 'what' and the second is about 'how'.

Performance benchmarking is the comparative analysis of key measures of performance from similar activities and, if that analysis reveals shortcomings in performance, can often be a very good 'driver for change'. Unfortunately a significant number of organisations consider this comparative analysis to be all that's involved in benchmarking and thus do little more than collect 'league table' information about themselves, carrying out any improvement projects as separate and detached activities. This situation can often be found in organisations where 'politically' or 'regulatory' defined measures are used by external stakeholders to judge their performance. The risk that is run here is that of a disconnection between the impact of the improvement interventions made and the defined measures. Another common occurrence in such cases is the inordinate amount of time and effort that is put into ensuring the measures used are consistent across the reference group used, i.e. the perennial problem of ensuring 'apples with apples' comparisons.

Best practice benchmarking, as defined by the Centre for Organisational Excellence Research (COER), is: "The comparison of performance data obtained from studying similar processes or activities and identifying, adapting and implementing the practices that produce the best performance results." As such, it is an extremely powerful process improvement methodology. However it should be noted that this type of formal benchmarking is resource-intensive and typical projects take from two to four months to identify best practices. Given the level of investment, care must be taken to ensure project focus is aligned with strategic intent and maintained throughout its life.

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A classic example of formal best practice benchmarking is that of Xerox. In the late 1970s it faced stiff competition from Japan and, unsettled by the success of its competitors, it compared its performance in a number of key areas. Its findings included:

- Key competitors had a ratio of indirect to direct staff of half its own
- It had nine times the number of production suppliers
- It's time to market for products was double that of the competition
- Its defect rate was seven times worse

You can imagine the unsettling effect that this comparative analysis had on the Xerox executives! The organisation embarked on a massive programme of learning, predominately from outside of its own industry, to identify and implement best practice. And the success it had is well documented.

A recent study conducted by COER, on behalf of the Global Benchmarking Network (GBN), involved nearly 500 organisations that used best practice benchmarking and this indicated an average financial return per project of $100,000 to $150,000 with some reaping benefits of more than $1,000,000.

The wide appeal and acceptance of benchmarking has led to various processes emerging. COER's TRADE, as recognised by the UK Benchmarking Institute, is one such methodology.

It consists of five stages:

- **T**erms of Reference (aims, objectives, scope, resources, cost/benefit analysis)
- **R**esearch (current performance)
- **A**ct (data collection and comparative analysis)
- **D**eploy (communicate and implement best practices)
- **E**valuate (review process and outcomes to ensure aims met)

Many benchmarking gurus advocate a 10-step generic process that includes:

- Select process to benchmark
- Put in place resources
- Plan benchmarking project
- Train staff
- Research and engage partners
- Collect and exchange data
- Analyse gaps
- Adapt superior practice
- Develop and implement new process

Review Results

Most organisations' benchmarking teams are small (typically less than four people); so if you are considering formal benchmarking then please ensure that you've thoroughly prepared the ground and put in place the critical success factors necessary for you to succeed. Below is a summary of the critical success factors for effective benchmarking identified by Keki Bhote, courtesy of the Best Practice Club knowledge base.

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- Tie in with strategy or goals
- Win top management support
- Tie in with other improvements
- Establish a robust infrastructure
- Get the planning right
- Link to key business outcomes
- Link internal customers to project
- Pick the right project team
- Get help from support services
- Get training for the project team
- Benchmark internally to 'know yourself'
- Run a pilot project
- Pick the right partners
- Use and test a questionnaire
- Plan on site visits thoroughly
- Be prepared for defeatism/scepticism
- Communicate your findings
- Repeat the process

Finally, the key word in all benchmarking projects for me is 'adapt'. No two organisations are exactly the same and what works in one organisation may not do so in another. Best practice always has to be adapted to the organisation concerned. Done well, best practice benchmarking is a force multiplier in the performance improvement world; but done badly it can be little more than an expensive ego massaging device.

Source: http://www.bus-ex.com/article/strategy-benchmarking

9.4.1 Reasons for Benchmarking

Continuous improvement is the most important need for any organization to remain competitive and to satisfy changing needs of customers. Originations have to either innovate, develop new processes, products and methods for improvement or they can also learn from the best in the world. Thus benchmarking becomes an important requirement for every organization. Benchmarking thus is used to measure key performance and compare it with others so that an organization can determine where it needs to improvement and what the future opportunities for improvement are. Sometimes benchmarking can also be used by an organization to determine whether it is able to meet customer expectations. It can be also used to determine how an organization is able to comply with standards. This helps the organizations to implement quality management systems like ISO 9000. Thus in general it is the benchmarking which helps organizations to determine areas for future improvement to remain competitive in the market.

Reasons for benchmarking are as follows:

(a) Learning from best practices from any industry and incorporating them for improvement

(b) Helping an organization to understand its current performance

(c) Encouraging for continuous improvement projects

Notes

(d) Improved customer satisfaction

(e) Improves competitiveness

(f) Enhances productivity

(g) Helps in thinking out of box

(h) Stimulates motivation among the employees

Self Assessment

Fill in the blanks:

12. Benchmarking is a/an …… tool.

13. …… improvement is the most important need for any organization to remain competitive and to satisfy changing needs of customers.

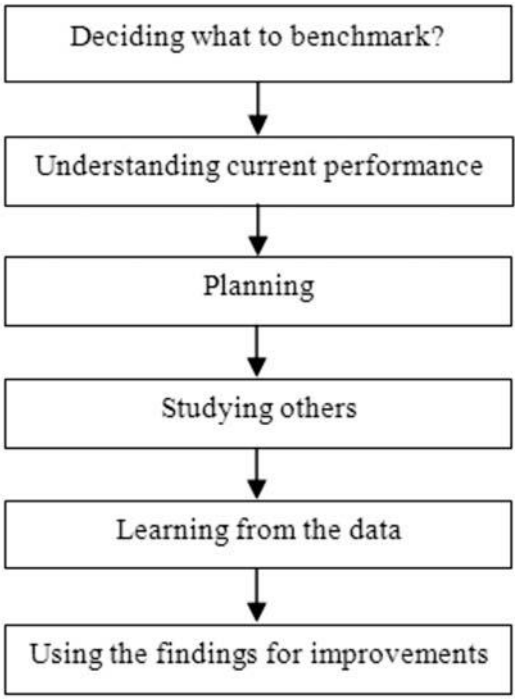
14. …… can be used by an organization to determine whether it is able to meet customer expectations.

9.5 Process of Benchmarking

There is no specific procedure for benchmarking and organizations can design their own method of benchmarking and hence it may vary from organization to organization. But in general the process of benchmarking may consist of the following steps as shown in the Figure 9.2.

The various steps of benchmarking process are explained below:

Figure 9.2: Process of Benchmarking



Deciding what to Benchmark?: Benchmarking can be applied to any business process or function of the organization.

Notes

Note The selection of area for benchmarking must be based on the business strategy of the organization. Thus the area chosen for improvement must be in line with business strategy.

Understanding Current Performance: Self analysis is an essential step for benchmarking process. Every organization which would like to benchmark must have clear knowledge about its own processes, products and services before it can compare itself with another organization. Hence it is necessary for the organization to first document its processes. Techniques like flow diagrams, cause-effect diagrams, etc. can be used for understanding current level of performance in the chosen areas for improvement.

Planning for Improvement: Planning phase determines the way to conduct benchmarking study. Organization has to select be benchmarking team and team has to make decisions on benchmarking and these decisions include type of benchmarking, the data required for benchmarking, method of data collection and which are the organizations which can be selected for benchmarking study from which this data is to be selected.

Thus first step in planning is to determine type of benchmarking. Thus organization has to determine whether to use internal benchmarking, competitive benchmarking or process benchmarking. Internal benchmarking can be very much useful for large organizations with several business units to learn best practices within the organization.

Studying Others: Once an organization is selected for benchmarking, the next step is to study its best practices. Study should focus on how best in the class processes are performed and what are the ways of measuring outcomes or results of these processes.

Learning from the Data: Once sufficient data is collected about the process or functional area selected, the benchmarking team can use the information for the analysis. This analysis should lead to what the organization can learn from the best in the class. It must identify gaps between the organization's performance and that of the best in the class organizations. It must also reveal the amount of gap and possible reasons for the gap. It should also reveal quantum of future improvements if these practices are learned form the best in the class and implemented successfully from the process of benchmarking.

Using the Findings for Future Improvement: When the benchmarking study reveals performance gaps, the outcomes of benchmarking study identifies the actions for future improvement. Successful changes need a clear communication about the need for changes from the benchmarking team to all those people who may be involved in the change process.

Caution The change process must identify definite goals for improvement, and prepare action plans for implementing improvement projects.

9.5.1 Xerox Twelve-step Process

The pioneer of Benchmarking Robert Camp (Manager of Benchmarking Competency Quality and Customer Satisfaction at Xerox) lists the benchmarking process in five phases. These five phases are divided into 12 steps as under:

1. ***Planning:*** This includes the following three steps:
   - (a) Identify what is to be benchmarked
   - (b) Identify comparative companies
   - (c) Determine data collection method and collect data

Notes

2. ***Analysis:*** This includes the following two steps:
   (a) Determine current performance "gap"
   (b) Project future performance levels
3. ***Integration:*** This includes the following two steps:
   (a) Communicate benchmark findings and gain acceptance
   (b) Establish functional goals
4. ***Action:*** This includes the following three steps:
   (a) Develop action plans
   (b) Implement specific actions and monitor progress
   (c) Recalibrate benchmarks
5. ***Maturity:*** This includes the following two steps:
   (a) Leadership position attained
   (b) Practices fully integrated into process.

9.5.2 Motorola's Five-step Process

1. Decide what to benchmark
2. Fined companies to benchmark
3. Gather data
4. Analyse data and integrate results into action plans
5. Recalibrate and recycle the process

Although the number of steps in the process may vary from organisation to organisation, the following six steps contain the core techniques.

1. Decide what to benchmark
2. Understand current performance
3. Plan
4. Study others
5. Learn from the data
6. Use the findings

Self Assessment

Fill in the blanks:

15. …… can be applied to any business process or function of the organization.
16. …… is an essential step for benchmarking process.
17. …… phase determines how to conduct benchmarking study.
18. First step in planning is to determine …… of benchmarking.
19. When the benchmarking study reveals the ……, then the outcomes of benchmarking study identifies the actions for future improvement.

Notes

9.6 Cost of Benchmarking

The three main types of costs in benchmarking are:

- ***Visit Costs:*** This includes hotel rooms, travel costs, meals, a token gift, and lost labor time.
- ***Time Costs:*** Members of the benchmarking team will be investing time in researching problems, finding exceptional companies to study, visits, and implementation. This will take them away from their regular tasks for part of each day so additional staff might be required.
- ***Benchmarking Database Costs:*** Organizations that institutionalize benchmarking into their daily procedures find it is useful to create and maintain a database of best practices and the companies associated with each best practice now.

The cost of benchmarking can substantially be reduced through utilizing the many internet resources that have sprung up over the last few years. These aim to capture benchmarks and best practices from organizations, business sectors and countries to make the benchmarking process much quicker and cheaper.

9.7 Some Issues of Benchmarking

Benchmarking is based on learning from others, rather than developing new and improved approaches. Since the process being studied is there for all to see, a firm will find that benchmarking cannot give them a sustained competitive advantage. Although helpful, benchmarking should never be the primary strategy for improvement.

Competitive analysis is an approach to goal setting used by many firms. This approach is essentially benchmarking confined to one's own industry. Although common, competitive analysis virtually guarantees second-rate quality because the firm will always be following their competitors. If the entire industry employs the approach it will lead to stagnation for the entire industry, setting them up for eventual replacement by outside innovators.

Self Assessment

Fill in the blanks:

20. The cost of benchmarking can substantially be …… through utilizing the many internet resources that have sprung up over the last few years.
21. Although helpful, …… should never be the primary strategy for improvement.
22. …… analysis is an approach to goal setting used by many firms.

Case Study

Xerox Benchmarking

Possibly the best-known pioneer of benchmarking in Europe is Rank Xerox, the document and imaging company, which created the original market for copiers. The virtual monopoly the company had in its sector almost became its undoing, however. Spurred by the threat from the emerging Japanese copier companies, an in-depth study within the company recognized that fundamental changes were needed. To understand how it should change, the company decided to evaluate itself externally – a process which became known as competitive benchmarking. The results of this study

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shocked the company. Its Japanese rivals were selling machines for about what it cost Xerox to make them. Nor could this be explained by differences in quality. The study found that, when compared with its Japanese rivals, the company had nine times more suppliers, was rejecting 10 times as many machines on the production line and taking twice as long to get products to market. Benchmarking also showed that productivity would need to grow 18 per cent per year over five years if it was to catch up with its rivals.

Rank Xerox sees benchmarking as helping it achieve two objectives. At a strategic level it helps set standards of performance, while at an operational level it helps the company understand the best practices and operations methods which can help it achieve its performance objectives. The benchmarking process developed by Rank Xerox has five phases.

Its experience of using this approach has led Xerox to a number of conclusions:

- The first phase, planning, is crucial to the success of the whole process. A good plan will identify a realistic objective for the benchmarking study, which is achievable and clearly aligned with business priorities.
- A prerequisite for benchmarking success is to understand thoroughly your own processes. Without this it is difficult to compare your processes against those of other companies.
- Look at what is already available. A lot of information is already in the public domain. Published accounts, journals, conferences and professional associations can all provide information which is useful for benchmarking purposes.
- Be sensitive in asking for information from other companies. The golden rule is: 'Don't ask any questions that we would not like to be asked ourselves.'

Questions

1. What kind of information did Xerox discover in its benchmarking study?
2. Of the five performance objectives (quality, speed, dependability, flexibility, cost) which do you think are the most difficult to discover about your competitors' performance?

9.8 Summary

- Learning can be from both internal and external sources.
- Xerox was the first organization which initiated benchmarking concept and it went on win Malcolm Baldrige National Quality Award.
- Benchmarking is a continuous, systematic process of evaluating and comparing the capability of one organization with others normally recognized as industry leaders, for insights for optimizing the organizations processes.
- Strategic Benchmarking must begin with the assessment of the needs and expectations of the customer.
- Strategic benchmarking deals with to management and looks at what strategies the organizations are using to make them successful.
- Operational Benchmarking is assessing and implementing the best practices of industry or public service leaders to improve processes to the extent possible to meet organizational goals.
- Performance benchmarking is an important technique secures external involved in the processes or feedback to the concerned persons involved in the processes or activities.

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- In 2008, a comprehensive survey on benchmarking was commissioned by The Global Benchmarking Network, a network of benchmarking centers representing 22 countries. Over 450 organizations responded from over 40 countries.
- There is no specific procedure for benchmarking and organizations can design their own method of benchmarking and hence it may vary from organization to organization.
- Every organization which would like to benchmark must have clear knowledge about its own processes, products and services before it can compare itself with another organization.
- The pioneer of Benchmarking Robert Camp lists the benchmarking process in five phases. These five phases are: planning, analysis, integration, action and maturity.
- Two-tune, Baldrige Award winning AT&T, an active bench marker, has developed a nine-step model.
- The two most common forms of quantitative analysis used in metric benchmarking are Data Envelope Analysis (DEA) and regression analysis.
- Regression analysis estimates what the average firm should be able to achieve.
- Benchmarking helps organizations to determine areas for future improvement to remain competitive in the market.
- Competitive analysis is an approach to goal setting used by many firms. This approach is essentially benchmarking confined to one's own industry.

9.9 Keywords

Benchmarking: A surveyor's mark on a permanent object of predetermined position and elevation used as a reference point.

Competitive Benchmarking: Competitive benchmarking is a process whereby businesses use primary data about their competitive set and industry best practices to pin down several core dimensions of success.

Core Competencies: A competency which is made necessary by the strategy of an organization and is central to the making of that strategy.

Operational Benchmarking: Operational benchmarking allows organisations to evaluate various aspects of their operations and compare them to industry standards.

Process Benchmarking: Process benchmarking is where a specific process is measured and compared against similar processes of the organisation known to be the best for that specific process.

Strategic Benchmarking: Involves observing how others compete. This type is usually not industry specific meaning it is best to look at other industries.

SWOT Analysis: A study undertaken by an organization to identify its internal strengths and weaknesses, as well as its external opportunities and threats

Technology Portfolio: A collection of observational notes, results from assessment instruments, and copies of children's creations in an authoring software program, such as HyperStudio.

Value Analysis: The systematic and critical assessment by an organization of every feature of a product to ensure that its cost is no greater than is necessary to carry out its functions.

Notes

9.10 Review Questions

1. Define benchmarking.
2. What are the two levels of benchmarking? Differentiate between them.
3. Explain the different types of benchmarking.
4. Discuss the benefits of benchmarking.
5. Explain the complete procedure of benchmarking.
6. Briefly explain the Xerox 12 step process.
7. What are the various types of cost of benchmarking?
8. Explain the reasons for benchmarking.

Answers: Self Assessment

1.	Xerox	2.	Benchmarking
3.	Benchmarking	4.	Strategic
5.	Corporate	6.	Operational
7.	Competitive	8.	Strategic benchmarking
9.	Generic	10.	External benchmarking
11.	Competing	12.	Improvement
13.	Continuous	14.	Benchmarking
15.	Benchmarking	16.	Self analysis
17.	Planning	18.	Type
19.	Performance gaps	20.	Reduced
21.	Benchmarking	22.	Competitive

9.11 Further Readings

Books

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Charantimath, M. Poornima (2009), *Total Quality Management,* Pearson Education, India

Mukherjee N.P. (2006), *Total Quality Management,* PHI Learning Pvt. Ltd.

Nigam. Shailendra (2009), *Total Quality Management,* Excel Books, India

Online links

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http://www.blurtit.com/q386762.html

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http://www.scribd.com/doc/24932697/Bench-Marking-in-TQM

Notes

Unit 10: Quality Management System

CONTENTS

Objectives

Introduction

10.1 ISO 9000

10.1.1 ISO Standard Series and Some Other Standards

10.1.2 ISO 9000 Quality System Certification

10.1.3 Benefits of ISO Certification

10.1.4 Limitation of ISO 9000 Certification

10.2 ISO 9001 Requirements

10.2.1 Scope

10.2.2 Normative Reference

10.2.3 Terms and Definitions

10.2.4 Quality Management Systems (QMS)

10.2.5 Management Responsibility

10.2.6 Resource Management

10.2.7 Product Realization

10.2.8 Measurement, Analysis and Improvement

10.2.9 Documentation

10.3 Implementation

10.3.1 Internal Audit

10.4 ISO 14000

10.5 Summary

10.6 Keywords

10.7 Review Questions

10.8 Further Readings

Objectives

After studying this unit, you will be able to:

- Define ISO
- Discuss ISO 9000
- Explain ISO 9001 & ISO 14000

Notes

Introduction

Previous unit gave you an insight on the concept of benchmarking, the various types of benchmarking and their levels. It also talked about the process, reasons and benefits of benchmarking.

In this unit, you will study about ISO 9000 Quality Standard and ISO certifications. In this unit you will also learn about the documentation of quality systems and implementation of ISO 9001:2000.

Quality is the basic requirement for business success and the survival of any business organization will depend on its ability meet or exceed both stated and implied expectations of the customers. Thus quality management has emerged as the most important strategic function for all business organizations. This resulted in the development of various standards and guidelines. In order to fulfill customer needs and expectations, all world class organizations create quality systems. This led to the concept of "Quality Management Systems" which is popularly known as QMS. A Quality Management System is the system which provides guidelines for the organization and its employees to identify the needs of customer and to design, develop, produce and deliver the products or services to meet these needs. Thus quality management systems ensure that an organization's efforts are directed towards achievement of high quality of products and services.

10.1 ISO 9000

ISO 9000 is a series of standards dealing with quality management systems. The standards are published by the International Organization. All industrialized countries are members and participate in writing the standards.

Most countries have adopted and published ISO 9000 as their own national standard. In the United States, it has been issued as Q9000 with virtually the same text as the original standard.

Did u know? ISO 9000 was first published in 1987 and has undergone several revisions since its inception.

10.1.1 ISO Standard Series and Some Other Standards

The ISO Standard Series includes the following Systems Standards indicating their specific purposes:

- ***ISO 9000:*** Quality Management and Quality Assurance Standards Guidelines for Selection and Use
- ***ISO 9001:*** Model for Quality Assurance in Design/Development, Production Installation, and Servicing.
- ***ISO 9002:*** Model for Quality Assurance in Production and Installation.
- ***ISO 9003:*** Model for Quality Assurance in Final Inspection and Test.
- ***ISO 9004:*** Generic Guidelines for Quality Management and Systems.
- ***ISO 9004-2:*** Guidelines for Services.
- ***ISO 14001:*** Environmental Management System Guidelines for Principles, Systems, and Supporting Techniques.

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Some other System Standards include:

- ***QS 9000:*** Encompasses ISO 9000 and the Big Three Auto Makers specific requirements.
- ***TS 9000:*** Based on ISO 9001 establishes quality systems requirements for the worldwide telecommunications network.
- ***FDA-CGMP:*** Medical Device, Current Good Manufacturing Practices (includes all of ISO 9001).

10.1.2 ISO 9000 Quality System Certification

Initially, ISO 9000 was used as the basis for specifying quality requirements in contractual arrangements between a purchaser and supplier. Customers would perform on-site assessments of their suppliers to ensure compliance.

Third-party "registrars" are now being used to perform independent ISO 9000 assessments. These certifying bodies are officially authorized by a national accreditation group to carry out the audits and issue certificates. Registrars certify to customers that a supplier is complying with all the applicable requirements of the standard.

10.1.3 Benefits of ISO Certification

Some basic benefits of ISO 9000 Certification are summarized below:

- Improved customer satisfaction
- Greater quality awareness
- Higher real and perceived quality
- Positive cultural change
- Competitive edge
- Increased market share
- Increased productivity
- Reduced costs.

10.1.4 Limitation of ISO 9000 Certification

Though ISO 9000 has proved to be very effective for software development organizations, however, it also suffers from several limitations.

- ISO 9000 does not automatically lead to Total Quality Management (TQM) i.e., continuous improvement.
- ISO 9000 does not provide any guideline for defining an appropriate process.
- ISO 9000 certification process is not foolproof and thus variations in the certification norms may exist.

Self Assessment

Fill in the blanks:

1. ISO 9000 is a series of standards dealing with …… management systems.

Notes

2. Customers would perform on-site assessments of their suppliers to ensure …….
3. …… certify to customers that a supplier is complying with all the applicable requirements of the standard.

Caselet

Gujarat: Khodaldham Temple Project Gets ISO 'Transparency' Tag

The Khodaldham Trust has received ISO 9000:2008 certification for its multi-crore project which includes construction of a temple, a hospital and an educational centre at Kagwad village in Rajkot district.

Sources in the trust, which was established to bring unity in among the powerful Leuva Patel caste of the Saurashtra region, said that the certification shows that there was transparency in the execution of the project. The construction of the temple began in 2012 and it will take another two years to complete.

President of the Khodaldham Trust, Naresh Patel, said that their aim was to show transparency in all operations of the organisation. He further said that the ISO 9000:2008 certificate means that the construction work done at Kagwad village was as per a standardised process that had international recognition.

"The purchase of construction materials, all construction activity, donations received, their management, and accounts and office administration are all as per an internationally certified process. There was complete transparency in the work done by the trust so far," Patel said.

The trust has plans to go for upgrading of the process certification once the temple is ready because the nature of activity and administration will then change. "We will seek an upgrading of the process once the temple is completed in 2015," Patel said.

In an official statement released on Friday, the trust said there are several organisations which certify ISO processes.

"However we had approached TUV SAD Asia as it has more stringent standards. We intend to improve our service standards and bring transparency in the work. For us, all members are part of a community and, therefore, of society. So the message that we want to send is that we want to improve our social service," the trust said in its statement. With the ISO certification, the trust wants to institutionalise the process and standard of work. Patel said that for the trust, instead of individuals who perform the task, it is the task which is paramount.

"The task should not be affected if a person is not on duty. Highest standards should be maintained in all our activities," he said.

Source: http://daily.bhaskar.com/article/GUJ-AHD-gujarat-khodaldham-temple-project-gets-iso-transparency-tag-4209205-NOR.html

10.2 ISO 9001 Requirements

ISO 9001 has eight clauses. The first three clauses Scope, Normative Reference, and Terms and Definitions are for information. The next five clauses Quality Management Systems, Management Responsibility, Resource Management, Product and/or Service Realization, and Measurement,

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Analysis and Improvement are requirements that an organization must meet. They are explained below:

10.2.1 Scope

The purpose of the standard is for the organization to demonstrate its ability to provide a product that meets customer and regulatory requirements and achieve customer satisfaction. This is achieved by continuous improvement of the system, rather than the product.

10.2.2 Normative Reference

ISO 9000:2000 Quality Management Systems – Fundamentals and vocabulary are normative reference that provides applicable concepts and definitions.

10.2.3 Terms and Definitions

For the purposes of this standard, the terms and definitions given in ISO 9000:2000 apply. In addition the supply chain is defined as:

Supplier ——— Organization ——— Customer

10.2.4 Quality Management Systems (QMS)

(a) ***General Requirements:*** Organization shall establish, document, implement, and maintain a QMS and continually improve its effectiveness. The organization shall:

- Identify needed processes such as management activities, provision of resources, product realization, and measurement.
- Determine their sequence and interaction.
- Determine criteria and methods for effective operation and control of these processes.
- Ensure the availability of resources and information necessary to support and monitor these processes.
- Monitor, measure, and analyze these processes.
- Implement actions to achieve planned results and continuous improvement of these processes.

(b) ***Documentation:*** General documentation includes a quality policy, a quality manual, required documented procedures, documents needed to ensure effective planning, operation and control of processes and various records required. A quality manual shall be established and maintained and it must contain information related cope of QMS, documented procedures and description of interactions among QMS processes. All the documents required by QMS shall be controlled and this includes approval of documents prior to their use, review, updation and re-approve as necessary, identifying current revision status, and prompt removal of obsolete documents. Records must be established and maintained to provide evidence of conformity to requirements and effective operation of QMS. Records must be legible, readily identifiable and retrievable.

10.2.5 Management Responsibility

(a) ***Management commitment:*** Top management should be committed for continuous improvement and it shall demonstrate through the evidence by communicating the need

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to meet customer, legal, and regulatory expectations, establishing a quality policy, ensuring that quality objectives are achieved, conducting management reviews, and ensuring that the resources needed are available.

(b) ***Customer focus:*** Top management shall also ensure that customer requirements are determined and met with the aim of enhancing customer satisfaction.

(c) ***Quality policy:*** Management must ensure that quality policy of the organization is appropriate to its mission, define its commitment to comply with requirements and for continuous improvement of the QMS, provides for establishing and reviewing quality objectives.

(d) ***Planning:*** Top management is responsible for establishing quality objectives and these objectives shall be measurable and be in line with quality policy of the organization. Top management shall also ensure that the planning of the QMS is accomplished in order to meet the requirements of QMS.

(e) ***Responsibility, authority and communication:*** Top management must ensure that responsibilities and authorities are defined and communicated within the organization. Responsibilities can be defined in job descriptions, procedures, and work instructions. Authority and interrelationships can be defined in organization charts. Top management shall also appoint a management representative, who regardless of his other duties, shall be responsible for ensuring that the processes needed for the QMS system are established, implemented and maintained. Top management shall also ensure that appropriate communication channels are established within the organization and communication takes place regarding the QMS.

(f) ***Management review:*** Top management shall review the QMS at planned intervals to ensure its continuing suitability, adequacy and effectiveness. The input to review shall include information on results of audits, customer feedback, status of corrective performance, follow up actions from previous reviews and recommendations for improvement.

10.2.6 Resource Management

(a) ***Provisions of resources:*** Organization must determine and allocate resources needed to implement and maintain QMS and improve its effectiveness, and to enhance customer satisfaction. This includes all resources like people, infrastructure, work environment, information, suppliers, natural resources, and financial resources.

(b) ***Human resources:*** All the employees involved in any task which affects product quality shall be competent and organization shall determine competence necessary for performing work. It shall provide training to develop those competencies.

(c) ***Infrastructure:*** The organization shall determine, provide and maintain the infrastructure needed to achieve conformity to product requirements. This includes buildings, workspace, and associated utilities, process equipment, and supporting services.

(d) ***Work environment:*** The organization shall determine and manage work environment needed to achieve conformity to product requirements.

10.2.7 Product Realization

(a) ***Planning of product realization:*** Organization shall plan and develop processes needed for product realization. Organization shall determine quality objectives and requirements of the product, the need to establish processes, documents, and provide resources, validating activities and criteria for product acceptance, and the records needed to provide evidence for the product realization.

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(b) ***Customer related processes:*** Organization shall also determine requirements specified by customers, related delivery and post delivery services. It shall also determine any statutory requirements related to product. It is also necessary to review the requirements related to product. Organization shall determine and implement effective management for communicating with customers in relation to product, and customer complaints.

(c) ***Design and development:*** Organization shall plan and control the design and development activities of the product. Inputs relating to product requirements shall be determined and records maintained. The outputs of design and development shall be provided in a form that enables verification against the design and development input and shall be approved prior to release. At suitable, stage, systematic reviews of design and development shall be performed in accordance with the planned arrangements. Verification shall be performed in accordance with planned arrangements to ensure that the design and development outputs have met the design and development input requirements. Design and development validation shall be performed in accordance with planned arrangements to ensure that the resulting product is capable of meeting the requirements for the specified application or intended use. Design and development changes shall be identified and records maintained.

(d) ***Purchasing:*** The organization shall ensure that the purchased product conformed to specified purchase requirements. Purchasing information shall describe product to be purchased and its requirements. The organization shall establish and implement the inspection to ensure the purchased product meets the specified purchase requirements.

(e) ***Production and service provision:*** The organization shall plan and carry out production and service provision under controlled condition. The organization shall validate any processes of production or service provision where the resulting output cannot be verified by subsequent monitoring or measurement.

(f) ***Control of monitoring and measuring devices:*** The organization shall determine the monitoring and measurement to be undertaken and the monitoring and measuring devices needed to provide evidence of conformity of product to determined requirements. All measuring instruments shall be calibrated at specified intervals.

10.2.8 Measurement, Analysis and Improvement

Organization shall plan and implement the monitoring, analysis, and improvement processes needed to demonstrate conformity of the product, conformity to QMS and for continuous improvement. Organization must monitor and measure customer satisfaction to ensure that it has met customer requirements. Organization shall conduct internal audits at planned intervals to check whether QMS conforms to planned arrangements and it is effectively implemented. Organization shall apply suitable methods for monitoring. Organization shall ensure that product which does not conform to product requirements is identified and controlled to prevent its unintended use or delivery. Organization shall also determine, collect, and analyze appropriate data to demonstrate the suitability and effectiveness of the QMS and to evaluate where continuous improvement of effectiveness of the QMS can be made. Organization shall continuously improve the effectiveness of the QMS through the use of the quality policy, quality objectives, audit results, analysis of data, corrective and preventive actions and management review. It shall also take action to eliminate the cause of non-conformities in order to prevent recurrence.

10.2.9 Documentation

ISO 9000 documentation includes the following functions:

- The quality policy is a formal statement from management, closely linked to the business and marketing plan and to customer needs. The quality policy is understood and followed

at all levels and by all employees. Each employee needs measurable objectives to work towards.

- Decisions about the quality system are made based on recorded data and the system is regularly audited and evaluated for conformance and effectiveness.
- Records should show how and where raw materials and products were processed, to allow products and problems to be traced to the source.
- ISO 9000 documentation includes procedures to control quality documents in your company. Everyone must have access to up-to-date documents and be aware of how to use them.
- To maintain the quality system and produce conforming product, ISO 9000 documentation must provide suitable infrastructure, resources, information, equipment, measuring and monitoring devices, and environmental conditions.
- You need to map out all key processes in your company; control them by monitoring, measurement and analysis; and ensure that product quality objectives are met. If you can't monitor a process by measurement, then make sure the process is well enough defined that you can make adjustments if the product does not meet user needs.
- For each product your company makes, you need to establish quality objectives; plan processes; and document and measure results to use as a tool for improvement. For each process, determine what kind of procedural documentation is required (note: a "product" is hardware, software, services, processed materials, or a combination of these).
- You need to determine key points where each process requires monitoring and measurement, and ensure that all monitoring and measuring devices are properly maintained and calibrated.
- You need to have clear requirements for purchased product.
- You need to determine customer requirements and create systems for communicating with customers about product information, inquiries, contracts, orders, feedback and complaints.
- When developing new products, you need to plan the stages of development, with appropriate testing at each stage. You need to test and document whether the product meets design requirements, regulatory requirements and user needs.

Self Assessment

Fill in the blanks:

4. The ..... is a formal statement from management, closely linked to the business and marketing plan and to customer needs.
5. ..... documentation stresses the need to regularly review performance through internal audits and meetings.

10.3 Implementation

The steps involved in implementing ISO 9001: 2000 are explained below:

1. ***Top Management Commitment:*** The first and most important requirement for implementing ISO 9000 is full commitment from top management. CEO and Board of Directors must be committed to provide all the necessary resources for successful implementation.

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2. ***Appointment of Management Representative:*** Top management must appoint a management representative to coordinate the implementation and maintenance of QMS.
3. ***Awareness Building:*** All members of the organization must have awareness about QMS and its potential benefits. This can be achieved through awareness building training programs.
4. ***Appointing an Implementation Team:*** After building awareness among the employees about ISO 9000, an implementation team should be constituted. The team shall be drawn from all the levels and all functional areas.
5. ***Training:*** The implementation team, supervisors, and an internal audit team shall undergo necessary training outside the organization about ISO 9000 and later these employees can conduct in-house training.
6. ***Time Schedule:*** There must be a definite time schedule for implementation and registration for ISO 9000. Hence organization must define deadlines for different stages of implementation.
7. ***Select Element Owners:*** Each system element must have an owner and each owner can select a team to assist in the process.
8. ***Reviewing the Present System:*** A thorough is needed on the current quality system in place. This can help in conducting gap analysis.
9. ***Writing the Documents:*** This step involves preparation of documents like quality manual and procedure manuals. Documentation process shall involve all the employees related to the task concerned.
10. ***Installing the New System:*** Once a quality manual is prepared and standard procedures are laid down, they must be integrated into day-to-day works of the organization.
11. ***Internal Audit:*** An internal audit shall be conducted for the new quality system. This ensures that new system is working effectively.
12. ***Management Review:*** Management review is used to determine effectiveness of the system in achieving the stated quality goals. Any revisions if required can be incorporated based on review.
13. ***Pre-assessment:*** Pre-assessment can be carried out to ensure that organization is ready for registration.
14. ***Registration:*** This is the last step in implementation and it involves submitting an application to registration. Registrar's office shall conduct an audit and if these auditors are satisfied then certification is issued.

10.3.1 Internal Audit

Internal audit is the most important requirement for successful implementation of ISO 9001. After the organization has established its quality polices, procedures and they are put into practice, checks must be made to ensure that they are being strictly followed and yielding the expected results. This is achieved through an internal audit conducted by a team of trained auditors. Internal helps in determining actual performance and its conformance to QMS, helps in taking any corrective actions, follow up actions for any previous non-conformances, and provide opportunity for continuous improvement.

Notes

10.4 ISO 14000

ISO 14001 is the international specification for an Environmental Management System (EMS). It specifies requirements for establishing an environmental policy, determining environmental aspects and impacts of products/activities/services, planning environmental objectives and measurable targets, implementation and operation of programs to meet objectives and targets, checking and corrective action, and management review.

ISO 14000 is similar to ISO 9000 quality management in that both pertain to the process (the comprehensive outcome of how a product is produced) rather than to the product itself. The overall idea is to establish an organized approach to systematically reduce the impact of the environmental aspects which an organization can control. Effective tools for the analysis of environmental aspects of an organization and for the generation of options for improvement are provided by the concept of Cleaner Production.

ISO 14000 standards are implemented by thousands of organisations internationally. It is most widely used in the private and public sectors and by large organisations, but it can also be used by small and medium sized organisation's and the social enterprise sector. There are many companies throughout the world that have implemented ISO standards. International organizations such as ISO, IEC, and ITU have developed standards to manage the quality of products and services, to assure the safety of medical devices and food products, to control risk, to protect information, and to ensure that business continues whenever disruptive incidents occur. They've also published standards that are used to protect the environment, the health and safety of workers, and the integrity of supply chains. Taken together, these management standards offer a wealth of knowledge and information that both public and private organizations can use to improve their practices, to enhance their performance, and to achieve success.

These are further expanded upon by the following:

- ISO 14020 series (14020 to 14025), Environmental Labelling, covers labels and declarations.
- ISO 14030 discusses post-production environmental assessment.
- ISO 14031 Evaluation of Environmental Performance.
- ISO 14040 series (14040 to 14044), Life Cycle Assessment, LCA, discusses pre-production planning and environment goal setting.
- ISO 14050 terms and definitions.
- ISO 14062 discusses making improvements to environmental impact goals.
- ISO 14063 is an addendum to 14020, discussing further communications on environmental impact.
- ISO 14064-1: 2006 is Greenhouse gases – Part 1: Specification with guidance at the organization level for the description, quantification and reporting of greenhouse gas emissions and removals.
- ISO 14064-2: 2006 is Greenhouse gases – Part 2: Specification with guidance at the project level for the description, quantification, monitoring and reporting of greenhouse gas emission reductions and removal enhancements.
- ISO 14064-3: 2006 is Greenhouse gases – Part 3: Specification with guidance for the validation and verification of greenhouse gas assertion.
- ISO 19011 which specifies one audit protocol for both 14000 and 9000 series standards together. This replaces ISO 14011 meta-evaluation—how to tell if your intended regulatory tools worked. 19011 is now the only recommended way to determine this.

Notes

Self Assessment

Fill in the blanks:

6. ISO 14001 is the international specification for an …… Management System.
7. Effective tools for the analysis of environmental aspects of an organization and for the generation of options for improvement are provided by the concept of …….
8. ISO 14004 is a …… document that explains the 14001 requirements in more detail.
9. ISO …… discusses making improvements to environmental impact goals.

Task Present an article on the procedures involved in the implementation of ISO 14000 standards.

Case Study

ISO 9000 Certificate for GMCH 32 Likely

India is emerging as an important global destination for affordable medical services or medical tourism, as it is termed, for both developed and developing countries. The reason is that it is the least expensive, as far as hotel accommodation, transport and medical treatment are concerned.

It is, therefore, being considered mandatory for all medical service providers to demonstrate their commitment to quality of services at the international level. Whereas many private hospitals already hold the ISO 9000 certification, the Government Medical College and Hospital, Sector 32, will most probably be the first government institution of its kind in north India to obtain it. Dr V.K. Kak, Director Principal, GMCH, says, "The hospital fulfils most of the conditions for getting the certification. Therefore, we are formally going ahead with the process."

The recent two-day exposition on "Healthcare in the new millennium" which concluded at the Indian Medical Association (IMA) complex, had deliberation mainly on ISO 9000 certification. The workshop, which was organised by the local branch of the IMA in association with Ind Medica. Com. concentrated on creating awareness about various aspects to meet the international standards of healthcare.

According to M.B. Mittal, Joint Director, Indian Institute of Quality Management (IIQM), the future will see a variety of changes in health-insurance, besides. medico-legal aspects in India. "Healthcare practitioners at all levels will have to be well-versed with these changing aspects and plan accordingly," he said. Besides, with increasing medico-legal aspects, insurance companies in the future will prefer a patient to receive treatment in a certified hospital.

International Organisation of Standardisation or ISO 9000 is a family of standards and quality assurances. Presently, three standards for certification exist which includes 9001, 9002 and 9003. These are generic standards which can be applied to any industry. IIQM is the only institute set up by the Ministry of Information Technology, which is providing ISO certification for medical treatment programmes.

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Mittal added that standardisation gains importance because India is fast becoming a global centre for medical treatment. "The treatment here is reasonably cheap and the waiting list almost non-existing."

Moreover, with the added aspect of the medico-Legal Insurance, ISO stands to gain specific significance. According to Dr G.S. Kochchar, President of the IMA internationally there is a need to better and sustain our capabilities and facilities. "In fact, ISO 9000 is not only for super specialities but can also be given to small nursing homes and laboratories."

ISO 9000 gains significance because, as of now, India doesn't have a hospital accreditation system. "Abroad, hospitals are given certificates like hotels, depending upon the facilities and services offered," says Mittal. ISO 9000 is globally accepted and recognised standard for quality.

With the certification, both the patients and doctors stand to gain, says Dr A.K Atri, Reader, Department of Surgery GMCH, "Patients will be benefited by quality healthcare service at economised cost and hospitals can concentrate on providing assured quality service."

He added that GMCH had thought of obtaining quality services assurance considering that it fulfills all the requirements set by IIQM. "The quality certification will be renewed every three years. Moreover, the supervising force within the area will ensure that once it gets a certificate it is maintained, as ISO also has an inbuilt capacity for verification."

Besides, there are inbuilt provisions for training doctors and paramedics, which further enhance the capabilities of an institute. "The component therapy unit established recently at GMCH provides an excellent example as to how blood can be conserved ensuring qualitative economy in blood," emphasises Dr J.G. Jolly, Emiretus Professor.

"This is being done as per directives of the World Health Organisation which gave the call for providing safe blood together with extending the programme in such a manner that the patient gets maximum benefits. This is all result of quality control," he adds.

"Considering the fact that state-of-the-art GMCH already fulfills most of the requirements for getting the certificate, the Director of the IIQM, Mr G. Giani has assured that we might get it within the next six months," said Dr Atri.

Questions

1. Do you think ISO 9000 is needed for healthcare services? If so, why?
2. What are the advantages of obtaining ISO 9000 for GMCH 32?
3. With ISO 9000 certification, both the patients and doctors stand to gain, says Dr A.K. Atri, Reader, Department of Surgery GMCH "Patients will be benefited by quality healthcare service at economised cost and hospitals can concentrate on providing assured quality service." Justify this statement.
4. "The quality certification will be renewed every three years. Moreover, the supervising force within the area will ensure that once it gets a certificate it is maintained, as ISO also has an inbuilt capacity for verification." Do you agree with the statement that ISO has inbuilt verification? Discuss.

Source: *Chandigarh Tribune, September 18, 2000*

10.5 Summary

- Quality is the basic requirement for business success and the survival of any business organization will depend on its ability meet or exceed both stated and implied expectations of the customers.

Notes

- A Quality Management System is the system which provides guidelines for the organization and its employees to identify the needs of customer and to design, develop, produce, and deliver the products or services to meet these needs.
- ISO 9000 is a series of standards dealing with quality management systems. The standards are published by the International Organization.
- Initially ISO 9000 was used as the basis for specifying quality requirements in contractual arrangements between a purchaser and supplier. Customers would perform on-site assessments of their suppliers to ensure compliance.
- Though ISO 9000 has proved to be very effective for software development organizations, however, it also suffers from several limitations.
- ISO 14001 specifies requirements for establishing an environmental policy, determining environmental aspects and impacts of products/activities/services, planning environmental objectives and measurable targets, implementation and operation of programs to meet objectives and targets, checking and corrective action, and management review.
- In order to effectively implement and benefit from an ISO 14001 EMS, it is important to have an understanding of the standard's requirements.
- Implementing ISO 14000 requires huge efforts and it can consume lot of time for an organization. But organizations which have successfully implemented ISO 9000 previously may find it easy and this is due to the fact that many requirements for ISO 14000 would have already in place.

10.6 Keywords

Cleaner Production: Cleaner Production is the continual effort to prevent pollution, reduce the use of energy, water and material resources and minimize waste, all without reducing production capacity.

Competitive Advantage: A situation in which one country, region, or producer can produce a particular commodity more cheaply than another country, region or producer.

Continuous Improvement: A philosophy of making frequent and small changes to production processes; the cumulative results of which lead to high levels of quality and efficiency.

Cost Effectiveness: When the money saved by renewable energy and energy efficiency more than pay for the capital and maintenance costs over a given period.

Environmental Management System: A defined system of procedures, training, and methods to monitor an organization's impact on the environment and evaluate ways to minimize negative impacts on the environment.

International Organization for Standards: International Organization for Standardization is a non-profit organization that develops and publishes standards of virtually every possible sort, ranging from standards for information technology to fluid dynamics and nuclear energy.

ISO 14001: ISO 14001 sets out the criteria for an environmental management system.

ISO 9000: ISO 9000 is a family of standards for quality management systems. ISO 9000 is maintained by ISO, the International Organization for Standardization and is administered by accreditation and certification bodies.

Quality Management Systems: A Quality Management System provides a management framework that gives you the necessary controls to address risks and monitor and measure performance in your business.

Notes

10.7 Review Questions

1. Briefly explain the concept of environmental management systems.
2. What are the benefits of EMS?
3. Explain ISO 9000 standard and some of its standard series.
4. What are the benefits & limitations of ISO certification to the companies?
5. Briefly discuss ISO 14000. What are its similarities with ISO 9000?
6. What are the requirements for ISO 14001 certification?
7. Write a short note on the development and broader aspect of ISO 14000.
8. What are the various checking and corrective actions taken in the context of ISO 14000?

Answers: Self Assessment

1.	Quality	2.	Compliance
3.	Registrars	4.	Quality Policy
5.	ISO 9000	6.	Environmental
7.	Cleaner Production	8.	Guidance
9.	14062		

10.8 Further Readings

Books

Besterfield. Dale H. (2011), *Total Quality Management*, Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management*, Pearson Education, India

Mukherjee N.P. (2006), *Total Quality Management*, PHI Learning Pvt. Ltd.

Nigam. Shailendra (2009), *Total Quality Management*, Excel Books, India

Online links

http://www.ellipson.com/files/ebooks/ISO14000.pdf

http://www.gov.ns.ca/nse/pollutionprevention/docs/EMS_factsheet.pdf

http://www.iso.org/iso/home/standards/management-standards/iso14000.htm

http://www.iso14000-iso14001-environmental-management.com/

Notes

Unit 11: Quality Function Deployment

CONTENTS

Objectives

Introduction

11.1 Meaning of Quality Function Deployment

11.2 Development of Quality Function Deployment

11.3 QFD Team

11.3.1 Benefits of QFD

11.4 Voice of the Customer

11.5 Organization of Information

11.6 House of Quality

11.6.1 Building House of Quality

11.7 QFD Process

11.8 Summary

11.9 Keywords

11.10 Review Questions

11.11 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Quality Function Deployment
- Discuss the Development of Quality Function Deployment
- Explain the Benefits of Quality Function Deployment
- Explain Organization of Information and House of Quality
- Elaborate the QFD Process

Introduction

Previous unit gave you an insight on EMS and ISO 9000 and 14000 standards. This unit will help you learn about the Quality Function Deployment, its processes and benefits.

Quality Function Deployment is a scientific technique for translating the voice of the customer into the development of products and services. It is a complete product planning process as opposed to problem solving and analysis.

11.1 Meaning of Quality Function Deployment

"Time was when a man could order a pair of shoes directly from the cobbler. By measuring the foot himself and personally handling all aspects of manufacturing, the cobbler could assure the

Notes

customer would be satisfied," lamented Dr. Yoji Akao, one of the founders of QFD, in his private lectures.

Quality Function Deployment (QFD) was developed to bring this personal interface to modern manufacturing and business. In today's industrial society, where the growing distance between producers and users is a concern, QFD links the needs of the customer (end-user) with design, development, engineering, manufacturing, and service functions.

QFD is a comprehensive quality system that systematically links the needs of the customer with various business functions and organizational processes, such as marketing, design, quality, production, manufacturing, sales, etc., aligning the entire company toward achieving a common goal.

It does so by seeking both spoken and unspoken needs, identifying positive quality and business opportunities, and translating these into actions and designs by using transparent analytic and prioritization methods, empowering organizations to exceed normal expectations and provide a level of unanticipated excitement that generates value.

The QFD methodology can be used for both tangible products and non-tangible services, including manufactured goods, service industry, software products, IT projects, business process development, government, healthcare, environmental initiatives, and many other applications.

11.2 Development of Quality Function Deployment

QFD was developed in Japan in the late 1960s by Professors Shigeru Mizuno and Yoji Akao. At the time, statistical quality control, which was introduced after World War II, had taken roots in the Japanese manufacturing industry, and the quality activities were being integrated with the teachings of such notable scholars as Dr. Juran, Dr. Kaoru Ishikawa, and Dr. Feigenbaum that emphasized the importance of making quality control a part of business management, which eventually became known as TQC and TQM.

Did u know? The technique of QFD was invented by Akashi Fukuhara of Japan and first applied with very good results at Toyota.

The purpose of Professors Mizuno and Akao was to develop a quality assurance method that would design customer satisfaction into a product before it was manufacturer. Prior quality control methods were primarily aimed at fixing a problem during or after manufacturing.

The first large scale application was presented in 1966 by Kiyotaka Oshiumi of Bridgestone Tire in Japan, which used a process assurance items fishbone diagram to identify each customer requirement (effect) and to identify the design substitute quality characteristics and process factors (causes) needed to control and measure it.

In 1972, with the application of QFD to the design of an oil tanker at the Kobe Shipyards of Mitsubishi Heavy Industry, the fishbone diagrams grew unwieldy. Since the effects shared multiple causes, the fishbone could be refashioned into a spreadsheet or matrix format with the rows being desired effects of customer satisfaction and the columns being the controlling and measurable causes.

At the same time, Katsuyoshi Ishihara introduced the Value Engineering principles used to describe how a product and its components work. He expanded this to describe business functions necessary to assure quality of the design process itself.

Merged with these new ideas, QFD eventually became the comprehensive quality design system for both product and business process.

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Today, QFD continues to inspire strong interest around the world, generating ever new applications, practitioners and researchers each year. Countries that have held national and international QFD Symposium to this day include the U.S., Japan, Sweden, Germany, Australia, Brazil and Turkey.

Self Assessment

Fill in the blanks:

1. ..... is a scientific technique for translating the voice of the customer into the development of products and services.
2. The first large scale application was presented in 1966 by Kiyotaka Oshiumi of ..... in Japan.
3. ..... links the needs of the customer with design, development, engineering, manufacturing, and service functions.

11.3 QFD Team

The success of QFD in any organization depend on the team involved in QFD process and it requires commitment from project and team members and also significant amount of efforts are needed from each one of the team members.

Note Top management must be clearly communicating priorities of projects so that teams can plan accordingly. The project should be clear about scope of the project and role of project team members.

Two types of teams are used in QFD projects: Teams for designing a new product and teams for improving the existing products. QFD needs cross functional teams as it requires multiple skills. Normally, QFD teams may contain employees from various functional areas like marketing, design, quality, finance and production. Effective time utilization is the key to success for QFD teams.

Note Teams must prepare a project schedule so that activities are carried as per schedule.

QFD teams must ensure that they meet regularly and it is duty of the team leader to ensure that meetings are effectively held and all members are kept informed about the meetings. Meetings must have clear agenda related to improvement projects and all members shall be able to contribute to the improvement projects.

11.3.1 Benefits of QFD

- ***Focus on Customer***
  - Focuses mainly on customer needs
  - Compare their product with competitors
  - Prioritize according to customer's level of importance
  - Identify the vital items to be acted upon

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- *Time Savings*
  - Enables to change the design in the starting itself
  - Limits the problems after introduction of the product
  - Reduces the time for redesigning since all changes are made in the first step itself
- *Team Work*
  - Based on every one's ideas
  - Creates good communication flow
  - Identifies team work and recognition to each team member
- QFD minimizes the later engineering changes and results in better quality because the clearer product definition helps in better product development cycle.
- The analytic vigour of QFD causes streamlining of processes and helps in elimination of many internal processes that do not add value to the new product development process.
- QFD through documentation helps in building product development intelligence, preventing recurrence of errors, helping new engineers to learn processes faster without assistance of senior managers and engineers.

Self Assessment

Fill in the blanks:

4. ..... must be clearly communicating priorities of projects so that teams can plan accordingly.
5. Effective ..... is key for success for QFD teams.
6. The ..... vigour of QFD causes streamlining of processes and helps in elimination of many internal processes that do not add value to the new product development process.

11.4 Voice of the Customer

The "voice of the customer" is a process used to capture the requirements/feedback from the customer (internal or external) to provide the customers with the best in class service/product quality. This process is all about being proactive and constantly innovative to capture the changing requirements of the customer along with time and as per changing tastes.

The "voice of the customer" is the term used to describe the stated and unstated needs or requirements of the customer. The voice of the customer can be captured in a variety of ways: Direct discussion or interviews, surveys, focus groups, customer specifications, observation, warranty data, field reports, complaint logs, and other various sources which can get significant information.

This data is used to identify the quality attributes needed for a supplied component or material to incorporate in the process or product.

Traditionally, Marketing has had responsibility for defining customer needs and product requirements. This has tended to isolate Engineering and other development personnel from the customer and from gaining a firsthand understanding of customer needs. As a result, customer's real needs can become somewhat abstract to other development personnel.

Product development personnel need to be directly involved in understanding customer needs. This may involve visiting or meeting with customers, observing customers using or maintaining

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products, participating in focus groups or rotating development personnel through marketing, sales, or customer support functions. This direct involvement provides a better understanding of customer needs, the customer environment, and product use; develops greater empathy on the part of product development personnel, minimizes hidden knowledge, overcomes technical arrogance, and provides a better perspective for development decisions. These practices have resulted in fundamental insights such as engineers of highly technical products recognizing the importance to customers of ease of use and durability rather than the latest technology.

Where a company has a direct relationship with a very small number of customers, it is desirable to have a customer representative(s) on the product development team.

Caution Mechanisms such as focus groups should be used where there are a larger number of customers to insure on-going feedback over the development cycle.

During customer discussions, it is essential to identify the basic customer needs. Frequently, customers will try to express their needs in terms of HOW the need can be satisfied and not in terms of WHAT the need is. This limits consideration of development alternatives. Development and marketing personnel should ask WHY until they truly understand what the root need is. Breakdown general requirements into more specific requirements by probing what is needed. Challenge, question and clarify requirements until they make sense. Document situations and circumstances to illustrate a customer need. Address priorities related to each need. Not all customer needs are equally important. Use ranking and paired comparisons to aid to prioritizing customer needs. Fundamentally, the objective is to understand how satisfying a particular need influences the purchase decision.

Self Assessment

Fill in the blanks:

7. The voice of the customer is a process used to capture the …… from the customer.
8. Product development personnel need to be directly involved in understanding …… needs.
9. Where a company has a direct relationship with a very small number of customers, it is desirable to have a …… on the product development team.
10. …… customers are the first source of information if the product is aimed at current market.

11.5 Organization of Information

Once customer needs are gathered, they then have to be organized. The mass of interview notes, requirements documents, market research, and customer data needs to be distilled into a handful of statements that express key customer needs. Affinity diagramming is a useful tool to assist with this effort. Brief statements which capture key customer needs are transcribed onto cards. A data dictionary which describes these statements of needs is prepared to avoid any misinterpretation. These cards are organized into logical groupings or related needs. This will make it easier to identify any redundancy and serves as a basis for organizing the customer needs.

Caution In addition to "stated" or "spoken" customer needs, "unstated" or "unspoken" needs or opportunities should be identified.

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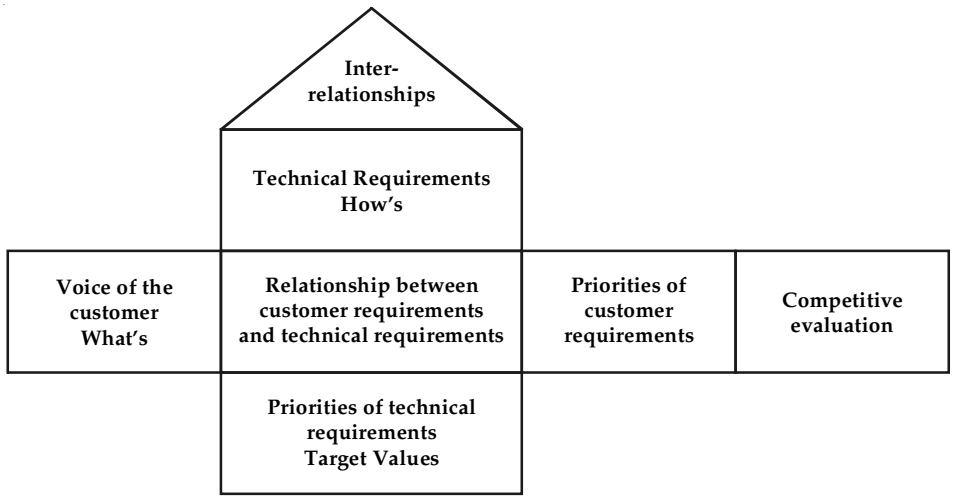
Needs that are assumed by customers and, therefore not verbalized, can be identified through preparation of a function tree. Excitement opportunities (new capabilities or unspoken needs that will cause customer excitement) are identified through the voice of the engineer, marketing, or customer support representative. These can also be identified by observing customers use or maintain products and recognizing opportunities for improvement.

11.6 House of Quality

The House of Quality is the first matrix in a four-phase QFD (Quality Function Deployment) process. It's called the House of Quality because of the correlation matrix that is roof shaped and sits on top of the main body of the matrix. The correlation matrix evaluates how the defined product specifications optimize or sub-optimize each other. It is shown in the Figure below.

Figure 11.1: House of Quality



11.6.1 Building House of Quality

Characteristics or design requirements (vertical section) and the centre of the house.

A set of matrices used to relate voice of customer to a product's technical requirements, component requirements, process control plans, and manufacturing operations. House of Quality, introduced by Hauser and Clausing, is the most commonly used matrix in traditional QFD methodology in order to translate the desires of customers into product design or engineering characteristics and subsequently into product characteristics, process plans and production requirements. The house of quality is applied for identifying customer requirements and establishing priorities of design requirements to satisfy CRs. The aim is providing right products for the right customers.

The house is made up of three main parts: the customer attributes or customer requirements (horizontal section); engineering customer requirements section indicates "the voice of customers". It shows the requirement of the customers and what they think is important in the product and also relative importance of the different customer attributes. Design requirements section records the technical aspects of designing a product. It indicates, "How the customer wants can be met". The objectives and targets section (basement of the house) indicates the relative importance of the different engineering characteristics and also indicates target levels or measures of effectiveness for each. The roof of the house indicates the positive and negative relationships between the design requirements. The centre of the house describes the correlation

Notes

between the design requirements and the customer attributes. The strength and direction of each relationship is represented by a graphical symbol creating a matrix of symbols indicating how well each engineering characteristic meets each customer attribute.

Each step of building House of quality is briefly explained below:

Step 1: Voice of the Customer

- The voice of the customer is the primary input the QFD process.
- WHAT that a customer needs?
- Market survey, sales persons, service team, customer complaints, customer feed back, Product testing, comparative studies, etc. are the sources to determine the needs.

Step 2: Determine Technical Requirements

- Technical requirements are design characteristics that describe the customer requirements as expressed in the language of the designer or an engineer.
- HOWs by which the company will respond to the WHATs.

Step 3: Develop Relationship between Kustomer Needs and Technical Descriptors

- It develops a relationship matrix which checks whether final technical descriptors adequately address customer requirements.
- 9:3:1 weightage is used to indicate relationship between them where 9 indicates strong relationship and 1 indicating weak relation.
- This process ensures defining strong relationship.

Step 4: Assess the Competitor

- Each customer requirement is evaluated with competitors existing products
- A scale of 1 to 5 can be used
- Evaluates strengths and weaknesses
- Provides opportunities for improvements
- Helps in developing marketing strategies

Step 5: Develop Prioritized Customer Requirements

- Ranking is done to each customer requirement by assigning ratings
- Focus groups can be used for ranking
- Represents relative importance of each customer requirement
- Helps in prioritizing and making trade off decisions

Step 6: Develop Prioritized Technical Requirements

- Identifies most needed product specifications which fulfill customer requirements.
- They provide specific objectives to guide design process.

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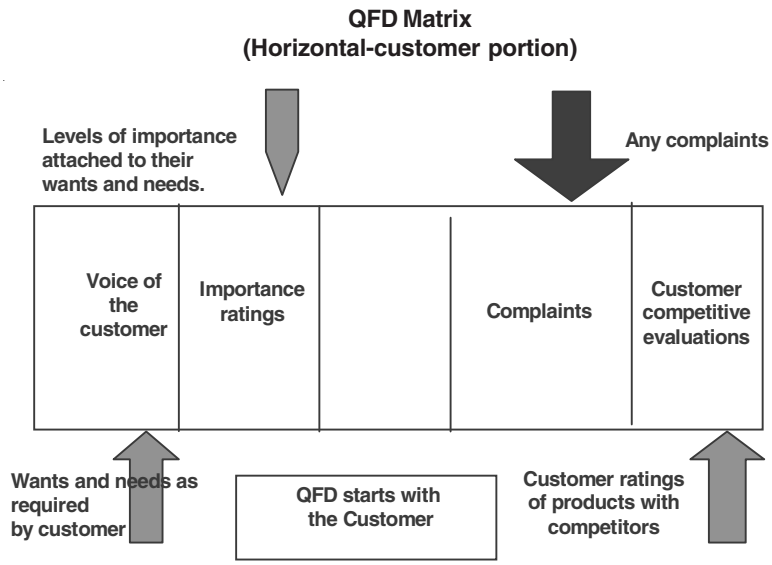
Figure 11.2: QFD Matrix



Task Make a presentation on the House of Quality and how is it built.

Self Assessment

Fill in the blanks:

11. ..... opportunities are identified through the voice of the engineer, marketing, or customer support representative.
12. The House of Quality is the ..... matrix in a four-phase QFD process.
13. The ..... matrix evaluates how the defined product specifications optimize or sub-optimize each other.
14. House of Quality was introduced by .....
15. The roof of the house indicates the ..... relationships between the design requirements.

11.7 QFD Process

Quality Function Deployment (QFD) is a structured, multi-disciplinary technique for product definition that maximizes value to the customer. The application of the QFD process is an art that varies somewhat from practitioner to practitioner. The Figure 11.1 shows a concept called the QFD House of Quality (HOQ), a device for organizing the flow of thinking and discussion that leads to finished product specifications. The House of Quality is built by a firm's own multi-disciplinary team under guidance from a trained QFD facilitator (preferably a facilitator with both marketing and technical experience).

Given one or more specific objectives (e.g., a narrow focus such as "optimize engine performance" or a more global focus such as "optimize overall passenger comfort"), the QFD process starts

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with obtaining customer requirements through market research. These research results are inputs into the House of Quality. Below is a discussion of each of the rooms of the House of Quality and how they are built.

The "Whats" Room: Typically there are many customer requirements, but using a technique called affinity diagramming, the team distils these many requirements into the 20 or 30 most important needs. The affinity diagramming process is critical to the success of QFD in that there is vigorous discussion to reach consensus as to what the customers really meant by their comments. This is a powerful technique for reconciling the different interpretations held by marketing, design engineering or field service. The affinity diagramming process usually takes about one to two solid team days to complete, depending on how narrow or global the objective is. The results from the affinity diagramming are placed into the "Whats" room in the HOQ.

The Importance Ratings and Customer Competitive Assessment Rooms: Marketing and/or the market researcher designs the market research so that the team can use the results as inputs to successfully complete the Importance Ratings and Customer Competitive Assessment rooms. These rooms are located on the matrix where benefit rankings and ratings are assembled for analysis. The Importance Rankings provide the team with a prioritization of customer requirements while the Customer Competitive Assessment allows us to spot strengths and weaknesses in both our product and the competition's products.

The "Hows" Room: The next step is the completion of the "Hows" room. In this activity the entire team asks for each "What", "How would we measure product performance which would provide us an indication of customer satisfaction for this specific 'What'?" The team needs to come up with at least one product performance measure, but sometimes the team recognizes that it takes several measures to adequately characterize product performance.

Relationships Matrix Room: After the "Hows" room has been completed, the team begins to explore the relationships between all "Whats" and all "Hows" as they complete the Relationships Matrix room. During this task the team systematically asks, "What is the relationship between this specific 'how' and this specific 'what'?" "Is there cause and effect between the two?" This is a consensus decision within the group. Based on the group decision, the team assigns a strong, medium, weak or no relationship value to this specific "what/how" pairing. Then the team goes on to the next "what/how" pairing. This process continues until all "what/how" pairings have been reviewed. The technical community begins to assume team leadership in these areas.

Absolute Score and Relative Score Rooms: Once the Relationships Matrix room has been completed, the team can then move on to the Absolute Score and Relative Score rooms. This is where the team creates a model or hypothesis as to how product performance contributes to customer satisfaction. Based on the Importance Ratings and the Relationship Matrix values, the team calculates the Absolute and Relative Scores. These calculations are the team's best estimate as to which product performance measures ("hows") exert the greatest impact on overall customer satisfaction. Engineering now begins to know where the product has got to measure up strongly in order to beat the competition.

The last three rooms receive the most input from the technical side of the team, but total team involvement is still vital.

Correlation Matrix Room: There are times in many products where customer requirements translate into physical design elements which conflict with one another; these conflicts are usually reflected in the product "hows". The Correlation Matrix room is used to help resolve these conflicts by highlighting those "hows" which have are share the greatest conflict.

For example, let's say that the "how" called "weight" should be minimized for greatest customer satisfaction. At the same time there might be two other "hows" titled "strength" and "power

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capacity". The customer has expressed preferences that these be maximized. Based on what we know about physics, there may be a conflict in minimizing "weight" and maximizing "strength" and "power capacity". The analysis that takes place in the Correlation Matrix Room systematically forces a technical review for all likely conflicts and then alerts the team to either optimize or eliminate these conflicts or consider design alternatives.

The mechanics of the analysis is to review each and every "how" for possible conflict (or symbiosis) against every other "how". As mentioned in the previous sentence sometimes symbiotic relationships between "hows" do surface in this analysis. This analysis also allows the team to capitalize on those symbiotic situations.

Technical Competitive Assessment Room: This is the room where engineering applies the measurements identified during the construction of the "Hows" room. "Does our product perform better than the competitive product according to the specific measure that we have identified?" Here is where the team tests the hypothesis created in the Relative Score room. It helps the team to confirm that it has created "hows" that really do accurately measure characteristics leading to customer satisfaction.

Analysis in the Technical Competitive Assessment and Customer Competitive Assessment rooms can also help uncover problems in perception.

Example: Perhaps the customer wants a car that is fast, so your team comes up with the "how" of "elapsed time in the quarter mile". After comparing performance between your car and the competitor's vehicle, you realize that "you blew the doors off the competitor's old crate". However when you look in the Customer Competitive Assessment Room, you see that most of the marketplace perceives the competitor's car as being faster. While you might have chosen one of the correct "hows" to measure performance, it is clear that your single "how" does not completely reflect performance needed to make your car appear faster.

Target Values Room: The last room of Target Values contains the recommended specifications for the product. These specifications will have been well thought out, reflecting customer needs, competitive offerings and any technical trade-off required because of either design or manufacturing constraints.

The House of Quality matrix is often called the phase one matrix. In the QFD process there is also a phase two matrix to translate finished product specifications into attributes of design (architecture, features, materials, geometry, subassemblies and/or component parts) and their appropriate specifications. Sometimes a phase three matrix is used to attributes of design specifications into manufacturing process specifications (temperature, pressure, viscosity, rpm, etc.).

Self Assessment

Fill in the blanks:

16. The ..... process is critical to the success of QFD in that there is vigorous discussion to reach consensus as to what the customers really meant by their comments.
17. The ..... provide the team with a prioritization of customer requirements.
18. Customer ..... allows us to spot strengths and weaknesses in both our product and the competition's products.
19. Based on the Importance Ratings and the ..... values, the team calculates the Absolute and Relative Scores.

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Case Study

Mission: Quality

Wipro Corp. is one organization that decided to change its tolerance level. A diversified conglomerate headquartered in Bangalore, India, the company reports that using the Six Sigma methodology during the past 15 months eliminated unnecessary steps and decreased rework, leading to an eightfold gain over the investments made.

It wasn't a difficult decision for the organization, notes Subroto Bagchi, corporate vice president of mission quality. "Our international software services' customers depend on us for mission-critical applications, which we run on their behalf from halfway across the globe via satellite links," he says. "In the Indian market, we make soaps, computers, hydraulic cylinders and computerized tomography scanners. Which customer is willing to live with a defect? There's no question of delivering anything less than perfect."

Wipro executives had heard about Six Sigma via the company's partnerships with General Electric Co.; so Bagchi attended a quality briefing at Motorola University in Chicago. Afterward, in November 1996, an MU team visited India to conduct a business systems analysis.

Results were shared with top management from Wipro's five divisions, and they developed an 18-month plan. The chairman and senior management participated in a six-day training retreat. Then 12 facilitators, chosen from among successful line managers, were trained. Together with MU personnel, these facilitators trained nearly 800 people between May and November 1997. This year, about 1,000 more employees will be trained.

"The entire scenario is like the fractal geometry exhibited in the petals of a flower," observes Bagchi. "Certified trainers train people who, in turn, train others, bringing a whole new change in the way we think and work."

Wipro's corporate goal is to reach Six Sigma in every process concerning customer satisfaction by the year 2002.

Lofty, but not Impossible

Six Sigma is a stretch goal intended to spur continuous improvement. Success doesn't come by radically restructuring a company or pumping new money into it; Six Sigma is attainable through time and strong dedication.

New Thought and Manufacturing Processes

Thinking outside the box also is important. "Before Six Sigma, we were interested in continuous improvement, but we tended to accept quality levels that merely mirrored our competitors'," notes Craig Erwin, quality engineering manager at Motorola Semiconductor Products Sector in Phoenix, Arizona. "We were somewhat internally focused and accepted the argument that things couldn't be made better." understood that our management team was serious about it, we accepted the challenge."

It's part of the SPS culture now. All new employees receive Six Sigma training during their orientation. For those who went through training years ago, the company also offers them an opportunity to recharge their commitment through a combination of classes and a renewed emphasis by senior management. Various customer satisfaction activities reward ideas and implementation.

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"One thing we looked at was changes in our thought and manufacturing processes to eliminate rework," reveals Erwin. "In the short-term, we saw some increased costs, but in the long run, we've improved our processes and applied more effective controls. We continue to see improvements in product reliability, manufacturing yields and internal quality metrics, despite increasing product complexity and higher customer expectations."

Product complexity continues to grow exponentially. Future products such as semiconductors and software undoubtedly will contain tens of millions, even billions, of elements. Creating more robust designs and reducing opportunities to introduce defects into the final product represents a onetime expense. If it's not done, however, repair, rework, excessive scrap costs and unhappy customers will continue through the product's life. Thus, it's imperative that companies reduce defect rates to a few parts per billion.

"Although Motorola has made huge reductions in defect rates, we still haven't achieved Six Sigma overall," reports Berg. "Motorola considers itself a 5.7 Sigma company now. Six Sigma remains a very noble goal, but it is the rate of improvement that is important. Six Sigma has saved the company billions of dollars in terms of scrap and rework, enabling greater customer satisfaction – our ultimate goal."

Six Sigma Successes

After examining how various financial companies pursue quality, Citibank, the international financial division of Citicorp, undertook the Six Sigma method in the spring of 1997. Its goal: to reduce defects within its various divisions by a factor of 10 during the first three years. The corporation already has seen reductions ranging from five to 10 times.

"Six Sigma appealed because it's pretty straightforward," comments James Bailey, Citicorp's executive vice president and corporate quality officer. "It also seemed like a programme that would involve everyone."

Previously, various businesses and divisions within Citibank had tried different quality programmes, but the company had never instituted a universal quality language or method.

"Continuous improvement is our goal," maintains Bailey. "We started training senior management in April 1997, and so far we've trained about 2,000 people around the world." Besides the defect reductions, the company has recorded a decreased response time for credit card applications and fewer errors in customer statements.

"We're on track," he declares. "We're more customer-focused. We know it's a long road, but we've made a reasonable start, and we're pleased."

GE, which launched a Six Sigma initiative in late 1995, says the $300 million invested in quality improvement in 1997 will deliver some $400 million to $500 million in savings. "Quality improvement, under the disciplined rubric of Six Sigma methodology, will define the way we work," the company announced in its 1996 annual report.

A three- to four-sigma level, average for most U.S. companies, can cost a company as much as 10 per cent to 15 per cent of its revenues. For GE, that would mean $8 billion to $12 billion.

"The methodologies of Six Sigma we learnt from other companies, but the cultural obsessiveness and all-struggle to achieve a boundaryless culture now seems 'laid-back' compared to the near monomania with which we are approaching Six Sigma quality."

Wipro also reports successes in its first year. "First of all, we now have a common language across our divisions," explains Bagchi. "People talk about the customer, defects, Sigma level and a plan for continuous improvement."

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"In India, many people have difficulty giving up the old and embracing the new, but the mind-set is changing. Six Sigma is making people look outward. We're shifting from an organizational focus to a customer focus."

Wipro's trained teams have launched close to 30 projects, including three major cross-functional undertakings. "Defects are steadily falling in cylinder manufacturing," discloses Bagchi. "In the fixed deposits area of our Financial Services division, we've established a process to eliminate non value-added steps and mistake-proof the system. We're also projecting a 30-per cent cycle-time reduction in our computer business. The estimated near-term gains will be six to eight times the total investments we've made in Six Sigma."

The First Step

Other re-engineering programmes often advocate tearing down an organization and rebuilding from scratch. MU advises organizations to start where they are, build on current successes and modify current processes. They must rely on the interwoven concepts of defect reduction, which encourages employees to relate more to each other, and cycle-time reduction, which eliminates unnecessary, non value-adding steps from processes.

Six Sigma requires more than a monetary investment, Erwin points out. "You must have a plan, necessary resources, the commitment of everyone and uncompromising matrixes," he says. "Then you set aggressive goals along the path and hold people accountable."

The MU Six Sigma programme emphasizes the following key components:

1. A goal of total customer satisfaction.
2. A common language throughout the organization.
3. Common, uniform quality measurement techniques for all business areas.
4. Goals with identical improvement rates, based on uniform matrixes.
5. Goal-directed incentives for both employees and management.
6. Coordinated training in "why" and "how" to achieve the goal.

No one set procedure will work when following the Six Sigma method. Every company is different and must account for its strengths and weaknesses; then leverage them accordingly.

"A clear, quantitative understanding of customer satisfaction typically is accomplished through surveys," notes Hayes. "Surveys should identify gaps between customer needs and a company's current performance level. Then, through benchmarking, a company's core processes are compared to another best-in-class performer. This is useful in determining the first layer of needed goals."

Motorola SPS statistician Skip Weed has been involved with Six Sigma since the programme began. "The major impact, especially when it first started, was on our culture - the people and systems required to produce high-quality products and services," he recalls. "Previously, there was minimal effort in preventing defects rather than inspecting them out. The directive for the programme came from our highly respected CEO, who was strongly behind it, and everyone then began to buy in."

Management by Fact, not Emotion

Ron Randall, quality improvement manager at Raytheon TI Systems, says his company is impressed with Six Sigma's quantitative methods. "We looked at our products and compared them to similar ones from Motorola,"

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He explains. "We were less than four Sigma and Motorola was close to six. We couldn't believe someone was 2,000 times better than us. It really got our attention.

"Six Sigma really will work for anybody. It's management by fact, not emotion."

MU consultant Paul Zaura concurs. "In a math sense, Six Sigma is a known quantity," he asserts. "As improvements increase, expectations increase. Customer perceptions will change, and they will drive you to places you never new existed.

"You also must look at the cultural aspects and changing behaviours. Many corporate cultures are fear-based; mistakes aren't tolerated, and people learn to hide defects. Six Sigma flourishes in an open and safe environment."

Six Sigma champions say there are plenty of things to count, measure and benchmark regardless of the type of business, whether it's an attorney's office or a car rental company. And within a company, you can look at all kinds of divisions – personnel policies, warehousing, security, how to run the cafeteria.

"If you're not improving, you're going down," warns Zaura. "Six Sigma is a philosophy of continuous improvement and measurement to drive the direction of goals. Its concepts aren't earthshaking: Talk to customers and find out what the defects are. Work on big errors first. Try to decide how they happen and how to correct them permanently."

"Whether it's handling paperwork, an idea, a customer call or a hard product, there must be a process for it. That's probably one of the biggest concepts for people to grasp. Then you track your process using simple tools like Pareto charts, cause-and-effect diagrams and benchmarking. You compare what you have to a similar industry or process."

Perhaps Six Sigma's biggest mandate is never rest.

Companies that are content with their current quality levels simply don't understand quality's true challenge. They need to determine not only the defect levels their customers experience but also internal defects that cause rework, additional inspections and higher product costs. Once a company has fully assessed itself, then improvement can really begin.

And no philosopher or cynic can quibble with improvement.

Source: http://www.qualitydigest.com/july98/html/sixsigma.html

11.8 Summary

- Quality Function Development is a scientific technique for translating the voice of the customer into the development of products and services.
- The technique was invented by Akashi Fukuhara of Japan and first applied with very good results at Toyota.
- The purpose of Professors Mizuno and Akao was to develop a quality assurance method that would design customer satisfaction into a product before it was manufacturer.
- QFD is a comprehensive quality system that systematically links the needs of the customer with various business functions and organizational processes, such as marketing, design, quality, production, manufacturing, sales, etc., aligning the entire company toward achieving a common goal.
- The success of QFD in any organization depend on the team involved in QFD process and it requires commitment from project and team members and also significant amount of efforts are needed from each one of the team members.

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- QFD teams must ensure that they meet regularly and it is duty of the team leader to ensure that meetings are effectively held and all members are kept informed about the meetings.
- QFD through documentation helps in building product development intelligence, preventing recurrence of errors, helping new engineers to learn processes faster without assistance of senior managers and engineers.
- The "voice of the customer" is a process used to capture the requirements/feedback from the customer (internal or external) to provide the customers with the best in class service/ product quality.
- Product development personnel need to be directly involved in understanding customer needs.
- Potential customers are the primary source of information if the product is aimed at new market.
- Excitement opportunities (new capabilities or unspoken needs that will cause customer excitement) are identified through the voice of the engineer, marketing, or customer support representative.
- House of Quality is so called because of the correlation matrix that is roof shaped and sits on top of the main body of the matrix.
- The house of quality is applied for identifying customer requirements and establishing priorities of design requirements to satisfy CRs. The aim is providing right products for the right customers.
- The objectives and targets section (basement of the house) indicates the relative importance of the different engineering characteristics and also indicates target levels or measures of effectiveness for each.
- The application of the QFD process is an art that varies somewhat from practitioner to practitioner.
- Analysis in the Technical Competitive Assessment and Customer Competitive Assessment rooms can help uncover problems in perception.

11.9 Keywords

Epistemology: Epistemology is the investigation of what distinguishes justified belief from opinion.

House of Quality: A house of quality is a product planning matrix, somewhat resembling a house which is developed during quality function deployment and shows the relationship of customer requirements to the means of achieving these requirements.

Organization of Information: It is a term used to refer to the standard protocols by which information is arranged.

Quality Assurance: Quality assurance is a structured review of the project by an external resource, to determine the overall project performance and conformance.

Quality Function Development: A systematic methodology that focuses on exactly translating customer wishes to product changes to process changes is known as QFD.

Systems Thinking: Systems thinking is a method of formal analysis in which the object of study is viewed as comprising distinct analytical sub-units.

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Value Engineering: Systematic evaluation of all aspects of the value-chain business functions, with the objective of reducing costs while satisfying customer needs is known as value engineering.

Voice of the Customer: In six sigma and other quality improvement programs, the identification and prioritization of true customer needs and requirements through the use of focus groups, interviews and other methods is referred to as voice of the customer.

11.10 Review Questions

1. What do you understand by the concept of Quality Function Development?
2. Explain the Development of Quality Function Deployment.
3. How do you think is the team involved in QFD process responsible for its success in the organization?
4. List the benefits of QFD.
5. What do you mean by voice of the customer?
6. Write a detailed note on house of quality and how is it built?
7. Briefly explain the steps of building house of quality.
8. Explain QFD process.

Answers: Self Assessment

1.	Quality Function Development	2.	Bridgestone Tire
3.	QFD	4.	Top management
5.	Time utilization	6.	Analytic
7.	Feedback	8.	Customer
9.	Customer representative	10.	Current
11.	Excitement	12.	First
13.	Correlation	14.	Hauser and Clausing
15.	Positive and negative	16.	Affinity diagramming
17.	Importance Rankings	18.	Competitive Assessment
19.	Relationship Matrix		

11.11 Further Readings

Books

Besterfield. Dale H. (2011), *Total Quality Management,* Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management*, Pearson Education, India

Mukherjee N.P. (2006), *Total Quality Management,* PHI Learning Pvt. Ltd.

Nigam. Shailendra (2009), *Total Quality Management,* Excel Books, India

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Online links

http://www.ciri.org.nz/downloads/Quality%20Function%20Deployment.pdf

http://www.ieee.li/tmc/quality_function_deployment.pdf

http://www.me.utexas.edu/~me366j/QFD/Notes.html

http://www.public.iastate.edu/~vardeman/IE361/s00mini/chen.htm

Notes

Unit 12: Failure Mode and Effect Analysis

CONTENTS

Objectives

Introduction

12.1 Meaning of FMEA

12.1.1 Relationship of Cause, Failure Mode & Effect

12.2 FMEA Process

12.2.1 Risk Priority Numbers in FMEA

12.3 FMEA Team

12.4 FMEA Documentation

12.5 Stages of FMEA

12.6 Benefits of FMEA

12.7 Summary

12.8 Keywords

12.9 Review Questions

12.10 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Failure Modes and Effects Analysis
- Discuss the Relationship of Cause, Failure Mode and Effect
- Explain the FMEA Process
- Discuss FMEA Team and Documentation
- Explain the Stages of FMEA

Introduction

In the previous unit, we dealt with the concept of Quality Function Deployment. In this unit, you will study about the FMEA approach, i.e. Failure Mode and Effect Analysis.

Ashwani Panesar, Lovely Professional University

Failure Mode and Effect Analysis (FMEA) has been a widely accepted Quality Management tool. Due to ISO 9000 and QS-9000 standards requirements, FMEA is now applied widely in electrical, electronics, telecom and automobile industries with more regularity.

12.1 Meaning of FMEA

Failure Modes and Effects Analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.

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"Failure modes" means the ways, or modes, in which something might fail. Failures are any errors or defects, especially ones that affect the customer, and can be potential or actual.

"Effects analysis" refers to studying the consequences of those failures.

Failures are prioritized according to how serious their consequences are, how frequently they occur and how easily they can be detected. The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones.

Failure modes and effects analysis also documents current knowledge and actions about the risks of failures, for use in continuous improvement. FMEA is used during design to prevent failures. Later it's used for control, before and during ongoing operation of the process. Ideally, FMEA begins during the earliest conceptual stages of design and continues throughout the life of the product or service.

Did u know? FMEA was developed in US Military. Military procedure MIL- P-1629, titled Procedures for Performing a Failure Mode, Effects and Criticality Analysis, is dated November 9, 1949. It was used as a reliability evaluation technique to determine the effect of equipment and system failures.

FMEA is a structured approach for:

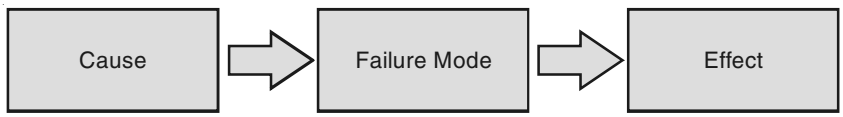
1. Identifying ways in which a process can fail to meet critical customer requirements.
2. Estimating the risk of causes with regard to these failures.
3. Evaluating control plan for preventing these failures.
4. Prioritizing the actions for improving the process.

When to use FMEA:

- For improving the reliability and safety of the products.
- For improving customer satisfaction.
- Tracking actions to reduce non-conformities
- New product development

12.1.1 Relationship of Cause, Failure Mode & Effect

Figure 12.1: Relationship of Cause, Failure and Effect



Self Assessment

Fill in the blanks:

1. FMEA stands for …….
2. …… refers to studying the consequences of the failures.
3. FMEA begins during the earliest conceptual stages of …… and continues throughout the life of the product or service.

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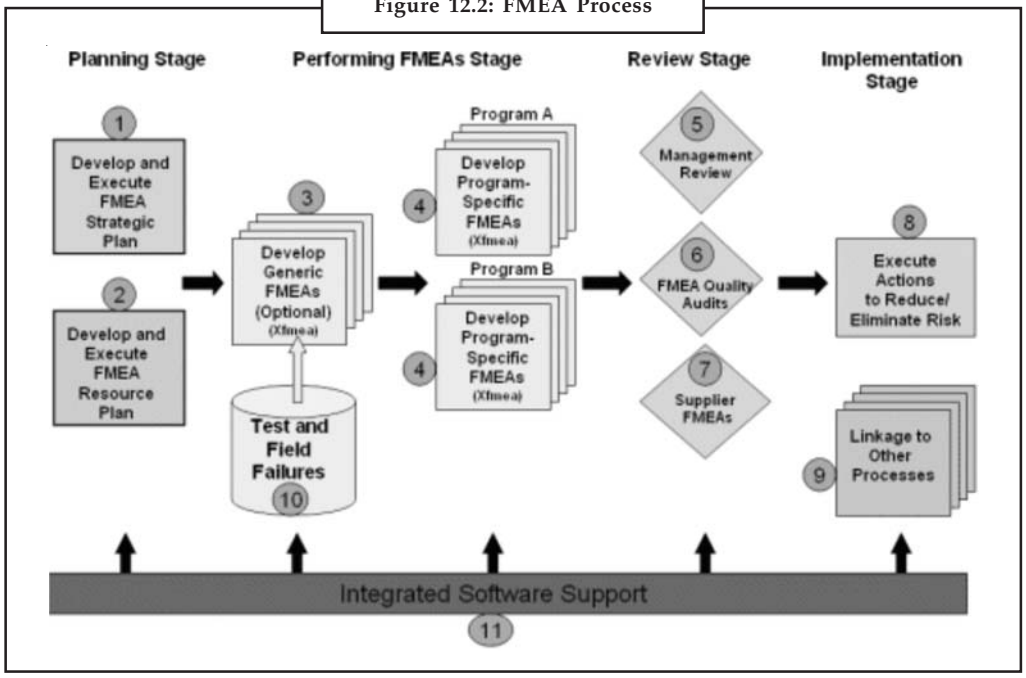
12.2 FMEA Process

- Develop a process map and identify process steps.
- List key process outputs for satisfying internal and external customer requirements.
- List key process inputs for each process step.
- List ways in which the process inputs can vary (causes) and identify associated failure modes and effects.
- Assign severity occurrence and detection rating for each cause.
- Calculate Risk Priority Number (RPN) for each potential failure mode.
- Determine recommended actions to reduce RPN's.
- Establish time frame for corrective actions.
- Take corrective actions
- Put all controls in place

Without an effective FMEA process, actual FMEA results will be dependent on individual personalities and the whims of varying company priorities. If participants happen to be knowledgeable in the application of FMEA and have the time to invest in FMEA team meetings, then it may be successful. If not, then the FMEA project may not be as successful. The entire process is presented graphically in Figure 12.2.

Figure 12.2: FMEA Process



Source: http://www.reliasoft.com/newsletter/v6i1/fmea_process.htm

Task 1: FMEA Strategic Plan

As with any significant project, it is important to develop and follow a strategic plan that will guide the organization's efforts. Some of the key decisions that management must make regarding FMEA policy include the type of FMEAs to be performed (such as Design, Process, Equipment,

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etc.), the timing of FMEAs (for example, prior to design freeze) and the selection criteria (such as new technology, new applications, etc.).

Task 2: FMEA Resource Plan

Together with the development of the FMEA Strategic Plan, management must also make decisions to ensure that the required resources will be available to all FMEA teams.

Task 3: Generic FMEAs (Optional)

The development of generic FMEAs may be part of the organization's FMEA Strategic Plan. They contain both historic (empirical) and potential failure modes, effects, causes and controls, and are done at the generic level of the system, subsystem or component. It is important to keep them updated based on test and field data and/or new technology.

Once accomplished, generic FMEAs can save considerable time in the performance of program-specific FMEAs. They are also useful in support of concept trade-off studies.

Task 4: Program-Specific FMEAs

Program-specific FMEAs are where the bulk of the FMEA work is performed. They focus on specific applications and can either be done right from the beginning or tailored from a generic FMEA.

Caution They should be performed by a team made up of the right experts to examine the design or process and follow the directions from FMEA strategic planning.

Task 5: Management Reviews

Most organizations have a Failure Review Board established to review and address high risk issues discovered during test or field phases. High risk issues identified from FMEAs should be included in the review format.

Task 6: Quality Audits

Effective process models inevitably include a feedback loop to improve the process by incorporating both positive and negative feedback. An effective FMEA process includes both FMEA quality surveys (of the internal customer of the FMEA) and FMEA quality audits (in-person audits of completed or nearly completed FMEAs, done by the FMEA manager).

Task 7: Supplier FMEAs

Potential higher risk system- or subsystem-level failures can have their root causes in components provided by independent suppliers. FMEA strategic planning should determine how to address supplier FMEAs, and how to identify which suppliers require formal FMEA review. For suppliers of parts that are identified as higher risk (critical parts), it is recommended that the supplier be required to perform and submit an FMEA for review and approval by a qualified company representative.

Task 8: Execution of Recommended Actions

FMEAs have little value unless the recommended actions are fully executed. Each recommended action must be followed up to ensure completion to the satisfaction of the FMEA team and the

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risk has been eliminated or mitigated to an acceptable level. The Failure Review Board must ensure that all high risk actions are successfully executed.

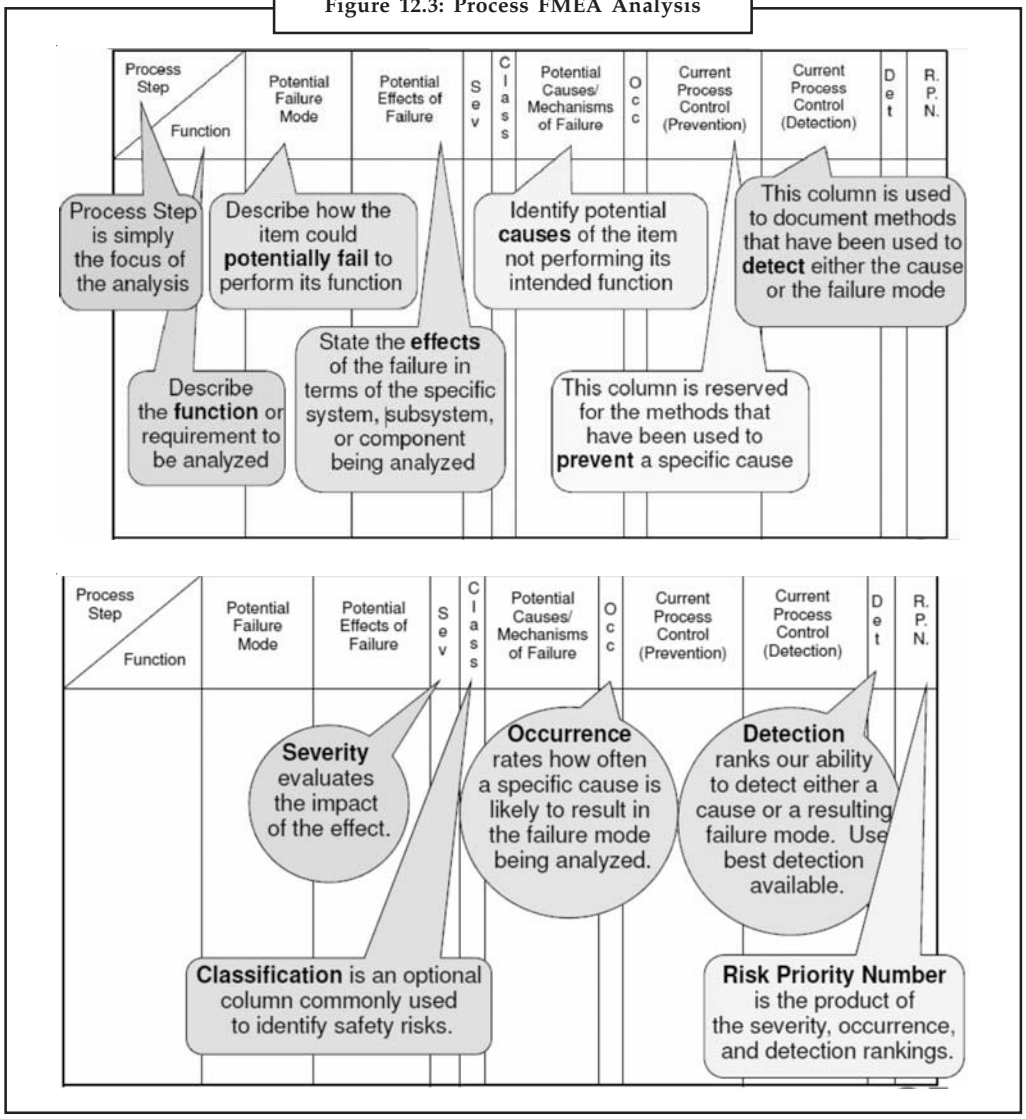
Task 9: Linkage to Other Processes

FMEAs can and should be linked to other important processes to leverage their effectiveness.

Task 10: Test and Field Failures

One of the common mistakes when implementing an FMEA process is to omit subsequent test and field failures. If generic FMEAs are used, they can be updated with information from the organization's Failure Reporting, Analysis and Corrective Action System (FRACAS). This is invaluable when FMEA documents become input to future design programs. When feedback from subsequent test and field failures is omitted from the FMEA process, future designs are at risk for repeating past failure modes.

Figure 12.3: Process FMEA Analysis



Source: http://static.squarespace.com/static/515082bbe4b0910b244269db/t/516d6e4ce4b0f84b6313c3ed/1366126156359/FMEA%20Webinar%20core%20tools.pdf

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12.2.1 Risk Priority Numbers in FMEA

The Risk Priority Number (RPN) methodology is a technique for analyzing the risk associated with potential problems identified during a Failure Mode and Effects Analysis (FMEA).

RPNs calculated at the level of the potential causes of failure (*Severity* × *Occurrence* × *Detection*).

The RPN method then requires the analysis team to use past experience and engineering judgment to rate each potential problem according to three rating scales:

- Severity, which rates the severity of the potential effect of the failure.
- Occurrence, which rates the likelihood that the failure will occur.
- Detection, which rates the likelihood that the problem will be detected before it reaches the end-user/customer.

Rating scales usually range from 1 to 5 or from 1 to 10, with the higher number representing the higher seriousness or risk. For example, on a ten point Occurrence scale, 10 indicate that the failure is very likely to occur and is worse than 1, which indicates that the failure is very unlikely to occur. The specific rating descriptions and criteria are defined by the organization or the analysis team to fit the products or processes that are being analyzed.

As an example, Figure 12.4 shows a generic five point scale for Severity.

Figure 12.4: Generic Five Point Severity Scale

Rating	Description	Criteria
1	Very Low or None	Minor nuisance.
2	Low or Minor	Product operable at reduced performance.
3	Moderate or Significant	Gradual performance degradation.
4	High	Loss of function.
5	Very High or Catastrophic	Safety-related catastrophic failures.

After the ratings have been assigned, the RPN for each issue is calculated by multiplying *Severity* × *Occurrence* × *Detection*.

$$RPN = Severity \times Occurrence \times Detection$$

The RPN value for each potential problem can then be used to compare the issues identified within the analysis. Typically, if the RPN falls within a pre-determined range, corrective action may be recommended or required to reduce the risk (i.e., to reduce the likelihood of occurrence, increase the likelihood of prior detection or, if possible, reduce the severity of the failure effect). When using this risk assessment technique, it is important to remember that RPN ratings are relative to a particular analysis (performed with a common set of rating scales and an analysis team that strives to make consistent rating assignments for all issues identified within the analysis). Therefore, an RPN in one analysis is comparable to other RPNs in the same analysis but it may not be comparable to RPNs in another analysis.

Revised RPNs and Percent Reduction in RPN

In some cases, it may be appropriate to revise the initial risk assessment based on the assumption (or the fact) that the recommended actions have been completed. This provides an indication of

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the effectiveness of corrective actions and can also be used to evaluate the value to the organization of performing the FMEA. To calculate revised RPNs, the analysis team assigns a second set of Severity, Occurrence and Detection ratings for each issue (using the same rating scales) and multiplies the revised ratings to calculate the revised RPNs. If both initial and revised RPNs have been assigned, the percent reduction in RPN can also be calculated as follows:

$$\% \text{ Reduction in } RPN = \frac{RPN_i - RPN_r}{RPN_i}$$

For example, if the initial ratings for a potential problem are S = 7, O = 8 and D = 5 and the revised ratings are S = 7, O = 6 and D = 4, then the percent reduction in RPN from initial to revised is (280-168)/280, or 40%. This indicates that the organization was able to reduce the risk associated with the issue by 40% through the performance of the FMEA and the implementation of corrective actions.

Table 12.1

	Severity	Occurrence	Detection	RPN
Initial	7	8	5	280
Revised	7	6	4	168
% Reduction in RPN				40%

Occurrence/Severity Matrix

Because the RPN is the product of three ratings, different circumstances can produce similar or identical RPNs. For example, an RPN of 100 can occur when S = 10, O = 2 and D = 5; when S = 1, O = 10 and D = 10; when S = 4, O = 5 and D = 5, etc. In addition, it may not be appropriate to give equal weight to the three ratings that comprise the RPN. For example, an organization may consider issues with high severity and/or high occurrence ratings to represent a higher risk than issues with high detection ratings. Therefore, basing decisions solely on the RPN (considered in isolation) may result in inefficiency and/or increased risk.

The Occurrence/Severity matrix provides an additional or alternative way to use the rating scales to prioritize potential problems. This matrix displays the Occurrence scale vertically and the Severity scale horizontally. The points represent potential causes of failure and they are marked at the location where the Severity and Occurrence ratings intersect. The analysis team can then establish boundaries on the matrix to identify high, medium and low priorities.

Caselet

Application of Failure Modes and Effects Analysis in iCubed Technologies

Requirement

The requirement was to evaluate the potential risks associated with the design of a cash handling mechanism to provide confidence that the specified performance could be achieved.

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Background

Handling bank notes and other "documents of value" in automatic mechanisms gives rise to a particular set of potential problems. We needed to provide a way of systematically documenting and analysing the main risks in the mechanism design and to show how these risks could be minimised or, at least, managed.

We chose to use the Failure Modes and Effects Analysis method as a well-proven approach to risk identification, prioritisation and reduction.

Solution

The mechanism consisted fundamentally of a series of banknote transport and storage systems and was used to validate and store customer deposits. The lifecycle of documents through the machine was plotted so that none of the major risk contributors would be missed. By dividing the mechanism into sections bounded by risk "hot spots", it was possible to define a set of segments that would undergo evaluation. Each of these segments was addressed in turn by listing all of its possible failure modes and then, for each failure mode, recording the "Severity Rating", the "Detection Rating" and the "Occurrence Rating". The product of these three ratings gave an overall "Risk Priority Rating" for that failure mode.

Severity Rating (SR)

The severity ratings of failure modes were defined in terms of the perceived impact that the risk would have if it were realised. These ratings range from 10 (most severe consequences) to 1 (least severe).

Priority	Area affected by fault	Severity Rating
1	Safety	10
2	Security against banknote and data theft	9
3	Regulatory compliance	9
4	Documents are transferred between owners	8
5	Accountancy error against customer-owned notes	8
6	Media damage (customer's notes)	6
7	Machine out of service	6
8	Reject rate	4
9	Media damage (bank's notes)	3
10	Mis-stored notes	3
11	Throughput performance	1

Detection Rating (DR)

The probability of detecting that a certain failure mode has occurred was then defined. If there was no way of sensing that a failure mode had occurred this was rated at 10 and conversely, if a failure mode was almost certain to be detected this was rated at 1.

Detection Rating	Definition
1	No chance of detection
2	Very remote chance of detection
3	Remote chance of detection
4	Very low probability of detection

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5	Low probability of detection
6	Moderate probability of detection
7	Moderately high chance of detection
8	High probability of detection
9	Very high chance of detection
10	Almost certain chance of detection

Occurrence Rating (OR)

The potential occurrence rating was defined in terms of the time that the system may run between fault occurrences and from that we could reduce the number of documents between occurrences of the particular fault. The assumption made here was that, on average, around 15,000 documents were processed per week.

Occurrence Rating	Definition of Frequency in Running Time	Probability in Number of Documents
10	Almost inevitable – there is a 1 in 2 chance of the fault occurring in one day	> 1 in 1000
9	Very high – once per day	1 in 2000
8	Repeated failure – once per week	1 in 15,000
7	High – once every 2 weeks	1 in 30,000
6	Moderately high – once per month	1 in 60,000
5	Moderate – once every 3 months	1 in 180,000
4	Relatively low – once every 6 months	1 in 350,000
3	Low – once per year	1 in 700,000
2	Remote – once every 2 years	1 in 1.5 million
1	Nearly impossible – less than once in 8 years	< 1 in 5 million

Section Failure Modes

The following table gives an example of some of the failure modes identified in a section that includes a mechanism for separating notes.

SR = Severity Rating

DR = Detection Rating

OR = Occurrence Rating

RPR = Risk Priority Rating

Where RPR = SR*DR*OR.

Item	Failure Mode	SR	DR	OR	RPR
1	Failure to feed notes	1	1	9	9
2	Stream feed of notes	4	1	6	24
3	Skewed feed of notes	6	1	6	36
4	Note damage (fold, tear) induced	6	1	8	48

This process was repeated for all failure modes and for all sections of the machine giving a complete picture of the risks associated with the mechanism design. Those failure modes with the highest Risk Priority Ratings were given the most immediate attention and design changes were identified to either, reduce the probability of occurrence or, to increase

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the probability of detection so that it would be possible to take remedial action whilst in operation.

Conclusion

Using a technique such as Failure Modes and Effects Analysis allowed us to systematically identify the risks in a mechanism design, quantify those risks with relative ratings and recommend design changes to increase the probability of product success. This process was used as a very effective tool for verifying if the proposed layout and design of the mechanism adequately coped with the failure modes that would predictably occur during machine operation.

Source: http://www.icubedtechnologies.com/csFMEA.php

Figure 12.5: FMEA by Using Cause & Effect Diagram

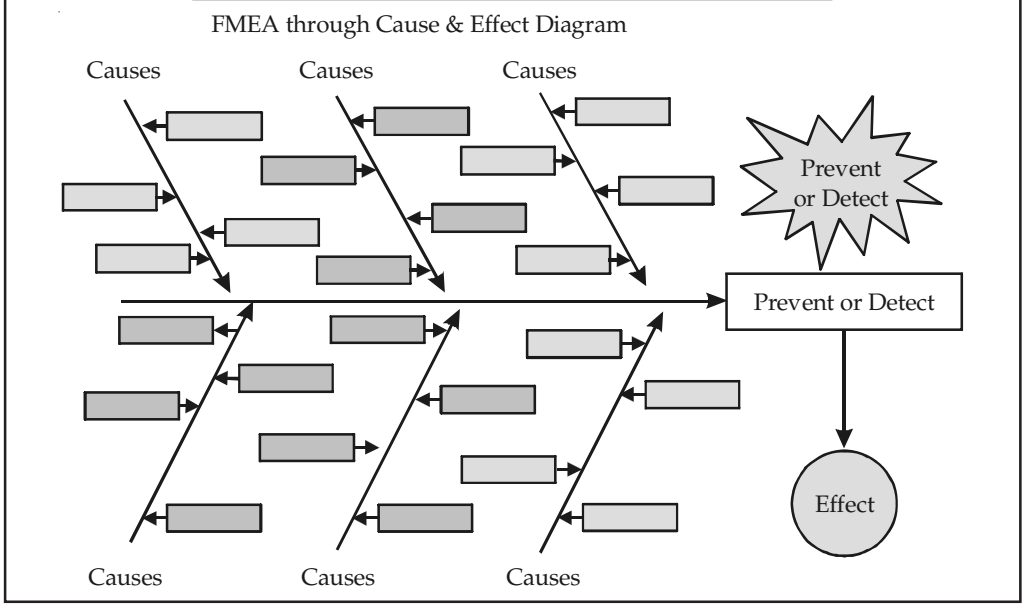

Figure 12.5 shows a model of Cause and Effect diagram used in FMEA. As the diagram shows, for every effect there is a failure mode. Further it is shown that a defect causes a failure mode. Cause and Effect analysis is carried out by the employees of the organization. The thought process, through brainstorming, generates the likely forms of failures and their effects and then finds out the likely causes of these failures. These can be in the categories of materials, manpower, equipment, environment, etc.

Self Assessment

Fill in the blanks:

4. For every …… there is a failure mode.
5. A defect causes a …… mode.
6. Cause and Effect analysis is carried out by the …… of the organization.

12.3 FMEA Team

Cross functional teams are used for FMEA. The FMEA methodology is a team effort where the responsible engineer involves people from assembly, manufacturing, materials, quality, service,

and other functional areas. The team is headed by team leader, who has the responsibility of conducting meetings, determining meeting schedules, communicating meeting schedules and agenda to all the members, and coordinating on corrective actions determined. He is also responsible for ensuring participation of all team members. He shall maintain all FMEA records and distributes them to all the members as and when they are needed.

Self Assessment

Fill in the blanks:

7. …… teams are used for FMEA.
8. The team leader is responsible for ensuring …… of all team members.

12.4 FMEA Documentation

FMEA generates lot of information and it generates several ideas and these ideas should be available for further use by others when they are useful to them. Hence it is important to document FMEA activities. The purpose of FMEA document is to allow all involved engineers to have access to other's thoughts and to design manufacture using collective group thoughts, which promotes team work.

Note Documents must be updated on regular basis as changes may occur during design and manufacturing process.

FMEA team generally use block diagrams to show different flows like information, energy, force, fluid, etc. involved in the component or process being analyzed. This diagram helps in understanding inputs, and outputs.

Self Assessment

Fill in the blanks:

9. The purpose of …… is to allow all involved engineers to have access to other's thoughts and to design manufacture using collective group thoughts, which promotes team work.
10. FMEA team generally use …… to show different flows like information, energy, force, fluid, etc. involved in the component or process being analyzed.

12.5 Stages of FMEA

The five stages of FMEA are listed below:

Stage 1: Poor FMEA Understanding

Typically the organisation in stage one uses FMEAs because it has to meet a paper requirement for a customer or quality standard. Personnel perform the FMEA right before it is due to be turned in to the customer, usually too late in the process to be useful.

Quite often, the wrong people perform the FMEA. The quality department ends up developing the documents rather than making design engineers responsible for design FMEAs and operating personnel responsible for process FMEAs.

Notes

Management does not understand the FMEA, and a lot of confusion and disagreement exists as to how to fill out the FMEA form. Debate occurs when individuals attempt to develop the ratings for occurrence and detection numbers. Because accurate feedback systems don't yet exist to base the ratings on, they're based on inaccurate guesses. Using inaccurate ratings, the organisation calculates erroneous RPNs and identifies an RPN level at which recommended actions are needed. If the number of recommended actions required based on this level is too high, the organisation "adjusts" the ratings to bring the RPNs down below the trigger level, which reduces the number of recommended actions. Obviously, this makes the entire FMEA process meaningless.

As a result, the organisation fulfills its paper requirement, but the value of the FMEA is greatly diminished. Problems still remain unsolved at a high cost to the organisation. The individuals performing the FMEAs believe they are doing them correctly because the customer or auditor is accepting them. Eventually, everyone sees the FMEA process not as a tool but as something that has to be done.

Stage 2: Learning Proper FMEA Techniques

Management ensures that the personnel who will perform and use the FMEA data are trained in the proper technique.

Note The people who perform design FMEAs must be experts in the product and the people who perform the process FMEAs must be experts in the process.

Rather than being confused by the FMEA terminology, they realize they have used the FMEA methodology before but never called it FMEA. They also learn that although they have used the methodology, they have not used it rigorously enough to achieve its full benefits.

In stage two, everyone involved gains understanding of what the ratings and class column mean and how to use them to prioritize what must be worked on first. They understand that the class column is the most important factor and not the RPN. Management also realized that they don't have systems in place that will give them data to accurately determine the failure probability occurrence ratings, detection ratings and class. Using the limited objective data they have, they know they will have to use their knowledge of the product and process to arrive at the ratings. Due to the lack of an objective basis, they know that it is a waste of time to argue for long periods about the ratings.

When leaving this stage, those who have been using FMEAs believe they can be a powerful tool. Unfortunately, the people who perform FMEAs doubt whether management will provide the time and resources necessary to support their successful implementation. They also question how they will explain the new approach to their auditor or customer, who may still be at stage one in their understanding of the FMEA implementation process.

Stage 3: Building a Proper FMEA

The organisation begins to use FMEAs correctly on a targeted product. Early on, there is excitement that the FMEAs are finally going to be done correctly. As the implementation continues, worry starts to set in as the FMEA uncovers and documents the complexity of the product and process being analysed. Everyone knew the complexity existed but had never seen it documented. The FMEA grows from the 5 or 10 pages that used to be normal to 100 or more pages.

Notes

Note The organisation must overcome its fear of the increased length and complexity of the complete FMEA if FMEAs are to be used successfully.

As the FMEA process continues, many problems may be uncovered that must be solved if the company is to become as good as it can be. There may not be enough resources to solve all of these problems and still meet the launch deadline.

Knowing this, people begin to proclaim that FMEAs will never work. They believe that all the hard work has been a waste of time. What good is it to know what is wrong and not be able to correct it? Life was a lot easier when all the problems were not documented. If organisations don't overcome this obstacle they may slip back into stage one.

Stage 4: Using a FMEA's Outputs

Management realises that the length of a FMEA cannot be predetermined. The complexity of the product and process being analysed determines the FMEA's length. Management understands that all of the problems uncovered in the FMEA can't be solved in one product launch. They understand that the product will be launched with known problems and that they will have to make objective decisions as to what to work on during this launch and what must be delayed. When a problem occurs in an area that management decided not to work on, it is handled without emotion. This is possible because the FMEA identified that it might happen and management chose not to work on it so that other problems could be prevented.

Once the organisation launches the product, management creates a long-term plan to improve the design and manufacturing systems. This plan minimizes the times the company must make difficult decisions when doing FMEAs in the future.

Stage 5: Full FMEA Implementation and Integration

The organisation has implemented new design and manufacturing systems to answer the majority of the problems identified in the FMEAs. Systems now exist to provide data to accurately set occurrence and detection ratings. Due to the accuracy of the new ratings, predictions about field failures and process yields can be made. The class column can now be accurately determined and actions required for improvement prioritized.

Design engineers review design FMEAs before making design changes. If a change must be made, operating personnel review the process FMEA and control plan to determine the impact the change will have on the process.

When a problem occurs, the appropriate personnel consult the FMEAs. If the FMEA inadequately addressed the problem, engineers make changes to the design and manufacturing system to ensure that all possible steps have been taken to prevent a similar problem in the future.

The organisation uses the FMEAs as training tools because they contain the collective knowledge of the company's experts.

Task Prepare a FMEA model of a company based on the stages of FMEA you have studied.

Notes

12.6 Benefits of FMEA

FMEA is designed to assist the engineer improve the quality and reliability of design. Properly used the FMEA provides the engineer several benefits.

The various benefits of FMEA are as follows:

- Improve product/process reliability and quality
- Increase customer satisfaction
- Early identification and elimination of potential product/process failure modes
- Prioritize product/process deficiencies
- Capture engineering/organisation knowledge
- Emphasizes problem prevention
- Documents risk and actions taken to reduce risk
- Provide focus for improved testing and development
- Minimises late changes and associated cost
- Catalyst for teamwork and idea exchange between functions

Self Assessment

Fill in the blanks:

11. Management ensures that the personnel who will perform and use the ..... data are trained in the proper technique.
12. Due to the lack of a/an ..... basis, they know that it is a waste of time to argue for long periods about the ratings.
13. The organisation must overcome its fear of the ..... and complexity of the complete FMEA if FMEAs are to be used successfully.
14. Management realises that the ..... of an FMEA cannot be predetermined.
15. ..... engineers review design FMEAs before making design changes.
16. FMEA is designed to assist the engineer improve the ..... and ..... of design.

Case Study

Performance Evaluation of Boparai Metals Pvt. Ltd. by FMEA

Boparai Metals Pvt. Ltd. was established on 23rd April 1994, founded by S. Prithipal Singh Boparai. It is one of the leading founders & manufacturers of ferrous & non-ferrous castings in Punjab. It specializes in all types of C.I. Castings, mainly produces tractor parts. The annual turnover of company is around ₹ 5 Crore & has a net production of 150 tonnes of casting product in a month. It has main customers of many reputed companies of India.

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Notes

The main parts which are produced in this industry are: Exhaust Manifold, Flywheel, Cylinder Block, Brake Discs, Portal Cover, Side Cover, Seal Carrier, Combined Pulleys and Door Closures, etc. It supplies these tractors parts to the reputed tractor industries of India. Various machines used in this industry are: Shell Core Making Machine, Shell Core Shooter, Molding Machine, Sand Mixture Machine, Drilling Machine, Grinder and Slotting Machine, etc.

FMEA technique is applied to two products, which are analyzed on the basis of their manufacturing operations and design as discussed in the following section.

1. Flywheel Housing
2. Flywheel

Flywheel Housing

Facing, drilling and tapping are the main manufacturing operations of the Flywheel Housing. Firstly, the basic requirements of the manufacturing processes are studied and then the potential failure mode of the specific process is found out. After that the potential effects of the failure mode are noted with their severity value. The occurrence value for the potential causes and their prevention is also calculated. The Detection value is assigned to the failure mode and finally the R.P.N. value is calculated. The sample calculations are given in the following section.

Sample Calculations

Step 1: Potential Failure Modes for Facing, Drilling and Tapping are found.

Step 2: Potential Effect of Failure and Severity value are calculated as:

Part may fail in field/Assembly & Customer dissatisfaction and corresponding Severity value = 7

Step 3: Potential causes of failure & occurrence value for Facing, Drilling and Tapping are calculated as: For defective machine tool setting and corresponding Occurrence value = 3

Step 4: For 100% in-process inspection and corresponding Detection value = 4

Step 5: Finally, the R.P.N. is calculated as:

$$\text{R.P.N.} = S \times O \times D$$

Considering $S = 7, O = 3$ and $D = 4$

The $\text{R.P.N.} = 7 \times 3 \times 4 = 84$

Flywheel

Following manufacturing operations are carried out on the Flywheel:

1. Turning on front side
2. Turning on back side
3. Drilling and Tapping
4. Balancing

After the study of the basic requirements of the manufacturing processes, the potential failure mode of the specific process is found out. The potential effects of the failure mode are required to be noted with their severity value. The potential causes and their prevention are decided along with their occurrence value.

Contd...

Notes

The Detection value is then assigned to the failure mode and finally the R.P.N value is calculated as following:

If $S = 4, O = 3, \& D = 4$

Then, $R.P.N = S \times O \times D$

$= 4 \times 3 \times 4 = 48$

Recommendations

For each specific product, the preventions suggested in the FMEA chart can considerably decrease the loss to the automobile industry in terms of both money and time. The following suggestions/recommendations are given for these products:

Flywheel

- Butting face should be properly cleaned during Balancing.
- Size of key lock may be adjusted according to shaft and flywheel.
- In-process inspection should be adopted more frequently and strictly.
- Snap gauge should be used for 100% inspection.
- Cross check the machine with master piece.

Flywheel Housing

- Thread Depth gauge should be used for 100% inspection.
- Offset compensation should be properly given to the tool.
- In-process inspection should be adopted more frequently.
- Assembly of manufactured parts should be performed in such a way that it should work satisfactorily in the field to avoid customer dissatisfaction.
- Preventive maintenance should be adopted as per the given schedule.

The present work deals with the FMEA study of two products i.e. flywheel and flywheel housing. The basic requirements of the manufacturing processes are first studied and then the potential failure mode of the specific process is found out. After that the potential effects of the failure modes are noted with their severity value and then the potential causes and their prevention are calculated along with their occurrence value. The Detection value was assigned to the failure mode and finally the R.P.N. value is calculated. FMEA analysis may easily help in improving the efficiency of the manufacturing process thus decreasing the number of defective products and saving of re-work cost and valuable time. For each specific product the preventions suggested in the chart can considerably decrease the loss to the casting industry in terms of both money and time.

Question

What does the above case study depict?

Source: http://technicaljournals.org/NPDF/IJMEAR-04-TJ-A18.pdf

12.7 Summary

- Failure Modes and Effects Analysis (FMEA) is a step-by-step approach for identifying all possible failures in a design, a manufacturing or assembly process, or a product or service.
- The purpose of the FMEA is to take actions to eliminate or reduce failures, starting with the highest-priority ones.

Notes

- Begun in the 1940s by the U.S. military, FMEA was further developed by the aerospace and automotive industries.
- Cause and Effect analysis is carried out by the employees of the organization.
- The FMEA methodology is a team effort where the responsible engineer involves people from assembly, manufacturing, materials, quality, service, and other functional areas.
- The purpose of FMEA document is to allow all involved engineers to have access to other's thoughts and to design manufacture using collective group thoughts, which promotes team work.
- Quite often, the wrong people perform the FMEA. The quality department ends up developing the documents rather than making design engineers responsible for design FMEAs and operating personnel responsible for process FMEAs.
- FMEA is designed to assist the engineer improve the quality and reliability of design.
- Taguchi Methods utilise two-, three-, and mixed-level fractional factorial designs.

12.8 Keywords

Cause and Effect Diagram: A graphical statistical technique used to tie multiple possible causes to a significant effect that is generally causing a problem is known as a cause and effect diagram.

Cross Functional Teams: Cross functional teams are the teams of employees representing different functional disciplines and/or different process segments who tackle a specific problem or perform a specific task, frequently on an ad hoc basis.

Design Engineers: Design engineer is a person or firm responsible for designing a project.

Effect Analysis: Effects analysis refers to studying the consequences of those failures.

Factorial Designs: An experimental design in which two or more independent variables are simultaneously manipulated is known as a factorial design. This design permits an analysis of the main effects of the independent variables separately, plus the interaction effects of these variables.

Failure Mode and Effect Analysis: A technique to find the weaknesses in designs before the design is realized, either in prototype or production is known as failure mode and effect analysis.

Failure Mode: Manner in which an equipment or machine failure can occur is called as failure mode.

Risk Priority Number: In Failure Mode Effects Analysis, the aggregate score of a failure mode including its severity, frequency of occurrence, and ability to be detected is referred to as risk priority number.

12.9 Review Questions

1. Explain the meaning of FMEA.
2. Discuss the relationship of cause, failure mode and effect with the help of a suitable diagram.
3. Explain FMEA process with the help of a fishbone diagram.
4. Briefly explain the different stages of FMEA.
5. What are the various benefits of FMEA?

Notes

Answers: Self Assessment

1.	Failure Mode and Effect Analysis	2.	Effects analysis
3.	Design	4.	Effect
5.	Failure	6.	Employees
7.	Cross functional	8.	Participation
9.	FMEA document	10.	Block diagrams
11.	FMEA	12.	Objective
13.	Increased length	14.	Length
15.	Design	16.	Quality; reliability

12.10 Further Readings

Books

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Mukherjee N.P. (2006), *Total Quality Management*, PHI Learning Pvt. Ltd.

Nigam, Shailendra (2009), *Total Quality Management*, Excel Books, India

Online links

http://castle.eiu.edu/~pingliu/tec5133/resources/FM.ppt

http://www.denizon.com/quality-assurance/total-quality-management/

http://www.fmeainfocentre.com/handbooks/umich.pdf

http://www.slideshare.net/arunkumarkgr/failure-mode-effect-analysis

Notes

Unit 13: Total Productive Maintenance

CONTENTS

Objectives
Introduction
13.1 What is TPM?
13.2 Planning for TPM
13.2.1 Learning the New Philosophy
13.2.2 Promoting the Philosophy
13.2.3 Training
13.2.4 Identifying Improvement Needs
13.2.5 Setting Improvement Goals
13.2.6 Developing Plans
13.2.7 Autonomous Work Groups
13.3 Summary
13.4 Keywords
13.5 Review Questions
13.6 Further Readings

Objectives

After studying this unit, you will be able to:

- Define Total Productive Maintenance.
- Explain the Planning for TPM.

Introduction

Previous unit gave you an insight on FMEA approach and the various stages of FMEA process. This unit will help you study about the concept of total productive maintenance.

TPM is an innovative Japanese concept. The origin of TPM can be traced back to 1951 when preventive maintenance was introduced in Japan. However, the concept of preventive maintenance was taken from USA. Nippon Denso was the first company to introduce plant wide preventive maintenance in 1960. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment.

13.1 What is TPM?

TPM is an organization wide effort aimed at reducing loss due to equipment failure, slowing speed, and defects. Japan Institute of Plant Maintenance (JIPM) defines TPM as a system of maintenance covering the entire life of equipment in every division, including planning, manufacturing, and maintenance. TPM involves everyone, from top executives to shop floor workers to promote productive maintenance through morale building management and small group activities in an effort to maximize equipment efficiency.

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It can be considered as the medical science of machines. Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.

TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

TPM was introduced to achieve the following objectives. The important ones are listed below:

- Avoid wastage in a quickly changing economic environment.
- Producing goods without reducing product quality.
- Reduce cost.
- Produce a low batch quantity at the earliest possible time.
- Goods send to the customers must be non-defective.
- Achieve maximum effectiveness of the equipment.
- Involve all equipment operators in developing maintenance skills.
- Improve reliability of the equipment.
- Achieve an economic balance between prevention costs and total costs while reducing failure costs.

Example: Companies that apply TPM:

1. Delicia
2. Heineken
3. Unilever
4. Solvay

Self Assessment

Fill in the blanks:

1. TPM is an innovative …… concept.
2. …… was the first company to introduce plant wide preventive maintenance in 1960.
3. TPM is an organization wide effort aimed at reducing …… due to equipment failure, slowing speed and defects.
4. The goal of the TPM program is to markedly increase …… while, at the same time, increasing …… and job satisfaction.

13.2 Planning for TPM

The first step in implementing Total Productivity Maintenance is assessment of current performance. It helps in understanding current level of performance so that future plans for improvement can be implemented. Thus organizations need to assess existing maintenance

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system, current condition of plant and equipment. Understanding the current system also helps whether existing system can be improved or a new system has to replace the existing one. TPM implementation in general consists of the following steps:

1. Management learning new philosophy
2. Management promoting new philosophy
3. Training everyone in the organization
4. Identifying areas of improvement
5. Formulating performance goals
6. Developing an implementation plan
7. Establishing autonomous work groups

13.2.1 Learning the New Philosophy

Proper understanding, commitment and active involvement of the top management in needed for this step. Senior management should have awareness programs, after which announcement is made to all.

Note Top management must understand how TPM will affect the operations of the organization. Top management should also be aware of resistance to change and how it can deal the same.

TPM call for cultural change, and any cultural change needs dedication from top management and its support for long-term improvement. TPM calls for tapping of unused resources of the organization especially the intellectual capital of its employees in the form of their problem solving ability. Hence people at the lower level must be empowered to make decisions. Thus top management must learn the new philosophy of managing things differently to involve all the employees.

13.2.2 Promoting the Philosophy

Senior management needs support of all the employees of the organization for successful implementation of TPM and hence it must spend significant time in promoting the new system. Top management must sell the idea as it requires complete commitment from all the employees. It also needs commitment from all the top management representatives of the organization. If the employees and management do not believe in new philosophy and they are committed to the same, then TPM may be failure in the organization resulting in waste of resources.

Caution Top management should have long-term commitment and it should not focus on short term gains as commitment to long-term investment is the key.

Management has the responsibility of promoting the new philosophy and hence mangers should become role models by practicing the new philosophy and leading others. Top managers shall actively involve and exhibit their keen interest in new philosophy. Management should also give more autonomy to maintenance and production personnel. If employees understand the seriousness of commitment and efforts of top management in implementing TPM, then employees will respond positively and put their efforts in implementation.

Notes

13.2.3 Training

Training is the backbone for success of TPM. All employees including top managers, front level supervisors and shop floor employees need to be trained. Training shall focus not just how TPM can be implanted, but should stress why it is needed and what are the possible advantages of TPM.

Top management should spend time in undergoing training and managers should learn and understand impact of applying TPM philosophy in their organizations. Training shall focus on attitudinal change among managers and if managers fail to understand the need for TPM they may need to be replaced. Those who support and actively involve in new philosophy should be identified and they must undergo thorough training.

Team approach is the key for implementation of TPM as TPM calls for autonomous teams.

Note Middle management must learn how to deal with team approach and how to develop small autonomous work groups.

Since it requires change in the management approach, some resistance to change may be inevitable. Hence awareness for need to change is very important among the middle management executives. Thus training to middle management must address the issues of structural changes which are needed for implementation of TPM.

Front line supervisors are backbone for TPM as they play a major role in productivity improvement projects. Hence they must understand the need for TPM and role of supervisors in implementing TPM. Supervisors must realize that they need to delegate authority to lower levels as they need more autonomous teams at operating level. Role of supervisors as effective coaches is also very important.

Caution Supervisory training should focus on providing leadership at shop floor level for implementing TPM.

Employee's involvement is the most important need for TPM. Employees should be capable of working in autonomous work groups. Hence they should learn about various tools used in performing new tasks needed for TPM as part small autonomous teams. Training shall focus on role of production people and maintenance people and need for working in cross functional teams.

Caselet

Implementing Total Productive Maintenance

As we conduct lean assessments at manufacturing facilities throughout the region, I have noticed organizations increasingly embracing lean concepts. But one key area that often falls by the wayside is equipment maintenance. I repeatedly see facilities in which there is a complacent attitude about equipment maintenance and reliability. "Equipment is expected to fail." Maintenance is primarily reactive. Where they exist, preventive maintenance plans are sketchy, often ignored, and not used because "we're experienced." Large inventories of spare parts are stored in conditions that

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significantly reduce their useful life. Operators ignore the early warning signs of pending failure. Furthermore, I always hear at least 10 reasons why "we can't change the way we do things around here."

What if other industries took the same path as these organizations? Take, for example, the aircraft maintenance industry. There is a high degree of discipline from the certifications of those who perform the maintenance to the suppliers of parts and materials used on the job. Procedures are very specific and every process and step is documented. Consequently, with over 27,000 take-offs and landings every day in the U.S., aircraft crashes due to equipment failure rarely happen. Another good example is NASCAR Winston Cup racing. The best-of-the-best in stock car racing depend on reliable equipment to do their job; every race car must meet rigid safety guidelines and has to be reliable. The old saying in the pits is: "If you can't finish, you can't win." Achieving 100 percent reliability takes discipline and teamwork. Organizations that want to compete and become "World Class" need to successfully implement Total Productive Maintenance (TPM) programs.

TPM requires effective leadership from the start. That is part of the meaning of "total" in Total Productive Maintenance. Without effective leadership that links TPM efforts to the business and holds people accountable for performing highly specified work, equipment performance and reliability will continue to decline and TPM initiatives will be short-lived. Many of today's business leaders have risen through the ranks when maintenance was only responsible for "fixing things" – not for preventing problems. Viewing maintenance as a non-value-adding support function, they often subject the maintenance department to severe cost-cutting; this usually results in higher costs due to decreased equipment effectiveness.

Companies that have been successful usually follow an implementation plan that includes the following 12 steps:

Step 1: Announcement of TPM: Top management needs to create an environment that will support the introduction of TPM. Without the support of management, skepticism and resistance will kill the initiative.

Step 2: Launch a formal education program: This program will inform and educate everyone in the organization about TPM activities, benefits, and the importance of contribution from everyone.

Step 3: Create an organizational support structure: This group will promote and sustain TPM activities once they begin. Team-based activities are essential to a TPM effort. This group needs to include members from every level of the organization from management to the shop floor. This structure will promote communication and will guarantee everyone is working toward the same goals.

Step 4: Establish basic TPM policies and quantifiable goals: Analyze the existing conditions and set goals that are SMART: Specific, Measurable, Attainable, Realistic, and Time-based.

Step 5: Outline a detailed master deployment plan: This plan will identify what resources will be needed and when for training, equipment restoration and improvements, maintenance management systems and new technologies.

Step 6: TPM kick-off: Implementation will begin at this stage.

Step 7: Improve effectiveness of each piece of equipment: Project Teams will analyze each piece of equipment and make the necessary improvements.

Step 8: Develop an autonomous maintenance program for operators: Operators routine cleaning and inspection will help stabilize conditions and stop accelerated deterioration.

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Notes

Step 9: Develop a planned or preventive maintenance program: Create a schedule for preventive maintenance on each piece of equipment.

Step 10: Conduct training to improve operation and maintenance skills: Maintenance department will take on the role of teachers and guides to provide training, advice, and equipment information to the teams.

Step 11: Develop an early equipment management program: Apply preventive maintenance principles during the design process of equipment.

Step 12: Continuous Improvement: As in any Lean initiative the organization needs to develop a continuous improvement mindset.

Maintenance and reliability as a core business strategy is the key to a successful TPM implementation. Without the support of top management, TPM will be just another "flavour of the month." Implementing TPM using the above 12 steps will start you on the road to "zero breakdowns" and "zero defects."

13.2.4 Identifying Improvement Needs

People at the operational level can throw better light on needs of improvements. Maintenance technicians have better knowledge about which machines are on the verge of breakdown, which machines need more attention for maintenance activities. Hence employees who work with machines on their day-to-day work are better capable of identifying the improvement needs than any other employees. Therefore involvement of operators and maintenance technicians is very important in identifying improvement needs. Opinion of these employees on which systems and machines need more urgent attention has to be taken into consideration. This may need constitution of an implementation team consisting of production operators and maintenance technicians.

The teams constituted should focus on current level performance and this can be done in the form of assessment existing systems. Japanese TPM practitioners have developed following measurements for identifying improvement needs. These measurements are six major areas of losses so that how improvements can reduce them. They are listed below:

Down Time Losses

1. Planned
   - (a) Start-ups
   - (b) Shift changes
   - (c) Coffee and lunch breaks
   - (d) Planned maintenance shut downs
2. Unplanned Downtimes
   - (a) Equipment breakdown
   - (b) Changeovers
   - (c) Lack of materials

Reduced Speed Losses

3. Idling and minor stoppages
4. Slow-downs

Poor Quality Losses

Notes

5. Process non-conformities
6. Scrap

These losses can be quantified into three metrics and can be summarized into equipment effectiveness metric. Equations for these metrics are explained below:

Downtime losses are measured by equipment availability using the equation:

$$A = (T/P) \times 100$$

Where A = availability

T = Operating time (P-D)

P = Planned operating time

D = Downtime

Reduced speed losses are measured by tracking performance efficiency using the equation

$$E = (C \times N/T) \times 100$$

Where E = Performance efficiency

C = Theoretical cycle time

N = Processed amount (quantity)

Poor quality losses are measured by tracking the rate of quality products using the equation

$$R = ((N-Q)/N) \times 100$$

Where R = Rate of quality of products

N = Processed amount (quantity)

Q = Non-conformance

Equipment effectiveness is measured as the product of the decimal equivalent of the three previous metrics using the equation

$$EE = A \times E \times R$$

Where EE = Equipment effectiveness

Or

Overall Equipment Effectiveness (OEE)

Thus improvement needs can be expresses in terms of amount of increase in OEE.

13.2.5 Setting Improvement Goals

Goals should be set for the improvement after improvement needs are identified. A time frame for improvement project should be clearly defined. Priorities for improvement projects should be developed. Project teams should be involved in setting these improvement goals.

13.2.6 Developing Plans

The next step in successful implementation of TPM is developing an implementation and training program. Plans for developing autonomous work groups should take place during the training

Notes

phase. Plans should focus on use of teams consisting of maintenance technicians and machine operators in production departments to work troublesome problems which may require urgent attention. They can determine priorities for improvement and management must commit resources which are required for correcting these problems. Use of teams in the initial stages can lead to future development of autonomous work groups. Hence plans must be prepared gradual changes in restructuring the organization into small autonomous workgroups.

13.2.7 Autonomous Work Groups

Autonomous work groups are established based on the natural flow of activity. Operators must be made responsible for the equipment and level of maintenance that they are capable of performing. Maintenance personnel with necessary skill levels should be identified. Operators and maintenance personnel are brought together in the form of autonomous work teams. These groups must have authority to make decisions about keeping the machines in good working condition. The structure of the autonomous workgroups may depend on the type of the industry and nature of application. Maintenance technicians should be consultants for production personnel. Maintenance personnel can also train production personnel on basic maintenance activities like oiling, minor troubleshooting, setting up, etc. The overall objective of autonomous workgroups is to reduce time spent on maintenance activity.

Task Prepare a flow chart explaining the various steps involved in TPM implementation.

Self Assessment

Fill in the blanks:

5. The first step in implementing Total Productivity Maintenance is assessment of …….
6. …… should have awareness programs, after which announcement is made to all.
7. TPM calls for tapping of …… resources of the organization.
8. Top management should have …… commitment and it should not focus on …… gains.
9. …… is the backbone for success of TPM.
10. …… approach is the key for implementation of TPM.
11. Front line supervisors are backbone for TPM as they play a major role in …… projects.
12. …… involvement is the most important need for TPM.
13. People at the …… level can throw better light on needs of improvements.
14. Plans for developing autonomous work groups should take place during the …… phase.
15. Autonomous work groups are established based on the …… of activity.
16. …… technicians should be consultants for production personnel.

Notes

Case Study

Fine Papers, South Africa

TQM has Positive Impact on Paper Manufacturers

Fine Papers, a South African subsidiary of Sappi Limited, London, consisted of three mills, Enstra, Stanger and Adamas. The implementation of both TQM and Reliability Centred Maintenance (RCM) at the Enstra mill, an uncoated paper manufacturing unit, achieved a positive impact on availability, reliability, quality and the elimination of waste. However, quality was still variable and needed to be inspected throughout the process. As a further improvement, Statistical Process Control (SPC) was introduced, process standards were developed, and capability studies carried out. As a result, production processes were simplified, quality was in-built at source and a move from inspection to prevention was achieved. However, something was still lacking and the mill decided to implement Total Productive Maintenance (TPM). TPM is an approach that improves product and process reliability, which are important concepts in TQM. As part of the implementation of TPM:

1. A multi-disciplinary team, chaired by the production superintendent, was formed and this enabled supplier issues such as non-conformance with specification of raw materials to be addressed immediately; the supplier could be brought to the meeting if required.
2. Autonomous maintenance tasks that enhanced and built on RCM methodologies were identified as: (a) setup; (b) minor adjustments; (c) machine cleaning (to clean is to inspect, which is a basic premise); (d) bolting (operators checking if bolts were tight).
3. Identified training issues could also be addressed immediately by the human resources representative.
4. Operational level day-to-day proactive problem identification and solving was carried out using tools like the "five whys" to check whether other possible causes of failure had been addressed-or whether failure could have been prevented and what was needed to prevent possible reoccurrence of the failure.
5. Any problems identified were put on a gap list. Any gap that could not be closed by the Strategic Business Unit team was then passed to the team at the next level, which was known as the focus team.
6. A third-level team, called the integration team, was set up to solve problems at the systemic level and a fourth level team, the strategic team, chaired by the general manager and comprising all the heads of departments, was made responsible for strategic issues and the entire productivity journey.

Staff agreed that TPM helped the company as a result of its structured and systematic solution approach.

Questions

1. Do you agree with the opening statement of the case "TQM has positive impact on paper manufacturer"? Explain why or why not.
2. Explain how teams were used by the company and what are the advantages of using teams in TQM?
3. Do you think TPM is useful for a manufacturing organization? How?

Source: http://timesofindia.indiatimes.com/city/pune/DRDO-labs-adapting-to-TQM/articleshow/839174.cms)

Notes

13.3 Summary

- TPM is an organization wide effort aimed at reducing loss due to equipment failure, slowing speed, and defects.
- TMP involves everyone, from top executives to shop floor workers to promote productive maintenance through morale building management and small group activities in an effort to maximize equipment efficiency.
- The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.
- The first step in implementing Total Productivity Maintenance is assessment of current performance.
- Understanding the current system also helps whether existing system can be improved or a new system has to replace the existing one.
- Top management must understand how TPM will affect the operations of the organization. Top management should also be aware of resistance to change and how it can deal the same.
- Senior management needs support of all the employees of the organization for successful implementation of TPM and hence it must spend significant time in promoting the new system.
- Top management should have long-term commitment and it should not focus on short term gains and commitment to long-term investment is the key.
- All employees including top managers, front level supervisors and shop floor employees need to be trained. Training shall focus not just how TPM can be implanted, but should stress why it is needed and what are the possible advantages of TPM.
- Middle management must learn how to deal with team approach and how to develop small autonomous work groups.
- Employees should be capable of working in autonomous work groups. Hence they should learn about various tools used in performing new tasks needed for TPM as part small autonomous teams.
- The teams constituted should focus on current level performance and this can be done in the form of assessment existing systems.
- Plans should focus on use of teams consisting of maintenance technicians and machine operators in production departments to work troublesome problems which may require urgent attention.
- The overall objective of autonomous workgroups is to reduce time spent on maintenance activity.

13.4 Keywords

Cultural Change: A shift that may occur within a culture, usually as a result of outside influences is known as a cultural change.

Employee's Involvement: Giving employees input and allowing them an impact on decisions affecting their jobs is referred to as employee's involvement.

Notes

Intellectual Capital: The term Intellectual capital collectively refers to all resources that determine the value and the competitiveness of an enterprise.

Life Cycle Cost: It is the concept of including acquisition, operating, and disposal costs when evaluating various alternatives.

Preventive Maintenance: An equipment maintenance strategy based on replacing, overhauling or remanufacturing an item at a fixed interval, regardless of its condition at the time is referred to as preventive maintenance.

Team Approach: An approach to assessment that requires the active involvement of professionals from many fields, parents, perhaps the person with a disability, and other interested parties is known as team approach.

Total Productive Maintenance: A series of methods, originally pioneered to ensure that every machine in a production process is always able to perform its required tasks so that production is never interrupted is known as total productive maintenance.

Training: The action of teaching a person or animal a particular skill or type of behaviour is called as training.

13.5 Review Questions

1. Briefly explain TPM and its objectives.
2. Discuss the planning step in total productivity maintenance.
3. Explain the areas of improvement which can be achieved through TPM.
4. What are the various attributes required for implementation of TPM in an organization?
5. What steps should be taken by the top management to promote the TPM philosophy?
6. Mention the various departments involved in the training stage of TPM implementation. Why do you think are they important?
7. Why TPM needs autonomous workgroups? Explain.
8. Mathematically explain downtime losses.
9. Explain different metrics used for measurement in TPM.
10. Explain the relationship between TPM and TQM.

Answers: Self Assessment

1.	Japanese	2.	Nippon Denso
3.	Loss	4.	Production; employee morale
5.	Current performance	6.	Senior management
7.	Unused	8.	Long-term; short-term
9.	Training	10.	Team
11.	Productivity improvement	12.	Employee's
13.	Operational	14.	Training
15.	Natural flow	16.	Maintenance

Notes

13.6 Further Readings

Books

Besterfield, Dale H. (2011), *Total Quality Management,* Pearson Education, India

Charantimath M. Poornima (2009), *Total Quality Management*, Pearson Education, India

Mukherjee, N.P. (2006), *Total Quality Management,* PHI Learning Pvt. Ltd.

Nigam. Shailendra (2009), *Total Quality Management,* Excel Books, India

Online links

http://et.nmsu.edu/~etti/fall97/manufacturing/tpm2.html

http://www.hutchins.co.uk/Ar_TPM.aspx

http://www.reliableplant.com/Read/8481/total-productive-maintenance

http://www.tvss.net/pm/tpm.htm

Unit 14: Statistical Process Control

Notes

CONTENTS

Objectives

Introduction

14.1 Statistical Process Control (SPC)

14.1.1 Benefits of SPC

14.2 Statistical Quality Control (SQC)

14.2.1 Advantages of Statistical Quality Control

14.3 Process Capability: A Discerning Measure of Process Performance

14.4 Control Charts

14.4.1 Steps for Developing Control Charts

14.4.2 Patterns in Control Charts

14.5 Design of Experiments and Statistical Process Control

14.5.1 Objectives of Experimentation

14.5.2 Various Terms used in Experimentation

14.5.3 Traditional Approach

14.5.4 Statistically Designed Experiments

14.5.5 Planning for Experimentation

14.5.6 Classification of Factors

14.5.7 Response and Type of Model for Analysis

14.6 Statistical Fundamentals

14.6.1 Variations and Their Representation

14.6.2 Measures of Central Tendency: Mean, Median and Mode of a Set of Data

14.6.3 Measures of Dispersion

14.6.4 Random Variables

14.6.5 Probability Distribution

14.6.6 Binomial Distribution

14.6.7 Poisson Distribution

14.6.8 The Normal Curve

14.6.9 Geometric Distribution

14.6.10 Central Limit Theorem

14.7 Summary

14.8 Keywords

14.9 Review Questions

14.10 Further Readings

Notes

Objectives

After studying this unit, you will be able to:

- Explain Statistical Process Control
- Discuss Statistical Quality Control
- Describe Process Capability
- Explain the Concept of Control Charts
- Elaborate the Design of Experiment and Statistical Process Control
- Explain the Statistical Fundamentals in SPC

Introduction

The concept of TQM is basically very simple. Each part of the organization has customers some external and many internal. Identifying what the customer requirements are and setting about to meet them is the core of a total quality approach. This requires a good management system, methods including Statistical Quality Control (SQC) and teamwork.

A well-operated, documented management system provides the necessary foundation for the successful application of SQC. Note, however, that SQC is not just a collection of techniques. It is a strategy for reducing variability, the root cause of many quality problems. SQC refers to the use of statistical methods to improve or enhance quality for it customer satisfaction. However, this task is seldom trivial because real world processes are affected by numerous uncontrolled factors. For instance, within every factory, conditions fluctuate with time. Variations occur in the incoming materials, in machine conditions, in the environment and in operator performance. A steel plant, for example, may purchase good quality ore from a mine, but the physical and chemical characteristics of ore coming from different locations in the mine may vary. Thus, everything isn't always "in control."

14.1 Statistical Process Control (SPC)

The application of statistical techniques to control a process; often used interchangeably with the term "statistical quality control."

Statistical Process Control (SPC) involves using statistical techniques to measure and analyze the variation in processes. Most often used for manufacturing processes, the intent of SPC is to monitor product quality and maintain processes to fixed targets. Statistical quality control refers to using statistical techniques for measuring and improving the quality of processes and includes SPC in addition to other techniques, such as sampling plans, experimental design, variation reduction, process capability analysis, and process improvement plans.

SPC is used to monitor the consistency of processes used to manufacture a product as designed. It aims to get and keep processes under control. No matter how good or bad the design, SPC can ensure that the product is being manufactured as designed and intended. Thus, SPC will not improve a poorly designed product's reliability, but can be used to maintain the consistency of how the product is made and, therefore, of the manufactured product itself and its as-designed reliability.

A primary tool used for SPC is the control chart, a graphical representation of certain descriptive statistics for specific quantitative measurements of the manufacturing process. These descriptive statistics are displayed in the control chart in comparison to their "in-control" sampling distributions. The comparison detects any unusual variation in the manufacturing process, which

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could indicate a problem with the process. Several different descriptive statistics can be used in control charts and there are several different types of control charts that can test for different causes, such as how quickly major vs. minor shifts in process means are detected.

Note Control charts are also used with product measurements to analyze process capability and for continuous process improvement efforts.

14.1.1 Benefits of SPC

- Provides surveillance and feedback for keeping processes in control
- Signals when a problem with the process has occurred
- Detects assignable causes of variation
- Accomplishes process characterization
- Reduces need for inspection
- Monitors process quality
- Provides mechanism to make process changes and track effects of those changes

Once a process is stable (assignable causes of variation have been eliminated), provides process capability analysis with comparison to the product tolerance.

Self Assessment

Fill in the blanks:

1. …… is a graphical representation of certain descriptive statistics for specific quantitative measurements of the manufacturing process.
2. …… is used to monitor the consistency of processes used to manufacture a product as designed.
3. Statistical Process Control (SPC) involves using …… techniques to measure and analyze the variation in processes.

Caselet

Statistical Process Control Tool

Statistical process control is the application of statistical methods to the measurement and analysis of variation process. Various regulatory authorities such as Validation Guidance for Industry (2011), International Conference on Harmonisation ICH Q10 (2009), the Health Canada guidelines (2009), Health Science Authority, Singapore: Guidance for Product Quality Review (2008), and International Organization for Standardization ISO-9000:2005 provide regulatory support for the application of statistical process control for better process control and understanding. In this study risk assessments, normal probability distributions, control charts, and capability charts are employed for selection of critical quality attributes, determination of normal probability distribution, statistical stability, and capability of production processes, respectively. The objective of this study is to determine tablet production process quality in the form of sigma process capability.

Contd...

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By interpreting data and graph trends, forecasting of critical quality attributes, sigma process capability, and stability of process were studied. The overall study contributes to an assessment of process at the sigma level with respect to out-of-specification attributes produced. Finally, the study will point to an area where the application of quality improvement and quality risk assessment principles for achievement of six sigma-capable processes is possible.

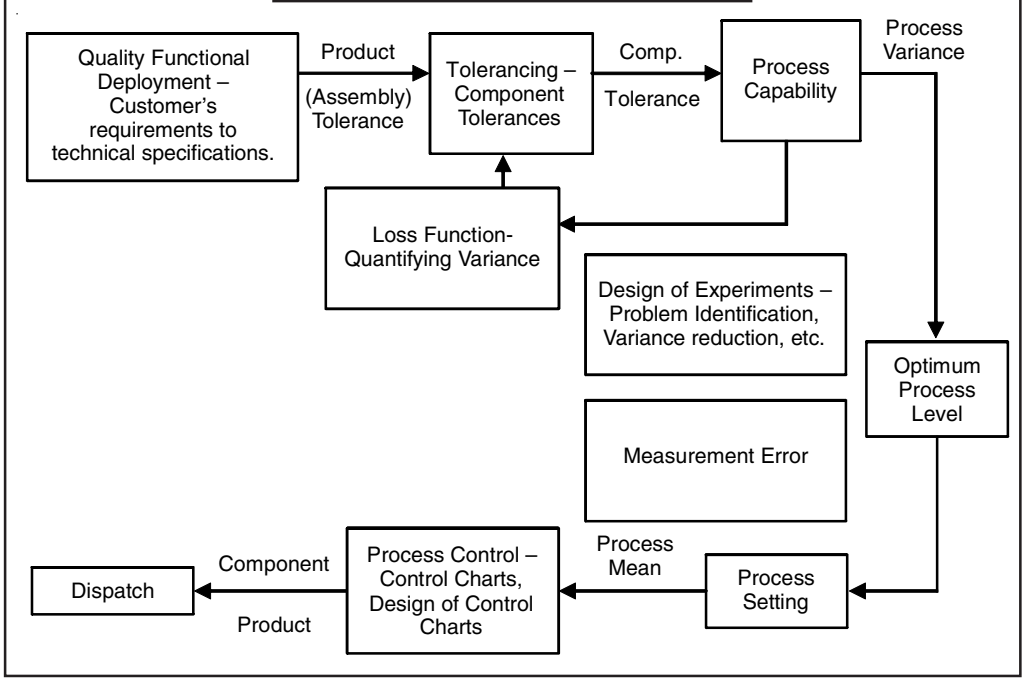
Statistical process control is the most advantageous tool for determination of the quality of any production process. This tool is new for the pharmaceutical tablet production process. In the case of pharmaceutical tablet production processes, the quality control parameters act as quality assessment parameters. Application of risk assessment provides selection of critical quality attributes among quality control parameters. Sequential application of normality distributions, control charts, and capability analyses provides a valid statistical process control study on process. Interpretation of such a study provides information about stability, process variability, changing of trends, and quantification of process ability against defective production. Comparative evaluation of critical quality attributes by Pareto charts provides the least capable and most variable process that is liable for improvement. Statistical process control thus proves to be an important tool for six sigma-capable process development and continuous quality improvement.

Source: http://journal.pda.org/content/66/2/98.abstract

14.2 Statistical Quality Control (SQC)

The application of statistical techniques to control quality often used interchangeably with the term "statistical process control," although statistical quality control includes acceptance sampling, which statistical process control does not. It provides the methods and tools for the manufacturing manager to improve quality, increase productivity, and enhance the competitive position of the manufacturing line. SQC proposes potentially controversial methods of performance appraisals, operation certification, line qualification, vendor certification and just-in-time manufacturing.

Figure 14.1: Statistical Quality Control



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Statistical quality control provides the statistical techniques necessary to assure and improve the quality of products. Most of the statistical quality techniques used have been developed during the last century. Basic steps in statistical quality control methodology are represented in Figure 14.1, which also lists the output of each step.

14.2.1 Advantages of Statistical Quality Control

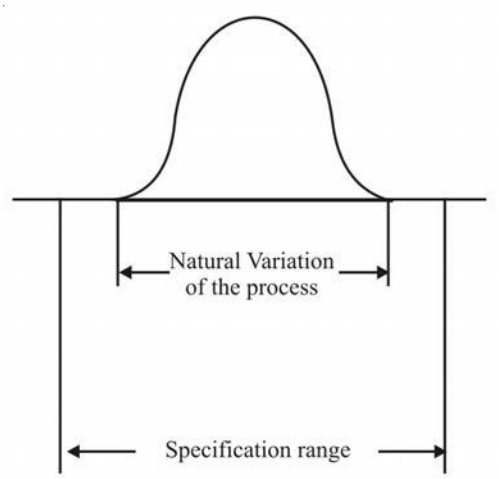
- When the quality of a product is tested by destructive testing, then 100% testing will spoil all the products. Under statistical quality control very few products will be destructed in testing.
- It ensures control, maintenance and improvement in the quality standards.
- It provides better quality assurance at lower inspection cost.
- It reduces the wastage of time and material to the minimum. It reduces the inspection and manufacturing cost and enhances profits.

14.3 Process Capability: A Discerning Measure of Process Performance

We introduce now an important concept employed in thinking statistically about real life processes. Process capability is the range over which the "natural variation" of a process occurs as determined by the system of common or random causes; that is, process capability indicates what the process can deliver under "stable" conditions when it is said to be under statistical control.

The capability of a process is the fraction of output that can be routinely found to be within specifications (specs). A capable process has 99.73% or more of its output within specifications (Figures 14.2 and 14.3).

Figure 14.2: A Capable Process: Natural Variation is within Spec



Process capability refers to how capable a process is of making parts that are within the range of engineering or customer specifications. Figure 14.2 shows the distribution of the dimension of parts for a machining process whose output follows the bell-shaped normal distribution. This process is capable because the distribution of its output is wholly within the specific range. The process shown by Figure 14.3 is not capable.

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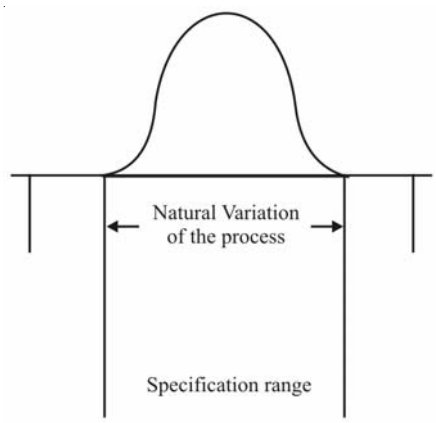
Figure 14.3: A Process that is not Capable: Natural Variation exceeds Spec Range

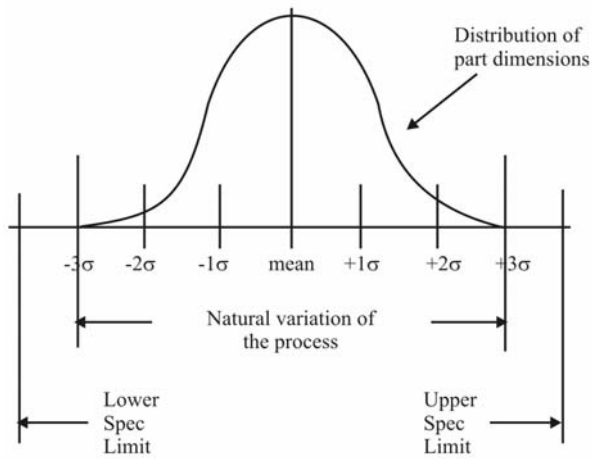


Process Control on the other hand refers to maintaining the performance of a process at its current capability level. Process control involves a range or activities such as sampling the process product, charting its performance, determining causes of any excessive variation and taking corrective action.

Knowing process capability allows manufacturing and quality managers to predict, quantitatively, how well a process will meet specs and to specify equipment requirements and the level of control necessary to maintain the firms' capability. For example, if a design space require a length of metal tubing to be cut within one-tenth of an inch, a process consisting of a worker using a ruler and hacksaw will probably result in a large percentage of non-conforming products in that case the process, due to its high inherent or natural variability, is not capable of meeting the design specs. Management would face here three possible choices:

- Measure each piece of the non-conforming tubing,
- Develop a better process by investing in new technology,
- Change the specifications.

Figure 14.4: A Capable Process: Output is Wholly within Spec Limits



Process capability has three important components: (1) the design specifications, (2) the centering of the natural variation, and (3) the range, or spread, of variation. Figures 14.4 to 14.5 illustrate

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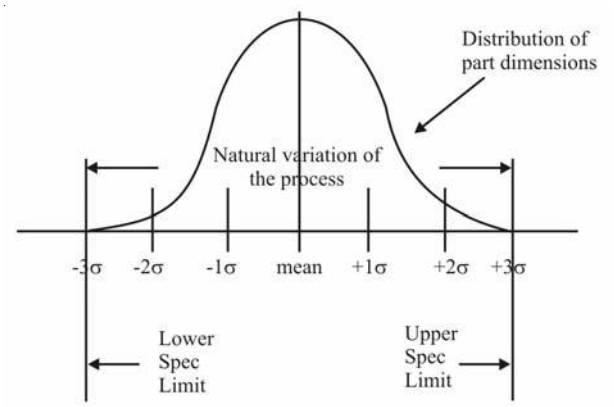
four possible outcomes that can arise when natural process variability is compared with product specs. In Figure 14.4 the specifications are wider than the natural variation; one would therefore expect that this process will always produce conforming products as long as it remains in control. It may even be possible to reduce costs by investing in a cheaper technology that permits a larger variation in the process output. In Figure 14.5, the natural variation and specifications are the same. A small percentage of nonconforming products might be produced; thus, the process should be closely monitored.

Figure 14.5: A Process with Natural Variability Equal to Spec Range



In Figure 14.6, the range of natural variability is larger than the specification; thus, the current process would not always meet specifications even when it is in control. This situation often results from a lack of adequate communication between the design department and manufacturing, a task entrusted to manufacturing engineers.

If the process is in control but cannot produce according to the design specifications, the question should be raised whether the specifications have been correctly applied or if they may be relaxed without adversely affected the assembly or subsequent use of the product. If the specifications are realistic and firm, an effort must be made to improve the process to the point where it is capable to producing consistently within specifications.

Finally, in Figure 14.6, the capability is the same as in Figure 14.7, but the process average is of-centre.

Figure 14.6: A Process with Natural Variability wider than Spec Limits

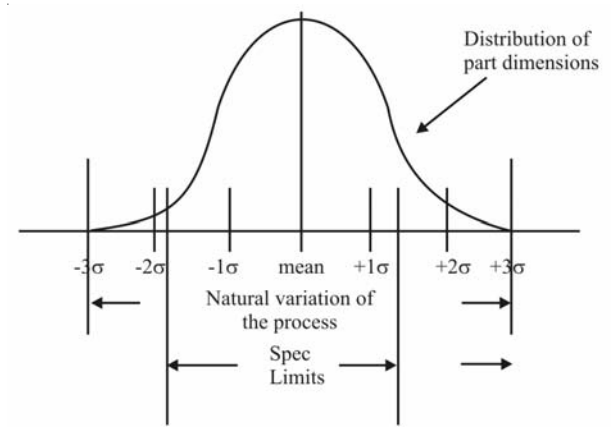


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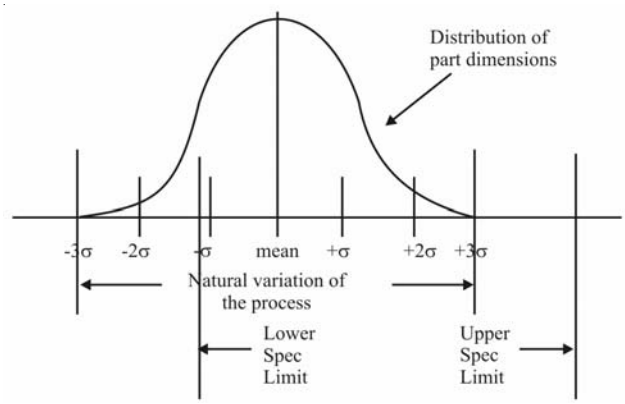
Figure 14.7: An Off-centred Process



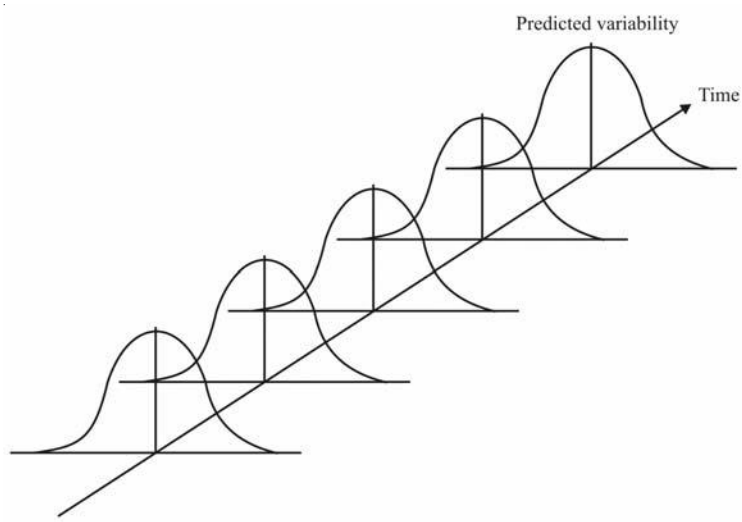
Usually this can be corrected by a simple adjustment of a machine setting or recalibrating the inspection equipment used to capture the measurements. If no action is taken, however, a substantial portion of output will fall outside the spec limits even though the process has the inherent capability to meet specifications.

We may define the study or process capability from another perspective. A capability study is a technique for analyzing the random variability found in a production process. In every manufacturing process there is some variability. This variability may be large or small, but it is always present. It can be divided into two types:

- Variability due to common (random) causes
- Variability due to assignable (special) causes

The first type of variability is said to be inherent in the process and it can be expected to occur naturally within a process. It is attributed to a multitude of factors which behave like a constant system of the chances affecting the process. Called common or random causes, such factors include equipment vibration, passing traffic, atmospheric pressure or temperature changes, electrical voltage or humidity fluctuations, changes in operator's physical nr emotional conditions,

Figure 14.8: Common Causes of Variation Present, but no Assignable Causes



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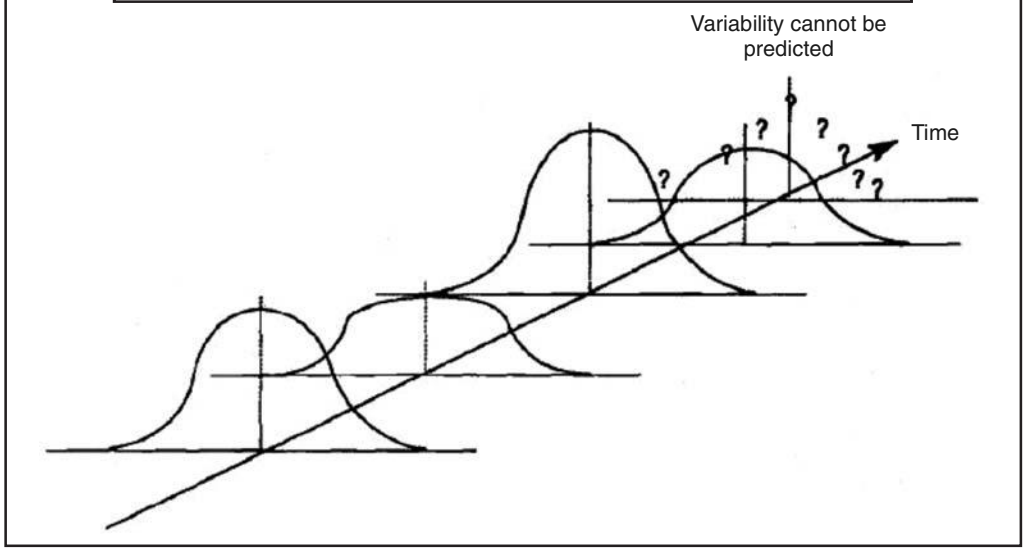
etc. Such forces determine whether a coin when tossed will end up, showing a head or tail when on the floor. Together, however, these "chances" form a unique, stable and describable distribution. The behaviour of a process operating under such conditions is predictable (Figure 14.8).

Inherent variability may be reduced by changing the environment or the technology, but given a set of operating condition; this variability can never be completely eliminated from a process. Variability due to assignable causes, on the other hand, refers to the variation that can be linked to specific or special causes that disturb a process. Examples are tool failure, power supply interruption, process controller malfunction, adding wrong ingredients or wrong quantities, switching a vendor, etc.

Assignable causes are fewer in number and are usually identifiable through investigation in the shop floor or an examination of process logs. The effect (i.e., the variation in the process) caused by an assignable factor, however, is usually large and detectable when compared with the inherent variability-seen in the process. If the assignable causes are controlled properly, the total process variability associated with them can be reduced and even eliminated. Still, the effect of assignable causes cannot be described by a single distribution (Figure 14.9).

Figure 14.9: Both Common and Assignable Causes affecting the Process



A capability study measures the inherent variability or the performance potential of a process when no assignable causes are present (i.e. when the process is said to be in statistical control). Since inherent variability can be described by a unique distribution, usually a normal distribution, capability can be evaluated by utilizing the properties of this distribution. Recall that capability is the proportion of routine process output that remains within product specs.

Even approximate capability calculations done using histograms enable manufacturers to take a preventive approach to defects. This approach is in contrast with the traditional two-step process: production personnel make the product while QC personnel inspect and screen out products that do not meet specifications. Such QC is wasteful and expensive since it allows plant resources including time and materials to be put into products that are not salable.

It is also unreliable since even 100 percent inspection would fail to catch all defective products. SPC aims at correcting undesirable changes in the output of a process. Such changes may affect the centering (or accuracy) of the process, or its variability (spread or precision). These effects are graphically shown in Figure 14.10 (a) and Figure 14.10 (b).

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Figure 14.10 (a): Process Accuracy and Precision

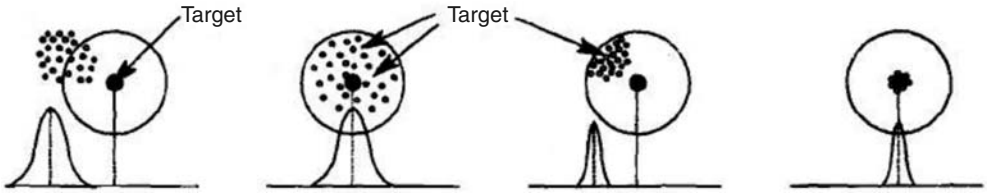
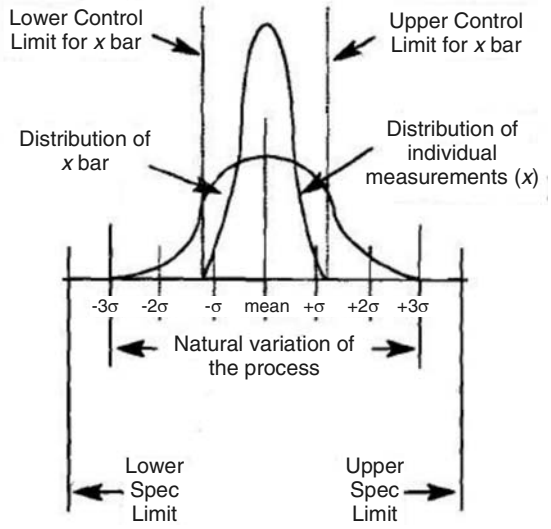


Figure 14.10 (b): Process Accuracy and Precision



Control Limits are not an Indication of Capability

Those new to SPC often have the misconception that they don't need to calculate capability indices. Some even think that they can compare their control limits to the spec limits. This is not true, because control limits look at the distribution of averages (x-bar; p, np, u, etc.) while capability indices look at the distribution of individual measurements (x). The distribution of x for a process will always be more spread out than the distribution of its x-bar values (Figure 14.10 (b)). Therefore, the control limits are often within the specification limits but the plus-and-minus 3-sigma distribution of individual part dimensions (x) is not.

Note The statistical theory of the "central limit theorem says that the averages, of samples or subgroups {x-bar} follow more closely a normal distribution. This is why we can easily construction control charts on process data that are themselves not normally distributed. But averages-cannot be used for capability calculation/because capability evaluates individual parts delivered by a process. After all, parts get shipped to customers, not averages.

Notes

Self Assessment

Fill in the blanks:

4. Statistical ..... control provides the statistical techniques necessary to assure and improve the quality of products.
5. The ..... of a process is the fraction of output that can be routinely found to be within specifications.
6. ..... capability refers to how capable a process is of making parts that are within the range of engineering or customer specifications.
7. A capability study measures the inherent variability or the ..... potential of a process when no assignable causes are present.
8. The ..... theory of the "central limit theorems says that the averages, of samples or subgroups follow more closely a normal distribution.

14.4 Control Charts

Statistical Quality Control (SQC) or Statistical Process Control (SPC) for repetitive, high volume production began in the 1930's when Shewart developed control charts.

The control chart is the fundamental tool of statistical process control, as it indicates the range of variability that is built into a system (known as common cause variation). Thus, it helps determine whether or not a process is operating consistently or if a special cause has occurred to change the process mean or variance.

The principles behind the application of control charts are very simple and are based on the combined use of run charts and hypothesis testing. Control charts are used to detect whether a process is statistically stable. Control charts differentiate variations.

Did u know? Control charts are decision-making tools. They provide an economic basis for deciding whether to alter a process or leave it alone. Control charts are problem-solving tools and provide a basis to formulate improvements actions.

They are trend charts with statistically determined upper and lower limits on either side of the process average. The bounds of the control chart are marked by upper and lower control limits that are calculated applying statistical formulas to data from the process.

Data points that fall outside these bounds represent variations due to special cause, which can typically be found and eliminated. On the other hand, improvements in common cause variation require fundamental changes in the process.

Control charts are powerful aids to understanding the performance of a process over time. They identify variation. They are time plots that also indicate the range of variation built into the system. They are used to monitor a process to see whether it is in statistical control.

Control charts help us learn more about process variation. They determine whether a process is in a state of statistical control or out-of-control. They are used to estimate the process parameters (mean, variation) and assess the performance of a process or its capability.

Note Control charts are outgrowth of run charts. Run chart records the output result of a process over time and shows the trends. But they do not distinguish the type of variations.

Notes

Elements of a Control Chart: A control chart consists of:

- A central line,
- An upper control limit,
- A lower control limit, and
- Process values plotted on the chart.

14.4.1 Steps for Developing Control Charts

Steps required for developing and using control charts are as follows:

1. Preparation
   - Choose the variable or attribute to be measured
   - Determine the basis, size and frequency of sampling
   - Set up the control charts
2. Data collection
   - Record the data
   - Calculate relevant statistics: averages, ranges, proportions, and so on
   - Plot the statistics on the chart
3. Determination of trial control limit
   - Draw the centre line (process average) on the chart
   - Compute the upper and lower control limits
4. Analysis and interpretation
   - Investigate the chart for lack of control
   - Eliminate out-of-control points
   - Recompute control limits if necessary
5. Use as a problem-solving tool
   - Continue data collection and plotting
   - Identify out-of-control situations and take corrective action
6. The chart may contain other optional features
   - Upper and lower warning limits, drawn as separate lines, typically two standard deviations above and below the centre line
   - Division into zones, with the addition of rules governing frequencies of observations in each zone
   - Annotation with events of interest, as determined by the Quality Engineer in charge of the process's quality

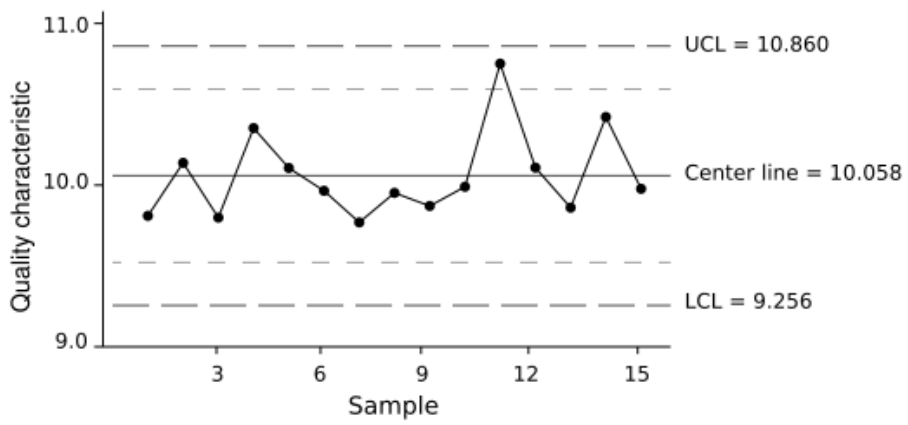
However in the early stages of use the inclusion of these items may confuse inexperienced chart interpreters.

In general, the chart contains a Centreline that represents the mean value for their-control process. Two other horizontal lines, called the Upper Control Limit (UCL) and the Lower Control

Notes

Limit (LCL), are also shown on the chart. These control limits are chosen so that almost all of the data points will fall within these limits as long as the process remains in-control.

Figure 14.11: Control Chart



Control limits are lines on the charts that represent the current acceptable level of variation in the process. They are functions of the natural variability of the process. They describe the process spread. They are usually chosen so that nearly all of the sample points would fall between them in the absence of any special causes of variation affecting the process.

The control limits represent the maximum amount that the average or range should vary if the process does not change. A point outside the control limits indicates that the process has changed. When the control chart identifies a change, an investigation should be made as to the cause of the change.

If all process values are plotted within the upper and lower control limits and no particular tendency is noted, the process is referred to as "In Control". If the process values are plotted outside the control limits or show a particular tendency the process is referred to as "Out of Control".

Caution The determination of the control limits, along with the sample size and the sampling frequency, is one of the most important tasks in designing a control chart.

If a single quality characteristic has been measured or computed from a sample, the control chart shows the value of the quality characteristics versus the sample number or versus time.

To monitor a process, we typically use two control charts: (1) mean (or some other central tendency measure) and (2) variation (typically using range or standard deviation). To monitor output, we use a control chart to check things like the mean, range, standard deviation.

In a control chart, control limits are calculated by the following formula:

(Average Process Value) ± (3 X (Standard Deviation which represented by σ))

Where the standard deviation is due to unassigned variation only.

Control charts make assumptions about the plotted static, namely:

- It is independent, i.e., A value is not influenced by its past value and will not affect future values.
- It is normally distributed, i.e. the data has a normal probability density function.

Notes

Control charts work on the basis of "6 sigma control". The six-sigma value is derived from looking at distance ± 3σ from the mean (μ), for a range of 6σ total.

When applying control charts it is common practice to establish the control limits based on the process capability study and then use fix limits on the chart during production. They should be reevaluated regularly depending on production volume, but at least once every 3 months to minimise error in control chart analysis.

Control limits can be managed to prioritize the efforts of operators and help allocate limited resources on the shop floor. This is done by setting control limits at 3 sigma for critical characteristics and perhaps 4 or 5 sigma for less critical characteristics.

14.4.2 Patterns in Control Charts

- ***One Point Outside Control Limits:*** Indicates variation due to a special cause like a sudden power surge, a broken tool, measurement error, or an incomplete or omitted operation in the process.
- ***Sudden Shifts in the Process Average:*** Indicates sudden shifting of the process average.
- ***Cycle:*** Short and repeated patterns in the chart with alternating high peaks and how valleys called cycles are the result of cause that come and go on a regular basis.
- ***Trends:*** A trend is the result of some cause that gradually affects the quality characteristics of the product and causes the point on a control chart to gradually move up or down from the centre line.
- ***Hugging the Centre Line:*** It occurs when nearly all the points fall close to the centre line indicating that the control limits are too wide.
- ***Hugging the Control Limits:*** The pattern shows up when many points are near the control limits with few in between.

Control charts are designed to be used by production operators rather than by inspectors or quality control personnel. The use of control charts allows the operators to react quickly to special cause of variation.

Control charts help to identify key input variables causing the process to shift and aid in the reduction of the variation. Control charts are used to detect changes in the process. They are also used as part of a capability study to demonstrate that the process is stable or consistent.

Elements of Typical Control Chart

1. Horizontal axis for sample number
2. Vertical axis for sample statistics e.g. mean, range, standard deviation of sample
3. Target Line
4. Upper control line
5. Upper warning line
6. Lower control line
7. Lower warning line
8. Plotting of sample statistics
9. Line connecting the plotted statistics

Notes

Grand Mean

Let the sample mean for the *i*th sample be $\bar{X}_i$. Then we estimate the mean of the population, μ, by the grand mean:

$$\bar{\bar{X}} = \frac{1}{m}\sum_{i=1}^{m}\bar{X}_i$$

Average Range and Estimator of σ

Let R_i be the range of the ith sample, and let

$$\bar{R} = \frac{1}{m}\sum_{i=1}^{m}R_i$$

be the average. Then $\bar{R}$ is an estimator of μ_R and an estimator of σ is:

$$\hat{\sigma} = \frac{\bar{R}}{d_2}$$

The $\bar{X}$ Control Chart

The center line and upper and lower control limits for an $\bar{X}$ control chart are:

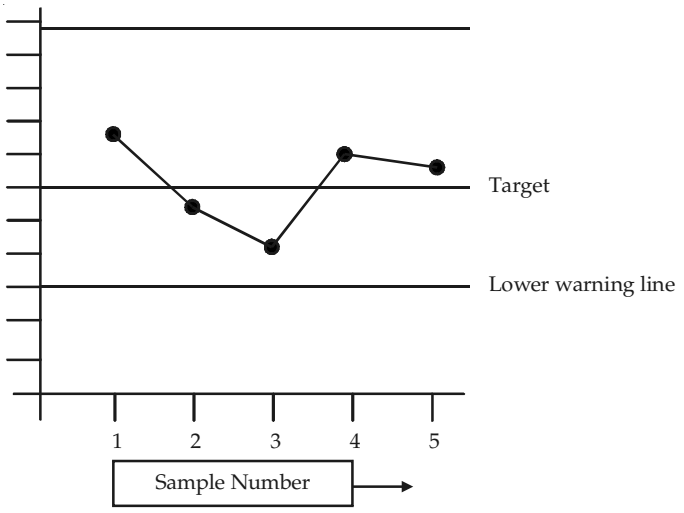
$$UCL = \bar{\bar{x}} + A_2\bar{r}$$

$$CL = \bar{\bar{x}}$$

$$LCL = \bar{\bar{x}} - A_2\bar{r}$$

where the constant A_2 is tabulated for various sample sizes in Appendix Table of Control Charts.

Figure 14.12: Control Chart



Notes

The R Control Chart

The center line and upper and lower control limits for an R chart are:

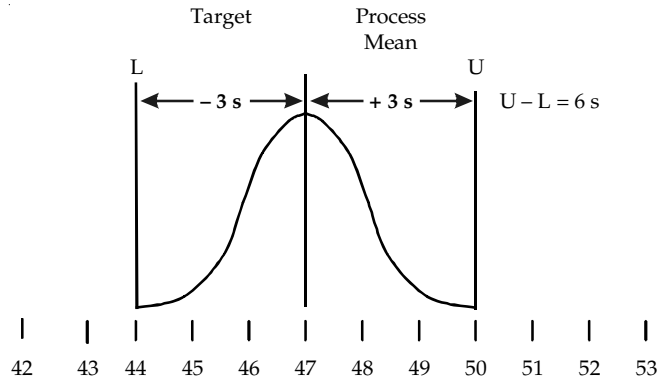
$$UCL = D_4\bar{r}$$

$$CL = \bar{r}$$

$$LCL = D_3\bar{r}$$

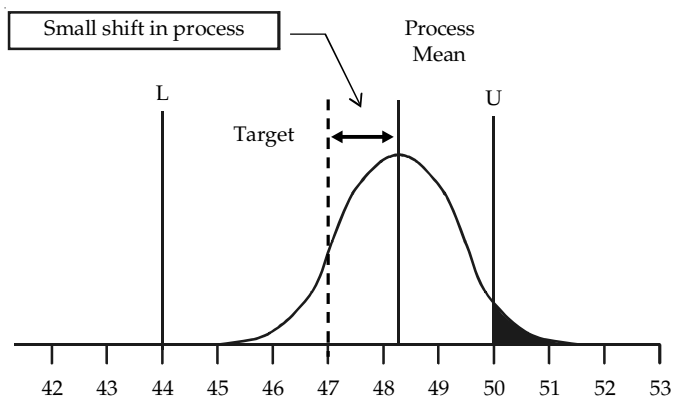
where $\bar{r}$ is the sample average range, and the constants D_3 and D_4 are tabulated for various sample sizes in Appendix Table of Control Charts.

Figure 14.13: Chances of getting a Reading beyond U&L is almost Nil



When an observation falls within original +3s and – 3s zone of mean of a process, we conclude that there is no shift in the mean of process. This is so because falling of an observation between these limits is a chance.

Figure 14.14: Shift in Process



When an observation falls beyond original +3s and – 3s zone of process mean, we conclude that there is shift in location of the process.

Step 1: Select quality characteristics which needs to be controlled

- Weight
- Length

Notes

- Viscosity
- Tensile Strength
- Capacitance

Step 2: Decide the number of units, n to be taken in a sample.

Notes The minimum sample size should be 2. As the sample size increases then the sensitivity i.e. the quickness with which the chart gives an indication of shift of the process increases.

However, with the increase of the sample size cost of inspection also increases.

Generally, n can be 4 or 5.

Step 3: Collect data on a special control chart data

Collection sheet (Minimum 100 observations)

The data collection sheet has following main portions:

1. General details for part, department, etc.
2. Columns for date and time sample taken
3. Columns for measurements of sample
4. Column for mean of sample
5. Column for range of sample

A manufacturing process produces gasket material blanks. In order to better understand the manufacturing process, it was suggested to the manufacturing engineer to construct a control chart. After meeting with his team, he decides to construct a control chart for the thickness of the gasket material blanks. The team decides to take a sample size of n=4 every have hour and measure the thickness of each gasket material blank. The average of the four thicknesses is then measured as well as the range for the four parts. Table 14.1 below has a list of the X-bar, or average, of each sample and it's range.

Table 14.1: The X-bar and Range of Each Sample

	8 am	8:30 am	9 am	9:30 am	10 am	10:30 am	11 am	11:30 am	12 pm	12:30 pm	1 pm
X-bar	1.25	0.95	0.8	1.0	1.15	0.95	0.95	1.2	1.05	1.0	0.9
range	0.5	0.45	0.55	0.00	0.25	0.5	0.4	0.65	0.1	0.5	0.35
	1:30 pm	2 pm	2:30 pm	3 pm	3:30 pm	4 pm	4:30 pm	5 pm	5:30 pm	6 pm	6:30 pm
X-bar	1.15	0.85	1.0	1.25	0.95	1.05	1.0	1.3	1.15	1.0	1.05
range	0.45	0.5	0.6	0.5	0.55	0.3	0.5	0.35	0.55	0.4	0.4

The average = Sum of the thickness for each measured part/number of parts.

The range = The biggest value in the sample – The lowest value in the sample.

The next step is to construct the three lines of each of the average and range control charts.

Notes

For the Range Chart

The center line = The average of all the sample ranges (R-bar) = 0.425.

$$UCL = D_4 \times (R\text{-bar}) = 2.283 \times 0.425 = 0.97$$

$$LCL = D_3 \times (R\text{-bar}) = 0 \times 0.425 = 0$$

For X-bar or Average Chart

The center line (X-double bar) = is the average of all the averages of the 25 sample points = 1.043

$$UCL = \text{X-double bar} + A_2 \times (\text{R-bar}).$$

$$= 1.043 + (0.729 \times 0.425) = 1.486$$

$$LCL = \text{X-double bar} - A_2 \times (\text{R-bar})$$

$$= 1.05 - (0.729 \times 0.425) = 0.60$$

Where the constants D_3, D_4, and A_2 are based on the sample size of each sample. Any text on the subject will have a table for these values with respect to the sample size n.

Illustration 1: Measurements on averages ($\overline{X}$) and ranges (R) from 20 samples each of size 5 gave the following results. $\overline{X} = 99.6$, $\overline{R} = 7.0$. Determine the values of the control limits for drawing a mean chart.

Given that for n = 5, mean range = 2.32 × population S.D.

Solution: Here we are given: $\overline{\overline{X}} = 99.6, \overline{R} = 7.0$

Now, $\overline{R} = 2.32\sigma \Rightarrow \hat{\sigma} = \dfrac{\overline{R}}{2.32} = \dfrac{7}{2.32} = 3.0172$

3s control limits for mean chart.

$$UCL_{\overline{X}} = \overline{\overline{X}} + 3\left(\frac{\hat{\sigma}}{\sqrt{n}}\right) = 99.6 + \left(3 \times \frac{3.0172}{\sqrt{5}}\right)$$

$$= 99.6 + \left(\frac{9.0516}{2.2361}\right) = 99.6 + 4.0479 = 103.6479$$

$$LCL_{\overline{X}} = \overline{\overline{X}} - \left(\frac{\hat{\sigma}}{\sqrt{n}}\right) = 99.6 - 4.0479 = 95.5521$$

$$CL_{\overline{X}} = \overline{\overline{X}} = 99.6$$

Illustration 2: The following figures give the number of defectives in 20 samples. Containing 2000 items. 425, 430, 216, 341, 225, 322, 280, 306, 337, 305, 356, 402, 216, 264, 126, 409, 193, 280, 389.

Calculate the values for central line and the control limits for P-chart (Fraction defectives chart).

Solution: Total number of defectives out of 40,000 items in sample is:

$$\Sigma d = 425 + 430 + \ldots + 389 = 6{,}148$$

$$\overline{P} = 6{,}148 \div 40{,}000 = 0.1537$$

For p-chart

$$CL_P = \overline{P} = 0.1537.$$

$$LCL_P = \overline{P} - 3\sqrt{\overline{P}\,(1 - \overline{P})\ln}$$

Notes

$$= 0.1537 - 3\sqrt{\frac{0.1537 \times 0.8463}{2500}}$$

$$= 0.1537 - 0.0242 = 0.1295.$$

$$UCL_P = \overline{P} + 3\sqrt{\overline{P}(1-\overline{P})\ln} = 0.1537 + 0.0242$$

$$= 0.1779.$$

Illustration 3: The following date shows the individual weights for the five boxes in each of 10 samples. Construct a $\overline{X}$ chart and R chart and determine whether this process is in control?

Sample No.	Box Number				
	1	2	3	4	5
1	8.41	7.70	7.90	7.55	7.92
2	7.68	8.21	7.58	7.67	8.09
3	8.69	7.64	8.16	8.05	8.15
4	7.48	8.17	8.50	7.67	7.66
5	8.38	7.97	8.05	7.98	8.31
6	7.48	8.23	8.23	7.74	7.75
7	8.29	8.03	8.21	7.57	7.93
8	8.00	7.81	8.33	7.95	7.76
9	7.90	7.94	8.07	8.02	7.31
10	7.52	7.81	7.93	8.14	8.07

Conversion failures for n = 5, $A_2 = 0.577$, $D_2 = 0$ and $D_4 = 2.115$.

Calculations for mean and range.

Solution:

Sample No.	Box Number					Total	($\overline{X}$) Mean	R Range
	1	2	3	4	5			
1	8.41	7.70	7.90	7.55	7.92	39.84	7.90	0.86
2	7.68	8.21	7.58	7.67	8.09	30.23	7.85	0.63
3	8.69	7.64	8.16	8.05	8.15	40.69	8.14	1.05
4	7.48	8.17	8.50	7.67	7.66	39.48	7.90	1.02
5	8.38	7.97	8.05	7.98	8.31	40.69	8.14	0.41
6	7.48	8.23	8.23	7.74	7.75	39.43	7.89	0.75
7	8.29	8.03	8.21	7.57	7.93	40.03	8.06	0.72
8	8.00	7.81	8.33	7.95	7.76	39.85	7.97	0.57
9	7.90	7.94	8.07	8.02	7.31	39.24	7.85	0.76
10	7.52	7.81	7.93	8.14	8.07	39.47	7.89	0.62
							79.54	7.39

For the 10 samples,

$$\Sigma = 79.54 \qquad \Sigma R = 7.39$$

Process average, $\overline{\overline{X}} = \frac{1}{10}(79.54) = 7.95$

Notes

Mean range, $\overline{\overline{R}} = \frac{1}{10}(7.39) = 0.74$

Control chart for Mean ($\overline{X}$)

Central line, $CL_{\overline{X}} = \overline{\overline{X}} = 7.95$

$$UCL_{\overline{X}} = \overline{\overline{X}} + A_2\overline{R} = 7.95 + 0.58 \times 0.74 = 8.38$$

$$UCL_{\overline{X}} = \overline{\overline{X}} - A_2\overline{R} = 7.95 - 0.58 \times 0.74 = 7.52$$

Control chart for Range (R)

Central line = $\overline{R}$

$$UCL_R = D_4\overline{R} = 2.115 \times 0.74 = 1.56$$

$$LCL_R = D_2\overline{R} = 0 \times 0.74 = 0$$

Since all the sample means ($\overline{X}$) and the sample ranges (R) lie within the corresponding control limits, the production process is in a state of statistical control.

Illustration 4: In the following data are given the number of defective founded on 24 consecutive production days in daily samples of 400 items. Draw (i) np-chart and (ii) p chart.

Production day:	1	2	3	4	5	6	7	8	9	10
No. of defections:	20	10	20	24	22	18	38	8	24	54

Production day:	11	12	13	14	15	16	17	18	19	20
No. of defections:	50	18	24	30	16	28	20	8	22	22

Production day:	21	22	23	24
No. of defections:	52	6	20	22

Solution: Total number of units examined.

= No. of samples × Sample size

= 24 × 400 = 9600

Total no. of units defective = 576.

$\therefore$ Average proportion of defectives = $\overline{P} = \frac{\text{No. of defectives}}{\text{No. of units}}$

$$= \frac{576}{9600} = 0.06$$

$\therefore$ Average proportion of defectives = 0.06.

(i) np chart

$$CL_{np} = n\overline{p} = 400 \times 0.06 = 24.$$

$$LCL_{np} = n\overline{p} - 3\sqrt{n\overline{p}(1-\overline{p})} = 24 - 3\sqrt{400 \times 0.06 \times 0.94} = 9.75$$

$$UCL_{np} = n\overline{p} + 3\sqrt{n\overline{p}(1-\overline{p})} = 24 + 3\sqrt{400 \times 0.06 \times 0.94} = 38.25$$

Notes

(ii) p chart

$$CL_p = \bar{p} = 0.06.$$

$$LCL_p = \bar{p} - 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 0.06 - 3\sqrt{\frac{0.06 \times 0.94}{200}} = 0.0096$$

$$UCLp = \bar{p} + 3\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 0.06 + 3\sqrt{\frac{0.06 \times 0.94}{200}} = 0.110$$

Illustration 5: Draw a suitable control chart for the following data pertaining to the number of foreign coloured threads (considered as defects) in 15 pieces of cloth of 2m × 2m in a certain make of synthetic fibre and state your conclusions.

7, 12, 3, 20, 21, 5, 4, 3, 10, 8, 0, 9, 6, 7, 20.

Solution: The required values for considering a chart are as follows:

(i) The number of defects in each of 15 pieces of cloth are:

C: 7, 12, 3, 20, 21, 5, 4, 3, 10, 8, 0, 9, 6, 7, 20

Average number of defects ($\bar{C}$)

$$\bar{C} = \frac{\Sigma C}{n} = \frac{135}{15} = 9.$$

3s control limits for C chart are given by:

$$UCL_C = \bar{C} + 3\sqrt{\bar{C}} = 9 + 9 = 18.$$

$$LCL_C = \bar{C} - 3\sqrt{\bar{C}} = 9 - 9 = 0.$$

$$CL_C = \bar{C} = 9$$

Task The number of customer's complaints received daily by an organisation are as follows:

Day :	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
No. of customer complaints :	2	3	0	1	9	2	0	0	4	2	0	7	0	2	4

Does it mean that the number of complaints is under statistical control? Establish the control scheme for the future.

Self Assessment

Fill in the blanks:

9. The control chart is the fundamental tool of statistical process control, as it indicates the range of …… that is built into a system
10. Control charts are ……-making tools.
11. Control …… are lines on the charts that represent the current acceptable level of variation in the process.

Notes

12. The determination of the control limits, along with the sample size and the sampling frequency, is one of the most important tasks in ..... a control chart.

13. A ..... is the result of some cause that gradually affects the quality characteristics of the product and causes the point on a control chart to gradually move up or down from the centre line.

14.5 Design of Experiments and Statistical Process Control

In general usage, design of experiments, or experimental design, (DoE) is the design of any information-gathering exercises where variation is present, whether under the full control of the experimenter or not. However, in statistics, these terms are usually used for controlled experiments. Other types of study and their design are opinion polls and statistical surveys (which are types of observational study), natural experiments and quasi-experiments (for example, quasi-experimental design).

In the design of experiments, the experimenter is often interested in the effect of some process or intervention (the ''treatment'') on some objects (the ''experimental units''), which may be people, parts of people, groups of people, plants, animals, etc. Design of experiments is thus a discipline that has very broad application across all the natural and social sciences.

Quality and productivity improvement has become an essential element of the overall strategic plan for most organizations. This has sparked renewed interest in statistical methods for quality improvement. Functions for design of experiments (DOE) enable you to create and test practical plans to gather data for statistical modeling. These plans show how to manipulate data inputs in tandem to generate information about their effect on data outputs.

Design of experiments (DOE) is a valuable tool:

1. To optimize product and process designs,
2. To accelerate the development cycle,
3. To reduce development costs,
4. To improve the transition of products from research and development to manufacturing,
5. To effectively trouble shoot manufacturing problems.

Today, Design of Experiments is viewed as a quality technology to achieve product excellence at lowest possible overall cost.

14.5.1 Objectives of Experimentation

The following are some of the objectives of experimentation in an industry:

- Improving efficiency or yield
- Finding optimum process settings
- Locating sources of variability
- Correlating process variables with product characteristics
- Comparing different processes, machines, materials, etc.
- Designing new processes and products.

Notes

14.5.2 Various Terms used in Experimentation

In the context of discussion on experimental designs, the common frequently used terms are:

- Factor
- Level
- Treatment combination
- Response
- Effect
- Interaction

14.5.3 Traditional Approach

The traditional approach to product and process optimization is to conduct one variable at-a-time experiments. This approach though simple to plan and execute, suffers from several drawbacks. For instance, varying factor 'A' from its nominal value 'A1' to some other value 'A2' may produce a given change in the quality of the product, when other factor 'B' is at a value 'B1'. However a different change in the quality of the product will result, when factor 'B' is at a value 'B2'. This effect known as interaction effect cannot be detected under traditional approach.

14.5.4 Statistically Designed Experiments

A statistically designed experiment permits simultaneous consideration of all the possible factors that are suspected to have a bearing on the response under investigation and as such even if interaction effects exist, a valid evaluation of the main effect can be made. Scanning a large number of variables is one of the ready and simpler objectives that a statistically designed experiment would fulfill in many problem situations. Even a limited number of experiments would enable the experimenter to uncover the vital factors as to which further trials would yield useful results. The approach has a number of merits, namely it is quick, reliable and efficient.

14.5.5 Planning for Experimentation

The various steps to be followed in this direction are listed below:

- Selection of area of study: Pareto analysis
- Proof of the need for experimentation
- Brain storming and Cause & Effect diagram: To list all the possible factors
- Classification of factors
- Interactions to be studied
- Response and type of model for analysis

If the problem is of chronic nature and there is stability in the process, then it establishes the need for experimentation. Before deciding to carry out experimentation the need for experimentation must be established.

Notes

14.5.6 Classification of Factors

Tools like brainstorming and cause & effect diagrams helps in identification of factors and preparing a complete list of the factors involved in any experiment. Factors listed can be classified into three categories:

- Experimental Factors
- Control Factors
- Error or Noise Factors

1. *Experimental factors* are those which we really experiment with by varying them at various levels.
2. *Control Factors* are those which are kept at a constant (controlled) level throughout experimentation.
3. *Error or Noise factors* are those which can neither be changed at our will nor can be fixed at one particular level. Effect of these factors causes the error component in the experiment and as such these factors are termed as error or noise factors.

14.5.7 Response and Type of Model for Analysis

The ultimate observations or data generated by the experiment is known as the response. The response may be:

- Continuous or measurement type and follows a normal distribution
- Continuous or measurement type but does not follow normal distribution

Self Assessment

Fill in the blanks:

14. …… is a discipline that has very broad application across all the natural and social sciences.
15. The …… to product and process optimization is to conduct one variable at-a-time experiments.

14.6 Statistical Fundamentals

Statistical Process Control (SPC) or Statistical Quality Control (SQC) is the main area covered under statistical tools for quality. This area includes the following techniques:

1. Control Charts
   (a) Control charts for variables
   (b) Control charts for attributes
2. Sampling Inspection

Control charts are aimed at process control. Use of control charts ensures that the process continues to work with its natural capability and any significant variation in the process is promptly detected and corrected. Scientific sampling ensures that amount of inspection is reduced while agreed upon quality levels are adhered to. Sampling inspection can be applied to only those products which have been produced with a controlled process.

Notes

Both control charts and sampling inspection make use of statistics and probability. Before discussing statistical process control in detail, a brief description of the statistical and probability concepts is necessary.

14.6.1 Variations and Their Representation

Variation is the law of nature. Examples of variations are marks of students in a class, dimensions of similar products made in mass production and so on. In statistical process control efforts are made to reduce these variations. The first requirement however is to represent the variation. There are two categories of methods to represent variation. One of them is to draw a frequency distribution from the actual data by counting frequencies of each value. Histograms, frequency polygon and frequency bar charts fall in this category. The other measure is to calculate the average and dispersion of various values of the data and then from these two statistics represent the variation. The measures of central tendency and dispersion are briefly explained below.

14.6.2 Measures of Central Tendency: Mean, Median and Mode of a Set of Data

A collection of specific values, or "scores", $x_1, x_2, ..., x_n$ of a random variable X is called a *sample*. If $\{x_1, x_2, ..., x_n\}$ is a sample, then the *sample mean* of the collection is

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_n}{n}$$

where n is the *sample size* i.e. the number of scores.

The *sample median* m is the middle score (in the case of an odd-size sample), or average of the two middle scores (in the case of an even-size sample), when the scores in a sample are arranged in ascending order.

A *sample mode* is a score that appears most often in the collection. (There may be more than one mode in a sample.)

If the sample $x_1, x_2, ..., x_n$ we are using consists of all the values of X from an entire population (for instance, the marks of the students in a subject, we refer to the mean, median, and mode above as the *population* mean, median, and mode.

We write the population mean as instead of $\bar{X}$.

14.6.3 Measures of Dispersion

Sample Variance and Sample Standard Deviation

Given a set of numbers $x_1, x_2, ..., x_n$ the **sample variance** is

$$S^2 = \Sigma \frac{(X_i - \bar{X})^2}{n-1}$$

$$= \frac{(X_1 - \bar{X})^2 + (X_2 - \bar{X})^2 + ... + (X_n - \bar{X})^2}{n-1}$$

The *sample standard deviation* is the square root, s, of the sample variance.

Notes

Population Variance and Population Standard Deviation

The population variance and standard deviation have slightly different formulas from those of the corresponding statistics for samples. Given a set of numbers $x_1, x_2, ..., x_n$ the *population variance,* σ, is found from the expression

$$\sigma^2 = \sum \frac{(X_i - \overline{X})^2}{n}$$

$$= \frac{(X_1 - \overline{X})^2 + (X_2 - \overline{X})^2 + ... + (X_n - \overline{X})^2}{n}$$

The *population standard deviation,* σ, is the square root of the population variance.

14.6.4 Random Variables

A random variable is an *abstraction* of the concept of *chance* into the theoretical domains of mathematics, forming the foundations of *probability theory* and *mathematical statistics*. Intuitively, a random variable describes a system that can exist in several states, with each state having a certain probability. For example, a coin used for tossing can be described as a random variable with two states, 'head' and 'tail', with each state having probability one half.

The theory and language of random variables were formalized over the last few centuries alongside ideas of probability. Full familiarity with all the properties of random variables requires a strong background in the more recently developed concepts of *measure theory*, but random variables can be understood intuitively at various levels of mathematical fluency; *set theory* and *calculus* are fundamentals.

There are two types of random variables – discrete and continuous.

A random variable has either an associated probability distribution (discrete random variable) or probability density function (continuous random variable).

The outcome of an experiment need not be a number, for example, the outcome when a coin is tossed can be 'heads' or 'tails'. However, we often want to represent outcomes as numbers. A random variable is a function that associates a unique numerical value with every outcome of an experiment. The value of the random variable will vary from trial to trial as the experiment is repeated.

Examples:

1. A coin is tossed ten times. The random variable X is the number of tails that are noted. X can only take the values 0, 1, ..., 10, so X is a discrete random variable.
2. A light bulb is burned until it burns out. The random variable Y is its lifetime in hours. Y can take any positive real value, so Y is a continuous random variable.

Discrete Random Variables

A ***discrete random variable*** is one which may take on only a countable number of distinct values such as 0, 1, 2, 3, 4, ... Discrete random variables are usually (but not necessarily) counts. If a random variable can take only a finite number of distinct values, then it must be discrete. Examples of discrete random variables include the number of children in a family, the Friday night attendance at a cinema, the number of patients in a doctor's surgery, the number of defective light bulbs in a box of ten.

Notes

The ***probability distribution*** of a discrete random variable is a list of probabilities associated with each of its possible values. It is also sometimes called the probability function or the probability mass function.

Example: Suppose a variable X can take the values 1, 2, 3, or 4.

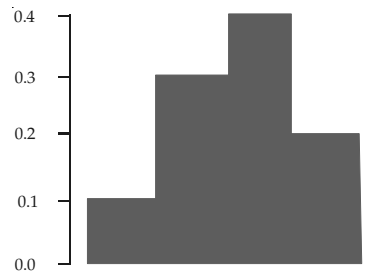
The probabilities associated with each outcome are described by the following table:

Outcome	1	2	3	4
Probability	0.1	0.3	0.4	0.2

The probability that X is equal to 2 or 3 is the sum of the two probabilities: P(X = 2 or X = 3) = P(X = 2) + P(X = 3) = 0.3 + 0.4 = 0.7. Similarly, the probability that X is greater than 1 is equal to 1 – P(X = 1) = 1 – 0.1 = 0.9, by the *complement rule*.

This distribution may also be described by the *probability histogram* shown in Figure 14.15.

Figure 14.15: Probability Histogram



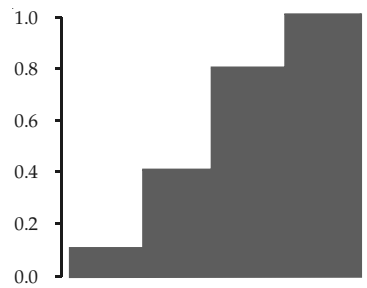
All random variables (discrete and continuous) have a *cumulative distribution function*. It is a function giving the probability that the random variable *X* is less than or equal to *x*, for every value *x*. For a discrete random variable, the cumulative distribution function is found by summing up the probabilities.

Example: The cumulative distribution function for the above probability distribution is calculated as follows:

The probability that X is less than or equal to 1 is 0.1, the probability that X is less than or equal to 2 is 0.1 + 0.3 = 0.4, the probability that X is less than or equal to 3 is 0.1 + 0.3 + 0.4 = 0.8, and the probability that X is less than or equal to 4 is 0.1 + 0.3 + 0.4 + 0.2 = 1.

The probability histogram for the cumulative distribution of this random variable is shown in Figure 14.16.

Figure 14.16: Probability Histogram for Cumulative Distribution



Notes

Continuous Random Variables

A continuous random variable is one which takes an infinite number of possible values. Continuous random variables are usually measurements. Examples include height, weight, the amount of sugar in an orange, the time required to run a mile.

A continuous random variable is not defined at specific values. Instead, it is defined over an *interval* of values, and is represented by the ***area under a curve*** (in advanced mathematics, this is known as an *integral*). The probability of observing any single value is equal to 0, since the number of values which may be assumed by the random variable is infinite.

Suppose a random variable *X* may take all values over an interval of real numbers. Then the probability that *X* is in the set of outcomes *A, P(A)*, is defined to be the area above *A* and under a curve. The curve, which represents a function *p(x)*, must satisfy the following:

1. The curve has no negative values, (p(x) > 0 for all x)
2. The total area under the curve is equal to 1.

A curve meeting these requirements is known as a ***density curve***.

14.6.5 Probability Distribution

A probability distribution describes the *values* and ***probabilities*** associated with a *random event*. The values must cover all of the possible outcomes of the event, while the total probabilities must *sum* to exactly 1, or 100%. For example, a single coin flip can take values *Heads* or *Tails* with a probability of exactly 1/2 for each; these two values and two probabilities make up the probability distribution of the single coin flipping event. This distribution is called a ***discrete distribution*** because there are a *countable* number of discrete outcomes with positive probabilities.

A ***continuous distribution*** describes events over a continuous range, where the probability of a specific outcome is zero. For example, a dart thrown at a dartboard has essentially zero probability of landing at a specific point, since a point is *vanishingly small*, but it has some probability of landing within a given area. The probability of landing within the small area of the bulls eye would (hopefully) be greater than landing on an equivalent area elsewhere on the board. A smooth function that describes the probability of landing anywhere on the dartboard is the probability distribution of the dart throwing event. The *integral* of the *probability density function* (pdf) over the entire area of the dartboard (and, perhaps, the wall surrounding it) must be equal to 1, since each dart must land somewhere.

The concept of the probability distribution and the *random variables* which they describe underlies the mathematical discipline of *probability theory*, and the science of *statistics*. There is spread or variability in almost any value that can be measured in a population (e.g. height of people, durability of a metal, etc.); almost all measurements are made with some *intrinsic error*; in *physics* many processes are described probabilistically, from the *kinetic properties of gases* to the *quantum mechanical* description of *fundamental particles*. For these and many other reasons, simple *numbers* are often inadequate for describing a quantity, while probability distributions are often more appropriate models. There are, however, considerable mathematical complications in manipulating probability distributions, since most standard *arithmetic* and *algebraic* manipulations cannot be applied.

Discrete Probability Distribution

A probability distribution is called *discrete* if its cumulative distribution function only increases in jumps.

Notes

The *set* of all values that a discrete random variable can assume with nonzero probability is either *finite* or *countably infinite* because the sum of uncountably many positive *real numbers* (which is the smallest upper bound of the set of all finite partial sums) always diverges to infinity. Typically, the set of possible values is topologically discrete in the sense that all its points are *isolated points*. But, there are discrete random variables for which this countable set is *dense* on the real line.

Combination Formula and its Application to Probability Calculations

Suppose we have a lot of 50 articles which contain 3 defective articles. If we draw a sample of 5 articles from the lot the respective probabilities of getting 0, 1, 2 and three defective articles in a sample of 5 can be calculated as under. A sample containing 0 defective articles will come only from 47 good articles. In this case no article will come from 3 defective articles. Number of ways in which this can happen can be calculated as under:

$$^{47}C_5 = \frac{47!}{5!42!} = \frac{(47)(46)(45)(44)(43)}{(5)(4)(3)(2)(1)} = 1533939$$

A sample containing 1 defective article will have 4 articles coming from 47 good articles and 1 defective article coming from 3 defective articles. Number of ways can be calculated as under:

$$^{47}C_4\,^{3}C_1 = \frac{47!3!}{(4!43!)(2!1!)} = \frac{(47)(46)(45)(44)}{(4)(2)(1)} = 535095$$

Similarly the number of ways in which 2 and 3 defective articles can be drawn can be calculated which come out to be 48645 and 1081 respectively. Further, the number of ways in which 5 articles can be drawn from 50 articles can be calculates as under:

$$^{50}C_5 = \frac{(50)(49)(48)(47)(46)}{(5)(4)(3)(2)(1)} = 2118760$$

Probabilities of 0, 1, 2 and 3 defectives can be calculated now as under.

$$P_0 = \frac{1533939}{2118760} = 0.72398$$

$$P_1 = \frac{535095}{2118760} = 0.25255$$

$$P_2 = \frac{48645}{2118760} = 0.02296$$

$$P_3 = \frac{1081}{2118760} = 0.00051$$

$$\text{Total} = 1.00000$$

Hypergeometric Probability Distribution

We have calculated the probability of getting r = 1, 2 or 3 defectives by drawing a sample of size n = 5 from a lot N = 50 which contained D = 3 defective items. Hypergeometric probability law describes such problems as under:

$$P(r/N/D/n) = \frac{D_{C_R} N - D_{C_{n-r}}}{N_{C_N}}$$

Notes

It states that the probability of r non-conforming items in a sample of size n is equal to the product of the possible combinations of nonconforming items, times the possible combinations of conforming items, divided by the possible combinations of samples of n that can be drawn from lots of size N.

It we use the hypergeometric probability law to calculate the probabilities of 0, 1, 2 or 3 defective article as was done in the previous section, we would get the same values.

Probability Density Function

The probability density function of a continuous random variable is a function which can be integrated to obtain the probability that the random variable takes a value in a given interval.

More formally, the probability density function, f(x), of a continuous random variable X is the derivative of the cumulative distribution function F(x):

$$f(x) = \frac{d}{dx} F(x)$$

Since $F(x) = P(X \leq x)$ it follows that:

$$\int f(x)dx = F(b) - F(a) = P(a < X < b)$$

If f(x) is a probability density function then it must obey two conditions:

(a) that the total probability for all possible values of the continuous random variable X is 1:

$$\int f(x)dx = 1$$

(b) that the probability density function can never be negative: $f(x) > 0$ for all x.

14.6.6 Binomial Distribution

In case of hypergeometric probability distribution the calculations of probability took into account the change in probabilities with every draw. However, it can be assumed that if the lot size is infinite, the probabilities remain constant over draws. Such problems can be solved using the binomial probability distribution.

Typically, a binomial random variable is the number of successes in a series of trials, for example, the number of 'heads' occurring when a coin is tossed 50 times.

A discrete random variable X is said to follow a Binomial distribution with parameters n and p, written X ~ Bi(n,p) or X ~ B(n,p), if it has probability distribution:

$$P(X = x) = \binom{n}{x} p^x (1 - p)$$

where $x = 0, 1, 2, ..., n$

$n = 1, 2, 3, ...$

p = success probability; $0 < p < 1$

$$\binom{n}{x} = \frac{n!}{x!(n - x)!}$$

Notes

The trials must meet the following requirements:

(a) the total number of trials is fixed in advance;

(b) there are just two *outcomes* of each trial; success and failure;

(c) the outcomes of all the trials are statistically *independent*;

(d) all the trials have the same probability of success.

The Binomial distribution has *expected value* E(X), $\mu = np$ and Variance, $\sigma^2 = npq = np(1-p)$.

14.6.7 Poisson Distribution

Poisson distributions model some *discrete random variables*. Typically, a Poisson random variable is a count of the number of events that occur in a certain time interval or spatial area. For example, the number of cars passing a fixed point in a 5 minute interval, or the number of calls received by a switchboard during a given period of time.

A discrete random variable X is said to follow a Poisson distribution with parameter m, written X ~ Po(m), if it has probability distribution

$$P(X = x) = \frac{m^x}{x!}e^{-m}$$

where $x = 0, 1, 2, ..., n$

$m > 0.$

The following requirements must be met:

(a) the length of the observation period is fixed in advance;

(b) the events occur at a constant average rate;

(c) the number of events occurring in disjoint intervals are statistically *independent*.

The Poisson distribution has expected value E(X) = m and variance V(X) = m; i.e. E(X) = V(X) = m.

The Poisson distribution can sometimes be used to approximate the *Binomial distribution* with parameters n and p. When the number of observations n is large, and the success probability p is small, the Bi(n, p) distribution approaches the Poisson distribution with the parameter given by m = np. This is useful since the computations involved in calculating binomial probabilities are greatly reduced.

14.6.8 The Normal Curve

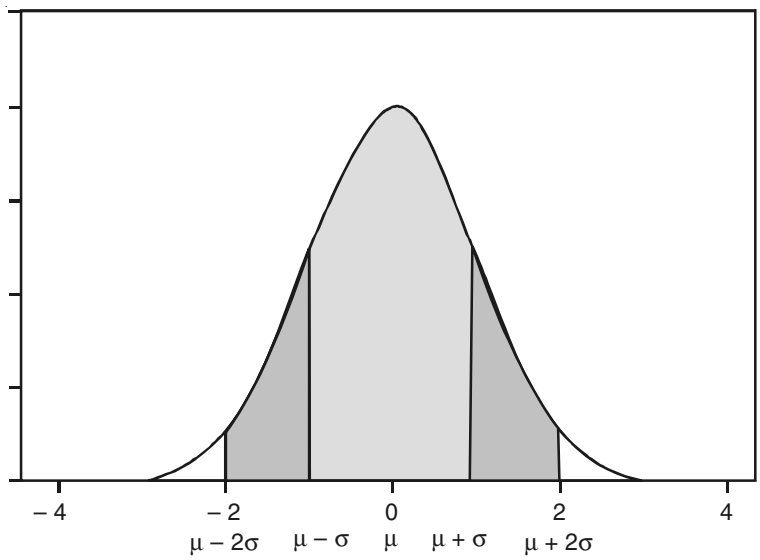
Many phenomena in life where quantitative data is generated follow a normal curve. A normal curve is shown in figure 14.17. This is a continuous density curve. The area under the curve is not easy to calculate for a normal random variable *X* with mean μ and standard deviation σ. However, tables (and computer functions) are available for the standard random variable *Z*, which is computed from *X* by subtracting σ and dividing by σ.

A normal distribution has a bell-shaped density curve described by its mean μ and standard deviation σ. The density curve is symmetrical, centered about its mean, with its spread determined by its standard deviation. The height of a normal density curve at a given point x is given by

$$\frac{1}{\sigma\sqrt{2\pi}}e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2}$$

Notes

Figure 14.17: Normal Curve



The Standard Normal curve, shown here, has mean 0 and standard deviation 1. If a dataset follows a normal distribution, then about 68% of the observations will fall within σ of the mean μ, which in this case is with the interval (–1, 1). About 95% of the observations will fall within 2 standard deviations of the mean, which is the interval (–2, 2) for the standard normal, and about 99.7% of the observations will fall within 3 standard deviations of the mean, which corresponds to the interval (–3, 3) in this case. Although it may appear as if a normal distribution does not include any values beyond a certain interval, the density is actually positive for all values, (–∞, ∞). Data from any normal distribution may be transformed into data following the standard normal distribution by subtracting the mean m and dividing by the standard deviation.

14.6.9 Geometric Distribution

Geometric distributions model (some) *discrete random variables*. Typically, a Geometric random variable is the number of trials required to obtain the first failure, for example, the number of tosses of a coin untill the first 'tail' is obtained, or a process where components from a production line are tested, in turn, until the first defective item is found.

A discrete random variable X is said to follow a Geometric distribution with parameter p, written X ~ Ge(p), if it has probability distribution

$$P(X = x) = p^{x-1}(1 - p)^x$$

where $x = 1, 2, 3, ...$

p = success probability; $0 < p < 1$

The trials must meet the following requirements:

(a) the total number of trials is potentially infinite;

(b) there are just two *outcomes* of each trial; success and failure;

(c) the outcomes of all the trials are statistically *independent*;

(d) all the trials have the same probability of success.

The Geometric distribution has *expected value* $E(X)= 1/(1 - p)$ and *variance* $V(X) = p/\{(1 - p)^2\}$.

Notes

The Geometric distribution is related to the *Binomial distribution* in that both are based on independent trials in which the probability of success is constant and equal to p. However, a Geometric random variable is the number of trials until the first failure, whereas a Binomial random variable is the number of successes in n trials.

14.6.10 Central Limit Theorem

The Central Limit Theorem states that whenever a random sample of size n is taken from *any* distribution with mean μ and variance σ^2, then the sample mean $\bar{x}$ will be *approximately* normally distributed with mean μ and variance σ^2. Larger the value of the sample size n, the better the approximation to the normal.

Self Assessment

Fill in the blanks:

16. …… ensures that amount of inspection is reduced while agreed upon quality levels are adhered to.
17. A …… is a score that appears most often in the collection.

Case Study

Statistical Process Control: A Case-Study on Haleeb Foods Ltd., Lahore

The process capability of Tetra Pack Machines of Haleeb Foods Limited (HFL) is analyzed. The process capability ratios Cp, Cpu, Cpl and Cpk are used as capability indices. In general, process capability position of machines is good. But the results have pointed out high variability points, as well. The process mean goes out of speciation limits at least once in a week, for every machine. The whole process goes out of specification limits once in a week, only for 2 machines. It should be taken care off. The HFL is suggested to introduce high technology to reduce the variability and insure the process capability.

Introduction

Haleeb Foods Limited (HFL) is a fast growing food product company. It was established in April 9, 1984, but its commercial production started from July, 1987. The Powder plant of HFL was installed in 1992. The HFL has launched its bottling milk in April, 1999, while Tetra Pack is started in November, 2000. The company's name is changed in November, 2000. Formerly it was CDL but now its name is Haleeb Foods Limited (HFL). The HFL is first Food Company and so far the only dairy company in Pakistan to get ISO-9002 certification in 1997 and HACCP Certification in June, 2003. In order to improve its processes, make the system more visible and identify the shortcomings, HFL is following the Total Quality Management (TQM) techniques. The HFL is committed to strict quality standards in all its operations from the collection of milk to the provision of hygienically processed nutritious products to its customers. The HFL has succeeded in this by continuously improving the quality of its products and by satisfying the needs of its customers.

The objective of this research is to study process capability of HFL machines and make suggestions for improvement, if required.

Contd...

Notes

Research Methodology

Process Capability determines whether a process with normal variation, is capable of meeting customer requirements. It compares the output of an in-control process to the specification limits by using capability indices. These are obtained by using the ratio of the "specification width" to the "process width".

There are several statistics that can be used to measure the capability of a process, e.g. Cp, Cpu, Cpl and Cpk. Most of the capability indices estimates are valid only for large samples, i.e. at least 100. These also assume that the sampled populations are normal. If μ and σ are the mean and standard deviation of the normal data respectively. The USL and LSL are the upper and lower specification limits, respectively. Then, the Process Capability Ratios (PCRs) defined by Montgomery (2001) are as below:

$$PCR = Cp = (USL - LSL)/6\sigma$$

$$PCR\ (Upper\ Sided) = CPU = (USL - \mu)/3\sigma$$

$$PCR\ (Lower\ Sided) = Cpl = (\mu - LSL)/3\sigma$$

$$Cpk = \min(Cpu, Cpl)$$

The Cp, CPU, Cpl and Cpk are obtained by using HLF's specification limits and estimates of μ and σ.

Statistical Analysis

The process capability of six machines i.e. A, B, C, D, E and F model TBA-19 of HLF is calculated and analyzed. The data of one week is collected from 3rd to 8th January, 2005 and the timings are from 9:00 a.m. to 15:00 p.m. From each machine 100 samples are taken during one hour. The process is considered capable which has Cpk = 1.33 or large and a process having Cpk between 1.0 and 1.33 as marginal. The Cpk exactly equals to 1.0 implies that the process variation exactly meets the specification requirements. The Cpk < 0 implies that the process mean lies outside the specification limits. The Cpk < -1 implies that entire process lies outside the specification limits and portrays the extreme situation of variability. If Cp = Cpk the process is centred at the mid point of the specifications, and if Cpk < Cp the process is off centred. The magnitude of the ratio Cr = Cpk/Cp shows degree of off-centre. The lower the value of Cr, the higher is the degree of off- centre . The capability indices Cp, Cpu, Cpl and Cpk of six machines are as given in Appendix.

Process capability Cpk of 6 machines at the 1st day of production from 9:00 to 10:00 a.m. shows that machine A and D are not capable with the process. The Cpk < -1 of machine D shows that entire process lies outside the specification limits and portrays the extreme situation of variability. It is also confirmed by the lowest value of Cr = -8.474. Machine B shows Cpk = 1.354 a capable process. Machine E and F show Cpk = 1.263 and 1.032, respectively, a marginal process. Machine C has Cpk = 0.937 which can be considered approximately a marginal process. There is need to watch the process of machines A and D carefully to reduce variability.

Process capability Cpk on the 2nd day from 10:00 to 11:00 a.m. shows that only machines A and D give Cpk greater that 1.33. The process is capable only for these 2 machines. Other machines show that process is not capable of meeting specification. The Cpk < 0 of machines B, C and F implies that the process mean lies outside the specification limits.

Process capability Cpk on 3rd day from 11:00 to 12:00 shows that machine A and C give Cpk 1.034 and 1.156, respectively. It implies that process is marginal. Machines B, C, D, E and F must be carefully watched.

Contd...

Notes

Process capability Cpk on 4th day from 12:00 to 13:00 shows that machine A has Cpk=1.276 a marginal process, machine D has Cpk =1.413 a capable process. All other machines show that process is not capable with these specifications. Moreover, Cpk < 0 of machines E implies that the process mean lies outside the specification limits.

Process capability Cpk on 5th day from 13:00 to 14:00 shows that machines C & F have Cpk =1.696 & Cpk = 1.352, respectively show capable process. Machine E has Cpk =1.016, a marginal process. The Cpk < 0 of Machines A implies that the process mean lies outside the specification limits. The Cpk < -1 of Machine B shows that entire process lies outside the specification limits and portrays the extreme situation of variability. It is also confirmed by the lower value of Cr = -2.738. Therefore, Machines A and B give losses in production and are not capable with the process.

Process capability Cpk on 6th day shows that machines B, D & F gives Cpk =1.089, Cpk =0.967 & Cpk = 1.130, respectively, show a barely marginal process. All other machines have process spread greater than specification limits. The Cpk < 0 of Machines A implies that the process mean lies outside the specification limits.

Conclusions

It is a remote probability of a capable process. For machines A, B, C and F it is 1/6. Only for machine B and D this probability is 1/3. The chance that machine E will achieve a process capability is zero.

The categories marginal and capable process is combined. The probabilities for combined processes are as: For machines A and F ½, B, C, D and E 1/3.

The probability that Cpk < 0 is 1/6 for machines C, D, E & F and 1/3 for machines A and B. It shows the chance that process mean can go beyond the specification limits. The probability that Cpk < - 1 for machines B and D is 1/6. It shows the chance that entire process lies outside the specification limits. It should be taken care off.

Thus, in general, position of machines is good with reference to the process capability. But to take care of isolated points, i.e. Cpk < -1 for machines B and D, HFL is suggested to introduce high technology to reduce the variability and insure the process capability.

Questions

1. Based on the case discussed above bring out the importance of process capability
2. Do a brief analysis of the case in your own words

Source: http://www.gcu.edu.pk/fulltextjour/stat/stat-journal2005/sarwatzahra-article2.pdf

Appendix: Table of Control Chart Constants

	X-bar Chart Constants		For Sigma Estimate	R Chart Constants		S Chart Constants	
Sample Size = m	**A_2**	**A_3**	**d_2**	**D_3**	**D_4**	**B_3**	**B_4**
2	1.880	2.659	1.128	0	3.267	0	3.267
3	1.023	1.954	1.693	0	2.574	0	2.568
4	0.729	1.628	2.059	0	2.282	0	2.266
5	0.577	1.427	2.326	0	2.114	0	2.089
6	0.483	1.287	2.534	0	2.004	0.030	1.970
7	0.419	1.182	2.704	0.076	1.924	0.118	1.882

Contd...

Notes

8	0.373	1.099	2.847	0.136	1.864	0.185	1.815
9	0.337	1.032	2.970	0.184	1.816	0.239	1.761
10	0.308	0.975	3.078	0.223	1.777	0.284	1.716
11	0.285	0.927	3.173	0.256	1.744	0.321	1.679
12	0.266	0.886	3.258	0.283	1.717	0.354	1.646
13	0.249	0.850	3.336	0.307	1.693	0.382	1.618
14	0.235	0.817	3.407	0.328	1.672	0.406	1.594
15	0.223	0.789	3.472	0.347	1.653	0.428	1.572
16	0.212	0.763	3.532	0.363	1.637	0.448	1.552
17	0.203	0.739	3.588	0.378	1.622	0.466	1.534
18	0.194	0.718	3.640	0.391	1.608	0.482	1.518
19	0.187	0.698	3.689	0.403	1.597	0.497	1.503
20	0.180	0.680	3.735	0.415	1.585	0.510	1.490
21	0.173	0.663	3.778	0.425	1.575	0.523	1.477
22	0.167	0.647	3.819	0.434	1.566	0.534	1.466
23	0.162	0.633	3.858	0.443	1.557	0.545	1.455
24	0.157	0.619	3.895	0.451	1.548	0.555	1.445
25	0.153	0.606	3.931	0.459	1.541	0.565	1.435

Control chart constants for X-bar, R, S, Individuals (called "X" or "I" charts), and MR (Moving Range) Charts.

Notes To construct the "X" and "MR" charts (these are companions) we compute the Moving Ranges as:

R_2 = range of 1st and 2nd observations, R_3 = range of 2nd and 3rd observations, R_4 = range of 3rd and 4th observations, etc. with the "average" moving range or "MR-bar" being the average of these ranges with the "sample size" for each of these ranges being n = 2 since each is based on consecutive observations ... this should provide an estimated standard deviation (needed for the "I" chart) of

σ = (MR-bar)/d_2 where the value of d_2 is based on, as just stated, m = 2.

Similarly, the UCL and LCL for the MR chart will be:

UCL = D_4 (MR-bar) and LCL = D_3 (MR-bar) but, since D_3 = 0 when n = 0 (or, more accurately, is "not applicable") there will be no LCL for the MR chart, just a UCL.

14.7 Summary

- SPC aims at controlling the variability of porocess output using a device called the control chart.
- On a control chart, a certain characteristic of the product is plotted. Under normal conditions these plotted points are expected to vary in a “usual way” on the chart.
- When abnormal points or patterns appear on the chart, it is a statistical indication that the process parameters or production conditions might have changed undesirably. At this

point an investigation is conducted to discover unusual and abnormal conditions (e.g. tool breakdown, use of wrong raw material, temperature controller failure, etc.). Subsequently, corrective actions are taken to remove the abnormality.

- In addition to the use of control charts. SPC also monitors process capability an indicator of the adequacy of the manufacturing process to meet customer requirements under routine operating conditions.
- The control chart is the fundamental tool of statistical process control, as it indicates the range of variability that is built into a system (known as common cause variation). Thus, it helps determine whether or not a process is operating consistently or if a special cause has occurred to change the process mean or variance.
- Control charts are decision-making tools. They provide an economic basis for deciding whether to alter a process or leave it alone. Control charts are problem-solving tools and provide a basis to formulate improvements actions.
- Control charts help us learn more about process variation. They determine whether a process is in a state of statistical control or out-of-control. They are used to estimate the process parameters (mean, variation) and assess the performance of a process or its capability.
- Thus, SPC aims at maintaining a stable, capable and predictable process.

14.8 Keywords

Control Chart: Control chart is the fundamental tool of statistical process control, as it indicates the range of variability that is built into a system (known as common cause variation).

Control Limits: Control limits are lines on the charts that represent the current acceptable level of variation in the process.

Cycle: Short and repeated patterns in the chart with alternating high peaks and how valleys called cycles are the result of cause that come and go on a regular basis.

Design of Experiments: Application of statistical methods for producing high quality, robust products and process designs.

Process Capability: The range over which the 'natural variation' of a process occurs and is determined by the system of common/random causes.

Statistical Process Control (SPC): A process to control the variability of output using control charts.

Statistical Quality Control (SQC): Use of statistical methods to improve or enhance quality for customer satisfaction. It involves monitoring a process to identify the unique causes of variation for signalling appropriate corrective actions.

Trends: A trend is the result of some cause that gradually affects the quality characteristics of the product and causes the point on a control chart to gradually move up or down from the centre line.

14.9 Review Questions

1. What do you mean by statistical process control?
2. Describe the advantages of statistical process control.
3. Describe control limits are not an indication of capability.

Notes

4. What do you mean by control charts?
5. What is Statistical Quality Control (SQC)?
6. Discuss the advantages of statistical process control.
7. What are the elements of typical control charts?
8. Explain the design of experiments and statistical process control.

Answers: Self Assessment

1.	Control chart	2.	SPC
3.	Statistical	4.	Quality
5.	Capability	6.	Process
7.	Performance	8.	Statistical
9.	Variability	10.	Decision
11.	Limits	12.	Designing
13.	trend	14.	Design of experiments
15.	Traditional Approach	16.	Scientific sampling
17.	Sample mode		

14.10 Further Readings

Books

Bailey, J. E., Pearson, S. W., *Development of a Tool for Measuring and Analyzing Computer User Satisfaction*, Management Science.

Delen, G.P.A.J. and Rijsenbrij, D.B. B., *A Specification, Engineering and Measurement of Information Systems Quality*

Drucker, P.E., *The Information Executives Truly Need*, Harvard Business Review

Fox, C., Levitin, A. and Redman, T., *The Notion of Data and Its Quality Dimensions*, Information Processing & Management

Online links

http://asq.org/learn-about-quality/statistical-process-control/overview/overview.html

http://smallb.in/sites/default/files/Guide%20to%20Statistical%20Process%20Control%20Techniques.pdf

http://www.freequality.org/documents/knowledge/x-bar%20and%20s%20charts%20MiniTutorial.pdf

http://www.jfcmonline.com/article.asp?issn=2230-8229;year=2009;volume=16;issue=1;spage=11;epage=17;aulast=Al-Hussein

http://www.spcpress.com/book_understanding_statistical_process_control.php