

POORNIMA M. CHARANTIMATH

TOTAL QUALITY MANAGEMENT



 Pearson

THIRD EDITION

Total Quality Management

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Total Quality Management

Third Edition

Poornima M. Charantimath

*Karnataka Law Society's Institute of Management
Education and Research, Belgaum*



Pearson

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ISBN 978-93-325-7939-2

eISBN 978-93-325-8698-7

Head Office: A-8 (A), 7th Floor, Knowledge Boulevard, Sector 62, Noida 201 309, Uttar Pradesh, India.

Registered Office: 4th Floor, Software Block, Elnet Software City, TS 140, Block 2 & 9, Rajiv Gandhi Salai, Taramani, Chennai - 600 113, Tamil Nadu, India.

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To my in-laws,

Late Sri. N. C. Charantimath

and

Late Smt. Lalita Devi Charantimath

About the Author



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Foreword

Traditionally, manufacturers and retailers lowered prices to clear inventory. Today, they're cutting prices because consumers are demanding it.

The recent global meltdown and recession has put great pressure on the organizations to produce the best quality products at the most affordable prices. Nano has already hit the market. The car has redefined the meaning of quality. It is not just a car—it is the automobile revolution. Novatium has come out with a PC for just Rs 3,000. Real estate now promises to give the best quality homes at previously unimagined prices. Telecom companies are reducing the cost of talk time every day. The price of white goods is coming down every day.

In the economy, struggling to come out of the recession, low price rules. The challenge is not just to produce great quality, but to provide the best quality in the most efficient and cost-effective manner. This book will enable organizations to maximize their quality of products and services through application of various quality improvement tools and minimize the cost by adoption of many proven techniques. It is important to know that quality is a "disciplined approach" and while lot of attention is paid to the technical side of quality, the human side of quality should not be forgotten. Quality is a passion to make a valuable contribution to the world we live in.

We are also in a world where today's breakthrough product is tomorrow's undifferentiated commodity. Innovation will drive the economy in the future and the companies have to play a proactive role. Organizations must establish innovation as a mainstream business process with defined people, responsibilities and targets, failing which innovation will be rhetoric (lucky accident). Quality is completely linked to the present and the future needs of the customers, and hence innovation has become integral to quality—two sides of the same coin.

In this world of fast-changing expectations, innovation is the only insurance against irrelevance and the antidote to margin crushing competition. Besides providing the best quality at the most affordable prices, the companies will have to innovate new products, services, business models, sources of raw materials and delivery mechanisms. They must understand unmet customer needs and have the ability of translating unperceived and unarticulated needs of the customer into development of new products and services in the fastest possible time. Time is of essence and the companies must reduce their innovation cycle time to be present in the market before the competition. Innovation is the only way for high growth and sustainable competitive advantages.

This book on quality covers an extensive compilation of topics. I am sure the students of management and engineering, academicians and organizations will benefit a great deal from the extensive topics of Kaizen, breakthrough improvements, value analysis, TRIZ mechanism, TPM, quality management system and quality models given in this book.

I wish the readers great success in their quality and innovation journey through the third edition of this rich treasure of quality by Ms. Poornima Charantimath.

Pravin Rajpal
Indian Management Expert, FICCI Quality Forum
www.pravinrajpal.com

Preface

Total quality management (TQM) is an approach to business that looks critically at the products and services a company provides in relation to the processes it employs to create them. It also focuses on the workforce to ensure that outputs fully satisfy customer requirements. Organizations that follow the TQM approach consistently meet or exceed customer requirements. TQM can, therefore, be referred to as a journey with the sky as the limit for excellence.

The first edition of *Total Quality Management* was written to help students develop a basic appreciation of quality concepts and learn the tools and techniques of TQM. The second edition of the book was updated and enlarged to conform to TQM's goal of continuous improvement. The third edition of the book has now been updated and enlarged based on changes happening in the industry.

■ CHANGES IN THE THIRD EDITION

The third enlarged and revised edition of *Total Quality Management* comprises of 18 chapters which embraces the art of managing the whole to achieve excellence. We all agree completely – the war for better quality must continue – which is why we continue to update and improve this book. The significant changes in the third edition include:

- **Chapter opening vignettes with a Picture:** Each chapter begins with a picture serve as ice-breakers and narrate the key concepts of the chapter through a powerful story around a customer or company for better understanding of the chapter.
- **Marginal additions:** Each page has provided with marginal additions to enhance learning.
- **Balanced coverage of the manufacturing and service sectors:** The manufacturing and service sectors have been covered in greater detail by showcasing real-world practices from the Indian and global scenarios.
- **Updated QMS ISO 9001:2015:** The revised version of Quality Management System (QMS) ISO 9001:2015 is explained is more compatible with other management systems such as ISO 14001:2015 Environmental Management System (EMS) and ISO 45001:2016 Occupation Health and Safety Management System, making it more effective and efficient to integrate with various other management systems.
- **Introduction to Integrated Management System:** Chapter 17 introduces an integrated management system (IMS) which combines all related components of a business into one system for easier management and operations. Quality (QMS), Environmental (EMS), and Occupation Health and Safety Management Systems (OHSMS) are often combined and managed as an IMS. This chapter also provides information on institutions supporting quality movement in India.
- **Updated ISO Management audit ISO 19011:2011 and ISO IEC 17021:2015:** Chapter 18 provides the revised version of ISO audit: ISO 19011: 2011 first and second party audit and ISO IEC 17021:2015 third party audit.
- **Comprehensive supplement package:** A complete supplement package comprising an instructors' manual, Power-Point lecture slides and multiple-choice questions support interactive teaching and learning.

■ STRUCTURE OF THE BOOK

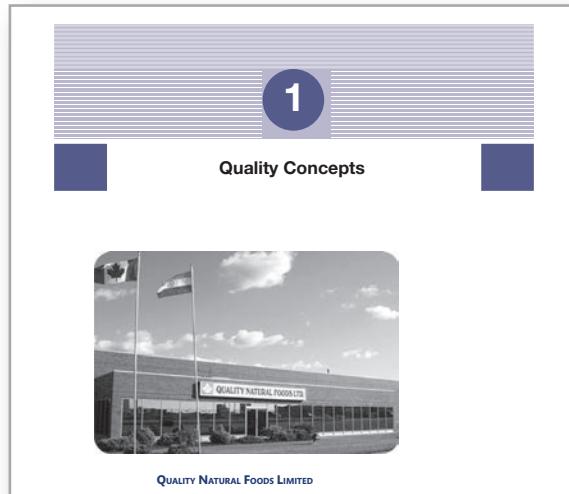
Total Quality Management (3/e) comprises 18 chapters, which focus on understanding the TQM philosophy, quality planning, statistical quality control, quality improvement and customer-driven quality. The key concepts discussed in each chapter are as follows:

Chapter 1 explains the various definitions of quality, importance of quality, different types and levels of quality, paradigms of quality, dimensions of product and service quality.

- Chapter 2* focuses on the contributions made by American and Japanese quality gurus in the area of TQM.
- Chapter 3* provides an insight into the evolution of TQM, identifies the common barriers to the implementation of TQM and also discusses the steps in implementing TQM & Total Quality Management Excellence (TQMEX) Model.
- Chapter 4* explains leadership and corporate social responsibility (CSR), strategic quality management and also describes the importance of managing change in organizations.
- Chapter 5* discusses the Deming Prize, the Malcolm Baldrige National Quality Award, the Ramakrishna Bajaj National Quality Award, the European Quality Award, the CII-EXIM Bank Award for Business Excellence, Tata Business Excellence model (TBEM), Rajiv Gandhi National Quality award, the International Quality Maturity Model and Capability Maturity Model Integration (CMMI).
- Chapter 6* explains the important statistical concepts in quality management. It also describes process capability, sampling plans, quality assurance, quality policy and quality manual.
- Chapter 7* discusses Six Sigma, Lean Six Sigma and the steps in implementing Six Sigma (DMAIC, DMADV and DFSS) and discusses various Six-Sigma training programmes.
- Chapter 8* explains the seven quality control tools and the seven new management and planning tools.
- Chapter 9* provides an insight into Kaizen, 5 S, company-wide quality control, quality function deployment, house of quality and the relevance of quality circles.
- Chapter 10* explains creativity, innovation, the S curve, TRIZ, systematic inventive value augmentation, value analysis and value engineering.
- Chapter 11* elaborates on the essence of benchmarking, evolution of benchmarking, process of benchmarking, types of benchmarking and the steps in the benchmarking process.
- Chapter 12* deals with business process re-engineering (BPR), the principles and advantages of BPR, the methodology of BPR, the implementation phases and explains re-engineering in the manufacturing and the service industry.
- Chapter 13* explains the relevance and importance of business process management.
- Chapter 14* deals with the concept of total productive maintenance (TPM), the pillars of TPM and overall equipment effectiveness (OEE).
- Chapter 15* focuses on customer relationship management (CRM), customer value management and CRM in the B2B and the B2C context.
- Chapter 16* deals with the importance of TQM in the service sector. It introduces the concept of service quality and discusses models used for measuring and improving service quality.
- Chapter 17* deals with quality management system ISO 9001:2015, EMS ISO 14001:2015, OHSAS ISO 45001:2016 and Integrated Management System. It explains the benefits of ISO certification and discusses the organisations promoting quality movement in India.
- Chapter 18* discusses the standards for planning and performing management audits ISO 19011:2011 (first and second party audit) & ISO IEC 17021 2015 (third party audit), the standards for selecting auditors and the standards for managing audit programmes. It also explains steps to ISO certification, role of certification bodies and registration requirements.

■ KEY FEATURES

Chapter opening vignettes with a picture



Marginal additions are provided as Bird's-eye view to provide contents related to TQM concepts, examples from industry, best practices, etc.



<@> Bird's-eye view:

If an automobile company finds a defect in one of their cars and a product recall, customer reliability and trust in production will decrease because trust will be lost in the car's quality.

<@> Bird's-eye view:

Quality is important to businesses but can be quite hard to define. A good definition of quality is: "Quality is about meeting the needs and expectations of customers".

<@> Bird's-eye view:

ISO 9000 2015 Definition of Quality
The adjective *quality* applies to objects and refers to the degree to which a set of inherent characteristics fulfills a set of requirements.

Each chapter contains several **boxes** that highlight innovative practices from the TQM arena.



Box 17.3 CII Institute of Quality

CII Institute of Quality is the leading authority in quality enhancement among organizations and industries. Over the past century, CII has provided Indian industries with the support, systems, and tools to make a mark in the competitive world. It is realized that the best way to enhance an organization's competitiveness is through the quality route.

What started as the Total Quality Management Division (TQMD) of CII in the mid-eighties has now evolved as CII Institute of Quality. As a champion of the quality movement, CII IQ is powered by the responsibility of enriching the lives of its members, improving their workplaces, and making the world, at a large, a better place by applying quality tools, techniques, and systems. CII IQ provides the best of its kind training and consulting services to organizations to help improve their performance and set a standard of excellence.

CII IQ has tied up with several international organizations to bring their best practices to India. It has helped several organizations improve their total QMS besides helping them win recognitions such as the Deming Prize and the Japan Quality Medal. CII IQ opens a world of opportunities to improve the quality of workplace, communities, and lives by providing information, contacts, and more. It realizes the importance of creating sustainable programs that are critical to an organization's QMS.

Source: Adapted from <http://www.cii-iq.in/index.php/about-us> accessed July 2016

The **discussion forum** tests students' understanding of key concepts and facilitates interaction and knowledge sharing.



DISCUSSION FORUM

1. What is ISO?
2. How many times were the standards revised?
3. Which is the latest version of ISO and what are the major changes it introduces?
4. What are the quality management principles on which the QMS standards are based?
5. What are the benefits of ISO certification?
6. Identify the organizations providing strategic direction to quality movement in India.

Key terms enable readers to quickly go through the important concepts discussed in each chapter.



Key Terms

Aesthetics	13	Perceived Quality	13
Appraisal Cost	15	Performance	13
Assurance	13	Prevention Cost	15
Big Q	14	Process Level	10
Conformance	13	Psychological Criteria	4
Durability	13	Reliability	13
Empathy	14	Responsiveness	14
Exciting Quality	10	Serviceability	13
Expected Quality	8	SERVQUAL	13
External Failure Cost	16	Support Services	4
Features	13	Tangibles	13
Hidden Quality Cost	18	The Manufacturing-based Approach	5
Indifferent Quality	10	The Performer/Job Level/Task Design Level	11
Internal Failure Cost	16	The Product-based Approach	5
Little q	14	The Transcendent Approach	4
New Quality	14	The User-based Approach	5
Old Quality	14	The Value-based Approach	5
One-dimensional Quality	10	Total Quality Cost Curve	18
Optimum Quality Cost	18	Value for Price Paid	4
Organizational Level	10	Zone of Indifference	19

The **summary** recapitulates the main points discussed in the chapter.



SUMMARY

- The term quality has many different definitions, ranging from the conventional to those that are strategic. Conventional definitions of quality usually describe a quality item as one that wears well, is well constructed and will last for a long time. However, managers competing in the fierce international market are increasingly concerned with the strategic definition of quality—meeting customer requirements.
- David Garvin identified five major approaches to defining quality: The transcendent approach, the product-based approach, the user-based approach, the manufacturing-based approach and the value-based approach.
- Quality of goods and services can provide an organization with competitive edge. The role of quality needs no emphasis for a firm because it is the key to success in business to achieve customer satisfaction. Today “quality” is the watchword for the survival and growth of any organization in the global business environment. Quality increases profits in addition to enhancing the image of the company.
- An organization that is committed to quality must examine quality at three levels: organizational level, process level and the performer/job level/task/design level.
- Quality of design, quality of conformance and quality of performance are required to produce goods and services of consistent quality and costs.
- The five paradigms of quality are custom-craft paradigm, mass production paradigm, statistical quality control paradigm, total quality management paradigm and techno-craft paradigm.
- David Garvin identified eight dimensions of product quality—performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. SREVQUAL dimensions of service quality are reliability, assurance, tangibles, empathy and responsiveness

A **case study** at the end of each chapter correlates quality management theories with their actual applications in the industry.



Case Study

Customer Relationship Management at Bharti

Bharti Tele-ventures is one of India's leading private sector telecom operators. Its cellular business, Airtel, is a leading mobile telephony brand. Like any telecom organization, Bharti considers information technology as a key business enabler. According to Amrita Gangotra, vice-president of Information Technology at Bharti, IT works as a support system as well as a key business driver.

The company has a wide area network (WAN) in place with a mix of leased lines and E1 and E3 lines. The company extends different applications to its dealers and partners through its extranet. The company also has procured a range of high-end servers from Sun and HP. The company also has a storage area network (SAN) in place because its daily storage requirements are in terabytes.

The main data centre is located in Gurgaon, Haryana. Bharti has procured billing, fraud management, revenue assurance and data warehousing software.

The Case for CRM

During the initial stages of its operations, the company's systems were run manually. Only 40 per cent of customer issues were getting resolved. The company decided to equip itself with tools that would help in resolving 90 per cent of its customer issues. The company decided to opt for a CRM solution to manage customer expectations and provide them with innovative products and services.

Exercises enhance problem-solving skills and facilitate the application of concepts.



Exercises

1. The standard error of measurement of the mean of measurement of a certain electrical characteristic of a product is determined to be 8 units. A sample consisting of 42 units of the product is taken under consideration. From this information, what is your estimate of the true standard deviation of the quality characteristic?
2. A sampling plan may be specified in this way:

$$N = 200, \quad n = 20, \quad c = 1.$$

Interpret the results.

3. A sampling plan may be specified in this way:

$$N = 500, \quad n_1 = 20, \quad c_1 = 1, \quad n_2 = 60, \quad c_2 = 4.$$

Interpret the results.

4. For a sampling plan, $N = 1,200, n = 64$ and $c = 1$, determine the probability of acceptance of the following lots:

- (a) 0.5 per cent defective
- (b) 0.8 per cent defective
- (c) 1 per cent defective
- (d) 2 per cent defective
- (e) 4 per cent defective
- (f) 10 per cent defective

Also, draw an OC curve.

Short-answer questions facilitate a review of the concepts discussed in each chapter.



Short-answer Questions

1. Define quality.
2. List David Garvin's five approaches to defining quality.
3. Name the three levels of quality.
4. What are the different types of quality?
5. Mention the five paradigms of quality.
6. What are Garvin's eight dimensions of product quality?
7. What are the SERVQUAL dimensions of service quality?
8. Differentiate between service quality and product quality.
9. Differentiate between old quality and new quality.

Match the following
enables students
to match the right
terms and facilitates
conceptual clarity.



Match the Following

- | | |
|----------------------|--------------------------------|
| a. Walter Shewhart | Theory of profound knowledge |
| b. W. Edwards Deming | Quality trilogy |
| c. Joseph Juran | Total quality control |
| d. Armand Feigenbaum | Gemba Kaizen |
| e. Philip Crosby | Poka-yoke |
| f. Kaoru Ishikawa | Design of experiments |
| g. Genichi Taguchi | Father of quality circles |
| h. Shigeo Shingo | Four absolutes of quality |
| i. Masaaki Imai | Grandfather of quality control |

Discussion questions
test students' learning of
the subject and provide
further opportunities
for the application of
concepts.



Discussion Questions

1. Why might a dictionary definition of quality be inadequate for a quality professional? Which of the definitions discussed in this chapter do you feel is the best? Why?
2. Which of Garvin's five approaches to defining quality makes the most sense to you and why?
3. Discuss what the different categories of quality costs might mean to your college and university. How can they be measured?
4. Why are cost of quality programmes valuable to managers?
5. Explain the three levels of quality and the key issues that must be addressed at each level.
6. How can quality and profitability be correlated?
7. What are the subjective and objective dimensions of quality?

Projects facilitate data
collection and enable
students to broaden
their knowledge of the
subject.



Projects

1. Visit a service organization and find out the costs associated with the poor quality. Prepare a two-page report.
2. Develop a portfolio of advertisements from newspapers and magazines and illustrate how quality is used in promoting these products. Do the advertisements suggest different definitions of quality?

■ THE TEACHING AND LEARNING PACKAGE

The student and instructor support resources provided with this book make learning and teaching a pleasurable experience. They include:

- An Instructors' Resource Manual that provides an analysis of all the case studies and answers to all the chapter-ending exercises in the book.
- PowerPoint lecture slides that outline the main theories discussed in the book and enable instructors to make effective presentations.

The instructors' manual and the PowerPoint slides are available at www.pearsoned.co.in/poornimamcharantimath.

■ ACKNOWLEDGEMENTS

I thank all those who have helped, encouraged and supported me all through the project. I thank all the members of the Board of Management, Karnataka Law Society, Belgaum, and the Director and all the members of the staff at my institution, the Institute of Management Education and Research, Belgaum. The conducive working environment provided by them greatly facilitated my work on this book. My students at IMER have always been a source of motivation. I would like to thank all the authors quoted here whose research and ideas have enriched this book. I am indebted to many practising managers for their valuable comments.

My husband Manoj N. Charantimath and my son Amit have been pillars of support and have been very accommodating of my odd routines. My father Late K. M. Veeresh, mother Ganga, sister Ujwala and brother Satish were a source of moral support. My special thanks to my uncle and aunt, Dr Muttu and Dr Jayashree Puranik, the United Kingdom, for their encouragement.

My thanks are also due to my publisher Pearson Education, the editorial team and all the reviewers of the book for their constructive suggestions. I acknowledge the efforts of Pradeep Kumar Bhattacharjee and M. Balakrishnan who worked hard to give this book its present form. Readers may please mail their feedback and suggestions to poornima_22@yahoo.com.

Poornima M. Charantimath

Reviewers

Total Quality Management has benefited from an extensive development process, which involved faculty reviewers providing feedback about the accuracy and relevance of the content as well as suggestions for its improvement. While we could not incorporate all suggestions from everyone, we do acknowledge that their feedback was invaluable in our attempt at creating the best possible total quality management textbook. We would like to thank the following people for their time and commitment:

K. K. Ganguly

KIIT School of Management Studies, Bhubaneswar

Prashant Gupta

Amity Global Business School, Ahmedabad

Vivek Kumar

FORE School of Management, New Delhi

S. K. Mandelia

Birla Institute of Technology and Science, Pilani

S. N. Parasnis

Maharashtra Institute of Technology, Pune

Murthy Pasumarty

Aspen School of Business, Hyderabad

R. Raghavendra Ravi

Chennai Business School, Chennai

Manoj K. Srivastava

Management Development Institute, Gurgaon

1

Quality Concepts



QUALITY NATURAL FOODS LIMITED

In its broadest sense, quality is a degree of excellence—the extent to which something is fit for its purpose. In the narrow sense, product or service quality is defined as conformance with requirements, freedom from defects or contamination, or simply a degree of customer satisfaction. A business would have no profits if it failed to create and retain satisfied customers. Providing products and services which meet customer needs and expectations creates satisfied customers. Anticipating future needs and expectations retains satisfied customers. Therefore, quality is vital to the survival of any enterprise.

Quality Natural Foods Ltd is a well-established and reputed food distribution company servicing the ethnic markets of Canada. It is a success story of its founders, Jar nail Singh and Sheila Singh, who understood the need for a high quality supplier of traditional ethnic products to the Asian market in Canada. Over 20 years, the company has acquired institutional knowledge, long-term relationships, and widespread recognition that continue to drive its growth. As a result, the company is now the leader in products and service for Asian ethnic population in Canada, serving retailers from coast to coast.

Quality has been the primary consideration in the origin and policy of the business. The commitment to quality required investment in people and equipment, including appropriate facilities for receiving, handling, and storage under safe and hygienic conditions. Strict adherence to, and implementation of, quality measures assured that products procured and distributed by the company always matched high quality standards. Products are sourced from suppliers with international standards accreditation such as ISO and with whom ongoing contact was maintained. Quality is closely monitored to the point of the end users. The commitment to customers was ensured with adequate inventory, reliable distribution networks, and new product offerings.

“Quality is not an art, it is a habit.”

Aristotle

Upon completion of this chapter, you will be able to:

1. Understand the various definitions and the importance of quality
2. Describe the different types and levels of quality
3. Explain the five paradigms of quality
4. Understand the eight dimensions of product quality and the determinants of service quality
5. Describe the differences between old quality and new quality
6. Understand the costs of poor quality

Bird's-eye view:

If an automobile company finds a defect in one of their cars and makes a product recall, production will decrease because trust will be lost in the car's quality.

■ INTRODUCTION

We are surrounded by quality failures that are appallingly expensive in terms of money lost, opportunities foregone and grief incurred. Poor quality processes at its Bhopal pesticide plant cost the Union Carbide Corporation 420 million pounds in compensation claims in March 1989. More than 3,400 people have died since December 1984 after a cloud of deadly methyl isocyanate gas leaked out of a storage tank at the Bhopal plant and floated over a city of 672,000. It was the worst industrial accident in history with over 200,000 people hurt and 15,000–20,000 suffering lasting injuries. The pesticide factory simply lacked the quality and safety processes that exist in similar pesticide plants in Germany and America, which include towers that rain down foam to neutralize escaping gases.

With the liberalization of the Indian economy, the customer has gained in terms of better quality of products and services offered by both multinationals and domestic companies. The competition in the market has widened the choice for customers. Market dynamics have also moved markets from a seller's to a buyer's market. Quality, therefore, has become critical in view of the stiff competition and the need for Indian manufacturers and service providers to gain a stronghold in the international arena.

The twenty-first century can be termed as the century of quality. Quality is a key driver to market share and quality will have to be integrated into all aspects of a successful organization. Efficient production of quality goods and services is a challenge for most businesses today.

A mistake is also termed as an error. When found by the tester, it is termed as a defect. A defect accepted by the development team is called a bug, and when the build does not meet the requirements, it is termed a failure. From the point of view of the producer, a defect is a

product requirement that has not been met. Therefore, quality refers to meeting the product requirements. Increasing the quality of conformance usually results in closing the producer's gap. Thus, quality also enables meeting product requirements.

From the customer's point of view, a defect is anything that causes customer dissatisfaction. Therefore, quality is the degree of fitness permitting use. Freedom from deficiencies in manufacturing industries covers freedom from defects and errors in the product at the time of delivery and during servicing. Similarly, in service industries, it means freedom from errors during initial and future transactions. Quality of design enables achievement of required product features and quality of conformance enables achievement of freedom from deficiencies. Quality thus functions to build product features and offers freedom from deficiencies while incurring profit by closing the customer gap and delighting the customer. This is explained in further detail in the section on the "importance of quality."

Quality is an idea which changes with time. It is a perception; a moving target. Quality (from the Latin term *qualita*) is an attribute or a property. Attributes are ascribed by a subject whereas properties are possessed. Some philosophers assert that quality cannot be defined. Contemporary philosophy defines the idea of quality differently specially focusing on how to distinguish certain kinds of qualities from one another, which remains controversial.

The word "quality" has diverse definitions, ranging from the conventional to those that are strategic. Conventional definitions of quality usually describe a quality item as one that wears well, is well constructed and will last for a long time. However, managers competing in the fierce international marketplace are increasingly concerned with the strategic definition of quality—meeting customer requirements.

DEFINITIONS OF QUALITY

Quality is a subjective term for which each person has his or her own definition. In technical usage, quality can have two meanings: (1) the characteristics of a product or service that bear on its ability to satisfy stated or implied needs and (2) a product or service free of deficiencies.

—American Society for Quality

Quality should be aimed at the needs of the customer, present and future.

—Dr Edward Deming

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

—Armand V. Feigenbaum

Quality is the degree of excellence at an acceptable price and control of variability at an acceptable cost.

—Robert A. Broh

The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.

—ISO 8402: Quality Vocabulary

The totality of features and characteristics of a product or service that bear on its ability to satisfy a given need.

—The European Organization for Quality Control Glossary (1981)

Quality is meeting the requirements of customers, both internal and external, for defect-free products services and business processes.

—IBM

Bird's-eye view:

Definitions of Quality:

- a. Conformance to requirements
- b. A degree of excellence
- c. Totality of characteristics which act to satisfy a need
- d. Fitness for use
- e. Fitness for purpose
- f. Freedom from defects
- g. Delighting customers

Fitness for use or purpose is a definition of quality that evaluates how well the product performs for its intended use.

—Joseph Juran

Quality is the conformance to requirements/specifications. This is a definition of quality to find out, how well a product or service meets the targets and tolerances determined by its designers.

—Philip Crosby

Quality is the loss (from function variation and harmful effects) a product causes to society after being shipped, other than any losses caused by its intrinsic functions.

—Dr Genichi Taguchi

Quality is meeting and exceeding the present and future requirements of the customer on a continuous basis.

—Poornima Charantimath

Bird's-eye view:

Quality is important to businesses but can be quite hard to define. A good definition of quality is: “**Quality is about meeting the needs and expectations of customers**”.

■ Customer-driven Definitions of Quality

Value for price paid: Quality is defined in terms of the utility of the product or service for the price paid.

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

Psychological criteria: A way of defining quality that focuses on judgemental evaluations of what constitutes product or service excellence.

The common definitions of quality are summarized below:

1. Conformance to requirements (Crosby, 1979)
2. Fitness for use (Juran, 1979)
3. Continual improvement (Deming, 1982)
4. As defined by the customers (Ford, 1984; 1990)
5. Loss to society (Taguchi, 1987)
6. Six Sigma (Harry and Stewart—Motorola, 1988)
7. Zero defects (Crosby, 1979)
8. Meeting and exceeding present and future requirements of customer on a continuous basis (Charantimath, 2006)

■ GARVIN'S APPROACHES TO DEFINING QUALITY

David Garvin identified five major approaches to defining quality.¹ The five approaches are as follows:

■ 1. The Transcendent Approach

Quality is recognized through learning and experience defined in terms of innate excellence. In this view “quality is synonymous with ‘innate excellence’ and is absolute and universally recognizable.” This is the approach which aligns most closely with Socrates’ question “What is the fine?” from *Greater Hippias*. This approach implies that there is a construct called quality that is universally applicable. This is the approach that forms the basis for

philosophical debate. Some say it is of little practical utility. Others argue that the transcendent approach is “the fundamentally most important approach to thinking about quality—particularly in the quality of design of breakthrough products and services.”

■ 2. The Product-based Approach

Quality is precise and measurable; it can be ranked on various attributes and is an inherent part of the product. In this regard, quality is “a precise and measurable variable” which is a composite of all the attributes that describe the degree of excellence of a product. This approach is illustrated by a draft of the ISO 8402 standard which stated that “quality is the degree to which a product possesses a specified set of attributes necessary to fulfill a stated purpose.”

■ 3. The User-based Approach

This is an approach to assure that the customer’s voice is incorporated during product design and is reflected in consumer demand curves. While this approach has been practical in the design of products based on incremental innovations, it is of limited value in designing products based on radical innovations. Products based on radical innovation enter a market that may not exist and where customers may not be able to articulate their needs. In the case of radical innovation, the transcendent approach may be of more than just philosophical interest.

■ 4. The Manufacturing-based Approach

Quality is defined as conformance to specifications; reduce costs by reducing the number of deviations with a focus on engineering and manufacturing practices. W. Edwards Deming criticizes this approach as “the absurdity of meeting specifications.” “Specifications don’t tell you what you need...Just to meet specifications—what you think the customer requires—no. That won’t keep you in business.” Taguchi argues that the manufacturing-based approach is fundamentally flawed. He says that simply meeting specifications is not good enough. He developed the quadratic loss function, which showed that losses increased exponentially as a parameter deviated from its target value.

Others argue that conformance to specifications is a practical approach to defining quality, if and only if, the specifications are derived from customer requirements (user-based approach). Philip Crosby goes so far as to say that, “we must define quality as ‘conformance to requirements’ if we are to manage it.” Instead of thinking of quality in terms of goodness or desirability (transcendent approach), we are looking at it as a means of meeting requirements. Quality means conformance. No quality is non-conformance.

■ 5. The Value-based Approach

Quality is defined as performance or conformance at an acceptable cost. In this approach, quality is defined in terms of costs and prices. A quality product is one that provides performance at an acceptable price or conformance at an acceptable cost. Philip Crosby also endorses this approach. This blends the value-based approach with the manufacturing-based approach.

■ QUALITY MANAGEMENT

Quality management is a method for ensuring that all the activities necessary for the design, development and implementation of a product or service are effective and efficient with

Bird’s-eye view:

ISO 9000 2015

Definition of Quality

The adjective *quality* applies to objects and refers to the degree to which a set of inherent characteristics fulfills a set of requirements.

Bird’s-eye view:

An object is any entity that is either conceivable or perceivable and an inherent characteristic is a feature that exists in an object.

Bird’s-eye view:

The *quality of an object* can be determined by comparing a set of inherent characteristics against a set of requirements.

David Garvin identified five major approaches to defining quality. The five approaches are: The Transcendent approach; The Product-based approach; The User-based approach; The Manufacturing-based approach and The value-based approach.

 **Bird's-eye view:**

Quality management includes all the activities that organizations use to direct, control, and coordinate quality.

respect to the system and its performance. Quality control, quality assurance and quality improvement are the three main components of quality management. Quality management focuses not only on product quality, but also on the means to achieve it. Quality management, therefore, uses quality assurance and the control of processes as well as products to achieve more consistent quality.

■ IMPORTANT QUALITY TERMS

- **Quality improvement** can be distinguished from quality control in that quality improvement refers to purposeful change of a process to improve the reliability of achieving an outcome.
- **Quality control** is the ongoing effort to maintain the integrity of a process to maintain the reliability of achieving an outcome.
- **Quality assurance** is the planned or systematic action necessary to provide enough confidence that a product or service will satisfy the given requirements of quality.

 **Bird's-eye view:**

QA and QC both are part of Quality Management however QA is focusing on preventing defect while QC is focusing on identifying the defect.

Quality Control vs Quality Assurance

Quality control is product-oriented and focuses on defect identification. It deals with adherence to requirements. It refers to quality-related activities associated with the creation of project deliverables and are performed after the product is developed. Quality control is used to verify if deliverables are of acceptable quality and that they are complete and correct. Examples of quality control activities include inspection, deliverable peer reviews, and testing process.

Quality assurance is process-oriented and focuses on defect prevention. It is generic and does not concern the specific requirements of the product being developed. It refers to the process used to create the deliverables, and can be performed by a manager, client, or even a third party reviewer. Quality assurance activities are determined before production work begins and these activities are performed while the product is being developed. Examples of quality assurance include process checklists, project audits and methodology, and standards development. Table 1.1 provides the differences between quality control and quality assurance.

Table 1.1 Quality Control vs Quality Assurance

Quality Control	Quality Assurance
It is a set of activities for ensuring quality in products. The activities focus on identifying defects in the actual products produced.	It is a set of activities for ensuring quality in the processes by which products are developed.
It aims to identify and correct defects in the finished product and is a reactive process.	It aims to prevent defects with a focus on the process used to make the product. It is a proactive quality process.
The goal is to identify defects after a product is developed and before it is released.	The goal is to improve development and test processes so that defects do not arise when the product is being developed.
Finding and eliminating sources of quality problems through tools and equipment so that customer's requirements are continually met.	It establishes a good quality management system and conducts assessment of its adequacy and periodic conformance audits of the operations of the system

(Continued)

Table 1.1 (Continued)

Quality Control	Quality Assurance
The activities or techniques used to achieve and maintain the product quality, process, and service.	Prevention of quality problems through planned and systematic activities including documentation is done.
It is usually the responsibility of a specific team that tests the product for defects.	All team members involved in developing the product are responsible for quality assurance.
It is a corrective tool	It is a managerial tool.
Statistical quality control (SQC) is a part of quality control.	Statistical process control is a part of quality assurance.
Validation/Software testing is an example of quality control.	Verification is an example of quality assurance.

■ IMPORTANCE OF QUALITY

The quality of goods and services can impart a competitive edge to an organization. The importance of quality is stated in the sentence—"No quality, no sales. No sale, no profit. No profit, no jobs." The role of quality needs no further emphasis because it is the key to success in business and for the achievement of customer satisfaction. Today "quality" is the watchword for the survival and growth of any organization in the global business environment. Quality increases profits in addition to enhancing the image of the company. Things done right 99.9% of the time means:

- One hour of unsafe drinking water per month
- Two unsafe landings at O'Hare Airport each day
- 16,000 lost pieces of mail per hour
- 20,000 incorrect drug prescriptions per year
- 500 incorrect surgical operations per week
- 50 newborn babies dropped each day by doctors
- 22,000 cheques per hour deducted from wrong accounts
- 32,000 missed heartbeats per person each year

Box 1.1 discusses how quality initiatives taken at HCL Infosystems enable the company to fulfill its mission of providing world-class information technology solutions and services to its customers.

Box 1.1 Quality at HCL Infosystems Ltd

HCL Infosystems is India's premier IT services, solutions, and distribution company enabling organizations to attain and sustain competitive advantage by leveraging information and communication technologies. It is a leader in IT services and solutions with a comprehensive portfolio of capabilities spanning IT and system integration services, digitally-enabled learning, career development solutions, value-added distribution of technology, and mobility products. The philosophy of quality at HCL Infosystems is as follows:

We shall deliver defect-free products, services, and solutions to meet the requirements of our external and internal customers, the first time, and every time.



Bird's-eye view:

Quality is associated with consistency. A client who is satisfied and happy with the first buying experience needs and wants to be equally happy on each further occasion. Or even happier.

HCL's pursuit of quality in all its endeavours is one of the key elements behind its success in the global marketplace. Quality journey began at HCL Infosystems in the late 1980s. It believes in the total quality management philosophy as a means for continuous improvement and customer satisfaction. Its concept of quality addresses people, processes, and products. The tryst for continuous quality improvement is never-ending in HCL Infosystems. The organization strives to maintain high-quality standards, to fulfill their mission to provide world-class information technology solutions and services, and to enable to serve their customers better.

HCL Infosystems received the prestigious CMMI (Capability Maturity Model Integration) Maturity Level 5 certification for its Jaipur Development Centre (JDC).

At the World Congress, the company won global awards for excellence in quality management and leadership. Speaking on the occasion, Anand Prakash, Vice President—Quality commented, 'We are honoured to be felicitated by the World Quality Congress awards, which recognizes world-class standards of quality attained by organizations across India. The award recognizes our commitment to create an enabling environment for HCL Infosystems to attain and sustain the highest standards of quality and services levels for our customers and partners.'

Source: www.hcl.com, last accessed in February 2016.

■ QUALITY AND PROFIT

Listen to the president of a specialty casting manufacturing company: "Our scrap and rework costs this year were five times our profit. Because of those costs, we have had to increase our selling price and we subsequently lost market share. Quality is no longer a technical issue; it is a business issue."

The above statement reveals that quality improves the image of a company in the market. Earlier quality was a technical issue mainly dependent on inspection. But today, quality needs to be integrated with the system. Therefore, quality is gradually becoming a strategic issue given its direct link to profit.

Fitness for use is achieved through two components: product features and freedom from deficiencies. Product features in manufacturing industries cover performance, reliability, durability, ease of use, serviceability, aesthetics, options, reputation, etc. In service industries, they cover accuracy, timeliness, completeness, friendliness, courtesy, anticipation of customer needs, aesthetics, the service provider's knowledge and reputation, etc. Product features have a major effect on sales income through market share and premium prices and include the quality of design. Improving the quality of design generally leads to higher costs.

Freedom from deficiencies in manufacturing industries covers freedom from defects and errors in the product at the time of delivery and servicing. Similarly, in service industries, it means freedom from errors during the initial and future service transactions. Both also include error-free billing and other business processes. Freedom from deficiencies has a major impact on costs through lower waste, lower warranty costs and lower cycle times. Freedom from deficiencies refers to the quality of conformance. Increasing the quality of conformance usually results in lower costs. In addition, greater conformance means fewer complaints and, therefore, increased customer satisfaction.

Figure 1.1 shows how product features and freedom from deficiencies integrate and lead to higher profit.

The approach taken by quality management for product features on the one hand and freedom from deficiencies on the other is characterized by dramatic differences. The former is proactive, while the latter is reactive. Managers, who are adept at one, need not necessarily

Bird's-eye view:

Quality is fitness for use. Fitness for use is achieved through two components: product features and freedom from deficiencies.

Fig. 1.1 Quality and Profit

excel in the other. There are dramatic differences within the manufacturing as well as the service industries, for example, assembly versus chemicals in the former and healthcare versus banking in the case of the latter.

DISCUSSION FORUM

1. Discuss why it is important to study matter.
2. Discuss the three levels of quality.
3. Define quality.
4. Discuss the different types of quality in small groups.

■ TYPES OF QUALITY

In order to produce goods and services of consistent quality and costs, three types of quality are recognized.² They are as follows:

1. Quality of design
2. Quality of conformance
3. Quality of performance

■ 1. Quality of Design

The quality of design is based on the use of market research to identify the product characteristics which connote quality to customers. Quality of design begins with consumer

Bird's-eye view:

Quality of design, quality of conformance and quality of performance are required to produce goods and services of consistent quality and costs. As quality improves profit increases.

 **Bird's-eye view:**

Quality of design is the quality which the producer or supplier is intending to offer to the customer.

research and sales call analysis and is followed by the development of adequate specifications. Here, the focus is to develop products and services that can meet the customer's needs at a given cost. This process of developing a product demands effective cross-pollination of ideas among the marketing, sales, services, manufacturing, research and development departments. Consumer research and service call analysis are at the heart of this process. Consumer research indicates the customer needs, both current and future while sales call analysis investigates the problems users face with the way the product performs.

 **Bird's-eye view:**

If the quality of design does not reflect the customer's requirements, the product which the producer offers him would not probably satisfy the customer, even if it does sufficiently conform to the design.

■ 2. Quality of Conformance

Quality of conformance deals with translating user-based characteristics into identifiable product attributes. It refers to the extent to which a firm and its suppliers can create products with a predictable degree of dependability and uniformity at a given cost in keeping with the quality requirements determined by the study on quality of design. Once the specifications have been determined by the study on quality of design, organizations must continuously strive to improve on these specifications.

■ 3. Quality of Performance

Quality of performance deals with organizing the manufacturing process to ensure that product quality stringently adheres to specifications. Quality of performance studies focus on ascertaining how quality characteristics determined in the quality of design, and improved and innovated through the quality of conformance studies, perform in the market. The profit incurred also depends on quality of performance in the market. The major tools used to deduce the quality of performance are a study of after-sales service and service call analysis. These tools evaluate why consumers like or dislike a product.

Table 1.2 shows other classifications of the types of quality.

■ THREE LEVELS OF QUALITY³

Viewing an organization from three levels helps clarify the roles and responsibilities of all employees in pursuing quality. Total quality management rests on the foundation of the total involvement of all the employees of the organization. An organization that is committed to quality must examine this at three levels:

1. Organizational level
2. Process level
3. The performer or job level or the task design level

 **Bird's-eye view:**

When the quality of a product entirely conforms to the specification (design), the quality of conformance is deemed excellent.

 **Bird's-eye view:**

Quality of performance can be assessed through measurements of physical products, statistical sampling of the output of processes, or through surveys of purchasers of goods or services.

Table 1.2 Types of Quality

1. Indifferent quality	It is the quality that the customer does not notice or appreciate
2. Expected quality	It is the quality that the customer expects and demands
3. One-dimensional quality	It is the quality that the customer expects but that does not necessarily result in loss of the order or a displeased customer when found lacking in the product
4. Exciting quality	It is the quality that exceeds customer expectations, attracting favourable attention

Source: Adapted from Debasish Sarkar, *The Managers Handbook for Total Quality Management* (Beacon Books, 1998).

1. **Organizational level:** At this level, quality concerns revolve around meeting the requirements of the external customer. An organization must seek customer inputs on a regular basis. Top managers must focus attention at the organizational level. The following questions are designed to help define quality at this level:

- What products and services meet your expectations?
- What products and services do not meet your expectations?
- What are the products or services that you need but are not receiving?
- Are you receiving products or services that you do not need?

2. **Process level:** At the process level, organizational units are classified as functions or departments such as those undertaking marketing, design, product development, operations, finance, purchasing, billing and so on. Since most processes are cross functional, the managers of particular organizational units may try to optimize the activities under their control, which can sub-optimize activities for the organization as a whole. Middle managers and supervisors must, therefore, focus their attention at the process level. To define quality at the process level, managers must ask questions such as:

- What products or services are the most important to external customers?
- What processes produce those products and services?
- What are the key inputs to the process?
- Which processes have the most significant effect on the organization's customer-driven performance standards?
- Who are my internal customers and what are their needs?

3. **Performer or job level or task design level:** At the performer level, standards for output must be based on quality and customer service requirements that originate at the organizational and process levels. These standards include requirements for innovation, timeliness, completeness, accuracy and costs. All employees must understand quality at the performer level. To define quality at the job level, one must ask questions such as:

- What is required by customers, both internal and external?
- How can the requirements be measured?
- What is the specific standard for each measure?

■ THE FIVE PARADIGMS OF QUALITY

Across the world there are five distinct ways and means of estimating the quality of activities. These are called the quality paradigms and have resulted from changes in technology, society and customer demands (refer End Note 2).

■ The Customer-craft Paradigm

In this paradigm, the product is created or services are rendered exactly in the manner desired by the customer. Hence, the focus on the product/service and their performance is relative to the demand. Some examples of this pattern are bank loans, coffee shops, tailor's shop, furniture supplier, etc.

■ The Mass-production Paradigm

This paradigm developed post mechanization. Here, the focus is on production rate with no direct involvement of the customer although the product is defined keeping the customer

Bird's-eye view:

The five paradigms of quality are: The Customer-craft paradigm; The Mass-production paradigm; The Statistical quality control paradigm; The Total quality management paradigm and The Techno-craft paradigm.

in mind. Product performance is relatively low here and rework and scrap generation are evident. The delivery time is typically low as sales happen from the stock held. Service organizations in this paradigm are labour intensive. Examples of this pattern are found in automobile parts, readymade buildings for commercial enterprises, etc.

■ The Statistical Quality Control Paradigm

This is similar to the mass production paradigm except that the emphasis here is more on the process. Applied together with mechanized production, the statistical process control results in low scrap and rework and low cost of production. Products are designed and built, and statistical techniques are used after which customers are acquired. Examples of this pattern are found in automobile parts, electronic components, etc.

■ The Total Quality Management Paradigm

The focus here is on the customer and the supplier. Product lines here are the same as in the case of the mass production paradigm. However, the customer is a part of the product definition, creation and performance evaluation phases. Employee involvement and empowerment, customer-focus, continuous improvement, top management commitment, training, teamwork are its key tenets. The result is a high quality product, low cost, fast delivery and substantially reduced opportunities for rework and low generation of scrap. Examples of this pattern are found in product/services produced by TQM companies.

■ The Techno-craft Paradigm

This paradigm is a new frontier of quality that seeks to employ the custom-craft paradigm in performance while reducing delivery time. This paradigm requires a high level of product process flexibility, which enables the customers to get exactly what they desire. The requirement here is to integrate machine, men and automation. Computer aided design and manufacturing is of great use here. Each unit is designed and built on the basis of customer requirements. Examples of this pattern are found in the software and apparel industries.

Bird's-eye view:

David Garvin has developed a list of eight dimensions of product quality. They are: Performance; Features; Reliability; Conformance; Durability; Serviceability; Aesthetics and Perceived quality.

■ DIMENSIONS OF PRODUCT QUALITY

There is widespread agreement that quality is a multidimensional construct (refer End Note 1). A number of researchers and scholars in the field of quality have developed various dimensions that define the quality of a product and/or a service. David Garvin has developed a list of eight dimensions of product quality. They are widely accepted as being applicable to most products with varying levels of importance attributed to particular dimensions. Table 1.3 explains Garvin's eight dimensions of product quality. These dimensions were proposed to facilitate strategic quality analysis by breaking down the word quality into manageable parts so that management can define the quality niches in which to compete.

■ DIMENSIONS OF SERVICE QUALITY⁴

Defining the dimensions of service quality is a daunting task. A number of scholars have developed general lists of service quality dimensions. These consist of 5 to 10 dimensions, which serve as good starting points. However, current research indicates that in terms of service quality, the dimensions and the relative emphasis on each are different for different

industries. So the dimensions developed in one or a group of service industries may not be directly applicable to another group of service industries.

The SERVQUAL instrument is often used to assess customer satisfaction in service industries. It measures quality by comparing customer perceptions of the quality of a service experience to customer expectations for that experience. The instrument is based on ten overlapping dimensions of service quality that are eventually distilled down to five dimensions. The instrument was developed in four different service industries: banking, credit card, repair and maintenance, and long distance telephone. Although they called this set "SERVQUAL" the five can be easily recalled through the acronym "RATER." Table 1.4 gives the SERVQUAL dimensions of service quality using an example.

Table 1.3 Garvin's Eight Dimensions of Product Quality

Dimension	Description	Example for Personal Computer
Performance	A product's primary operating characteristics	Clock speed; RAM; hard drive size
Features	Characteristics that supplement basic functioning	Wireless mouse; flat-screen monitor; DVD-RW
Reliability	Probability of a product malfunctioning within a specific time period	Mean time between failures
Conformance	The degree to which a product's design and operating characteristics meet established standards	Underwriter Laboratories labeled; mouse, monitor, keyboard included with CPU
Durability	Expected product life	Time to technical obsolescence; rated life of monitor
Serviceability	Speed, courtesy, competence and ease of repair	Warranty conditions; availability of customer service and replacement parts.
Aesthetics	How a product looks, feels, sounds, tastes or smells	Computer housing colour scheme; keyboard "touch"
Perceived quality	Reputation and other indirect measures of quality	Brand name; advertising

Source: Adapted from David A. Garvin, *Managing Quality: The Strategic and Competitive Edge* (New York: Free Press, 1988).

Table 1.4 SERVQUAL Dimensions of Service Quality

Dimension	Description	Example from the Banking Sector
Reliability	Ability to perform the promised service with dependable and accurate results	Promised deadlines met; reassuring problem resolution
Assurance	Knowledge and courtesy of employees and their ability to inspire trust and confidence	Trustworthiness; safe environment around ATMs; polite tellers
Tangibles	Physical facilities, equipment and appearance of personnel	ATM access; lobby layout; tellers dressed professionally

Bird's-eye view:

 The SERVQUAL service quality model is a quality management framework was developed by a group of American authors, 'Parasuraman, Valarie Zeithaml and Len Berry, in 1988. SERVQUAL dimensions of service quality are: Reliability; Assurance; Tangibles; Empathy and Responsiveness

Bird's-eye view:

Businesses using SERVQUAL to measure and manage service quality deploy a questionnaire that measures both the customer expectations of service quality in terms of these five dimensions, and their perceptions of the service they receive. When customer expectations are greater than their perceptions of received delivery, service quality is deemed low.

(Continued)

Table 1.4 (Continued)

Dimension	Description	Example from the Banking Sector
Empathy	Caring, individualized attention provided by the firm to its customers	Personal attention to customers; convenient hours
Responsiveness	Willingness to help customers and provide prompt service	Respond quickly to customer requests; willingness to help customers

Source: Adapted from Valarie A. Zeithaml, Leonard L. Berry and A. Parasuraman, "The Nature and Determinants of Customer Expectations of Service," *Journal of the Academy of Marketing Science* (April 2008): 1–12.

■ OLD QUALITY VERSUS NEW QUALITY

The difference between old and new quality lies in the fact that the old is the work of craftsmen, whereas the new is the work of a system. Old quality was created by a few, for the few. New quality is the work of many, for the many. The first is expensive, in terms of labour if not cash; while the second, reduces cost. Old quality still matters because it produces beautiful products. However, new quality can drive the economy by making business more competitive and by serving the population with products and services of a certain standard never before achieved. Table 1.5 states the differences between old quality and new quality. Box 1.2 highlights the difference between small “q” and big “Q.”

According to the conventional view of quality, products are manufactured exactly to specifications. As per the new view of quality (total quality), products and services totally satisfy customer needs and expectations in every respect on a continuous basis.

Table 1.5 Old Quality Versus New Quality

Old Quality	New Quality
About products	About organizations
Technical	Strategic
For inspectors	For everyone
Led by experts	Led by management
High grade	The appropriate grade
About control	About improvement
Little “q”	Big “Q”

👁 Bird's-eye view:

Big Q and little q is a term coined by Dr. Juran and is key in fully understanding quality. Expression that contrasts the difference between striving for quality in all of the firm's products and processes (the big 'Q') and striving for quality in a limited or specific area (the little 'q').

Box 1.2 Big “Q” versus Small “q”

Big “Q” is a term used to describe the process of managing quality in all business processes and products. Small “q” denotes the management of quality in a limited capacity—traditionally only in factory products and processes.

The small “q” approach to quality focuses on segregating the good from the bad rather than eliminating the defects. Whether there is a method to prevent the recurrence of defects is, however, not considered. The small “q” approach exists in situations where demand exceeds supply and competition is negligible. In cases where defects exist in products, an attempt is made to rework and salvage rather than try to prevent the defects recurring in future. A system of learning based on feedback on the quality of the product being produced is absent.

The big “Q” approach to quality is the closest to total quality management. The starting point consists of the customers and their needs. Customer needs are converted into product features, which are then optimized to maximize customer satisfaction by providing maximum quality at the least cost. The emphasis in the manufacturing process is on “zero defects” rather than correction or rework. The mechanism that provides feedback information on product quality provides a high degree of learning that is aimed at preventing a recurrence of errors in the process. People are considered the major variables in many processes and efforts are made to enable them to perform tasks without error. A conscious effort is made to train employees in handling tools and empower them to do the job right the first time.

Source: Adapted from Debasish Sarkar, *The Manager's Handbook for Total Quality Management* (Beacon Books, 1998).

DISCUSSION FORUM

1. Discuss the five paradigms of quality.
2. List Garvin's eight dimensions of product quality.
3. List SERVQUAL's five dimensions of service quality.

■ COST OF QUALITY (COQ)⁵

Cost of quality measures the impact of quality of any business. It is defined as the cost of those activities, which an organization or process has incurred over and above the minimum costs required to do the job well. This is the amount of money a business loses because its products or services failed to secure customer satisfaction in the first place. Businesses lose money everyday due to poor quality. For most businesses, these losses can range from 15 per cent to 30 per cent of their total costs. By addressing COQ, companies can look to adding 10 per cent to 15 per cent of the total costs to the bottom line without any capital investment.

Any cost associated with correcting failure or waste comes under quality costs, as do any assurance or approval activities built in to cushion customers from the effects of such failures. A further set of activities are those in which organizations attempt to prevent such failures from occurring at all. Cost of quality is, therefore, the sum of all costs a company invests into the release of a quality product/service.

Cost of quality has two main components—cost of conformance and cost of non-conformance. Cost of conformance is the cost of providing products or services as per the required standards. This can be termed as a good amount spent (prevention and appraisal costs). Cost of non-conformance refers to failure costs associated with a process not operating according to the requirements. This can be termed as unnecessary amount spent (internal and external failure costs).

$$\text{Cost of Quality} = \text{Cost of Conformance} + \text{Cost of Non-conformance}$$

Essentially, quality costs are defined as the total costs incurred by (1) Investing in the prevention of non-conformance to requirements, (2) Appraisal of a product or service for conformance to requirement and (3) Failure to meet requirements.

Table 1.6 shows the costs associated with poor quality.

Bird's-eye view:

Cost of poor quality (COPQ): The costs associated with providing poor quality products or services. There are four categories: internal failure costs, external failure costs, appraisal costs and prevention costs

1. **Prevention costs:** These are the costs associated with trying to prevent failure and arise from efforts to keep defects at bay. Prevention activities lead to the reduction of failure

 **Bird's-eye view:**

Prevention costs are incurred to prevent or avoid quality problems. These costs are associated with the design, implementation, and maintenance of the quality management system.

 **Bird's-eye view:**

Appraisal costs are associated with measuring and monitoring activities related to quality. These costs are associated with the suppliers' and customers' evaluation of purchased materials, processes, products, and services to ensure that they conform to specifications.

 **Bird's-eye view:**

Internal failure costs are incurred to remedy defects discovered before the product or service is delivered to the customer. These costs occur when the results of work fail to reach design quality standards and are detected before they are transferred to the customer.

 **Bird's-eye view:**

External failure costs are incurred to remedy defects discovered by customers. These costs occur when products or services that fail to reach design quality standards are not detected until after transfer to the customer.

Table 1.6 *The Costs of Quality*

Category	Measure of Quality	Mapping of Quality Costs
Failure cost (internal and external failure)	Scrap, rework, labour, sorting, downtime, slowdown, complaints, investigations, travel, recall, unpaid invoices, lost sales	<ul style="list-style-type: none"> • Operating costs • Operating expenses (labour) • Variable expenses • Losses
Appraisal	Receiving, in-process and final inspection, test equipment, test technicians, special tests, laboratory maintenance, quality control, quality control overheads	<ul style="list-style-type: none"> • Operating expenses • Fixed expenses • Depreciated assets (equipment) • Fixed assets (technicians)
Prevention	Quality planning, design tolerances, training, house keeping, packaging, special sourcing, lifecycle tests, field tests, pre-production tests, shelf-tests, inventories, cash flow	<ul style="list-style-type: none"> • Operating expenses • Fixed expenses • Variable assets (cash flow) • Inventory

and appraisal costs. The motto is prevention rather than appraisal. The activities associated with prevention costs are training and education, market research, quality planning, quality improvement projects, supplier evaluation, design review, contract review, field trials and preventive maintenance.

2. **Appraisal costs:** These are costs to determine conformance with quality standards and performance requirements. These costs arise from detecting defects. Appraisal activities are associated with discovery of defects rather than their prevention. The activities associated with appraisal costs are inspection, checking, auditing, surveying, inquiries, prototype testing, vendor surveillance and calibration of measuring and test equipment.
3. **Failure costs:** The costs resulting from products or services not conforming to requirements or customer/user needs are termed failure costs and can be divided into categories such as internal and external failure costs.
 - **Internal failure costs:** Internal failure costs arise when results of work fail to reach designated quality standards, and are detected before transfer to the customer takes place. Activities associated with internal failure costs are scrap, rework, downgrading, design changes and corrective action.
 - **External failure costs:** These costs occur when the product or service is offered to the customer and found to be defective. External failure costs can be higher than internal failure costs because the stakes are much higher. These may also influence the company's reputation leading to a loss in customers. These costs include post-release customer and technical support. External failure costs occur when the product or service from a process fails to reach designated quality standards, and is not detected until after transfer to the customer. Activities associated with external failure costs are returned products, product recalls, rejected services, unhappy customers, warranty claims, processing/investigation of customer complaints, interest charges on delayed payment due to quality problems.

Total quality costs: The sum of all the above costs. It represents the difference between the actual cost of a product or service and what the reduced cost would be if there were no possibility of substandard service, failure of products or defects in their manufacture.

■ Size of Four Categories of Quality Costs⁶

Figure 1.2 displays various cost elements and Figure 1.3 shows the COQ model, which is often referred to as the preventive, appraisal, failure (PAF) model. The relationship between various cost elements is explained below:

- In organizations which do not follow TQM, there is less emphasis on prevention of defects while main quality efforts focus on appraisal with very little control on internal and external failure costs.
- Various studies have shown that quality costs in manufacturing companies the world over, range from 20 per cent to 30 per cent of the turnover and in the case of service companies it can go up to 40 per cent.
- A penny of prevention is worth a pound of cure. The relationship between costs is expressed as 1:10:100. It means that an expenditure of Re 1 on prevention can bring about savings of Rs 10 on appraisal and Rs 100 on failure costs. This rule will help one to prioritize expenditure. Any expenditure on prevention is sure to bring greater returns.

Fig. 1.2 Various Quality Cost Elements

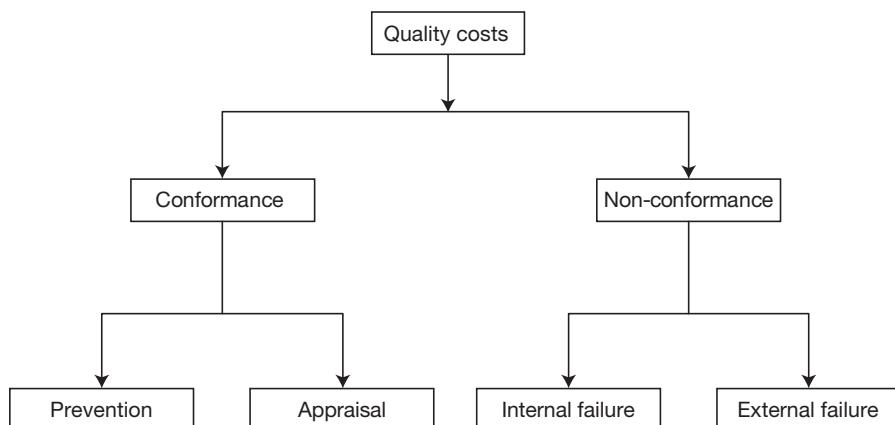
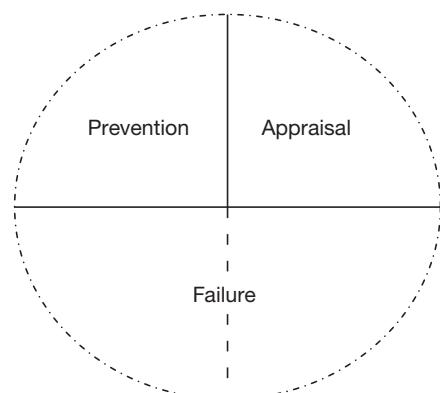


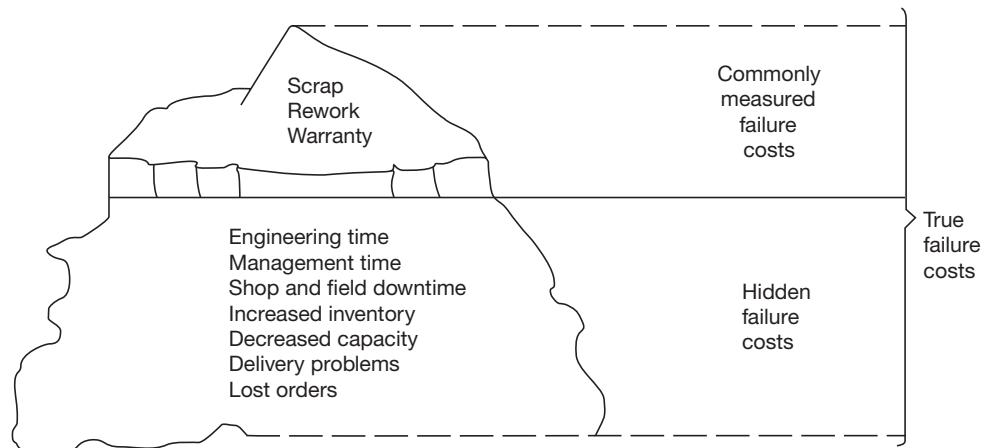
Fig. 1.3 PAF Model



 **Bird's-eye view:**

Cost of quality is also an important communication tool. **Philip Crosby** demonstrated what a powerful tool it could be to raise awareness of the importance of quality.

Fig. 1.4 Hidden Costs of Poor Quality



■ Hidden Quality Costs

There are also costs incurred when trying to understand the costs of poor quality. Figure 1.4 illustrates both the obvious and hidden costs for a manufacturing company. These hidden costs include:

- Potential lost sales.
- Costs of redesign due to poor quality.
- Costs of changing manufacturing processes due to the inability to meet quality requirements.
- Costs of software changes attributed to quality reasons.
- Extra manufacturing costs due to defects.
- Scrap not reported.
- Costs included in standards because history shows that a certain level of defects is inevitable and allowances should be made when formulating the standards.
- Excess process costs for creating an acceptable product.

■ Total Quality Costs

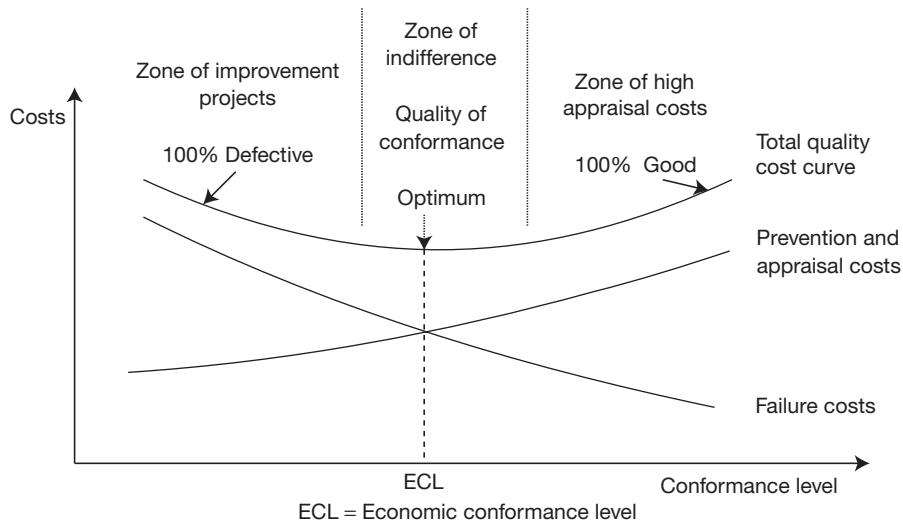
This is the sum of prevention costs, appraisal costs and failure costs. It represents the difference between the actual cost of a product or service and what the reduced cost would be, if there was no possibility of substandard service, failure of products, or defects in their manufacture. Figure 1.5 shows a model for optimum quality cost and the total quality cost curve.

The optimum quality cost model shows the following three curves⁷:

1. **Failure costs:** These equal zero when the product is 100 per cent perfect, and the costs rise to infinity when the product is 100 per cent good, and fall to infinity when the product is 100 per cent defective.
2. **Costs of appraisal plus prevention:** These costs are zero when the product is 100 per cent defective and rise as perfection is achieved.
3. **Total quality cost curve:** The sum of curves 1 and 2. It represents the total cost of quality per good unit of the product.

 **Bird's-eye view:**

Crosby referred to the measure as the “price of nonconformance” and argued that organizations choose to pay for poor quality.

Fig. 1.5 Model for Optimum Quality Cost

Total quality cost curve divides into three zones. The zone a company is in can usually be identified from the prevailing ratios of the quality costs in the principal categories as follows:

Zone of Improvement Projects: This is the left-hand portion of the total quality cost curve. Failure costs constitute more than 70 per cent of the total quality costs while prevention costs are less than 10 per cent of the total. In such cases, there are opportunities for reducing total quality costs by improving the quality of conformance. The approach is to identify specific improvement projects and pursue them to improve the conformance, thereby reducing the costs of poor quality, especially failure costs.

Bird's-eye view:

The costs associated with poor quality are due to both sporadic and chronic quality problems.

Zone of High Appraisal Costs: This is the right-hand portion of the total quality cost curve. It is usually characterized by the fact that appraisal costs exceed failure costs. In such cases there are also opportunities to reduce costs.

Bird's-eye view:

A sporadic problem is a sudden, adverse change in the status quo, which requires remedy through restoration of the status quo. A chronic problem is a long-standing, adverse situation, which requires remedy through a change in status quo.

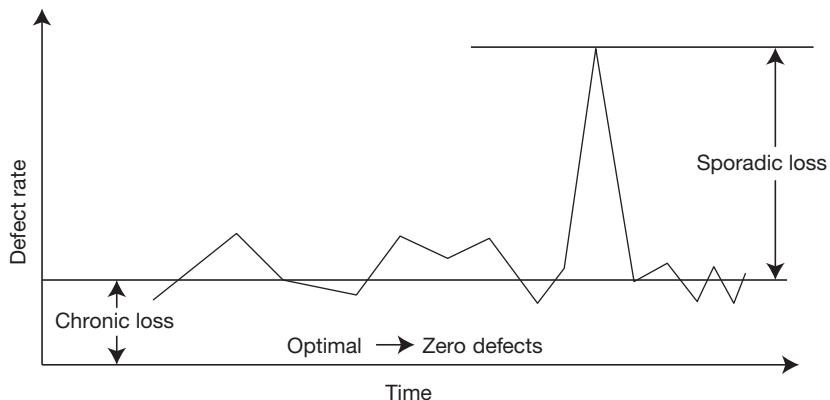
Zone of Indifference: This is the central area of the total quality cost curve. In this zone, the failure costs are usually about half the quality costs while prevention costs are about 10 per cent of the quality costs. In the indifference zone, the optimum has been reached in terms of worthwhile quality improvement projects to be pursued. Continuous improvement is always desirable, but the projects compete against other worthwhile projects, which have not yet attained optimum levels.

The costs associated with poor quality are due to both sporadic and chronic quality problems⁷ (see Figure 1.6). A sporadic problem is a sudden, adverse change in the status quo, which requires remedy through restoration of the status quo. A chronic problem is a long-standing, adverse situation, which requires remedy through a change in status quo. The distinction between chronic and sporadic problems is important for two reasons:

1. The approach to solving sporadic problems differs from that used to solve chronic problems. The control process attacks sporadic problems. Chronic problems use the improvement process.
2. Sporadic problems are dramatic and must receive immediate attention. Chronic problems occur over a period of time, are often difficult to solve and are accepted as inevitable.

Bird's-eye view:

A chronic problem is a long-standing, adverse situation, which requires remedy through a change in status quo.

Fig. 1.6 Sporadic and Chronic Quality Problems**Eye icon:** **Bird's-eye view:**

COQ is usually understood as the sum of conformance plus non-conformance costs, where cost of conformance is the price paid for prevention of poor quality, and cost of non-conformance is the cost of poor quality caused by product and service failure.

Eye icon: **Bird's-eye view:**

Cost of quality (COQ) data is useful as a measurement tool for it can be used very effectively to identify and prioritize improvement opportunities and to track the impact of the change once it is initiated.

Eye icon: **Bird's-eye view:**

The COQ data is aimed at attacking the failure costs and driving them to zero. This strategy is implemented to enable quick problem solving and initiation of change or improvement in the processes that produce the product or service.

The danger is that firefighting sporadic problems may assume greater priority over efforts to achieve the larger savings that are possible, i.e. on chronic problems.

■ Quality Costs in Service Organizations

The nature of quality costs differs in service and manufacturing organizations. In organizations dealing with manufacturing, quality costs are primarily product-oriented whereas for organizations extending services, they are generally labour dependent, with labour often accounting for up to 75 per cent of the total cost (refer End Note 4). The intangible nature of the output makes quality cost accounting difficult for such organizations.

Internal failure costs might not be as evident in services organizations as in the manufacturing sector. They tend to be lower in organizations with high customer contact where there is little opportunity to correct an error before it reaches the customer by which time, the error becomes an external failure. Also, traditional external failure costs such as warranty and field support are less relevant to the services organizations than to manufacturing organizations. Process-related costs such as customer service, complaint-handling staff and lost customers are more critical.

■ Identifying and Using Quality Cost Information

Cost of quality (COQ) data is useful as a measurement tool for it can be used very effectively to identify and prioritize improvement opportunities and to track the impact of the change once it is initiated. The COQ data is aimed at attacking the failure costs and driving them to zero. This strategy is implemented to enable quick problem solving and initiation of change or improvement in the processes that produce the product or service.

Appraisal costs activities should be minimized as they do not add value since they do not change the quality of the product or service being evaluated. The more the inspections or verifications conducted, the less likely that the poor quality product will be shipped to the customer. However, these activities do not prevent the poor quality product from being produced. By spending more money on prevention activities, appraisal activities can be reduced and this also leads to low failure costs.

A five-step process has been recommended by D. W. Webster for using activity-based costing to identify the costs of poor quality⁸:

- Identify all activities (appraisal and prevention) and results (internal and external failures).
- Determine the activity costs associated with prevention and appraisal tasks and internal and external failures.
- Identify the activities that benefit from prevention and appraisal activities and that cause internal and external failures.
- Assign the activity-based cost of quality as appropriate. Assign the cost of prevention and appraisal to the activities that benefit from these processes. Assign the costs of internal and external failures to the activities identified as the root causes of these failures.
- Adjust the calculated costs of products and services to reflect these additional costs of quality.

Cost of quality has numerous objectives, however, perhaps the most important one is to translate quality problems into the “language” of upper management—the language of money. Quality cost information can be used in a number of ways:

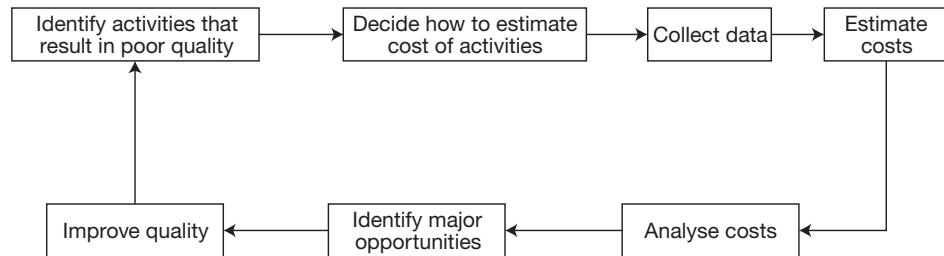
- To identify profit opportunities
- To make capital budgeting and other investment decisions
- To improve purchasing and supplier-related costs
- To identify waste caused by activities not required by the customer
- To identify redundant systems
- To determine whether quality costs are properly distributed
- To establish goals for budgets and profit planning
- To identify quality problems
- As a management tool for comparative measures of input–output relationships
- As a tool for Pareto analysis to distinguish between the “vital few” and the “trivial many”
- As a strategic management tool to allocate resources for strategy formulation and implementation
- As an objective performance appraisal measure

Interpretation of cost of quality is aided by relating total quality costs to other figures with which managers are familiar. They are:

- Quality costs as a percentage of sales
- Quality costs compared to profit
- Quality costs per share of common stock outstanding
- Quality costs as a percentage of cost of goods sold
- Quality costs as a percentage of total manufacturing costs
- Effect of quality costs on the break-even point

■ Cost of Quality Assessment

Assessing the cost of poor quality (COPQ) is very important when identifying the areas for improvement. Every quality improvement exercise requires an investment of resources, which in turn must be justified by the dramatic improvement in terms of returns on quality investments. Successful COPQ exercises result in reduced cost of errors, improved process

Fig. 1.7 Cost of Poor Quality Assessment

Bird's-eye view:

One format for reporting quality costs is with **index numbers**, or **indices**.

Bird's-eye view:

Index numbers are ratios that measure quality costs relative to some base value, such as the ratio of quality costs to total sales revenue or the ratio of quality costs to units of final product.

Bird's-eye view:

These index numbers are used to compare quality management efforts between time periods or between departments or functions. Index numbers themselves do not provide very much information about the effectiveness of a quality management program.

capability, reduced customer defections, an increase in new customers, etc. Considering the size and range of the benefits, the investment required may include diagnosis and other forms of analysis, training, redesign of products and processes, testing and experimentation and equipment. Many improvement projects require little or no costly equipment or facilities so the investment is mainly in the analytical work. The concept of minimizing COPQ aims at preventing failure costs and minimizing appraisal costs. It represents a method to design processes with zero defects. Figure 1.7 illustrates the COPQ Assessment. Box 1.3 discuss the importance provided to quality at Bharat Petroleum.

■ **QUALITY COST INDICES**

Quality costs expressed in pounds, dollars, rupees, etc. do not tell the whole story. The amount of activity involved in creating quality costs must also be considered. This may be

Box 1.3 Pure for Sure: Signs of a Revolution at Bharat Petroleum



Bharat Petroleum Corporation Limited (BPCL) is an Indian state-controlled oil and gas company headquartered in Mumbai, Maharashtra. The Corporation operates two large refineries of the country located at Mumbai and Kochi. BPCL has been ranked 280th in the Fortune Global 500 rankings of the world's biggest corporations for the year 2015.

BPCL has launched its **Pure For Sure Platinum** initiatives across the country. The initiative has been launched to ensure 100% quality, quantity, service, and efficiency to customers through modern technology, promising a fresh and welcoming environment. The cornerstones of Pure For Sure Platinum are Hi-tech and environment friendly offerings. The aspects factored in the design of the Pure for Sure Platinum fuel stations are convenience, comfort, and of course, charm.

The retail outlets covered under this programme display the Pure for Sure sign—an upturned palm forming a circle with the thumb and the first finger. The sign is also imprinted on the dispensing units and on the blue uniform sported by TUV (German pronunciation: **Technischer Überwachungsverein**, English: **Technical Inspection Association**) and the DSM certificate displayed at the outlet. Pure for Sure Platinum is an all-out effort to strengthening the relationship between the company and its customers with a tagline Vaada Nahi Daava.

done by calculating some kind of index (refer End Note 2). The costs are then related to a basis, which is a measure of the amount of activity. The index takes the form of a fraction or ratio usually expressed as a percentage. The index should be selected so that it gives accurate information without being influenced by other factors. It may, therefore, be preferable to follow the quality cost development with more than one index, i.e. several types of bases may be used for forming indices. Usually, for long-range planning purposes, total quality costs as a per cent of net sales is used as an index. There may be no better common denominator than net sales for year-to-year planning and measures of accomplishment according to top management. For current and ongoing applications, however, several bases can be used. The bases selected should be related to the management emphasis already being placed on specific areas for improvement.

- **Cost bases measured by cost ratio:** Such bases are prime cost, manufacturing and processing costs. Prime cost includes all the costs for a product until it is delivered and paid for. Manufacturing costs include costs of direct labour, direct materials and of manufacturing overheads. Processing costs are made up of costs of direct labour and manufacturing overheads. Cost bases are reported in terms of cost ratio, which is the ratio of the total cost of quality to the overall cost of operation.

$$\text{Cost Ratio} = \text{Total Quality Cost}/\text{Cost of Operation}$$

- **Sales bases:** Sales income is a basis which is often used. A disadvantage is that an index based on sales income is influenced by the pricing policy. Sales bases are reported in terms of sales ratio. Sales ratio is the ratio of the total cost of quality to the net sales value (usually expressed in financial terms and reported to senior management).

$$\text{Sales Ratio} = \text{Total Quality Cost}/\text{Net Sales}$$

- **Labour/wage bases:** Such a basis is the cost of direct production of labour. An advantage is that the figure for each manufacturing department is easily available from the accountants. A disadvantage is that the index is affected by the rationalization work. Wage bases are reported in terms of labour ratio, which is the ratio of the cost of quality to the direct cost of labour (usually expressed in hours and reported to line management).

$$\text{Labour Ratio} = \text{Total Quality Cost}/\text{Direct Labour Costs}$$

DISCUSSION FORUM

1. Describe each of the four costs of quality: prevention, appraisal, internal failure and external failure.
2. Describe how each type of cost would change (increase, decrease or remain the same) if we designed a higher quality product that was easier to manufacture.
3. Draw the total quality cost curve.
4. Discuss how quality and profit are related.
5. Describe hidden quality costs.

Bird's-eye view:

Labor index: The ratio of quality cost to direct labor hours; it has the advantage of being easily computed (from accounting records) and easily understood, but it is not always effective for long-term comparative analysis when technological advances reduce labor usage.

Bird's-eye view:

Cost index: The ratio of quality cost to manufacturing cost (direct and indirect cost); it is easy to compute from accounting records and is not affected by technological change.

Bird's-eye view:

Sales index: The ratio of quality cost to sales; it is easily computed, but it can be distorted by changes in selling price and costs.

Bird's-eye view:

Production index: The ratio of quality cost to units of final product; it is easy to compute from accounting records but is not effective if a number of different products exist.

- **Unit/number bases:** Bases for this type are the number of units manufactured or sold, the number of direct production hours or the number of employees. Indices formed thus are affected by inflation, which of course is a disadvantage. Number bases are reported in terms of unit ratio, which is the ratio of the cost of quality per unit produced (manufacturing) or provided (service).

$$\text{Unit Ratio} = \text{Total Quality Cost}/\text{Units Produced}$$

SUMMARY

- The term quality has many different definitions, ranging from the conventional to those that are strategic. Conventional definitions of quality usually describe a quality item as one that wears well, is well constructed and will last for a long time. However, managers competing in the fierce international market are increasingly concerned with the strategic definition of quality—meeting customer requirements.
- David Garvin identified five major approaches to defining quality: The transcendent approach, the product-based approach, the user-based approach, the manufacturing-based approach and the value-based approach.
- Quality of goods and services can provide an organization with competitive edge. The role of quality needs no emphasis for a firm because it is the key to success in business to achieve customer satisfaction. Today “quality” is the watchword for the survival and growth of any organization in the global business environment. Quality increases profits in addition to enhancing the image of the company.
- An organization that is committed to quality must examine quality at three levels: organizational level, process level and the performer/job level/task/design level.
- Quality of design, quality of conformance and quality of performance are required to produce goods and services of consistent quality and costs.
- The five paradigms of quality are custom-craft paradigm, mass production paradigm, statistical quality control paradigm, total quality management paradigm and techno-craft paradigm
- David Garvin identified eight dimensions of product quality—performance, features, reliability, conformance, durability, serviceability, aesthetics and perceived quality. SERVQUAL dimensions of service quality are reliability, assurance, tangibles, empathy and responsiveness
- Small ‘q’—the symbol for a product focus on quality. Big Q—the symbol for product, process and customer focus.
- Fitness for use is achieved through two components: product features and freedom from deficiencies. There are four categories of quality costs. The first two are prevention and appraisal costs, which are incurred by a company in attempting to improve quality. The last two costs are internal and external failure costs, which are the costs of quality failures that the company wishes to prevent.
- The costs associated with poor quality are due to both sporadic and chronic quality problems. A sporadic problem is a sudden, adverse change in the status quo, which requires remedy through restoring the status quo. A chronic problem is a long-standing adverse situation, which requires remedy through changing the status quo.

- In manufacturing, quality costs are primarily product oriented; for services, however, they are generally labour dependent, with labour often accounting for up to 75 per cent of the total costs.

Key Terms

Aesthetics 13	Perceived Quality 13
Appraisal Cost 15	Performance 13
Assurance 13	Prevention Cost 15
Big Q 14	Process Level 10
Conformance 13	Psychological Criteria 4
Durability 13	Reliability 13
Empathy 14	Responsiveness 14
Exciting Quality 10	Serviceability 13
Expected Quality 8	SERVQUAL 13
External Failure Cost 16	Support Services 4
Features 13	Tangibles 13
Hidden Quality Cost 18	The Manufacturing-based Approach 5
Indifferent Quality 10	The Performer/Job Level/Task Design Level 11
Internal Failure Cost 16	The Product-based Approach 5
Little q 14	The Transcendent Approach 4
New Quality 14	The User-based Approach 5
Old Quality 14	The Value-based Approach 5
One-dimensional Quality 10	Total Quality Cost Curve 18
Optimum Quality Cost 18	Value for Price Paid 4
Organizational Level 10	Zone of Indifference 19

Case Study

Quality is King

“While a top manager should be the ideal customer, he should also be the greatest critic of his company’s products. If the CEO compromises, or is only looking at the margins, then even if he is successful, the company’s success will be short lived.”

—Ratan Tata, Chairman, Tata Group

Company

Tata Motors, previously known as Tata Engineering and Locomotive Co Ltd (TELCO), is one of the largest companies in the Tata Group, and one of India’s largest business

houses. Tata Motors is India's leading commercial vehicle manufacturer and the third largest passenger car manufacturer. The company is the sixth-largest truck manufacturer in the world. Tata Motors recently received the Balanced Scorecard Collaborative Hall of Fame Award for having achieved a significant turnaround of its overall performance. A comprehensive quality improvement and cost-cutting initiative in September 2000 has played an important role in the company's turnaround, from a loss of Rs 500 million in the year ended March 2001 to a profit of Rs 28 million in the first quarter of 2002–2003.

Business Segments

Tata Motors has two main business segments: Commercial Vehicle Business Unit (CVBU) and Passenger Car Business Unit.

The Cost of Success

The people at Tata Engineering do not fancy the phrase "cost cutting" for no other reason than that they see it as inadequate, even misleading in their context. "Cost erosion" is a preferred terminology at India's largest automotive company, simply because it captures the breakthrough exercise that has shaved more than Rs 600 million off Tata Engineering's expenses over the last two years. The big positive of the cost-erosion initiative goes beyond the statistics of money saved. It is going to be a permanent feature of Tata Engineering's agenda for the future. However, the problem is that the going gets tougher on this score with every passing month, because finding new costs to eliminate becomes ever more difficult.

The cost-erosion initiative, which began in April 2000, is arguably the most important element in a remarkable revival that has seen Tata Engineering recover from a loss of Rs 500 million in the year ended March 2001 to a profit of Rs 28 million in the first quarter of 2002–2003. Prakash M. Telang, senior vice president (manufacturing), was designated the "cost-erosion champion" and put in charge of the entire initiative. Four specific areas were identified:

- a. Direct material costs (which constitute roughly 65 per cent of all costs);
- b. Variable conversion costs (power, fuel, water, tools, etc.);
- c. Fixed costs (labour, marketing, corporate expenses, plant operations, research and development);
- d. Financial restructuring (working capital, debt restructuring, balance sheet, etc.).

Mr. Telang says, "Everybody had a cost-erosion target built into his area of work and we saw a cascading effect take hold."

Three-tiered teams—members, leaders and champions—were set up at the plant level to implement, drive and monitor the exercise across the organization. Their task began with spreading the cost-reduction message, emphasizing its importance to bringing the company back to good health, and defining the methods to accomplish it. The company's union was co-opted to communicate the programme and the house journal did the same.

Quality Management

Tata Motors started a comprehensive quality improvement initiative in September 2000. The initiative played an important role in the company's turnaround. Every year, about a quar-

ter of Tata Motors' workforce went through training courses, which were rated highly in the Indian engineering industry.

The company's quality management project and its cost erosion exercise have run concurrently, and each has helped the other. For one, its people understood that cutting costs did not mean cutting corners. The same teams and the same people were involved in both exercises. This led to many win-win situations.

With operating margins in its flagship commercial vehicle operations now up at about 13 per cent, Tata Engineering can afford to breathe easy. Where two years back it looked dark as tar, the future now promises the rewards of a war that seems well and truly won.

Source: Adapted from www.tatamotors.com, accessed December 2010.

For Discussion

1. What is the difference between cost cutting and cost erosion?
2. Which were the four specific areas, identified by Prakash Telang as part of the cost-erosion initiatives?
3. What were the benefits accruing to Tata Motors on implementing the cost-erosion exercise and the quality management project?

Exercises

1. Reed Engineering Ltd is a valve manufacturing company that was established two decades ago. The valves are high-end products. The company used to manufacture a variety of valves to cater to the needs of different customers. Over the years, several competitors entered the field and Reed started facing tough competition in the marketplace. The situation forced Reed to look at reducing operating costs. With the help of the employees, the management identified three models of valves, which were felt to have the greatest opportunity for savings. You have been invited as a consultant to look at the following cost data, analyse and prepare a report for the management.

Quality Cost Statement by Product Line

Quality Cost	Product A	Product B	Product C
Prevention	5,698	1,569	1,908
Appraisal	37,676	10,384	9,206
Internal failure	119,107	60,876	63,523
External failure	133,168	12,625	15,755
Total sales	8,165,000	1,750,000	90,392
Total labour cost	5,800	5,650	4,585
No. of machines	71	14	14

2. ABC Company reported the following costs for a one-month period.

Sl No.	Activity	Amount (in Rupees)
1.	Design reviews	60,000
2.	Inspection and tests	40,000
3.	Excess inventory	30,000
4.	In-house scrap and rework	20,000
5.	Customer returns	10,000

- a. How much was spent on external failure costs?
- b. How much was spent on internal failure costs?
- c. How much was spent on failure costs?
- d. How much was spent on appraisal costs?
- e. How much was spent on preventive costs?
- f. What were the total quality costs of ABC Company for the month?

Short-answer Questions

1. Define quality.
2. List David Garvin's five approaches to defining quality.
3. Name the three levels of quality.
4. What are the different types of quality?
5. Mention the five paradigms of quality.
6. What are Garvin's eight dimensions of product quality?
7. What are the SERVQUAL dimensions of service quality?
8. Differentiate between service quality and product quality.
9. Differentiate between old quality and new quality.
10. What are the four categories of cost of poor quality?

Match the Following

- | | |
|---------------|---|
| a. Appraisal | Correcting or replacing products after shipment to the customer |
| b. Prevention | Correcting or replacing products that fail to conform to specifications |

c. Internal failure	All activities specifically designed to prevent defects
d. External failure	Measuring, checking, or auditing products to assure conformance to quality standards

Discussion Questions

1. Why might a dictionary definition of quality be inadequate for a quality professional? Which of the definitions discussed in this chapter do you feel is the best? Why?
2. Which of Garvin's five approaches to defining quality makes the most sense to you and why?
3. Discuss what the different categories of quality costs might mean to your college and university. How can they be measured?
4. Why are cost of quality programmes valuable to managers?
5. Explain the three levels of quality and the key issues that must be addressed at each level.
6. How can quality and profitability be correlated?
7. What are the subjective and objective dimensions of quality?
8. What are the determinants of service quality? Why is it difficult to measure service quality? What dimension of service quality is more critical in hospital service?

Projects

1. Visit a service organization and find out the costs associated with the poor quality. Prepare a two-page report.
2. Develop a portfolio of advertisements from newspapers and magazines and illustrate how quality is used in promoting these products. Do the advertisements suggest different definitions of quality?

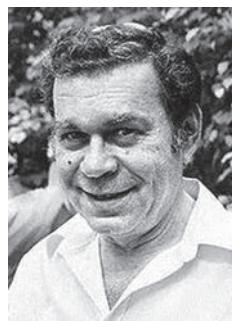
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2

Quality Gurus



ELIYAHU M. GOLDRATT

Eliyahu M. Goldratt (1947–2011) was an Israel-born physicist who became a business management guru. He is the originator of the Theory of Constraints (TOC). He authored several books, mainly on the application of theory of constraints to various manufacturing, engineering, and other business processes. The TOC is one of the most profound developments in the practical aspect of making organizational decisions in situations in which constraints exist. It provides a practical framework for managing enterprises with a holistic and a focused approach and does away with conflicts between local operating-level decisions and global objectives and goals of a company.

There is always at least one constraint and TOC uses by focusing process to identify the constraints and restructure the rest of the organization around it. Most constraints in an organization are of their own making. TOC brings in the powerful 'five-focusing step' methodology to identify the constraints in a company and systematically attach the associated problems. This results in dramatic improvement of throughput and customer order due date performance, and inventory reduction. The five steps in applying TOC, also called the process of on-going improvement (POOGI) are as follows:

1. Identify the system's constraint
2. Exploit the constraint
3. Subordinate everything to the constraint
4. Elevate the constraint
5. Prevent inertia from becoming the constraint

Goldratt has authored several books. Some noteworthy ones include *The Goal* (1984); *The Race* (1986); *The Haystack Syndrome* (1990); *What is This Thing called Theory of Constraints and How Should it be implemented?* (1990); *It's Not Luck; Critical Chain* (1997); *Necessary But Not Sufficient* (2000); *The Choice* (2008); and *Isn't it Obvious* (2009).

“Being a quality leader has become crucial to the economic strength and business future of companies around the globe.”

Armand V. Feigenbaum

Upon completion of this chapter, you will be able to:

1. Explain Walter Shewhart's and W. Edwards Deming's contribution to TQM
2. Understand Joseph Juran's and Armand Feigenbaum's contribution to TQM
3. Identify Philip Crosby's contribution to TQM
4. Understand Kaoru Ishikawa's and Genichi Taguchi's contribution to TQM
5. Describe Shigeo Shingo's contribution to TQM
6. Discuss Masaaki Imai's contribution to TQM

■ INTRODUCTION

To fully understand the TQM movement, we must look at the philosophies of notable individuals who have shaped the evolution of TQM. Their qualitative and quantitative contributions have been critical in the emergence and development of contemporary knowledge regarding quality. Although their philosophies are different, these “masters” of quality assurance point to leadership and commitment flowing from the top as an absolute essential for success. Their common thrust is towards the concept of continuous improvement of every output; be it a product or service by removing unwanted variation and improving underlying work processes. Their philosophies and teachings have contributed to our knowledge and understanding of quality.

This chapter details the contributions of Walter Shewhart, W. Edwards Deming, Joseph Juran, Armand Feigenbaum, Philip Crosby, Kaoru Ishikawa, Genichi Taguchi, Shigeo Shingo and Masaaki Imai to the quality movement. They have been selected here for having contributed significantly to quality management.

● Bird's-eye view:

Walter Shewhart was one among the giants in the quality movement during the first half of the 20th century. Walter Andrew Shewhart was an American physicist, engineer and statistician, sometimes known as the father of statistical quality control and also developed the Shewhart cycle.

■ WALTER SHEWHART

Walter Shewhart¹ (1891–1967) was a statistician at Bell Labs and is considered by many to be the founder of the modern quality movement, and an innovator in the application of statistics to quality. His seminal contributions were based on his work at Bell Telephone Laboratories during the 1920s and the 1930s and were compiled in two books; *Economic Control of Quality of Manufactured Product* in 1931 and *Statistical Method from the Viewpoint of Quality Control* in 1939.

Shewart² is often referred to as the “grandfather of quality control.” He studied randomness and recognized that variability existed in all manufacturing processes. He developed what came to be known as the Shewart cycle; Plan-Do-Study-Act (PDSA) or Plan-Do-Check-Act (PDCA) to manage the effects of variation. He developed quality control charts that are presently used to identify whether the variability in the process is random or due to an assignable cause such as unskilled workers or equipment not being calibrated. He stressed that eliminating variability improved quality. His work created the foundation for statistical process control measures used today.

■ W. EDWARDS DEMING

W. Edwards Deming³ (1900–1993) is often referred to as the “father of quality control.” Deming is best known for initiating a transformation in the Japanese manufacturing sector in the aftermath of World War II, which enabled it to become a big player in the world market. The Deming Prize, the highest award for quality in Japan, is named in his honour. He is also known for his 14 Points (a new philosophy for competing on the basis of quality), for the Deming Chain Reaction and for the Theory of Profound Knowledge. He also modified the Shewhart PDSA (Plan, Do, Study, Act) cycle to what is now referred to as the Deming Cycle (Plan, Do, Check, Act).

 **Bird's-eye view:**

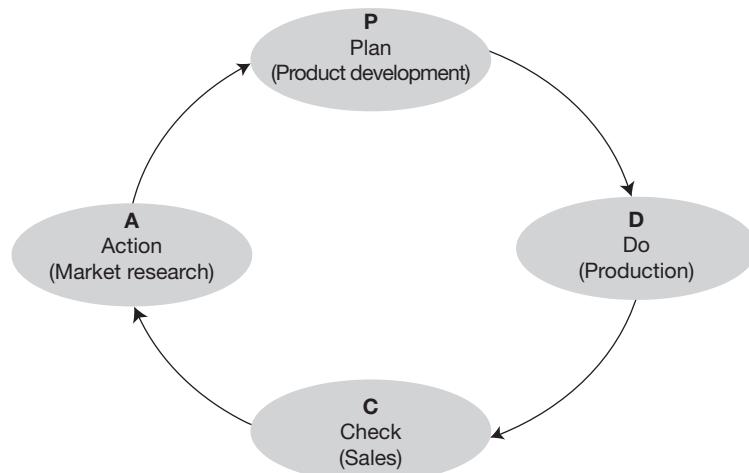
William Edwards Deming (1900-1993) father of quality evolution is often referred as the “father of quality control”. He is widely acknowledged as the leading management thinker in the field of quality.

■ The Deming Cycle: PDCA Cycle⁴

Deming introduced the “Deming cycle,” one of the crucial QC tools for assuring continuous improvement. The Deming cycle is also known as the Deming wheel or the PDCA (Plan-Do-Check-Action) cycle (Figure 2.1). It is a problem-solving process adopted by firms engaged in continuous improvement. Deming stressed the importance of constant interaction among the four stages of Design, Production, Sales and Research for a company to arrive at better quality that satisfied customers. He stated that this wheel should be operated in accordance with quality first perceptions and responsibilities.

He stated that to arrive at a quality that satisfied customers, the four stages should be rotated constantly with quality as the most critical criterion. Later, this concept of the

Fig. 2.1 PDCA Cycle



Bird's-eye view:

The **Deming Cycle**, or **PDCA Cycle**, is a continuous quality improvement model consisting of a logical sequence of four repetitive steps for continuous improvement and learning: Plan, Do, Check and Act.

Deming wheel was extended to all phases of management and modified as the “PDCA” cycle: Plan, Do, Check, Action, which corresponded to specific managerial actions.

The PDCA is a series of activities pursued to achieve improvement. It begins with a study of the current situation during which data are gathered to formulate a plan for improvement. Once this plan has been finalized, it is implemented. The implementation is also checked for anticipated improvement. When the experiment is successful, a final action such as methodological standardization is taken to ensure that the new methods introduced will be practised continuously for sustained improvement. The entire focus is on problem prevention rather than remedies (i.e. firefighting).

■ PDCA Cycle—Description

The PDCA (or PDSA) cycle was originally conceived by Walter Shewhart in the 1930s, 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 the target areas requiring improvement have been identified.

■ Applications of the PDCA Cycle

It is used to satisfy the quality requirements of the customer. It may be used for the development of a new product based on the quality requirements of the customer. It develops teamwork between the company’s various functions and aids in product design and development, production, sales and market research. Box 2.1 discusses how the PDCA cycle can be applied to education.

Box 2.1 Deming’s PDCA Cycle Applied to Education

The Deming cycle can be applied to all academic activities without any immediate financial implications. One of the crucial factors required for successful implementation of the PDCA cycle is to act upon obtaining feedback.

The Deming cycle can be applied to faculty members teaching in an academic institution. To begin with, feedback needs to be collected every month-end at appropriate checkpoints. Secondly, feedback needs to be collected at the end of all sessions. Thus, the use of the PDCA cycle will offer ample opportunities to teachers to improve teaching methods in technical education. The following activities need to be carried out in each of the phases of the PDCA cycle:

Plan: Class scheduling, syllabus planning, evaluation methods, teaching aids, learning tools, feedback methods, case studies and projects, expert lectures, industrial visits, improvements in teaching methods, extra-curricular activities, computer-based learning, practical coverage planning and lab development.

Do: Classroom teaching, practical guidance, external interaction, continuous self-learning, conduct exams and tests, conduct practical exercises in laboratories, demonstration, computer-aided methods.

Check: Evaluation (seminars, presentations, tests, quizzes, *viva voce*, etc.), progress of learning, review of feedback, analysis of results and scope for further exercises.

Act: Redesign the system, revise the syllabus, modify and report, corrective action on feedback and input for plans to take preventive action.

Design → Plan: When a problem is detected in product design and development, find the causes of the problem.

Production → Do: A pilot project is done, or implemented.

In the Do phase, one collects correct data about the problem and sorts it out statistically. Then one identifies probable causes and verifies the most plausible ones and takes corrective action. At this stage, always make sure that the relevant job standards have been followed.

Sales → Check: The results of the effort are observed and analysed against the plan.

In the Check phase, one evaluates the results after implementation of a corrective procedure. If the targets are not achieved, one goes back to the Plan or Do stage and starts all over again. Upon satisfactory achievement of the target, one proceeds to the next stage.

Research → Action: At this stage, the cycle starts again with planning an improvement.

One documents and standardizes the process concerned and provides training to employees in the new procedures.

The PDCA cycle is designed to be used as a dynamic model. The completion of one turn of the cycle flows into the initialization of the next. The cycle must be constantly rotating. Following in the spirit of continuous quality improvement, the process can always be reanalysed and a new test of change begun. This continual cycle of change is represented in the ramp of improvement. Using what we learn in one PDCA cycle, we can begin another more complex cycle.

■ The Ramp of Improvement

This is a schematic representation of the use of the PDCA cycle in the improvement process. As each PDCA cycle reaches completion, a new and slightly more complex project is undertaken. This roll-over feature is integral to the continual improvement process. The ramp of improvement is shown in Figure 2.2.

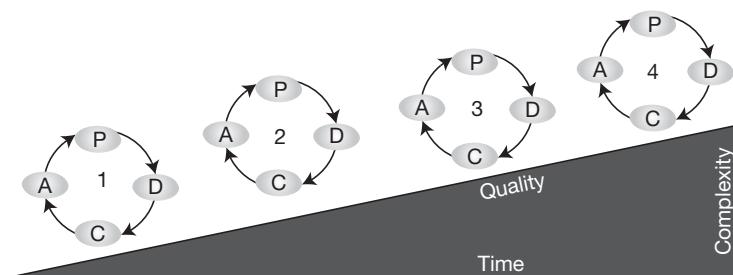
Plan: A change or a test aimed at improvement.

In this phase, one must analyse what one intends to improve, looking for areas that hold opportunities for change. The first step is to choose areas that offer the most returns for the effort one puts in. In order to identify these areas for change one must consider using a flow chart or Pareto chart.

Do: Carry out the change or test (preferably on a small scale).

The change that has been decided on in the plan phase needs to be implemented.

Fig. 2.2 Ramp of Improvement



Bird's-eye view:

Dr. Edward Deming, provided a simple yet highly effective technique that serves as a practical tool to carry out continuous improvement in the workplace. This technique is called **PDCA Cycle** or simply Deming Cycle.

Bird's-eye view:

PDCA is acronym of Plan, Do, Check and Action. Deming Cycle provides conceptual as well as practical framework while carrying out Kaizen activities by the employees.

Check or study: The results need to be examined for lessons learned from the exercise. What was learned? What went wrong?

This is a crucial step in the PDCA cycle. After one has implemented the change for a short time, one must determine how well it is working. Is it really leading to improvement in the way one had hoped? One must decide on several measures with which the level of improvement can be monitored. Run Charts are helpful in measuring this.

Act: Adopt the change, abandon it or run through the cycle again.

After planning a change, implementing and then monitoring it, one must decide whether it is worth continuing that particular change. If it consumed too much of one's time, was difficult to adhere to, or even led to no improvement, one may consider aborting the change and planning a new one. However, if the change has led to a desirable improvement or outcome, one may consider expanding the trial to a different area or increasing the complexity slightly. This takes one back to the Plan phase thereby starting the ramp of improvement again.

👁 Bird's-eye view:

Deming (1986) proposed his famous **Chain Reaction Model** to explain the relationships among quality, productivity, cost, and eventually sustainability.

👁 Bird's-eye view:

Quality improvement in any organizational process, in terms of variability reduction, results in higher productivity.

■ The Deming Chain Reaction

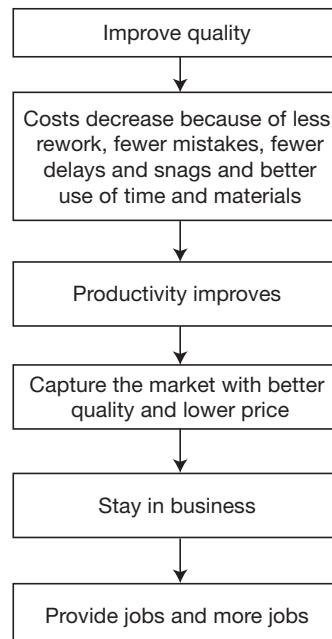
The Deming chain reaction was first presented in 1950 in Japan after World War II. It is shown in Figure 2.3. It illustrated Shewhart's concept that productivity and quality improved as variation reduced. His book *Out of the Crisis* (1989) is considered a quality classic. Deming identified seven deadly sins affecting quality:

1. Lack of constancy of purpose
2. Emphasis on short-term profits
3. Over-reliance on performance appraisals
4. Mobility of management

Fig. 2.3 The Deming Chain Reaction

👁 Bird's-eye view:

Deming's Chain Reaction has a potential for groups and teams to gain and establish continuous improvement understanding in daily routine work operations.



5. Overemphasis on visible figures
6. Excessive medical costs for employee healthcare
7. Excessive costs of warranty and legal costs

Deming's Theory of Profound Knowledge states that a production system is composed of many interacting subsystems. It is the management's responsibility to set the purpose for the system and to optimize it. Deming advocated improving the system rather than criticizing the workers. He believed that workers were already doing their best with the systems that the management provided. However, doing one's best without direction led to poor results. He inferred that it was the responsibility of the management to provide the direction that workers needed. However, Deming stated that this could not be done by the management's use of objectives (which Deming referred to as management by fear) or annual performance reviews (which he condemned). The plan he proposed is embodied in his 14 points, which he felt would have to be implemented in its entirety in order to be effective. According to Deming, skipping one point would inhibit the efficacy of the other 13.

■ Deming's 14-Point Methodology

1. **Constancy of purpose:** Create constancy of purpose for continual improvement of products and service, and allocate resources to cater to long term needs rather than short-term profitability with a plan to become competitive, stay in business and provide jobs.
2. **The new philosophy:** Adopt the new philosophy for one can no longer accept delays, mistakes and defective workmanship. Transformation of the Western management style is necessary to halt the continued decline in the industry.
3. **Cease dependence on inspection:** Eliminate the need for mass inspection as a way to achieve quality by building quality into the product in the first place. Demand statistical evidence of built-in quality in both manufacturing and purchasing functions.
4. **End lowest tender contracts:** End the practice of awarding business contracts solely on the basis of price tags. Instead, go for meaningful measures of quality along with price. Reduce the number of suppliers for the same item by eliminating those that do not qualify against the statistical yardstick of quality. The aim is to minimize total cost, not merely the initial cost. Purchasing managers now have their task cut out and must learn their responsibilities.
5. **Improve every process:** Constantly improve every process involved in the stages of planning, production and service. Search continually for problems in order to improve every activity in the company because better quality leads to increased productivity and decreased costs. It is the management's job to continually work on all aspects of the system (design, incoming materials, maintenance, improvement of machines, training, supervision, retraining, etc.)
6. **Institute training on the job:** Institute modern methods of training on the job, including management to make maximum use of all employees. New skills are required to keep up with changes in materials, methods, product design, machinery, techniques and service.
7. **Institute leadership:** Adopt and institute leadership, which is aimed at helping people do a better job. The responsibilities of managers and supervisors must be changed to emphasize on quality rather than quantity. This will automatically improve productivity. The management must ensure that immediate action is taken on reports of inherited defects, maintenance requirements, poor tools, fussy operational definitions and other conditions detrimental to quality.

 **Bird's-eye view:**
Deming's 14 Points on Quality Management, a core concept on implementing total quality management, is a set of management practices to help companies increase their quality and productivity.

8. **Drive out fear:** Encourage effective two-way communication and other means to drive out fear throughout the organization so that all employees are able to work effectively and ensure greater productivity for the company.
9. **Breakdown barriers:** Breakdown barriers between people in different divisions of the organization such as R&D, Sales, Administration and Production. They must work in teams to tackle problems that may be encountered.
10. **Eliminate exhortations:** Eliminate use of slogans, posters and exhortations demanding zero defects and new level of productivity from the workforce, without providing commensurate methods. Such exhortations only create adversarial relationships; the bulk of the cases of low quality and low productivity belong to the system and; thus, lie beyond the power of the workforce.
11. **Eliminate arbitrary numerical targets:** Eliminate work standards that prescribe numerical quotas for the workforce and numerical goals for people in the management. Substitute these with aids and helpful supervision and use statistical methods for continual improvement of quality and productivity.
12. **Permit pride of workmanship:** Remove the barriers that rob hourly workers and people in the management of their rights to pride of workmanship. This implies the abolition of the annual merit rating (appraisal of performance) and management by objectives. Again, the responsibility of managers, supervisors and foremen must be changed from sheer numbers to quality.
13. **Encourage education:** Institute a vigorous programme of education and encourage self-improvement. What an organization needs is not just good people; it needs people who improve with education. A workforce rooted in knowledge will always enable an organization to be competitive.
14. **Top management's commitment:** A clearly defined commitment by the top management to constantly improve quality and productivity and reinforcement of obligations to implement all these principles is always beneficial to the workforce and the organization. Create a structure in the top management whose main task will be to push these 13 points constantly and take action in order to accomplish the transformation.

Bird's-eye view:

Joseph Juran's major contribution to society was in the field of quality management and he is often called the father of quality.

Bird's-eye view:

In 1937, Dr. Juran created the "Pareto principle," which millions of managers rely on to help separate the "vital few" from the "trivial many" in their activities. This is commonly referred to as the 80-20 principle.

Box 2.2 discusses Deming's famous Red Bead Experiment.

■ JOSEPH JURAN

Joseph Juran⁵ (1904–2008) assisted the Japanese in their reconstruction processes after World War II. Juran first became famous in the US as the editor of the *Quality Control Handbook* (1951), and later for his paper introducing the quality trilogy—quality planning, quality control and quality improvement.

- Quality planning provides a system that is capable of meeting quality standards.
- Quality control is used to determine when corrective action is required.
- Quality improvement seeks better ways of doing things.

Questioning which aspect of the quality trilogy is most critical is similar to asking which leg of a stool is the most important. The stool (and the quality system) cannot function effectively without all three. Juran defined quality as "fitness for use" and also developed the concept of cost of quality.

Box 2.2 Deming's Red Bead Experiment

Dr Deming developed a teaching tool in 1982 to teach his famous 14 obligations of management. He named this tool the Red Bead Experiment, and used it in his seminars across the world.

The game consists of players using a special metal paddle to draw small red and white coloured beads from a large bowl. Each draw of the paddle gets 50 beads. Some are white and some are red. The white beads symbolize the good things experienced at work each day and the red beads symbolize the problems encountered. As each player draws his paddle full of 50 beads, he receives a different mix of red and white beads. Many management points get brought to the fore when one plays this game. Workers cannot be blamed for all the problems in the organization since they did not form it. Consequently, they should not be held responsible for all the mistakes. If managers expect better work, they need to employ specialists to ask questions, and then design improvements to the system to remove the problems (red beads) encountered each day. Reprimanding the workers does no good and only results in workers becoming more quiet and reticent. This, in turn, conceals the process problems further. So the workers have a very important role in assisting the managers to improve each day's work experiences. A friendly work environment should be created so that workers feel free to speak their minds and share what they know.

Source: Adapted from www.pathmaker.com/resources/leaders/deming.asp, accessed February 2010.

While Deming's approach is revolutionary in nature (i.e. throw out one's old system and "adopt the new philosophy", his 14 points), Juran's approach is more evolutionary (i.e. one can work to improve the current system). Deming refers to statistics as being the language of business while Juran says that money is the language of business, and quality efforts must be communicated to the management in their language. Juran agrees with Deming that more than 80 per cent of defects are caused by the system rather than the workers and lists motivation of workers as a solution to quality problems.

Juran's Quality Trilogy⁶

Juran developed the idea of the quality trilogy to bring continuous improvement in the process. The elements of the trilogy are quality planning, quality improvement and quality control. These are broken into key constituents as shown in Table 2.1.

Table 2.1 Universal Process for Managing Quality

Quality Planning	Quality Control	Quality Improvement
Establish quality goals	Choose control subjects	Prove the need
Identify customers	Choose units to measure	Identify projects
Discover customer needs	Set goals	Organize project teams
Develop product features	Create a sensor	Diagnose the causes
Develop process features	Measure actual performance	Provide remedies, prove that the remedies are effective
Establish process controls, transfer to operations	Interpret the difference	Deal with the resistance to change and control to hold the gains
	Take action on the difference	

Source: Adapted from Joseph M. Juran, *Juran on Planning for Quality* (New York: Free Press, 1988).

Bird's-eye view:

The **Juran Trilogy**, published in 1986, identified and was accepted worldwide as the basis for quality management.

Bird's-eye view:

After almost 50 years of research, his trilogy defined three management processes required by all organizations to improve. Quality control, quality improvement, and quality planning have become synonymous with Juran and Juran Institute, Inc.

Bird's-eye view:

Juran is the founder of Juran Institute in Wilton, Connecticut. He promoted a concept known as *Managing Business Process Quality*, which is a technique for executive cross-functional quality improvement.

Juran propounded the following message on quality⁷:

- Quality control must be an integral part of management
- Quality is no accident
- Quality must be planned
- There are no shortcuts to quality
- Use problems as sources of improvement

■ Juran's Formula

1. Build an awareness regarding the need and offer an opportunity for improvement
2. Set goals for improvements
3. Organize paths to reach the goals (establish a quality council, identify problems, select projects, appoint teams, designate facilitators, etc.)
4. Provide training
5. Carry out projects to solve problems
6. Report progress
7. Give recognition
8. Communicate results
9. Keep score
10. Maintain momentum by making annual improvements part of the regular systems and processes of the company

DISCUSSION FORUM

1. Discuss Walter A. Shewhart's contribution to quality management in small groups.
2. Describe Deming's 14 points of quality.
3. Explain Juran's quality trilogy.

Bird's-eye view:

Armand Vallin Feigenbaum was an American quality control expert and businessman. He devised the concept of Total Quality Control which inspired Total Quality Management. The name Armand V. Feigenbaum and the term "total quality control" are virtually synonymous.

■ ARMAND FEIGENBAUM

Armand Feigenbaum⁸ is credited with the creation of the idea of total quality control in his book *Quality Control—Principles, Practice, and Administration* (1961) and in his article "Total Quality Control" (1956). The Japanese version of this concept is called Company Wide Quality Control, while it is termed Total Quality Management (TQM) in the US and elsewhere. He was also the first to classify quality costs as costs of prevention, appraisal and internal and external failures. Feigenbaum's philosophy is summarized in his "Three Steps to Quality," which has been described below.

- (i) **Quality leadership:** This is evident when the management emphasizes on sound planning rather than reacting to failures. The management must maintain a constant focus and lead the quality effort.
- (ii) **Modern quality technology:** The traditional quality development processes cannot resolve 80 to 90 per cent of quality problems. This task requires the integration of office

staff, engineers as well as the shop-floor workers who continually evaluate and implement new techniques to satisfy customers in the future.

- (iii) **Organizational commitment:** Continuous training and motivation of the entire workforce as well as an integration of quality in business planning stage indicates the importance of quality and provides the means for including it in all respects of the organization's activities.

■ Key Elements of Feigenbaum's Philosophy of Quality Control⁹

1. Total quality control refers to a system of integrating quality development, maintenance and improvement efforts in an organization that will enable engineering, marketing, production and service to function at optimal economic levels while achieving customer satisfaction.
2. The "control" aspect of quality control should involve setting quality standards, appraising performances relative to these standards, taking corrective action when the standards are not met and planning for improvement in the standards.
3. Factors that affect quality can be divided into two major categories—technological and human. The human factor is the more critical factor.
4. Operating quality costs can be divided into four categories: Prevention costs, appraisal costs, internal failure costs and external failure costs.
5. It is important to control quality at the source.

■ PHILIP CROSBY

Philip Crosby¹⁰ (1926–2001) came to national prominence with the publication of his book *Quality is Free* (1979). He established the Absolutes of Quality Management, which states that the only performance standard (that makes sense) is zero defects, and the basic elements of improvement.

While Crosby, like Deming and Juran, stresses on the importance of the management's commitment and error-cause removal, some aspects of Crosby's approach to quality are quite different from Deming's. Zero defects, central to Crosby's philosophy, was criticized by Deming as being directed at the wrong people (workers) and generating worker frustration and resentment. Goal setting, central to Crosby's theory, was also criticized for leading to negative accomplishment. The reality is that Deming was probably reacting to the inappropriate use of slogans and goals. Deming may not have condemned them if they had always been used properly within the Crosby system.

The essence of Crosby's teachings is contained in what he calls the "four absolutes of quality."

The definition: Quality is conformance to requirements, not goodness.

The system: Prevention, not appraisal.

The performance standard: Zero defects.

The measurement: The price of non-conformance to requirements, not quality indices.

Based on these premises, he developed a 14-step methodology.

■ Crosby's 14 Steps¹¹

1. **Management commitment:** To clarify the management's stand on quality.
2. **Quality improvement team:** To run the quality improvement programme.

Bird's-eye view:

Philip B. Crosby was a legend in the discipline of quality. A noted quality professional, consultant, and author, he is widely recognized for promoting the concept of "zero defects" and for defining quality as conformance to requirements.

Bird's-eye view:

Philip Crosby has authored many books, including *Quality is free*, *Quality without tears*, *Let's talk Quality* and *Leading: The art of becoming an executive*.

Bird's-eye view:

Crosby originated the concept of zero defects. The essence of Crosby's teaching is contained in "four absolutes of quality" and the fourteen steps to quality improvement.

3. **Quality measurement:** To display current and potential non-conformance problems in the manner that permits objective evaluation and corrective action.
4. **Cost of quality:** To define the ingredients of the cost of quality, and explain its use as a management tool.
5. **Quality awareness:** To provide a method of raising personal concern among the personnel in the company towards the conformance of the product and service, and the reputation of the company on the issue of quality.
6. **Corrective action:** To provide a systematic method of resolving the problems identified through actions taken previously.
7. **Zero defects planning:** To examine the various activities that must be conducted in preparation for formally launching the zero defects programme.
8. **Supervisor training:** To define the type of training that supervisors need in order to actively carry out their roles with regard to the quality improvement programme.
9. **Zero defects day:** To create an event that will let all employees realise, through a personal experience, that there has been a change.
10. **Goal setting:** To turn pledges and commitments into action by encouraging individuals to establish improvement goals for themselves and their groups.
11. **Error cause removal:** To give individual employees a method of communicating to the management, the situations that make it difficult for employees to meet the pledge to improve.
12. **Recognition:** To appreciate those who participate.
13. **Quality councils:** To bring together professionals in the domain of quality for planned communication on a regular basis with the workforce and management alike.
14. **Do it over again:** To emphasize that the quality improvement programme never ends.

■ DISCUSSION FORUM

1. Summarize the key contributions of Feigenbaum to modern quality thinking.
2. What are Crosby's four absolutes of quality management?

Bird's-eye view:

Kaoru Ishikawa a Japanese organizational theorist, Professor at the Faculty of Engineering at The University of Tokyo, noted for his quality management innovations. He is best known for: Ishikawa diagram; Seven basic quality tools; Quality circles and Company-wide quality control.

■ KAORU ISHIKAWA

Professor Kaoru Ishikawa¹² (1915–1989) is known as the “father of quality circles” for his role in launching Japan’s quality movement in the 1960s. Ishikawa advocated the following principles:

- Quality is a company-wide issue and must wield an all-pervasive influence on the way every issue of business is conducted.
- Seven simplified tools of quality control need to be used by all the people in an organization.
- Quality circles.

Kaoru Ishikawa is credited with developing the idea of company-wide quality control in Japan. He pioneered the use of quality circles and championed the use of quality tools to understand the root causes of problems. He developed one of those tools, the

cause-and-effect diagram, which is also referred to as the Ishikawa diagram or the fishbone diagram. In his book *What is Total Quality Control?*¹³ Ishikawa said that seven basic tools were “indispensable for quality control.” These are Pareto analysis, fishbone diagrams, stratification, tally charts, histograms, scatter diagrams and control charts. Ishikawa argued that with these tools, managers and staff could tackle and solve the quality problems facing them. Ishikawa was the first quality guru to emphasize the importance of the “internal customer,” the next person in the production process.

Ishikawa emphasized on quality as a way of management. He influenced the development of participative, bottom-up view of quality, which became the trademark of the Japanese approach to quality management. Some of the key elements of his philosophy are:

- (i) Quality begins with education and ends with education
- (ii) The first step in quality is to know the customers' requirements
- (iii) The ideal state of quality control occurs when inspection is no longer necessary
- (iv) Remove the root cause, not the symptoms
- (v) Quality control is the responsibility of all workers and all divisions
- (vi) Do not confuse means with the objectives
- (vii) Put quality first and set your sights on long-term profits
- (viii) Market is the entrance and exit of quality
- (ix) Top management must not show anger when facts are presented by subordinates
- (x) Ninety-five per cent of problems in a company can be solved with simple tools for analysis and problem solving
- (xi) Data without dispersion information (variability) are false data

■ GENICHI TAGUCHI

Dr Genichi Taguchi¹⁴ is a Japanese quality expert known for his work in the area of product design. He estimated that as much as 80 per cent of all defective items were caused by poor product design. Taguchi stressed that companies needed to focus their quality efforts on the design stage, as it was much cheaper and easier to make changes during this stage than later in the production process.

Taguchi developed approaches to assess outside influences (which he referred to as noise) on processes that he used to establish the signal-to-noise ratio as a measure of the quality of a process. He devised a quadratic function, referred to as the Taguchi Loss Function, which quantified the loss to society of the variation in processes which resulted in products not being produced exactly at the target values. He developed the Taguchi Method, an approach using orthogonal arrays and linear graphs to understand and to optimize the performance of processes. He also developed the idea of robustness, which is the ability of a process or product to perform even in the face of uncontrollable outside influences (noise).

Bird's-eye view:

Genichi Taguchi was an engineer and statistician. From the 1950s onwards, Taguchi developed a methodology for applying statistics to improve the quality of manufactured goods. He is best known for: Taguchi methods; Taguchi Loss Function and Design of experiments.

■ Design of Experiments

Taguchi is known for applying a concept called design of experiments to product design. This method is an engineering approach that focuses on developing robust design that enables products to perform under varying conditions. He believed that it was more difficult to control the environmental conditions. Taguchi's approach focuses on a statistical method that zeros in rapidly on the variations in a product that distinguish the bad parts from the good.

Box 2.3 Five Primary Tools of Robust Design

1. **Parameter diagrams:** Used to identify input and output in the design, noise factors that are out of the designer's control, identify relationships and determine the control factors.
2. **Ideal function:** The ideal function is a mathematical model that represents the relationship between the signal and response when the system is working properly. Also, noise factors will cause the relationship to deviate from the ideal operation.
3. **Quadratic or quality loss function:** Also known as the Taguchi Loss Function, it is used to determine the losses suffered by the user when the product performance deviates from its real performance. It is represented by the equation:

$$\text{Quality Loss Function} = L = C(X - T)^2$$

Field data is required to determine the relationship.

4. **Design of experiments or design optimization (orthogonal arrays):** It is used to quickly gather information on the effects that control factors have on product performance. It can also be used to determine the interaction between control and noise factors.
5. **Signal-to-noise ratio:** Used to measure how the variation in control factors interacts with the variation in noise factors.

Source: Adapted from Yulin Wu and Alan Wu, *Taguchi Methods for Robust Design* (New York: ASME Press, 2000).

He advocated that all factors that can hamper uniformity between products and their long-term stable performance must be studied, and safeguards must be built in the product design stage itself. He called it the concept of robust design. Robust design results in a product that can perform over a wide range of conditions. Box 2.3 discusses the five primary tools of robust design. Taguchi's eight-point approach is presented in the next section.

■ Bird's-eye view:

Taguchi methodology is fundamentally a prototyping technique that enables engineers/designers to produce a robust design which can survive repetitive manufacturing in order to deliver the functionality required by the customer.

■ Taguchi's Approach

1. Identify the main functions, side effects and failure modes.
2. Identify noise factors and the testing conditions for evaluating loss of quality.
3. Identify the quality characteristics to be observed and the objective functions to be optimized.
4. Identify the control factors and their alternate levels.
5. Design the matrix experiment and define the data analysis procedure.
6. Conduct the matrix.
7. Analyse the data, determine optimum levels for the control factors and predict performance under these levels.
8. Conduct the verification experiment and plan future actions.

Taguchi's philosophy has also impacted greatly on the current view of the costs of quality. He pointed out that the traditional view of costs of conformance to specifications was incorrect, and proposed a different way of looking at these costs. According to Taguchi, for quality improvements, quality must be introduced during the design stage itself.

The design of experiments (DOE) using the Taguchi approach can economically satisfy the needs of problem-solving and product/process design optimization projects in the

manufacturing industry. By learning and applying this technique, engineers, scientists and researchers can significantly reduce the time required for experimental investigations.

Taguchi also propounded that the teams should aim for robust designs that can withstand the variabilities that occur in transformation processes or during customer usage.

■ Advantage of DOE Using Taguchi's Approach

The application of DOE requires careful planning, prudent layout of the experiment and expert analysis of results. Based on years of research and applications, Dr Genichi Taguchi standardized the methods for each step of the DOE application. Thus, DOE using the Taguchi approach has become a much more attractive tool to practising engineers and scientists. The DOE applied to a wave-soldering process is discussed in Box 2.4.

Bird's-eye view:

Taguchi received the Indigo Ribbon from the Emperor of Japan in 1986 for his outstanding contributions to Japanese economics and industry.

Box 2.4 Design of Experiments Applied to a Wave-soldering Process

This study illustrates the application of Design of Experiments based on the Taguchi approach for optimizing a certain wave-soldering process. The study was carried out in Amit Engineering, a manufacturing company in Baroda, India. A certain manufacturer of assembled electronic circuit boards was suffering from severe quality problems in terms of high percentage of solder defects. The production consisted of two stages, assembly of printed circuit boards followed by a wave-soldering process.

A Pareto analysis revealed that most of the defects occurred due to bridges, (i.e. short circuits between terminals) on microprocessors. A sample of 1,000 under standard production conditions revealed a defect rate of 9.9%, which was quite unacceptable to the customers. In order to rectify the above problem, it was decided that an experimental design based on the Taguchi approach be performed with the objective of reducing the number of defects.

The steps involved in the experiment are summarized as follows:

1. **Nature of the problem:** High defect rate due to bridges in a wave-soldering process.
2. **Selection of the quality characteristic:** Percentage of defects.
3. **Selection of the control and noise factors:** Nine control factors were considered during the brainstorming session. No noise factors were considered for the experiment.
4. **Number of interactions:** The experiment conductor was interested in studying one interaction between the factors.
5. **Number of factor levels:** It was decided to study five factors at three levels and four factors at two levels. The factors included both quantitative (continuous) and qualitative (discrete) types.
6. **Choice of suitable experimental design:** The number of degrees of freedom required for studying the nine effects was equal to 14. Similarly, the interactions between two three-level factors consumed 4 degrees of freedom. In brief, the total degrees of freedom equaled 18. Therefore, the most desirable and suitable design was an L-27 (orthogonal array).
7. **Experimental execution:** The experimental trials were conducted in random order using the software program, Qualitek-4. Experiments were carried out during the night shifts to avoid production breaks.
8. **Experimental analysis and interpretation:** Analysis of variance was performed to identify the most dominant factors and the interaction of interest. The insignificant factors were pooled in order to obtain adequate degrees of freedom for the error term. Four main effects and the interaction effect were found to be statistically significant.

9. **Determination of optimal condition:** The optimal settings were determined and the percentage of defects was predicted. For better additives, Omega Transformation proposed by Taguchi was utilized.

10. **Confirmation runs:** Confirmation runs yielded zero defects. The optimal condition was recommended for implementation.

Source: Adapted from Tsene V. and Marinov L., "Design of Experiments of Automatic Soldering Process," *International Journal of Electronic Technology* (May 2004).

Overall Application Goals

- Optimize product and process designs
- Study the effects of multiple factors (variables, parameters, ingredients, etc.) on performance
- Solve production problems by objectively laying out the investigative experiments

Specific Objectives

- Influence of individual factors on the performance
- Deciding which factor has more influence and which ones have less
- Deciding which factor should have tighter tolerance and whose tolerance should be relaxed
- Deciding which factor's influences are significant and which are not
- How to allocate quality assurance resources based on objective data
- Whether a supplier's part causes problems or not (ANOVA data)
- How to combine different factors in their proper settings to get the best results
- How can one substitute a less expensive part to get the same performance
- How much money can one save if one improves the design
- How can one determine which factor is causing most of the problems
- How can one set up a process that is insensitive to uncontrollable factors
- Which factors have more influence on the mean performance
- What one needs to do to reduce performance variation around the target
- How can one adjust factors for a system whose response varies proportional to signal factor (dynamic response)
- How to combine multiple criteria of evaluation into a single index
- How can one adjust factors for overall satisfaction of criteria of evaluations
- How uncontrollable factors affect the performance



Bird's-eye view:

Design of experiments (DOE) is a systematic method to determine the relationship between factors affecting a process and the output of that process. In other words, it is used to find cause-and-effect relationships.

Experiment Planning and Problem Formulation

Experiment planning guidelines are consistent with modern work disciplines of working as teams. Consensus decisions about experiment objectives and factors make the projects more successful.

Experiment Layout

- High emphasis on cost and size of experiments
- Size of experiment for a given number of factors and levels is standardized

- Approach and priority for column assignments are established
- Clear guidelines are available to deal with factors and interactions (interaction tables)
- Uncontrollable factors are formally treated to reduce variation
- Descriptions of discrete prescriptions for setting up test conditions under uncontrollable factors are made available
- Guidelines for carrying out the experiments and number of samples to be tested are defined

Data Analysis

- Steps for analysis are standardized (main effect, ANOVA and optimum)
- Standard practices for determination of the optimum are recommended
- Guidelines for test of significance and pooling are defined

Interpretation of Results

- Clear guidelines about the meaning of error terms
- Discrete indicator about confirmation of results (confidence interval)
- Ability to quantify improvements in terms of dollars (loss function)

Overall Advantage

DOE using the Taguchi approach attempts to improve quality, which is defined as the consistency of performance. Consistency is achieved when variation is reduced. This can be done by moving the mean performance to the target as well as by reducing variations around the target (also known as robust design). The prime motivation behind the Taguchi experiment design technique is to achieve reduced variation. This technique, therefore, is focused to attain the desired quality objectives at all steps. The classical DOE does not specifically address quality.

A Review of Taguchi's Method

What's new?

1. New philosophy
 - Quality is built with product design
 - Measuring quality by deviation from target (not by rejection)
2. New discipline
 - Complete planning of experiments and evaluation criteria before conducting experiments
 - Determining a factor's influence by running the complete experiment
3. Simpler and standardized experiment design format
 - Orthogonal arrays for experimental design
 - Outer array design for robust product design
 - More clear and easier methods for analysis of results
4. Quality: Definition and objective
 - Reduced variation around the target with least cost

Bird's-eye view:

DOE can be used at the point of greatest leverage to reduce design costs by speeding up the design process, reducing late engineering design changes, and reducing product material and labor complexity.

Bird's-eye view:

DOE are also powerful tools to achieve manufacturing cost savings by minimizing process variation and reducing rework, scrap, and the need for inspection.

5. Approach: Robust design

- Reduce variation without actually removing the cause (of variation). Achieve consistent performance by making products/processes insensitive to the influence of uncontrollable factors

What does it do?

- Optimize design, solve problems, build robust products, etc.

Why do it?

- Saves cost (reduce warranty, rejection and cost of development)

Areas of application

- Analytical simulation (in early stages of design)
- Development testing (in design and development)
- Process development
- Manufacturing
- Problem-solving in all areas of manufacturing and production

Bird's-eye view:

DOE begins with determining the objectives of an experiment and selecting the process factors for the study.

Bird's-eye view:

An Experimental Design is the laying out of a detailed experimental plan in advance of doing the experiment.

Bird's-eye view:

Well-chosen experimental designs maximize the amount of “information” that can be obtained for a given amount of experimental effort.

Experimental Procedure

The Taguchi method is used to improve the quality of products and processes. Improved quality results when a higher level of performance is consistently obtained. The highest possible performance is obtained by determining the optimum combination of design factors. The consistency of performance is obtained by making the product/process insensitive to the influence of the uncontrollable factors. In Taguchi's approach, optimum design is determined by using the design of experiment principles, and consistency of performance is achieved by carrying out the trial conditions under the influence of the noise factors.

1. Planning experiments (brainstorming)

- This is a necessary first step in any application. The session should include individuals with first-hand knowledge of the project. All matters should be decided based on group consensus (one person—one vote)
- Determine what one is after and how to evaluate it. When there is more than one criterion of evaluation, one needs to decide how each criterion is to be weighted and combined for overall evaluation
- Identify all influencing factors and those to be included in the study
- Determine the factor levels
- Determine the noise factor and the condition of repetitions

2. Designing experiments

Using the factors and levels determined in the brainstorming session, the experiments can be designed and the method carrying them out can now be established. To design the experiment, implement the following:

- Select the appropriate orthogonal array
- Assign factor and interaction to columns
- Describe each trial condition
- Decide the order and frequency of repetition of trial conditions

3. Running the experiment

- Run experiments in random order when possible

4. Analysing results:

Before analysis, the raw experimental data may have to be combined into an overall evaluation criterion. This is particularly true when there are multiple criteria for evaluation. Analysis is performed to determine the following:

- The optimum design
- Influence of individual factors
- Performance at the optimum condition
- Relative influence of individual factors, etc.

5. Running confirmation experiment(s)

Running the experiments at the optimum condition is the necessary final step

■ QUALITY CHARACTERISTIC

Quality characteristic (QC) generally refers to the measured results of the experiment. The QC can be a single criterion such as pressure, temperature, efficiency, hardness, surface finish, etc. or a combination of several criteria taken together in a single index. QC also refers to the nature of the performance objectives such as “bigger is better,” “smaller is better” or “nominal is the best.”

■ Factors and Levels

The factors are:

- Design parameters that influence the performance
- Input that can be controlled
- Included in the study for the purpose of determining their influence and control upon the most desirable performance. Example: Time, temperature, etc.

The levels are values that a factor assumes when used in the experiment.

Example: Time: 5 s, 10 s (continuous level)

Part: Type 1, Type 2, etc. (discrete level)

■ Interaction Between Factors

Two factors (A and B) are considered to have interaction between them when one exercises some influence on the effect of the other factor.

Interaction

- Is an effect (output) and does not alter the trial condition
- Can be determined even if no column is reserved for it
- Can be fully analysed by keeping appropriate columns empty
- Affects the optimum condition and the expected result

■ Noise Factors and Outer Arrays

Noise factors are those factors which are not controllable, whose influences are not known and which are intentionally not controlled.



Bird's-eye view:
Quality characteristic (QC) generally refers to the measured results of the experiment. The QC can be a single criterion such as pressure, temperature, efficiency, hardness, surface finish, etc. or a combination of several criteria taken together in a single index.

To determine robust design, experiments are conducted under the influence of various noise factors. An “outer array” is used to reduce the number of noise conditions obtained by the combination of various noise factors.

■ Order of Running Experiments

There are two common ways of running experiments. Suppose an experiment uses an L-8 array and each trial is repeated thrice, then, how are the $3 \times 8 = 24$ experiments carried out?

Replication: The most desirable way is to run these 24 experiments in a random order.

Repetition: The most practical way may be to select the trial condition in random order then complete all repetitions in that trial.

Note: In drawing conclusions from the results of the designed experiments and assigning statistical significance, it is assumed that the experiments were unbiased in any way. Thus, randomness is desired and should be maintained when possible.

Minimum requirement: A minimum of one experiment per trial condition is required. Avoid running an experiment in an upward or downward sequence of trial numbers.

■ Orthogonal Arrays

Orthogonal arrays refer to the set of tables for determining trial conditions and number of experiments (tool for designing experiments).

Standard notations for orthogonal arrays:

L-8 (2⁷), 8 = Number of experiments
 2 = Number of levels
 7 = Number of factors

Examples of orthogonal arrays:

At 2 levels: L-4 L-8 L-12 L-16 L-32 L-64

At 3 and 2 levels: L-9 L-18 L-27

Modified at 4 levels: L-16 and L-32

■ MSD and S/N Ratios

Recommendation: If you are not looking for a specific objective, then select S/N ratio based on Mean Squared Deviation (MSD) for analysis of repeated results.

MSD expression combines variation around the given target and is consistent with Taguchi's quality objective.

Relationships among observed results, MSD and S/N ratio:

MSD = $(Y_1 - m)^2 + (Y_2 - m)^2 + \dots + (Y_n - m)^2 / n$ for nominal is best

MSD = $(Y_1^2 + Y_2^2 + \dots + Y_n^2) / n$ for smaller is better

MSD = $(1/Y_1^2 + 1/Y_2^2 + \dots + 1/Y_n^2) / n$ for bigger is better

S/N = $-10 \times \log(1/MSD)$ for all characteristics

👁 Bird's-eye view:

Taguchi Loss Function also called **Quality Loss Function (QLF)** is a statistical method developed by Genichi Taguchi, a Japanese business statistician, that shows how manufacture of each defective part results in a loss for the company.

■ Taguchi's Quality Loss Function

Taguchi defines quality in terms of the social loss, which is the loss to producers and consumers from the time a product is conceived. The smaller the value of this social loss, the more desirable is the product.

Quality loss function (QLF) is a process used to measure quality. It establishes a financial measure of customer dissatisfaction with a product's performance as it deviates from a target value. Both average performance and variation are critical measures of quality. Engineering robust designs that are insensitive to uncontrolled sources of variation improves quality. Taguchi's QLF theory estimates the loss to society arising from the failure of a product to meet its target value due to particular performance characteristics. This loss can be of three types:

1. Incurred by the company, for example, in terms of increased scrap, rework and warranty costs, damage to the company's reputation and loss of market share.
2. Incurred by the consumers, for example, in terms of short product life, increased maintenance and repair costs.
3. Incurred by the society in general, for example, in terms of pollution, safety, etc.

Taguchi's QLF is a statement that any deviation from the target value of a quality characteristic results in extra costs to some segment of the society. It is an algebraic function that illustrates the loss of quality that occurs when a characteristic deviates from its target value. The QLF is often expressed in monetary terms. Dr Genichi Taguchi's work suggests that quality losses vary as the square of the deviation from target. Figure 2.4 illustrates Taguchi's QLF.

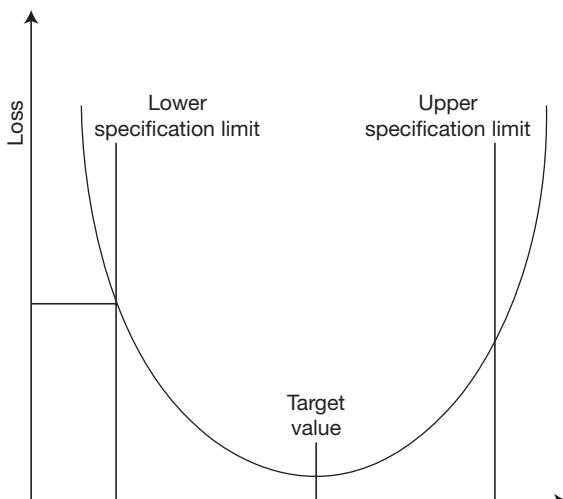
$$\text{Quality Loss Function} = L = C (X-T)^2$$

where L = total loss, C = a cost constant, X = actual average value of quality characteristic and T = target value of quality characteristic.

Example: An Exercise in Taguchi's QLF

A certain quality characteristic has a specification of 0.500 ± 0.020 . An analysis of company records reveals that if the value of the quality characteristic exceeds the target of 0.75 by the tolerance of 0.020 on either side, the product is likely to fail during the warranty period and may cost Rs 100 for repair. Determine the total loss using Taguchi's loss function for a deviation of ± 0.010 .

Fig. 2.4 Taguchi's Quality Loss Function



Solution: $100 = C (0.020)^2$

$$C = 100/0.0004 = 250,000$$

Therefore, the loss function is

$$L(X) = C(X - T)^2$$

Thus, if the deviation is only 0.010, the estimated loss is

$$L(0.10) = 250,000 (0.010)^2 = \text{Rs } 25$$

■ DR SHINGO SHIGEO

Dr Shingo Shigeo (1909–1990)¹⁵ was perhaps the greatest contributor to modern manufacturing practices. While he is not as well known as the others in the field of quality, his teachings and principles have formed the backbone of efficient engineering practices. In applying his experience and expertise in the field of industrial engineering, Dr Shigeo Shingo was able to provide a better way of life for both the operators and the corporations. His policies have gained tremendous popularity because of the benefits received by companies in the manufacturing sector that implemented his teachings.

In view of his contributions, the Utah State University founded the Shingo Prize for operational excellence in 1988. The Shingo Prize promotes world-class manufacturing and recognizes organizations that achieve superior customer satisfaction and business results. This has been compared to a Nobel Prize for manufacturing.

■ Shingo's Key Teachings

The impact of Dr Shingo Shigeo's teachings can be classified into three concepts listed below:

- Just in time (JIT)
- Single minute exchange of dies (SMED)
- Zero quality control

Using his key teachings, many modern day manufacturing companies have realised substantial profits. The impacts of his teachings are discussed in detail below.

Shingo's Theory of JIT

The just-in-time manufacturing concept was founded in part due to the contribution of Dr Shingo Shigeo and Taichii Ohno of Toyota Motor Corporation from 1949 to 1975. During this period, Dr Shigeo took charge of industrial engineering and factory improvement training at Toyota Motor Corporation. This is commonly referred to as JIT or the Toyota Production System. The essential element in developing JIT was the use of the Ford System along with the realisation that factory workers had more to contribute than just muscle power. According to the American Production and Inventory Control Society (APICS), JIT is defined as:

"A philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all stages of conversion from raw material onward. The primary elements include having only the required inventory when needed; to improve quality to zero defects; to reduce lead time by reducing setup times, queue lengths and lot sizes; to incrementally revise the operations themselves; and to accomplish these things at minimum cost."

The basic essence of JIT has been implemented in the new "continuous improvement" or "lean manufacturing" wave in the industry today. The primary objective in implementing

Bird's-eye view:

Shigeo Shingo, born in Saga City, Japan, was a Japanese industrial engineer who is considered as the world's leading expert on manufacturing practices and the Toyota Production System. The best known contributions of Shigeo Shingo are: JIT, SMED and Zero quality control.

JIT to a production facility was to obtain a competitive advantage and bring about increased productivity by eliminating the following wastes:

- Waste from overproduction
- Excess transportation
- Excess inventory
- Waiting time
- Processing waste
- Wasted motion
- Waste from production defects

By applying these simple concepts, a company can realise monetary savings. The use of statistical process control; thus, helps ensure that the outcome of production is consistently met with desired results.

Shingo's Theory of SMED

Dr Shingo Shigeo, as part of the JIT theory, also pioneered the concept of single minute exchange of dies (SMED). SMED was developed in order to reduce the fixed costs associated with the setup and changeover of dies. The basic elements driving the SMED concept is to reduce the setup time of dies, which directly results in smaller batch sizes for parts. A smaller batch size translates into lower costs associated with work in process inventory storage. This concept is especially beneficial as it allows the manufacturing system to quickly adjust to engineering design changes with very little costs. In addition, SMED allows for higher machine utilization and results in greater productivity.

Dr Shigeo Shingo's approach when developing the SMED concept was to isolate and identify the setup time as two entities—internal setup time and external setup time. According to him, a simple approach to achieving a quick setup and changeover of the dies entailed the following steps:

- Separating internal and external setups as they existed
- Converting internal to external setup
- Streamlining all aspects of the setup operation

Many companies that conduct stamping operations in a manufacturing environment have found success by implementing this principle into their existing improvement programmes.

Shingo's Theory of ZQC

Dr Shigeo Shingo's zero quality control (ZQC) technique makes use of the following engineering principles:

- 100 per cent inspections done at the source instead of sampling inspections
- Immediate feedback from successive quality checks and self-checks
- Poka-yoke designed manufacturing devices

The ZQC concepts are based on a theoretically ideal scenario. However, quality improvements can be made by using these principles and concepts. Dr Shigeo's basic idea was to implement error-proofing devices in the assembly line to eliminate the possibility of defective operations. In addition, his emphasis was on targeting the root cause of defect (source defect) whenever a defect occurred, thereby virtually eliminating the need for statistical process control.

In 1977, Matsushita's Washing Machine manufacturing facility went for a one-month period with zero part defects. This example reinforced Dr Shigeo's theories by illustrating the potential improvements that could be made possible by implementing principles of ZQC.

Bird's-eye view:

Just-in-time (JIT) manufacturing, also known as just-in-time production or the Toyota production system (TPS), is a methodology aimed primarily at reducing flow times within production as well as response times from suppliers and to customers.

Bird's-eye view:

SMED (Single-Minute Exchange of Dies) is a system for dramatically reducing the time it takes to complete equipment changeovers.

Bird's-eye view:

The essence of the SMED system is to convert as many changeover steps as possible to "external" (performed while the equipment is running), and to simplify and streamline the remaining steps.

Bird's-eye view:

The name Single-Minute Exchange of Dies comes from the goal of reducing changeover times to the "single" digits (i.e. less than 10 minutes).

 **Bird's-eye view:**

Zero Quality Control (ZQC) is a quality control approach for achieving zero defects. ZQC is based on the principle that defects are prevented by controlling the performance of a process so that it cannot produce defects, even when a mistake is made by the machine or a human operator.

 **Bird's-eye view:**

ZOC is achieved by combining four basic elements: i) source inspection ii) 100 percent inspection iii) immediate feedback and iv) use of poka-yoke (mistake-proofing) devices.

 **Bird's-eye view:**

A poka-yoke device is any mechanism that either prevents a mistake from being made or makes the mistake obvious at a glance.

Although Dr Shigeo realised that statistical quality control could aid in elimination of defects, he argued that by using sound manufacturing and process engineering practices, defects could be removed from processes without the use of many statistical tools used in most quality control techniques.

$$\text{Poka-yoke Techniques to Correct Defects} + \text{Source Inspection to Prevent Defects} \\ = \text{Zero Quality Control}$$

This famous equation is the essence of the ZQC concept formulated by the Japanese quality guru, Dr Shigeo Shingo. Dr Shigeo wielded tremendous influence on Japanese quality control and his contributions to quality improvement revolutionized the Japanese industrial sector and consequently influenced industries in the West.

Poka-yoke relates to stopping processes as soon as a defect occurs, identifying the defect source and preventing it from happening again so that there will be reduced dependence on statistical quality inspections and the production process will have “zero defects.”

Poka-yoke relies on source inspection and detecting defects before they affect the production line and working to eliminate the defect cause. Mistake proofing is also a component of poka-yoke. Dr Shingo introduced simple devices that made it impossible to fit a part incorrectly or made it obvious when a part was missing. This meant that errors could be prevented at source, thereby supporting a zero defect process. Box 2.5 discusses some examples of poka-yoke in consumer products.

Box 2.5 Examples of Poka-yoke in Consumer Products

- **Subscriber Identity Module (SIM cards):** The upper left corner is trimmed in the SIM card diagonally to guide the card correctly into position.
- **Automatic transmissions:** One is unable to remove the car key from the ignition switch of an automobile if the automatic transmission is not put in the “Park” position first. This is done so that the driver cannot leave the car in an unsafe parking condition where the wheels are not locked against movement.
- **High-security padlocks:** It is impossible to remove the keys from some high-security padlocks unless the shackle on the padlock is closed. Only after the padlock is locked can the key be withdrawn. Security mistakes/accidents are, therefore, less likely to occur, particularly where the padlock key is kept on a chain attached to someone’s belt. The design ensures that a key cannot be left in an unlocked padlock, or a padlock cannot be left unlocked once it has been opened, and that the shackle needs to be fully closed before the key can be withdrawn. The three scenarios would be dangerous in high-security environs such as armories, military installations, prisons or bonded warehouses. In contrast, most standard-security padlocks do allow a key to be removed from a padlock, regardless of whether the shackle is closed or not.
- **UK 13 amp electric plugs:** Arrangement of three rectangular pins makes it impossible to wrongly insert the plug into the socket.
- **Microwave ovens:** A door-switch automatically disconnects the activation button when the door of the oven is opened. As a result, it is impossible to cook anything in a microwave oven unless the door is shut. If it were possible to activate an oven keeping the door open, it would allow leakage of high-intensity microwave radiation, which would be very harmful to living creatures in the immediate vicinity.
- **3.5" floppy disks:** The disk cannot be inserted upside down because of the shape of its top-right corner.

Source: Adapted from Nikkam Kogyo Shimbun, *Improving Product Quality by Preventing Defects* (Productivity Press, 1988).

■ The Shingo Prize for Operational Excellence

The Shingo Prize for Operational Excellence¹⁶ is named after Japanese industrial engineer Shigeo Shingo who distinguished himself as one of the world's leading experts in improving manufacturing processes. Dr Shingo has been described as an "engineering genius" who helped devise many aspects of revolutionary manufacturing practices, one of which is the renowned Toyota Production System.

The Prize was established in 1988 to promote awareness of lean manufacturing concepts and to recognize companies that achieved world-class manufacturing status around the globe. The philosophy behind the Shingo Prize is that world-class business performance may be achieved through focused improvements in core manufacturing and business processes.

The Shingo Prize recognizes organizations, which are consistent with its mission and model:

- **The Shingo Prize** promotes the use of world-class operational excellence strategies and practices to achieve world-class results in business and public sector/government owned facilities.
- **The Research Prize** promotes research and writing regarding new knowledge and understanding of manufacturing processes.

The recipients of the Shingo and Research Prizes are honoured at the international Shingo Prize Annual Conference. Table 2.2 furnishes the details of quality gurus and their contributions.

Bird's-eye view:

The **Shingo Prize for Operational Excellence** was established in 1988 to promote awareness of lean manufacturing concepts and to recognize companies that achieved world-class manufacturing status around the globe.

Table 2.2 Contributions of Quality Gurus

Quality Guru	Major Contribution
Walter A. Shewhart	<ul style="list-style-type: none"> • Contributed to the understanding of process variability
W. Edwards Deming	<ul style="list-style-type: none"> • Developed the concept of statistical control charts • Stressed management's responsibility for quality • Developed "14 points" to guide companies in quality improvement
Joseph M. Juran	<ul style="list-style-type: none"> • Defined quality as "fitness for use" • Developed the concept of cost of quality • Introduced the quality trilogy
Armand V. Feigenbaum	<ul style="list-style-type: none"> • Introduced the concept of total quality control
Philip B. Crosby	<ul style="list-style-type: none"> • Coined the phrase "quality is free" • Introduced the concept of zero defects • Four absolutes of quality management
Kaoru Ishikawa	<ul style="list-style-type: none"> • Developed the cause-and-effect diagram • Proponent of the implementation of quality circles • Identified the concept of "internal customer"
Genichi Taguchi	<ul style="list-style-type: none"> • Focused on robust design by applying a concept called design of experiments • Developed the Taguchi loss function
Shigeo Shingo	<ul style="list-style-type: none"> • Just in time • Single minute exchange of dies • Zero quality control
Masaaki Imai	<ul style="list-style-type: none"> • Kaizen, <i>Gemba Kaizen</i>

Bird's-eye view:

Masaaki Imai is a Japanese organizational theorist and management consultant, known for his work on quality management, specifically on Kaizen.

Bird's-eye view:

Masaaki Imai is the Founder of Kaizen Institute which was established in Switzerland in 1985 to help companies implement the practice of kaizen and the various systems and tools known today as Lean Management.

Bird's-eye view:

Today Kaizen Institute Consulting Group (KICG) is the leading global operational excellence consultancy with offices across the globe.

■ MASAAKI IMAI

Masaaki Imai, a quality management consultant, was born in Tokyo in 1930. In 1955, he received his bachelor's degree from the University of Tokyo, where he also did graduate work in international relations. In 1962, he founded Cambridge Corp., an international management and executive recruiting firm based in Tokyo. As a consultant, he assisted more than 200 foreign and joint-venture companies in Japan in fields including recruiting, executive development, personnel management and organizational studies. From 1976 to 1986, Imai served as president of the Japan Federation of Recruiting and Employment Agency Associations.

In 1986, Imai established the Kaizen Institute¹⁸ to help Western companies introduce Kaizen concepts, systems and tools. That same year, he published his book on Japanese management; *Kaizen: The Key to Japan's Competitive Success*. This best-selling book has since been translated into 14 languages. Other books by Imai include, *16 Ways To Avoid Saying No, Never Take Yes for an Answer* and *Gemba Kaizen* published in 1997. The Kaizen Institute operates in over 22 countries and continues to act as an enabler to companies to accomplish their manufacturing, process and service goals.

DISCUSSION FORUM

1. Discuss the contribution of Kaoru Ishikawa to quality management.
2. Explain Taguchi's quality loss function.
3. What is the Shingo Prize for operational excellence?
4. What is the mission of the Kaizen Institute set up by Masaaki Imai?

SUMMARY

- **Walter Shewhart (1891–1967)** was a statistician at Bell Labs and is considered by many to be the founder of the modern quality movement and an innovator in the application of statistics to quality. His work created the foundation for the statistical process control measures in use today, and he is often referred to as the “grandfather of quality control.”
- **W. Edwards Deming (1900–1993)** is often referred to as the “father of quality control.” He defined quality as a function of continuous improvement based on reduction in variation regarding the desired output. The highest quality award in Japan, the Deming Prize, is named in his honour. He is also known for his 14 principles of transformation, the seven-point plan, the Deming Chain Reaction and the Theory of Profound Knowledge. He also modified the Shewhart cycle (Plan, Do, Study, Act) to what is now referred to as the Deming Cycle (Plan, Do, Check, Act).
- **Joseph Juran (1904–2008)** also assisted the Japanese in the reconstruction of their economy after World War II. Juran first became well known in the quality field in the US as the editor of the *Quality Control Handbook* (1951) and later for his paper introducing the quality trilogy—quality planning, quality control and quality improvement. Juran defined quality as “fitness for use” and also developed the concept of cost of quality. He introduced the ten steps to quality improvement.
- **Armand Feigenbaum** is credited with the creation of the idea of total quality control in his 1961 book *Quality Control—Principles, Practice, and Administration* and in his 1956 article

“Total Quality Control.” The Japanese version of this concept is termed Company Wide Quality Control, while it is called Total Quality Management (TQM) in the US and elsewhere.

- **Philip Crosby (1926–2001)** came to prominence with the publication of his book *Quality is Free* (1979). He established the Four Absolutes of Quality Management, which stated that “the only performance standard (that makes sense) is Zero defects,” and the basic elements of improvement. He introduced the 14-step quality programme.
- **Professor Kaoru Ishikawa (1915–1989)** is known as the “Father of Quality Circles” for his role in launching Japan’s quality movement in the 1960s. Ishikawa advocated Company Wide Quality Control, instituted the seven quality control tools and quality circles. He is the author of the book *What is Total Quality Control*.
- **Dr Genichi Taguchi** is a Japanese quality expert known for his work in the area of product design. He applied the concept of Design of Experiments to product design. He is known for the prototyping method, the eight steps of parameter design and the quadratic loss function. Taguchi defines quality as the loss imparted to society from the time a non-quality product is shipped.
- **Dr Shingo Shigeo** was a Japanese industrial engineer and perhaps the greatest contributor to modern manufacturing practices. He defined quality as the defects in a process. He introduced the concept of poka-yoke (zero defects). The greatest impact of Dr Shingo Shigeo’s teachings can be classified into three concepts—just in time (JIT), single minute exchange of dies (SMED) and zero quality control (ZQC). The Shingo Prize for Operational Excellence is named after him because he distinguished himself as one of the world’s leading experts on improving manufacturing processes.
- **Masaaki Imai’s** concept of “Kaizen” has been largely responsible for Japan’s economic success. He established the Kaizen Institute to help Western companies introduce Kaizen concepts, systems and tools.

Key Terms

Appraisal Cost 41	Kaizen 35
Company Wide Quality Control 41	PDCA Cycle 34
Cost of Quality 42	PDSA Cycle 34
Deming Chain Reaction 56	Poka-yoke 54
Deming Cycle 33	Prevention Cost 41
Deming Prize 33	Quality Circles 42
Deming’s 14 Points 37	Quality Control 32
External Failure Cost 41	Quality Trilogy 38
Fitness for Use 56	Seven Quality Control Tools 57
Four Absolutes of Quality 57	Single Minute Exchange of Dies 52
Gemba Kaizen 55	Statistical Process Control 33
Internal Failure Cost 41	Theory of Profound Knowledge 33
Ishikawa Diagram 42	Zero Defects 41
Just in Time 52	Zero Quality Control 52

Case Study

Deming's Red Bead Experiment at Technosystems

Technosystems, a private company manufacturing hydraulic valves, decided to conduct Deming's Red Bead Experiment among its workforce. It selected six willing workers as participants in the experiment.

Components of the Red Bead Experiment

The experiment included a box comprising 4,000 wooden beads of which 800 were red beads and 3,200 were white beads. There was a paddle with 50 bead-sized depressions, a second smaller box for mixing the beads and six willing workers as participants. There were two inspectors who would count the beads independently, a chief inspector who would verify the counts, an accountant to record the counts and a customer who would not accept red beads. The job at hand entailed producing white beads, and the standard for each worker was set at fifty white beads per day. No two beads were exactly alike. The paddle responded to the red and white beads differently and in return the beads also responded differently to the paddle. Additionally, the depressions in the paddle were also seen to be different in terms of size.

The daily production operation for each worker included:

1. Pouring the beads from the first box into the second box and then back into the first box to mix the beads.
2. Dipping the paddle into the first box without shaking it.
3. Carrying the loaded paddle to each inspector for separate counts and subsequent verification
4. Dumping the day's work back into the supply box.

The six workers performed this operation four times to represent four days' work. The results of this are shown in Exhibit 2.1.

Exhibit 2.1 Red Beads Recorded During the Experiment at Technosystems

Worker	Day 1	Day 2	Day 3	Day 4	Total	Mean
Amogh	14	10	9	10	43	10.75
Chetan	17	5	8	5	35	8.75
Sachin	11	6	5	9	31	7.75
Alok	8	8	9	6	31	7.75
Anand	12	11	12	8	43	10.75
Subhash	9	11	7	10	37	9.25
Total	71	51	50	48	220	
Mean	11.83	8.50	8.33	8.00	9.17	9.17

For Discussion

1. What does Exhibit 2.1 reveal about the red beads recorded during the experiment at Technosystems?
2. What is the point of the red beads experiment in this case study?
3. What is the message conveyed by the case study?

Short-answer Questions

1. Define the Deming cycle.
2. Name the components of the “Juran quality trilogy.”
3. What are the three steps to quality suggested by Feigenbaum?
4. What are the four absolutes of quality management?
5. What are the other names for fishbone diagram?
6. Define Taguchi’s quality loss function.
7. Define the term JIT.
8. What is SMED?
9. What is poka-yoke?
10. Who is the founder of the Kaizen Institute?

Match the Following

a. Walter Shewhart	Theory of profound knowledge
b. W. Edwards Deming	Quality trilogy
c. Joseph Juran	Total quality control
d. Armand Feigenbaum	Gemba Kaizen
e. Philip Crosby	Poka-yoke
f. Kaoru Ishikawa	Design of experiments
g. Genichi Taguchi	Father of quality circles
h. Shigeo Shingo	Four absolutes of quality
i. Masaaki Imai	Grandfather of quality control

Discussion Questions

1. Why is Walter Shewhart often referred to as the “grandfather of quality control”?
2. Discuss Crosby’s assertion that “there is no such thing as a quality problem.”
3. Deming suggests that 94 per cent of quality problems are the responsibility of management. Review this statement.
4. Taguchi believes that quality is a societal rather than an organizational issue. Discuss whether this is a reasonable belief.
5. Explain Juran’s ten steps to quality improvement.
6. Explain the key elements of Feigenbaum’s philosophy of quality control.
7. Why is Kaoru Ishikawa known as the “father of quality circles”?
8. Explain Shigeo Shingo’s contribution to modern manufacturing practices and give an example for poka-yoke.
9. Discuss the concepts introduced by Masaaki Imai for quality improvement.

Projects

1. Compare the quality gurus—Deming, Juran, Crosby, Feigenbaum, Ishikawa and Taguchi and present a summary of their approaches.
2. Visit www.juran.com and study the Juran Management System (JMS) and prepare a report on JMS.

End Notes

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3

The Philosophy of Total Quality Management



TVS TQM

TVS MOTOR COMPANY

The TVS group is one of India's most respected business groups and the country's leading supplier of automotive components. Founded as a transport company in 1911 in Tamil Nadu, India, today, this renowned business conglomerate remains faithful to its core ideals of trust, values, service, and ethics. The group operates in diverse fields that range from two-wheeler and automotive component manufacturing to automotive dealerships, finance, and electronics. Uniting these multiple businesses is a common ethos of quality, customer service, and social responsibility. The TVS group includes Sundaram Fasteners, Lucas TVS, Brakes India, Wheels India, Sundaram Brake Linings, TVS Motor Company, and TVS Electronics.

Regardless of the field it works in, the group is known for its unwavering commitment to quality. Most companies of the group have adopted total quality management (TQM) as a way of life. While each company in the group has achieved significant milestones on its quality path, five companies (Sundaram Clayton, Sundaram Brake Linings, Brakes India, TVS Motor, and Lucas-TVS) have won the coveted Deming Award instituted by the Union of Japanese Scientists and Engineers (JUSE).

TVS Motor Company, the flagship company of the TVS group, is a leading two- and three-wheeler manufacturer in India. It is the third largest two-wheeler manufacturer in the

country and one among the top 10 in the world. TVS has completely implemented TQM following quality programmes and has been awarded the prestigious Deming prize, Technology award, TPM excellence award, and the Asian network for quality award. The group has adapted TQM concepts and assimilated them in its own ‘TVS culture’ to the extent that the auditors from JUSE commented that the TQM practices in the group as ‘**TVS TQM**’. The company encourages and allows its employees to identify and diagnose quality problems and to take corrective actions without going through the management hierarchy.

“TQM is a journey not a destination.”

V. Daniel Hunt

Upon completion of this chapter, you will be able to:

1. Explain the evolution of total quality management (TQM)
2. Understand the key principles and key elements of TQM
3. Explain the core concepts of TQM
4. Discuss the Total Quality Management Excellence Model (TQMEX)
5. Understand the differences between TQM and traditional organizations
6. Identify common barriers to the implementation of TQM, its prerequisites and benefits

👁 Bird’s-eye view:

Total Quality Management, is a management philosophy that enables organizations to gain customer loyalty.

👁 Bird’s-eye view:

Organisations that practice the principles of **TQM** deliver high levels of service and high-quality products at reasonable prices.

👁 Bird’s-eye view:

Total quality management (TQM) is considered a very important factor for the long-term success of an organization.

■ INTRODUCTION

Total quality management (TQM) is an approach to business that looks critically not only at the products and services a company provides in relation to the process it employs to create them, but also at the workforce, to ensure that outputs fully satisfy customer requirements. This approach is called “total” because it encompasses everything the company does—all its processes and employees at every level in the company at all times. TQM is a management philosophy that seeks to integrate all organizational functions (marketing, finance, design, engineering, production and customer service, etc.) to focus on meeting customer needs and organizational objectives. TQM is a necessity. It is a journey that will never end. It is a totally integrated effort directed at gaining competitive advantage by continuously improving every facet of an organization’s activities.

One theory is that TQM was created as a result of a misinterpretation of the Japanese words for “control” and “management” since no difference exists between these words in Japanese. William Golimski, an American quality scholar and consultant, refers to Koji Kobayashi, former CEO of Nippon Electrical Company (NEC) as being the first to use the words TQM during a speech when he received the Deming prize in 1974. The American Society for Quality says that the term total quality management was used by the US Naval Air Systems Command in 1984 to describe its Japanese-style management approach to quality improvement since they did not like the word “control” in the term total quality control. The word “management” was then suggested by one of the employees, Nancy Warren. This is consistent with the story which states that the United States Navy Personnel Research and Development Center began researching the use of statistical process

control (SPC), the works of Juran, Crosby, Ishikawa and the philosophy of W. Edwards Deming to initiate performance improvements in 1984. This approach was first tested at the North Island Naval Aviation Depot.

■ DEFINITIONS OF TQM

TQM is an integrated effort designed to improve quality performance at every level of the organization.

Total: Quality involves everyone and all the activities performed in the company.

Quality: Conformance to the requirements (meeting customer requirements).

Management: Quality can and must be managed.

Therefore, TQM is a process for managing quality. It is viewed as a continuous way of life and a philosophy of perpetual improvement in everything we do.

According to the British Standard BS 7850, TQM is defined as, “Management philosophy and company practices that aim to harness the human and material resources of an organization in the most effective way to achieve the objectives of the organization.”¹

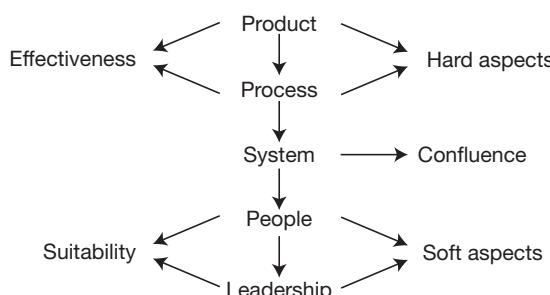
TQM is defined as a management approach that tries to achieve and sustain long-term organizational success by encouraging employee feedback and participation, satisfying customer needs and expectations, respecting societal values and beliefs and obeying governmental statutes and regulations. Product, process, system, people and leadership form the five pillars of TQM. This is shown in Figure 3.1.

TQM is a management philosophy, a paradigm and an approach to continuous improvement in business through a new management model. The TQM philosophy evolved from the continuous improvement philosophy with a focus on quality as the main dimension of business. Emphasizing the quality of the product or service predominates under TQM. It expands beyond statistical process control to embrace a wider scope of management activities surrounding people and organizations by focusing on the entire process and not just simple measurements.

■ THE TOTAL QUALITY SYSTEM

There have been many new quality initiatives and methodologies in recent times. Introducing them adhoc without a basic total quality system in place will result in a less-than-optimum benefit. Even without new initiatives, all ongoing quality efforts—product quality improvements, processes, employee morale, customer issues and needs, planning, and a host of other issues—must run like clockwork. This is even more crucial in today's turbulent times and highly competitive environment.

Fig. 3.1 Five Pillars of TQM



👁 Bird's-eye view:

A core definition of **Total Quality Management (TQM)** describes a management approach to long-term success through customer satisfaction.

👁 Bird's-eye view:

In a TQM effort, all members of an organization participate in improving processes, products, services, and the culture in which they work.

👁 Bird's-eye view:

Five pillars of TQM are:

- Product
- Process
- System
- People
- Leadership

 **Bird's-eye view:**

Total Quality Management (TQM) is a comprehensive and structured approach to organizational management that seeks to improve the quality of products and services through ongoing refinements in response to continuous feedback.

TQM is a comprehensive management system which:

- Focuses on meeting the needs of the owners' or customers' by providing quality services at a cost that offers value to the owners/customers.
- Is driven by the quest for continuous improvement in all operations.
- Recognizes that everyone in the organization has internal or external owners or customers.
- Views an organization as an internal system with a common aim rather than as individual departments acting to maximize their own performances.
- Focuses on the way tasks are accomplished rather than simply on what tasks are accomplished.
- Emphasizes on teamwork.

■ THE EVOLUTION OF TQM—FROM INSPECTION TO TOTAL QUALITY MANAGEMENT²

 **Bird's-eye view:**

TQM is a philosophy for managing an organisation in a way which enables it to meet stakeholder needs and expectations efficiently and effectively, without compromising ethical values.

The concepts and ideas of TQM were formalized based on the foundations of the work done over the last few centuries. This section charts the evolution of TQM, from inspection through to the present-day concepts of total quality. Quality management started with a simple inspection-based system, where a product was compared with a product standard by a team of inspectors. The first revolutionary change in the form of a system of quality control accompanied World War II. At that time, quality was achieved through control systems, which included product testing and documentation. In the quality assurance stage, there was a shift in focus from product quality to systems quality. Quality manuals, quality planning and advanced document control were typical of this stage. Quality assurance was, however, a preventive measure. The fourth stage of development brought about total quality management. A clear and unambiguous vision, few interdepartmental barriers, staff training, excellent customer relations, emphasis on continuous improvement and quality of the company as a whole were seen as being typical of a TQM environment.

 **Bird's-eye view:**

TQM is not a system, a tool or even a process. Systems, tools and processes are employed to achieve the various principles of TQM.

■ The Four Stages of TQM

The following four stages can be identified in the evolution of TQM and are shown in Table 3.1:

Table 3.1 Evolution of Total Quality Management

Quality Management Stages	Areas of Focus	Scope
Inspection	Detection	<ul style="list-style-type: none"> • Error detection • Rectification • Sorting, grading, reblending • Decision about salvage and acceptance
Quality control	Maintaining status quo	<ul style="list-style-type: none"> • Quality standards • Use of statistical methods • Process performance • Product testing

(Continued)

Table 3.1 (Continued)

Quality Management Stages	Areas of Focus	Scope
Quality assurance	Prevention	<ul style="list-style-type: none"> • Quality system (ISO 9000) • Quality costing • Quality planning and policies • Problem solving • Quality design
Total quality management	Quality as a strategy	<ul style="list-style-type: none"> • Quality strategy • Customers, employees and suppliers involvement • Involve all operations • Empowerment and teamwork

- Inspection-based
- System of quality control
- Quality assurance
- Total quality management

Inspection-based: The quality movement traces its roots back to medieval Europe, when craftsmen began organizing themselves into unions called guilds in the late thirteenth century.

Until the early nineteenth century, manufacturing in the industrialized world tended to follow this model. The factory system, with its emphasis on product inspection, began in Great Britain in the mid-1750s and grew into the Industrial Revolution in the early 1800s. In the early twentieth century, manufacturers began to include quality processes in quality practices.

During the early days of manufacturing, an operative's work was inspected and a decision whether to accept or reject it was made. As businesses expanded, so too did this role, and full-time inspection jobs were created. This brought about the following other problems:

- Technical problems requiring specialized skills, often not possessed by production workers, occurred.
- Some of the inspectors lacked training.
- Inspectors were ordered to accept defective goods to increase output.
- Skilled workers were promoted to other roles, leaving less skilled workers to perform operational jobs, such as manufacturing.

These changes led to the birth of a separate inspection department with a "chief inspector," reporting to either the person in charge of manufacturing or the works manager. With the creation of this new department there came newer services such as standards, training, recording of data and the accuracy of measuring equipment. It became clear that the responsibilities of the "chief inspector" included more than just product acceptance, and a need to address defect prevention emerged.

System of quality control: The quality control department evolved with an intention to undertake actions and measures to control quality in a desired manner. The "quality control

 **Bird's-eye view:**

TQM will force change in culture, processes and practice. These changes will be more easily facilitated and sustained if there is a formal management system in place.

 **Bird's-eye view:**

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, such as Deming, Juran and Feigenbaum.

 **Bird's-eye view:**

The four stages identified in the evolution of TQM are: Inspection; Quality Control; Quality Assurance; TQM

manager" heading this department was responsible for inspection services and quality control engineering.

In the 1920s, statistical theory began to be applied effectively to quality control and in 1924, Shewart made the first sketch of a modern control chart. His work was later developed by Deming. The early works of Shewart, Deming, Dodge and Romig constitutes much of what comprises the theory of statistical process control (SPC), today. However, there was little use of these techniques in manufacturing companies until the late 1940s.

At that time, Japan's industrial system had been virtually destroyed and it had gained a reputation as a producer of cheap, imitation products and an illiterate workforce. The Japanese recognized these problems and set about solving them with the help of some notable quality gurus—Juran, Deming and Feigenbaum.

In the early 1950s, quality management practices developed rapidly in Japanese plants and become a major theme in Japanese management philosophy. By 1960, quality control and management had become a national preoccupation. Quality control, however, is not an independent act; rather, it works in accordance with the guidelines set by quality assurance. The whole idea is to see whether planned quality is actually being achieved. Thus, quality assurance is more comprehensive and quality control is a part of it.

By the late 1960s and early 1970s, Japan's imports into the US and Europe increased significantly due to its cheaper though better quality products compared to its Western counterparts.

In a Department of Trade and Industry publication of 1982, it was stated that Britain's world trade share was declining and this was having a dramatic effect on the standard of living in the country. There was intense global competition and any country's economic performance and reputation for quality was made up of the reputations and performances of its individual companies and products/services.

The British Standard (BS) 5750 for quality systems had been published in 1979. In 1983, the National Quality Campaign was launched using the BS 5750 as its main theme. The aim was to bring to the attention of industry the importance of quality for competitiveness and survival in the world market.

Bird's-eye view: **Quality assurance:** The International Organization for Standardization (ISO) 9000 has become the internationally recognized standard for quality management systems. It comprises a number of standards that specify the requirements for the documentation, implementation and maintenance of a quality system. These standards were published for the first time in 1987. The aim was to effectively document the requirements of the quality management system, which had to be implemented to attain customer satisfaction. These standards were revised for the first time in 1994. Based on actual experiences of several thousand companies, these standards were revised again leading to an improved version being published in 2000. These standards were developed to assure quality.

Total quality management (TQM): The birth of total quality in the United States came as a direct response to the quality revolution in Japan following World War II. The Japanese welcomed the inputs of Americans, Joseph M. Juran and W. Edwards Deming, and rather than concentrate on inspection, focused on improving all organizational processes through the people who used them.

In 1969, the first international conference on quality control sponsored by Japan, America and Europe was held in Tokyo. Feigenbaum presented the paper, which used the term "total quality" for the first time, and referred to wider issues such as planning, organization and management responsibility. Ishikawa presented a paper explaining how

Bird's-eye view:

Quality Control was introduced to detect and fix problems along the production line to prevent the production of faulty products. Statistical theory played an important role in this area.

Bird's-eye view:

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.

Bird's-eye view:

Quality assurance is a component of quality management and is 'focused on providing confidence that quality requirements will be fulfilled.'

"total quality control" in Japan was different in the sense that it implied "company-wide quality control," and he described how all the employees, from the top management to the workers were required to study and participate in quality control for the process to be effective. By the 1970s, the US industrial sectors of automobiles and electronics had been broadsided by Japan's high-quality competition. The US response, emphasizing not only statistics but approaches that embraced the entire organization, became known as total quality management (TQM).

TQM is now part of a much wider concept that addresses overall organizational performance and recognizes the importance of processes. There is also extensive research evidence that demonstrates the benefits from this approach. Box 3.1 discusses the benefits of the TQM initiatives of Tata Steel.

In the twenty-first century, TQM has developed in many countries to form holistic frameworks aimed at helping organizations achieve excellent performance, particularly in customer relationships and business expansion. In Europe, a widely adopted framework is the "Business Excellence" or "Excellence" Model, promoted by the European Foundation for Quality Management (EFQM). The equivalent model in the United States of America is the Malcolm Baldrige National Quality award.

Box 3.1 TQM Implementation at Tata Steel

Tata Steel, established in 1907, is Asia's first integrated private sector steel company and among the top global steel companies with an annual crude steel capacity of nearly 30 million tonnes per annum (2015). It is the world's second most geographically diversified steel producer, with operations in 26 countries and a commercial presence in over 50 countries. The Tata Steel group, is a Fortune 500 company, with a turnover of \$22.32 billion in 2015, and has over 80,000 employees across five continents.

Tata Steel has been practicing TQM since the late 1980s. Back then, the company initiated several quality activities such as quality circles, ISO certification, and quality improvement. In 2005, Tata Steel conducted a TQM diagnosis along with the Union of Japanese Scientists and Engineers that gave the company the status of its TQM implementation and helped it uncover a lot of areas that required improvement in both processes and culture. The TQM diagnosis directed the company to specifically look at the following:

- Strategic and policy management:** Adopting the TQM philosophy as a part of the competitive strategy was formally launched in the company in late 1980s. It started by relooking at the balanced score card and looking at areas that needed to change the business with massive effort on education and training on TQM.
- Daily management:** The company established a standardized approach for integrating daily management activities in various functions such as operations, maintenance, customer services, and so on.
- People management:** Tata Steel created guidelines and reference manuals to have uniformity and alignment across the organization, as it dealt with 35,000 employees in standardized approaches. People engagements through improvement activities, such as quality circles, suggestion management, knowledge manthan, and so on, were executed.

Tata Steel India became the first integrated steel plant in the world, outside Japan, to be awarded the Deming Application Prize 2008 for excellence in TQM and the Deming Grand Prize 2012 instituted by the JUSE. The company identified several tangible and intangible benefits in its TQM journey.

Source: Adapted from <http://www.tatasteel.com/media/awards-and-recognitions.asp>, last accessed in March 2016.

Bird's-eye view:

TQC

- Emphasis is placed on the process and continuous process improvement.
- Total participation is required. Employees are encouraged to generate ideas and implement them.
- It is flexible - processes and methods can be easily changed.
- The target is not absolute - good for a changing market.

Downside: Sometimes the end result is very different from the original target - employees tend to lose sight of the goal because they are too focused on the process.

Bird's-eye view:

TQM

- Emphasis is placed on the target and achieving the target as soon as possible.
- The system is simple and straight-forward.
- Information delivery is accurate.
- The process is considered after the goal has been established.

Downside: Employees stop actively thinking of and implementing process improvement - they don't want to risk making a mistake or creating delays.

 **Bird's-eye view:**

Total quality management (TQM) consists of organization-wide efforts to install and make a climate in which an organization continuously improves its ability to deliver high-quality products and services to customers.

 **Bird's-eye view:**

Total Quality Control is an effective system for integrating quality development, quality maintenance and quality improvement efforts of the various groups in an organization so as to enable marketing, engineering, production and service at the most economic levels which allow for full customer satisfaction.

 **Bird's-eye view:**

As **Total Quality Control (TQC)** has come to have a major impact on management and engineering practices, it has provided the foundation for the evolution of **Company Wide Quality Control (CWQC)** or **Total Quality Management (TQM)** in the decade of 1980s and beyond.

 **Bird's-eye view:**

- In 2015, the ISO 9000 series of quality management standards was revised to increase emphasis on customer satisfaction.

■ SEVEN PHASES IN THE DEVELOPMENT OF TQM³

Quality is an effect—the outcome of some act or course of action. The cause behind the effect is quality assurance. The term “control” is normally interpreted through those actions and measures, which are taken to direct the behaviour or working of any system or subsystem to control quality in a desired manner. It can be in the context of quality systems, marketing, production and human resources.

The concept of total quality control (TQC) was first popularized by Armand V. Feigenbaum, a quality guru. It clearly expands the domain of activities in the context of quality. It positively involves other functions and sections of businesses. Thus, the scope increases from QC to TQC, where T stands for total involvement and practice of quality principles in other sections and areas, besides the production and quality departments.

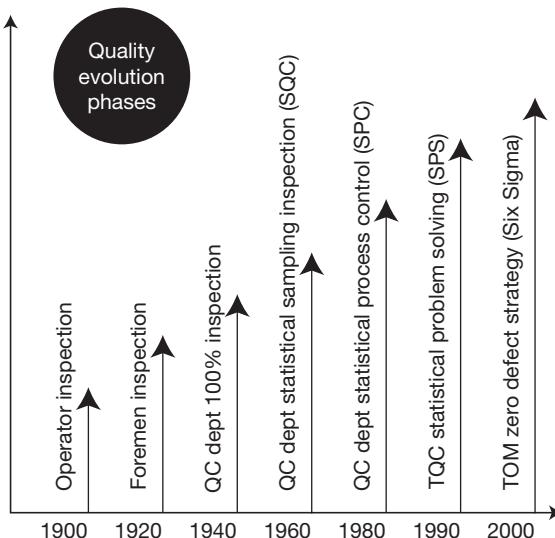
The Japanese understood the essence of quality and they not only applied it as a company-wide quality control (CWQC) movement, but also extended it further. The purpose and the intention of the drive were very clear, to encompass the organization from top to bottom. One can say that they adopted an original concept, nurtured it and expanded its domain even further. Right from the beginning, many authors on TQM have been treating it as an umbrella philosophy. Hence, TQM is a better choice than CWQC or TQC.

In the twenty-first century, the quality movement has only matured. New quality systems have evolved upon the foundations laid by Deming, Juran and the early Japanese practitioners of quality. The various phases in the development of total quality management are shown in Figure 3.2.

Some examples of this maturation are as follows:

- In 2015, the ISO 9000 series of quality management standards was revised to increase emphasis on customer satisfaction.
- Beginning in 1995, the Malcolm Baldrige National Quality Award added a business results criterion to its measures of judging an applicant’s success.
- Six Sigma was a methodology developed by Motorola to improve its business processes by minimizing defects. This evolved into an organizational approach that achieved major

Fig. 3.2 Phases in the Development of TQM



breakthroughs and significant bottom-line results. When Motorola received a Baldrige Award in 1988, it shared its quality practices with others.

- Yoji Akao developed deployment of quality functions as a process for focusing on customer wants or needs in the design or redesign of a product or service.
- Sector-specific versions of the ISO 9000 series of quality management standards were developed for such industries as automotive (QS 9000), aerospace (AS 9000) and telecommunications (TL 9000 and ISO/TS 16949) and for environmental management (ISO 14000).
- Quality has moved beyond the manufacturing sector into areas such as service, health-care, education and government.
- The Malcolm Baldrige National Quality Award has added education and healthcare to its original categories of manufacturing, small business and service. Many advocates are pressing for the adoption of another category, that of “non-profit organizations” as well.

DISCUSSION FORUM

1. Explain the meaning of TQM.
2. Describe the evolution of TQM.
3. Discuss the five pillars of TQM.

■ PRINCIPLES OF TOTAL QUALITY MANAGEMENT⁴

Quality management principles are a set of comprehensive and fundamental rules or beliefs for leading and operating an organization (Figure 3.3). These are aimed at continually improving performances over the long-term, by focusing on customers while addressing the needs of all stakeholders.

Quality management principles provide understanding and guidance on the application of quality management in an organization. As per the International Organization for Standardization (ISO), the following eight quality management principles can facilitate the creation of a quality work culture and successful implementation of quality management in any organization.

1. ***Customer-focused organization:*** Organizations depend on their customers and, therefore, should focus on understanding the current and future needs of the customer, meet customer requirements and strive to exceed customer expectations while satisfying them. Customer-focused organizations produce products and services that are needed by the customer and provide customer satisfaction. This can be achieved by the following actions:

- Identifying the customer's needs
- Design a product, which responds to the customer's needs
- Produce and deliver the product as per the design
- Enhance after-sales service and handle complaints quickly
- Measure customer satisfaction
- Improve quality to delight the customer

2. ***Leadership:*** An organization's senior leaders need to set directions and create clear and visible quality values, high expectations and a customer-oriented approach. These values,

Bird's-eye view:

Principles of Total Quality

- A focus on customers and stakeholders
- Participation and teamwork by everyone in the organization
- A process focus supported by continuous improvement and learning

Fig. 3.3 The Key Principles of TQM

 **Bird's-eye view:**

People at all levels are the essence of an organization and their full involvement enables their abilities to be used for the organization's benefit.

 **Bird's-eye view:**

The **process approach** is a management strategy. When managers use a **process approach**, it means that they manage and control the **processes** that make up their organizations.

 **Bird's-eye view:**

A system is a set of interrelated but separate parts working towards a common purpose.

 **Bird's-eye view:**

System approach to management views the organization as a unified, purposeful system composed of interrelated parts.

Management commitment

1. Plan (drive, direct)
2. Do (deploy, support, participate)
3. Check (review)
4. Act (recognize, communicate, revise)

Employee empowerment

1. Training
2. Suggestion scheme
3. Measurement and recognition
4. Excellent teams

Fact-based decision making

1. Statistical process control
2. Design of experiments, failure mode and effect analysis
3. The seven statistical tools
4. Team oriented problem solving

Continual improvement

1. Systematic measurement
2. Excellent teams
3. Cross functional process management
4. Attain, maintain, improve standards

Customer focus

1. Supplier partnership
2. Service relationship with internal customers
3. Never compromise quality
4. Customer-driven standards

directions and expectations need to address all stakeholders. The leaders need to ensure the creation of strategies, systems and methods for achieving excellence. Strategies and values should help guide all activities and decisions of the organization. The senior leaders must commit to the development of the entire workforce and should encourage participation, learning, innovation and creativity by all employees. Through their personal roles in planning, communication, review or organizational performance and employee recognition, the senior leaders need to serve as role models reinforcing values and expectations, and building leadership and initiative throughout the organization.

3. **Involvement of people:** People involvement is one approach to improving quality and productivity. Involving people at all levels enables full utilization of their abilities for the organization's benefit. This can be done by providing a good corporate work culture, providing an interesting work system and work environment and building the capabilities of people to perform the assigned tasks in the organization.
4. **Process approach:** A desired result is achieved more efficiently when related resources and activities are managed as a process.
5. **Systems approach to management:** Identifying, understanding and managing a system of interrelated processes for a given objective contributes to the efficacy and efficiency of the organization.

6. **Continuous improvement:** A permanent objective of the organization is that it should continuously improve performance by addressing the needs of all interested parties.
7. **Factual approach to decision making:** Effective decisions are based on the logical or intuitive analysis of data and information.
8. **Mutually beneficial supplier relationships:** The ability of the organization and its suppliers to create value is enhanced by mutually beneficial relationships.

THE KEY ELEMENTS OF TQM⁵

Total quality is a description of the attitude, culture and organization of a company that strives to provide customers with products and services that satisfy their needs. The culture mandates quality in all aspects of the company's operations, with processes being done right the first time every time and defects and waste eradicated from operations.

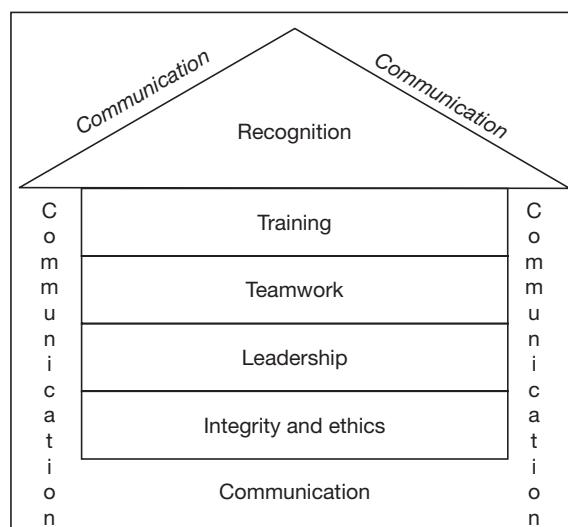
The term TQM has been coined to describe a philosophy that makes quality the driving force behind leadership, design, planning and improvement initiatives. For this, the organization needs to concentrate on eight key elements—ethics, integrity, trust, leadership, teamwork, training, communication and recognition as shown in Figure 3.4. These elements can be divided into the following four groups—foundation, building bricks, binding mortar and roof.

I. Foundation:

It includes ethics, integrity and trust. TQM is built on a foundation of ethics, integrity and trust. It fosters openness, fairness and sincerity and encourages the involvement of everyone in the organization. This is the key to unlocking the ultimate potential of TQM. Though these three elements coexist, each offers something unique to the TQM concept.

1. **Ethics:** It is a combination of written and unwritten codes of principles and values that govern decisions and actions within a company. In the business world, an organization's culture sets standards for determining the difference between good and bad decision

Fig. 3.4 TQM—Key Elements



Bird's-eye view:

Factual approach to decision making encourages an organization to do quantitative or statistical analysis based on data before making any conclusion or decision at any level within the organization.

Bird's-eye view:

An organization and its suppliers are interdependent and a **mutually beneficial relationship** enhances the ability of both to create value.

making and behaviour. Business ethics boils down to knowing the difference between right and wrong and choosing to do what is right. It describes the actions of individuals within an organization, as well as those of the organization as a whole.

2. **Integrity:** It is the consistency of actions, values, methods, measures, principles, expectations and outcomes. As a holistic concept, it judges the quality of a system in terms of its ability to achieve its own goals. Integrity may be seen as the quality of having a sense of honesty and truthfulness in regard to the motivation for one's actions.
3. **Trust:** Trust builds a cooperative environment essential for TQM. Trust is a by-product of integrity and ethical conduct. It is a relationship based on reliance. Trust fosters everybody's participation and allows empowerment that encourages pride of ownership and commitment. Trust fosters individual risk-taking for continuous improvement and is essential to ensure customer satisfaction.

II. Building Bricks: It includes leadership, teamwork and training.

Leadership, teamwork and training are the building bricks of TQM. Leadership in TQM requires the manager to provide an inspiring vision, make strategic decisions and instill values that guide subordinates. Teamwork offers continuous improvement in processes and operations. The teams may be quality improvement teams or excellence teams, problem-solving teams or natural work teams. Training is very important for employees to be highly productive.

4. **Leadership:** It is the most important element in TQM. Leadership is about raising the aspirations of followers and enthusing people with a desire to reach the goals. A good leader creates a vision, passionately owns it and relentlessly drives it till completion. Total quality management initiatives have to be introduced and led by the top management.
5. **Teamwork:** There are some well-established links between the use of work teams and the development of total quality management programmes. There are, however, a great variety of teams that are used in conjunction with the philosophy of TQM and there is seemingly no settled or dominant combination of team types that are used. The attributes of teams that are used in conjunction with TQM may vary greatly. Teams may be temporary, adhoc or permanent, they may be functional or cross-functional, voluntary or compulsory, have members with multiple skills or complementary skills, and may have a limited scope of responsibility or they may exercise considerable autonomy and self-direction. TQM organizations mainly adopt three types of teams:
 - a. Problem-solving teams: These are temporary and formed to solve certain problems, identify and overcome causes of those problems. They generally last from one week to three months.
 - b. Quality improvement teams: These are temporary teams with the purpose of dealing with specific problems that often recur. These teams are set up for a period of three to twelve months.
 - c. Natural work teams: These teams consist of small groups of skilled workers who share tasks and responsibilities. These teams use concepts such as employee involvement teams, self-managing teams and quality circles.
6. **Training:** Training is essential for all the employees to be highly productive. All the employees will need to be trained in interpersonal skills, ability to function in teams, problem solving, decision making, job performance and improvement, business economics and technical skills. Employees are trained by supervisors of each department so that they can become effective employees of the company.

Bird's-eye view:

Total quality is a description of the attitude, culture and organization of a company that strives to provide customers with products and services that satisfy their needs.

Bird's-eye view:

To be successful in implementation of TQM there are eight key elements. These eight key elements of TQM are: ethics, integrity, trust, leadership, teamwork, training, communication and recognition.

III. Binding Mortar: It includes communication.

Communication binds everything together, starting from the foundation and going up to the roof. Communication is the vital link between all the TQM elements and must be prevalent in an organization in order for TQM to work the way it should. The channels of communication need to be credible and easily interpreted for all members of the organization.

7. Communication: It acts as a link between all the elements of an organization. For communication to be effective, the receiver must interpret the message in the way the sender intended. The different types of communication are downward communication, upward communication and lateral communication.

Downward communication: This is a dominant form of communication in an organization. Presentations and discussions are two examples of this form of communication. The supervisors are able to make the employees clearly understand TQM using this.

Upward communication: The lower-level employees are able to offer suggestions on the effects of TQM to the upper management using upward communication. Supervisors must listen effectively and incorporate the insights and constructive criticism offered by the employees in correcting the situations that arise through the use of TQM. This creates a level of trust between supervisors and employees. This is also similar to empowering communication, where supervisors listen to others.

Lateral communication: This type of communication is important because it breaks down barriers between departments. It also allows a more professional dealing with customers and suppliers.

IV. Roof: It includes recognition.

Recognition is the last and final element of TQM. There can be a huge change in self-esteem, productivity and quality when the contributors are recognized. This recognition brings greater internal customer satisfaction, which in turn leads to external customer satisfaction in the organization.

8. Recognition: Recognition should be provided for both suggestions and achievements, for both teams and individuals. The most important responsibility on a supervisor is that of according recognition to the employees under him. Box 3.2 discusses the quality journey undertaken at automobile major, Mahindra and Mahindra.

Box 3.2 TQM Journey at Mahindra and Mahindra

Mahindra and Mahindra pursued the path of TQM to retain market leadership and grow further. The TQM journey at M&M was introduced in three phases.

The first phase (1990–1994) was deemed the introduction phase. The introduction of initiatives like Juran's process of quality improvement (JQI), statistical process control (SPC), supplier support activity and business process reengineering (BPR) in manufacturing, both at Mumbai and Nagpur, were the main features of this phase.

The second phase (1995–1999) was the promotion phase and the focus was not only on the standardization of all operations as per the international guidelines, but also on their improvement and furtherance. Accordingly, certifications like ISO 9000 and the automotive sector specific standard QS 9000 (for both Mumbai and Nagpur locations) were applied for and obtained. Further, with the help of external consultants, the company upgraded the manufacturing facilities and initiated the Deming Prize guidelines.

Bird's-eye view:

At the core of TQM is effective communication. Starting from the foundation or the root of the TQM house, communication acts as a vital link between all elements of TQM.

Bird's-eye view:

Effective communication is logical, rational and persuasive and it is especially useful in industrial relations, organizational change and relaxation.

Bird's-eye view:

Which are the different channels of communication?

Bird's-eye view:

Customer Satisfaction, Process Approach, Measurement, Synergy in Teamwork, Employee engagement, Continuous Improvement Cycle, Prevention are the core concepts of TQM.

Bird's-eye view:

These core concepts of TQM can be used to drive the process of continuous improvement and to develop a framework for quality improvement over many years.

Bird's-eye view:

There are two distinct types of customers i.e. external and internal.

Bird's-eye view:

Internal customers are within the company—the colleagues working together for delivering a service or product for the external customer.

Bird's-eye view:

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.

Bird's-eye view:

Customer satisfaction is not an objective statistics but more of a feeling or attitude.

The objective of the final phase that was termed the development phase from 2000 onwards was to get closer to the vision of becoming the world's largest tractor manufacturer by creating dominance in local markets and building substantial presence in international markets through aggressive use of the Deming Prize guidelines and also to win the coveted medal before 2004. The major activities, therefore, consisted of further improvement in core processes such as new product development, manufacturing, supplier management and sales and customer operations under the guidance of Dr Yasutoshi Washio, the Japanese quality expert.

The company also introduced the policy deployment and daily work management technique and certification to environment management system standard ISO 14001, both at the Mumbai and Nagpur facilities. The continuous improvement activity was also stepped up considerably to touch employee involvement of 100 per cent during this period.

The benefits derived from TQM were reduction in rework and rejection at all stages of operation, improvement in field quality indicated by number of consumer complaints during the first 250/500/1,000/2,000 hours of tractor operation, increased productivity, customer satisfaction, employee involvement, continuous improvement and introduction of 15 new models in three years.

Source: Adapted from www.mahindra.com, accessed February 2016.

■ CORE CONCEPTS OF TQM⁶

Each of the following core concepts of TQM can be used to drive the process of continuous improvement and to develop a framework for quality improvement over many years.

■ Customer Satisfaction

TQM is focused on the requirements of the customer. In order to meet customer requirements, it is important to listen to them and do what is agreed upon. In this activity, the companies have to give equal importance to the internal as well as the external customers. A better way for companies to use their customers is to learn what is important to them and then, match their performance to the customer's expectations. Many forward-looking companies of the world have started the process of conducting a survey known as "energy meter," which reflects the satisfaction, morale and motivation levels of employees and develops the concept of "employeeship" with core emphasis on the principles of customer satisfaction. Further, on the external customer front, surveys are conducted among the customers for identifying their satisfaction, expectations and the causes for low customer satisfaction. Accordingly, the satisfaction index is compiled and product qualities are monitored to improve customer satisfaction.

■ Internal Customer Satisfaction

Customers are not only external customers—the people outside who are the end users of a firm's products and services. There is also the internal customer, the person within the company who receives the work of another and adds his or her contribution to the product or service before passing it on to someone else. It states that it is necessary to achieve a successful internal working relationship in order to satisfy the needs of the external customer. If the internal customers' requirements are agreed and met, a chain of quality is built that reaches out to the external customer. Whether an organization supplies products or services, the people it supplies internally are as real as its external customers. Therefore, they also require speed, efficiency and accuracy. Hence, the idea of the internal customer can be used as a focus for improvement.

■ All Work is Process

Another possible focal point of improvement is that of business processes. A process is a combination of methods, materials, manpower and machines that work together to produce a product or service. All processes contain inherent variability and one approach to quality improvement is to progressively reduce variation. First, this can be done by removing variation due to special causes, and secondly by driving down the common cause of variation, thus bringing the process under control and improving the capability.

There are two basic steps in measurement system:

1. Develop key indicators that drive customer satisfaction.
2. Collect data regarding perception of quality received by customers

■ Measurement

In order to improve, one must first measure one's present performance. This will help one focus both on satisfying internal customers and meeting the requirements of external customers. There are seven generic ways (in addition to the cost of quality) in which the quality of outputs can be measured:

- Defects (work not up to specification)
- Rework (work requiring correction)
- Scrap (work thrown away)
- Lost items (work done again)
- Backlogs (work behind schedule)
- Late deliveries (work after agreed time)
- Surplus items (work not required)

■ Synergy in Teamwork

The idea of synergy in teamwork, where the whole is greater than the sum of its parts, is a key concept in TQM. Here, it is used to promote collaboration, consensus, "creative conflict" and team winning. One of the strengths of using teams for TQM is that they can combine the mutually exclusive individual qualities needed for running businesses today.

Teamwork can provide opportunities for people to work together to achieve quality improvement. People who work on their own or in a small group often have a compartmentalized picture of their organization and the work that it does. They are quite unfamiliar with the work done even by people who are in their vicinity. Consequently, they are unaware of the results of the poor quality of their work. Bringing people together within teams with the common goal of quality improvement aids communication between people, departments and functional activities. Teamwork slowly breaks down the communication barriers and acts as a platform for change. Teamwork also enables a group of people to work as a task force as seen in cross-functional teams, committees, etc. which look at cross-functional problems, solving problems and identifying and adopting new ways of doing things. In this connection, quality circles and quality improvement tools facilitate team-building processes in organizations.

■ People Make Quality

Most of the quality problems within an organization are not normally within the control of an individual employee. The system often comes in the way of employees who are trying to do a good job. In such a situation, motivation alone cannot work. Therefore, managers are required to ensure that everything necessary is in place to allow people to produce quality. This creates an environment where people are willing to take responsibility for the quality

Bird's-eye view:

A process is a combination of methods, materials, manpower and machines that work together to produce a product or service.

Bird's-eye view:

Performance measurement is a fundamental building block of TQM and a total quality organisation.

Bird's-eye view:

In a successful total quality organisation, performance will be measured by the improvements seen by the customer as well as by the results delivered to other stakeholders, such as the shareholders.

Bird's-eye view:

The essence of **Synergy** is valuing difference, the mental, the emotional, and psychological difference between people - respect them, to build on strengths, which compensate weaknesses.

 **Bird's-eye view:**

People Create

Quality by:

Change Management

Leadership

Quality Professionals

Teams

Employee Empowerment
and Involvement

of their own work. Releasing the talents of everyone within the organization in this way can create a culture for quality improvement.

■ Continuous Improvement Cycle

The continuous cycle of establishing customer requirements, meeting and measuring them, measuring success and continuing the improvement can be used both externally and internally to fuel quality improvements. The continuous improvement cycle used repeatedly will lead to a new “chemistry” within the organization so that the culture begins to change to one of continuous improvement.

 **Bird's-eye view:**

PDCA (plan–do–check–act or plan–do–check–adjust) is an iterative four-step management method used in business for the control and **continual improvement** of processes and products.

■ Prevention

At the heart of TQM is the conviction that it is possible to achieve defect-free work most of the time. This is termed as “right first time, every time” or zero defects. The “right first time” or zero defects policy is the result of an emphasis on prevention, and the diligent use of measurement, process controls and the data-driven elimination of waste and error. It serves as a goal for continuous improvement. Prevention is the goal of all quality assurance. Through planned and systematic action such as documentation of work processes, or cost of quality audits, quality assurance prevents quality problems. Box 3.3 discusses the TQM *mantra* at Godrej Industries.

 **Bird's-eye view:**

Zero Defects is a management tool aimed at the reduction of **defects** through **Prevention**. It is directed at motivating people to prevent mistakes by developing a constant, conscious desire to do their job right the first time.”

DISCUSSION FORUM

1. Discuss the key principles of TQM.
2. Explain the key elements of TQM.
3. Describe the core concepts of TQM.

Box 3.3 TQM Mantra at Godrej Industries

Godrej Industries embarked on its total quality management (TQM) *mantra* in April 1995. Every employee of the company was exposed to the principles of TQM during a series of awareness programmes held over a period of nine months. Later, TQM's scope was extended to cover business partners, suppliers, carrying and forwarding agents, distributors, etc. The following TQM principles were adopted:

- Customer satisfaction
- PDCA cycle
- Management by fact
- Respect for people

The following TQM elements were introduced:

- Total Employee Involvement (TEI)
- Total Waste Elimination (TWE)
- Total Quality Control (TQC)

Their TQM focus areas were customer satisfaction, product quality, plant reliability and waste elimination. In order to achieve this, the following TQM initiatives were taken:

- Introduction of a task force
- Departmental purpose analysis

- Identifying key business processes
- Small group activity
- Quality circle
- Kaizen
- 5 S
- TPM
- Six Sigma

An increased focus on the customer, better product quality, continuous improvement, better systems and procedures, cross-functional teamwork, increased plant reliability and waste elimination in offices and factories were the key benefits achieved through TQM.

Source: Adapted from www.godrej.com, accessed February 2016.

■ TOTAL QUALITY MANAGEMENT EXCELLENCE MODEL (TQMEX)⁷

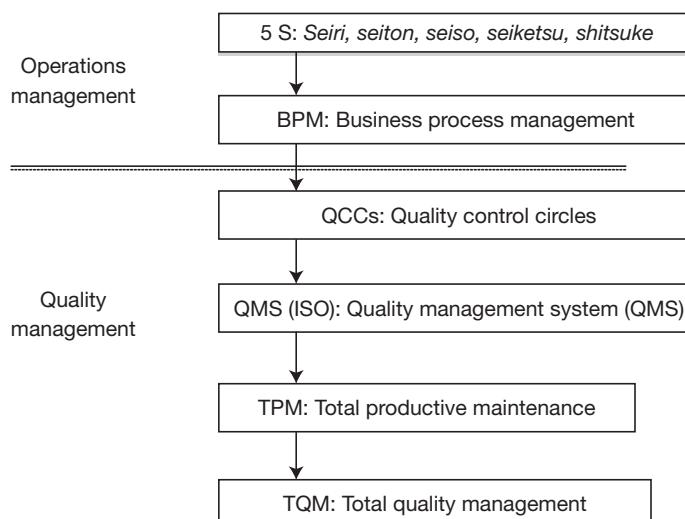
The TQMEX Model advocates an integrated approach in order to support the transition to systems management, which is an ongoing process of continuous improvement that begins when the company commits itself to managing by quality. The model illuminates the elements that help us to understand the TQM philosophy and its implementation company-wide.

It is necessary to develop a conceptual model in order to have a systematic approach to TQM. TQMEX model is a sequence of steps arranged logically to serve as a guideline for the implementation of a process in order to achieve the ultimate goal. The idea was to develop a universally applicable step-by-step guideline by including the recognized practices of TQM as shown in Figure 3.5.

■ The Japanese 5-S Practice (5 S)

The 5 S is the key to total quality environment, a philosophy most Japanese factories endorse and practice. Japanese factories well known for their cleanliness and orderliness and; hence, are addressed as “parlours.” The 5-S practice is a technique used to establish and maintain

Fig. 3.5 The TQMEX Model



Bird's-eye view:

TQMEX model is a sequence of steps arranged logically to serve as a guideline for the implementation of a process in order to achieve the ultimate goal. The sequence of steps are: 5 S; BPM; QCCs; QMS; TPM and TQM.

Bird's-eye view:

The 5-S is the key to total quality environment, a philosophy most Japanese factories endorse and practice. The 5-S stands for five Japanese words—Seiri, Seiton, Seiso, Seiketsu and Shitsuke.

Bird's-eye view:

The Japanese 5-S practice is useful not just for improving the physical environment, but also for improving the thinking processes.

Table 3.2 The Japanese 5-S Practice

Japanese	English	Meaning	Typical Example
Seiri	Structurize	Organization	Discard rubbish
Seiton	Systemize	Neatness	Retrieving a document within 30 seconds
Seiso	Sanitize	Cleaning/cleanliness	Individuals responsible for maintaining cleanliness
Seiketsu	Standardize	Standardization	Transparency of storage
Shitsuke	Self-discipline	Discipline	Performing the 5 S daily

quality environment in an organization. The name stands for five Japanese words—*Seiri, Seiton, Seiso, Seiketsu* and *Shitsuke*. The Japanese 5-S practice is useful not just for improving the physical environment, but also for improving the thinking processes. The English equivalent, their meanings and typical examples are shown in Table 3.2.

Bird's-eye view:

BPM is a systematic approach to improving a company's business processes.

■ **Business Process Management (BPM)**

BPM is a holistic management discipline aimed at enhancing or improving the efficiency of business processes. BPM can leverage the benefits of technology to achieve innovation, flexibility and operational efficiency. It attempts to continuously improve processes—the ones that define, measure and improve other processes. It is a discipline that treats business processes as assets when working towards the goal of improving agility and operational performance. BPM is a structured approach that employs methods, policies, metrics, management practices and software tools to manage and continuously optimize an organization's activities and processes. The three areas where BPM plays a crucial role are business strategy, governance and structure and culture and values.

Bird's-eye view:

A **Quality Control Circle** or Quality Circle is a participatory **management** technique that enlists the help of employees in solving problems related to their own jobs.

■ **Quality Control Circles (QCC)**

QCCs originated in Japan in the 1950s. A QCC is a small group of staff working together to contribute to the improvement of the enterprise, to respect humanity and to build a cheerful workgroup through the development of the staff's infinite potential.

A QCC team of people usually come from the same work area, meet voluntarily on a regular basis to identify, investigate, analyse and solve their work-related problems. The basic concepts behind QCC activities as part of the company-wide quality control efforts are:

- To contribute to the improvement and development of the enterprise.
- To respect humanity and to build worthwhile lives and cheerful work areas.
- To give maximum recognition to human capabilities and to draw out each individual's infinite potential.

Bird's-eye view:

Circles are formed of employees working together in an operation who meet at intervals to discuss problems of **quality** and to devise solutions for improvements.

■ **The Seven Quality Control Tools**

Prof Karou Ishikawa, "the father of QCCs," developed the seven QC tools. Through his experience, he identified a set of tools, which could be used by teams and individuals to interpret the data fully and derive maximum information from it. These seven effective methods offer any organization a means of collecting, presenting and analysing most of its data and problems. They are process flowchart, check sheet, histogram, Pareto analysis, cause-and-effect analysis, scatter diagram and control charts. Since their applications are so wide, they are also known as the seven tools for QCCs.

QCC is essential to the quality of product and improvement of service. To implement QCC, companies must spend time in the early stages ensuring that everyone in the company is properly informed and consulted before any QCC activity begins. QCC needs employee empowerment. Moreover, the specifications for improvement should not be too rigid.

■ Quality Management Systems

The International Organization for Standardization (ISO) is the specialized agency for standardization and comprises the national standards bodies of 163 countries. ISO is made up of approximately 300 technical committees. Each technical committee is responsible for one of the many areas of specialization, ranging from asbestos to zinc. The purpose of ISO is to promote the development of standardization and related activities in order to facilitate easier international exchange of goods and services and to develop cooperation in intellectual, scientific, technological and economic activities. The results of ISO technical projects are published as international standards. The ISO 9000 series is a result of this process.

ISO is a worldwide standard that establishes requirements for the management of quality. Unlike product standards, these standards are for quality management systems. The impact of these standards is reflected in the widespread distribution of the ISO 9000 series, which has become the bestseller in the history of the ISO. ISO 9000 even outsold the universal and long-standing international weights and measurements standards. However, it is worth repeating that ISO 9000 does not set standards for products, but standards for the operation of a quality management system.

■ Total Productive Maintenance

In 1971, The Japan Institute of Plant Maintenance (JIPM) defined TPM as a system of maintenance covering the entire life of equipment in every division including planning, manufacturing and maintenance. The term TPM is sometimes known as total productivity management because it focuses on improving productivity.

TPM involves everyone from the top executives to the shop floor workers. Productive maintenance is promoted through morale-building management and small-group activities in an effort to maximize equipment efficiency. Basically, TPM implies utilizing plant capability to its fullest extent to:

- Reduce equipment stoppages (both line stoppages and stoppages for reworking)
- Quantitatively and qualitatively enhance equipment capability
- Improve safety, health and environmental factors in the expectation that such improvements will contribute to better quality and higher profits
- Utilize small-group activities and prevention

■ TRADITIONAL ORGANIZATION VERSUS TQM ORGANIZATION⁸

A TQM organization is not the same as a traditional organization. Table 3.3 gives the actual differences between a TQM organization and a traditional organization.

Table 3.3 Traditional Organizations Versus TQM Organizations

Traditional Organization	TQM Organization
1. Company driven	Customer driven
2. Short-term orientation	Long-term orientation

Bird's-eye view:

A **Quality Management System (QMS)** is a formalized system that documents processes, procedures, and responsibilities for achieving quality policies and objectives.

Bird's-eye view:

A **QMS** helps coordinate and direct an organization's activities to meet customer and regulatory requirements and improve its effectiveness and efficiency on a continuous basis.

Bird's-eye view:

ISO is an independent, non-governmental international organization with a membership of 163 national standards bodies comprising of around 300 technical committees.

Bird's-eye view:

ISO through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.

Bird's-eye view:

Total Productive Maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization.

(Continued)

Table 3.3 (Continued)

Traditional Organization	TQM Organization
3. Opinion driven 4. Tolerance of waste 5. Fire fighting 6. Inspection 7. Fortressed departments 8. Top-down hierarchy 9. Blame 10. Isolation 11. Management	Data driven Elimination of waste Continuous improvement Prevention Cross-functional teams High employee participation Problem solving Systems thinking Leadership

 **Bird's-eye view:**
Common barriers
in the implementation
of TQM program

- Lack of management commitment
- Inability to change organizational culture
- Lack of continuous training and education
- Improper planning
- Inadequate resources
- Lack of customer orientation

■ COMMON BARRIERS TO THE IMPLEMENTATION AND DEVELOPMENT OF A TQM PROGRAMME

Several firms have experienced considerable problems with the introduction, development and measurement of quality improvement. Some programmes have never been initiated and many have encountered common barriers. Although the TQM points appear obvious and make sense, they are in reality difficult to execute and very time consuming. A TQM philosophy must be driven throughout the entire organization as it requires major changes in the way companies operate. The common barriers in the implementation and development of a TQM programme are poor planning, lack of management commitment, resistance of the workforce, lack of proper training, teamwork complacency, use of an off-the-shelf programme, failure to change the organizational philosophy, lack of resources and lack of effective measurement of quality improvement.

■ PREREQUISITES FOR TQM

The following points should be kept in mind while implementing TQM:

- The management must establish TQM as an objective and accept responsibility.
- Top management must be able to overcome the obstacles, most of which will emanate from the management itself.
- It must be understood that TQM cannot be accomplished with the participation of only a few. All employees in the organization must pursue this end.
- Resources, i.e. people, time, money and effort, must be dedicated over a long period of time.
- Employees will need to be continually assured of the management's commitment in the form of actions and not mere words.
- As a cultural change is warranted, managers must alter their style and methods from one of controlling employees in a bureaucratic manner to that of encouraging employee initiative and involvement.
- It will require tremendous effort from the top management to create a quality environment by launching behavioural changes, building skills through training and communication and ensuring timely actions to sustain the effort.

■ TQM IMPLEMENTATION⁹

Any organization wishing to implement TQM must understand clearly that TQM is not a management technique but a programme that initiates change. Like any other programme that initiates change, it needs to be designed, sequenced and managed. Adopting the right kind of method is one of the most crucial responsibilities of the senior management and the degree of success obtained will depend on their knowledge and understanding of these methods. TQM methods are unlikely to be very useful if not implemented properly. The following points must be kept in mind for the successful working of TQM in any organization.

1. Establishment of a corporate TQM steering committee and the formation of a TQM council at the unit level involving staff from senior management. A TQM centre can be formed to plan, manage and train employees for implementing TQM.
2. Selection of proper TQM methods required for the organization by conducting the required surveys based on the need and the organizational climate.
3. Complete knowledge for implementing TQM tools aimed at problem solving.
4. In order to make the TQM programme a success, a culture that focuses on customer satisfaction and permanent elimination of problems must be put in place.
5. Sustained and continuous effort must be made for company-wide TQM activities rather than view it as a one-time activity/project.

The following are the generic models for implementing TQM theory:

1. Train the top management on TQM principles.
2. Assess the current culture, customer satisfaction levels and quality management system.
3. Determine the core values and principles to be used and communicate them to the top management.
4. Develop the TQM master plan based on steps 1, 2, 3.
5. Identify and prioritize customer needs and determine products or service to meet those needs.
6. Determine the critical processes to produce those products or services.
7. Create process improvement teams.
8. Support should be given to the teams by managers through proper planning, training and timing.
9. Integrate changes for improvement in daily process management and standardize them.
10. Evaluate progress against plan (step 8) and adjust as needed.
11. Provide constant employee awareness and feedback on status and establish a reward/recognition process.

Box 3.4 provides steps in implementing TQM. Box 3.5 provides Barriers to TQM implementation.

Box 3.4 Steps in Implementing TQM

The steps involved in implementing TQM are as follows:

- Obtain the CEO's commitment
- Educate the upper-level management
- Create a steering committee

Bird's-eye view:

TQM works best in an environment where it is strongly supported by management, it is implemented by employee teams, and there is a continual focus on process improvement that prevents errors from occurring.

- Clarify the vision, mission, and values
- Prepare a flow diagram of the company's processes
- Identify Critical Success Factor (CSF) and develop measures and metrics to track CSF data
- Identify customer groups and solicit feedback
- Monitor CSF and develop an improvement plan
- Provide a quality training programme
- Establish quality improvement teams
- Implement process improvements by using TQM tools
- Know the benefits of TQM

Box 3.5 Barriers to TQM Implementation

The barriers to TQM implementation are as follows:

- Competitive markets
- Bad attitudes/abdication of responsibility/management infallibility
- Lack of quality leadership
- Deficiency of cultural dynamism
- Inadequate resources for TQM
- Lack of customer focus
- Lack of effective measurement of quality improvement
- Poor planning
- Lack of management commitment
- Resistance of the workforce
- Inadequate human resource development
- Lack of proper training

 **Bird's-eye view:**

It has been observed that effective TQM implementations improve organizational effectiveness, long-term profitability and financial returns. Also, higher intensity of TQM practices results in improved quality performance.

■ BENEFITS OF TQM¹⁰

There are many advantages of TQM. Essentially, TQM refers to the total quality in fulfilling the needs of the customers, the quality of the products and the quality of life (at the workplace and home). Having these focuses leads to better business results and also benefits business in several different ways. Here are some of the benefits of TQM:

1. **Creates a good corporate culture:** Total quality management is an approach where the customer is the focal point of the business rather than the department. Therefore, quality is transformed from an issue of the production department to a strategic business entity to meet global challenges. The TQM philosophy revolves around developing a culture that advocates total commitment to customer satisfaction through continuous improvement.
2. **Better reviews from customers:** Another benefit of TQM is that customers and clients are highly satisfied with the performance. Given the quality assurance testing procedures, the products of the company will constantly meet the requirements and needs of clients and customers. Therefore, the customers stay with the company longer, deepen their relationship with the company and demonstrate less price sensitivity while recommending the company's products or services to others. Customer satisfaction and high performance results also possibly lead to high reviews in different publications and newspapers, which further enhances the image of the company and in turn that of the business.
3. **Better performance from employees:** Through TQM, there is often more attention placed on meeting the needs of the employees or internal customers. The training given to the

employees as part of the programme can boost employee morale at the workplace resulting in employees working harder to achieve the goals of TQM.

TQM is closely linked to the workplace and the company environment. Often, the management offers incentives to employees in the form of higher salaries or wages, which boost performance levels and increase productivity. The benefits derived from TQM are summarized below:

- Encourages a strategic approach to management at the operational level by involving multiple departments in cross-functional improvements and systemic innovation processes.
- Provides high returns on investment through improving efficiency.
- Works equally well in both service and manufacturing sectors.
- Allows organizations to take advantage of developments that enable managing operations as cross-functional processes.
- Creates an orientation toward inter-organizational collaboration and strategic alliances by establishing a culture of collaboration among the different departments within an organization.

DISCUSSION FORUM

1. Explain the TQMEX model.
2. Compare the traditional organization with a TQM organization.
3. Discuss the prerequisites of TQM.
4. What are the steps for implementing a TQM programme?
5. Describe the barriers in implementing a TQM programme.
6. Explain the benefits of TQM with an example.

SUMMARY

- TQM is an integrated effort designed to improve the quality of performance at every level of the organization. Product, process, system, people and leadership are the five pillars of TQM. TQM is a comprehensive management system.
- Four stages can be identified in the evolution of TQM. They are inspection-based, system of quality control, quality assurance and total quality management.
- The seven phases in the development of TQM are operator inspection, foremen inspection, quality control department 100 per cent inspection, SQC, SPC, SPS and Six Sigma.
- The key principles of TQM are customer-focused organization, leadership, the involvement of people, a process approach, a systems approach to management, continuous improvement, a factual approach to decision making and mutually beneficial supplier relationships.
- The eight key elements of TQM are ethics, integrity, trust, training, teamwork, leadership, recognition and communication.
- The core concepts of TQM are used to drive the process of continuous improvement. They are explained by the criteria such as customer satisfaction, internal customer satisfaction, all work is a process, measurement, synergy in teamwork, people make quality, continuous improvement cycle and prevention.

- The TQMex Model advocates an integrated approach in order to support the transition to systems management, which is an ongoing process of continuous improvement that begins when the company commits itself to managing by quality. The model illuminates the elements that form a base to the understanding of TQM philosophy and implementation of the process company-wide. 5 S, BPM, QCCs, ISO, TPM and TQM are some of the step-by-step guidelines in the TQMex model.
- TQM approaches must be customized for each company. A TQM organization needs some prerequisites and is driven by the customer's needs, whereas a traditional organization is driven by the company's needs. A TQM programme offers several benefits to the company but the company has to surpass certain barriers during implementation.
- The common barriers in the implementation of TQM are systems and procedures, culture, organization design and management perspectives.

Key Terms

5 S	77	People	59
BPM	78	Process	63
Communication	73	Process Approach	70
Continuous Improvement	71	Product	63
Continuous Improvement Cycle	76	QCC	78
Customer-focused Organization	69	Quality Assurance	66
Customer Satisfaction	74	Recognition	73
Ethics	71	System	63
Factual Approach to Decision Making	71	System of Quality Control	65
Inspection-based	65	Systems Approach to Management	70
Integrity	72	Teamwork	72
Internal Customer Satisfaction	74	TPM	79
Involvement of People	70	TQMEX Model	77
ISO	66	Training	72
Leadership	69	Trust	72
Mutually Beneficial Supplier Relationship	71		

Case Study

Total Quality Management at Sundaram-Clayton Ltd

Sundaram-Clayton Ltd is a member of the TVS group, one of the largest automotive components manufacturing groups in India, with total sales revenue of more than USD 2.5 billion. The group has been able to achieve success through its commitment to the cherished values of promoting trust, value and customer service.

The Company

Sundaram-Clayton has two divisions, namely Brakes Division and Die Casting Division. SCL-Brakes Division commenced its operations in 1962 at Chennai in collaboration with Clayton Dewandre Holdings Limited, UK (now part of WABCO Automotive group). SCL's Brakes Division pioneered the manufacture of air and air-assisted braking actuation system products. A market leader since inception, SCL's Brakes division develops and manufactures products for a wide range of commercial and off-highway vehicles.

SCL's Understanding of TQM

TQM is a company-wide effort aimed at continuous quality improvement of all processes, products and services through total employee involvement that results in increasing customer satisfaction, loyalty and improved business results.

It is an approach focusing on breakthrough improvements in selected areas identified strategically and continuous improvement in other critical areas. Appropriate training, discipline and ordering of things—the mantra of Japanese quality covering the breadth and depth of processes, enable the building of a system of excellence. Such a process doesn't give birth to extraordinary people but brings out extraordinary results from ordinary people.

TQM at Sundaram-Clayton

A TQM journey at Sundaram-Clayton involves the identification of critical problems, finding their solutions, standardization and passing it on for control and further improvement. Such a model is applicable to all cultures and countries. Leadership builds culture in an organization and culture builds the next generation of leaders. This ensures that there are quality leaders in the pipeline, which is the concept of sustainable leadership.

During the days when the Indian commercial vehicle industry was stagnant, Sundaram Clayton's fortunes depended entirely on the air braking systems it supplied to commercial vehicle manufacturers. The company was solely dependent on the fortunes of that industry. Both sales and profits had seen sharp declines.

The man to machine ratio was 3:1—each machine required three workers, one to load and unload the component, another to switch-on the machine and the third to inspect the part's quality. Similarly, the plant layout was process-oriented, which resulted in the accumulation of inventories. Peer-to-peer communication was poor. And, as is usual, middle level managers along with the workers resisted change.

The company started its total quality management (TQM) processes under very difficult and strained circumstances in the late 80s. Prior to introducing TQM, Sundaram-Clayton had a traditional manufacturing layout and a hierarchical organizational structure leading to inefficiencies and waste. A series of steps, beginning with diagnosis, leading to a resolution of the strategic directions and followed by sustained communication and intensive staff "education" on the change methodology were undertaken in three phases:

- Introduction phase (1987–1990)
- Promotion phase (1990–1994)
- Deployment phase (1994–1998)

Introduction Phase (1987–1990)

The process of change was started with the aim of getting a "buy-in" from the employees. As a first step, "change seminars" were conducted for all employees, stressing the need for change.

The visible barriers were broken with a common uniform and canteen for all employees, no cabins for managers and open offices to enable easy accessibility of heads of the departments. This contributed to a change in the mindset of employees, which began viewing the management as part of the same team.

Another major initiative was related to the restructuring of the manufacturing system. The process layout gave way to product-based layouts. Manufacturing units (factories within factory) were formed, based on product groups. Workmen were trained to become multi-skilled, whereby they worked on many machines. The production managers were empowered and held accountable for quality, cost and delivery.

Promotion Phase (1990–1994)

The policy management process, which commenced at SCL between 1990 and 1991, helped create company-wide goal congruence. The annual targets of the company were deployed to various departments and individuals. Guidelines were provided towards achieving company objectives highlighting broad strategies that needed to be followed by all. Each department aligned its objectives and action plans towards achieving the company objectives. As a part of TQM implementation, the company-wide quality assurance system was executed. The culture of quality by inspection was gradually changed to quality control and quality assurance (QA). Focus was placed on ownership of quality by the manufacturing units, supplier quality improvements and the *gemba* audit concept.

Deployment Phase (1994–1998)

During this phase, management of daily work, i.e. defining and monitoring key processes, ensuring that they met set targets, detecting abnormalities and preventing their recurrence were strengthened. Continuous improvement in all aspects of work, using total employee involvement, became the norm.

According to Venu Srinivasan, CEO of Sundaram-Clayton, it was in between 1995 and 1996 that the Brakes Division began experiencing the positive effects of TQM in terms of its market share, profit and sales index, sales per employee, value added per employee. Even suggestions from employees for improvements went up from two per employee per annum between 1997 and 1998 to 38 in the last fiscal.

For Discussion

1. What made Sundaram-Clayton use the TQM philosophy?
2. What was the approach chosen by Sundaram-Clayton to come out of the strained circumstances?
3. Discuss the TQM journey of Sundaram-Clayton.
4. What was SCL's understanding of TQM?
5. What was the impact of TQM on the company?

Short-answer Questions

1. What are the four main stages in the development of TQM?
2. List the five pillars of TQM.
3. Mention the eight key elements of TQM.

4. What are the seven phases in the development of TQM?
5. Mention the key principles of TQM.
6. Differentiate between a TQM organization and a traditional organization.
7. Define TQM.
8. Differentiate between conventional quality and total quality.

Match the Following

- | | |
|----------------------|------------------------|
| a. TQM | Conceptual model |
| b. TQMEX | Prevention |
| c. Inspection | Quality as a strategy |
| d. Quality control | Detection |
| e. Quality assurance | Maintaining status quo |

Discussion Questions

1. Outline the emergence of the TQM movement.
2. Illustrate the principles of TQM with examples.
3. Explain the benefits derived from TQM with examples.
4. What are the prerequisites of TQM? Discuss the barriers in implementing the TQM programme.

Projects

1. Examine the annual reports of a company of your choice over a period of five years. Summarize how quality is discussed or implied in the company's statements and philosophy. Trace the journey of TQM in the company.
2. Examine your experiences at a post office or other government agencies and describe your perception of the quality of the service. Suggest some TQM approaches that might help the agency to improve.

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4

Leadership and Strategic Planning



QUALITY LEADER VENU SRINIVASAN

Venu Srinivasan, the grandson of the TVS Group's founder, Sundaram Iyengar, completed his engineering in College of Engineering Guindy, Anna University, Chennai and his master's degree in engineering from Purdue University, USA. He took over the TVS group in 1979 with a commitment to achieve robust systems and value systems of excellence and, to instill greater levels of quality into the business. Even though TVS was a family-owned business, he considered the organization more important than the owners. In 2002, he became the chairman and managing director of Sundaram Clayton group, which includes TVS Motor Company.

During the 1980s, when the company was experiencing slow growth, he steered the ship through choppy waters and turned the company around by settling labour unrest, better machinery, new technology, etc. Srinivasan was a pioneer in the field of quality management in India by starting quality movement at TVS. He implemented the total quality management (TQM) approach in 1980s at a time when people did not have a clear idea about the same.

His passion and belief in TQM was so strong that he installed better and more efficient processes at TVS. Regardless of the field they work in, TVS companies are known for their unwavering commitment to quality. In 1998, Sundaram Clayton's brakes divisions won the Deming Prize for 'distinctive performance improvement through application of

company-wide quality control' and the Japanese quality medal for brake division in 2002. In 2004, TVS Motor Company won the Deming Prize and became the first two-wheeler company to bag the award. In the same year, Srinivasan's work on quality was further acknowledged with the Ishikawa-Kano award in Hong Kong. Srinivasan not only made TQM a part of the DNA in his own companies, but also led the way in creating awareness about the concept and its importance among corporate India. He is remembered as the total quality pioneer in corporate India.

"Good business leaders create a vision, passionately own a vision and relentlessly drive it till completion."

—Jack Welch

Upon completion of this chapter, you will be able to:

1. Explain leadership
2. Discuss corporate social responsibility
3. Identify vision, mission and values
4. Understand strategic quality management
5. Discuss quality culture
6. Describe change management

■ INTRODUCTION

Organizations are witnessing a lot of upheavals and changes today. Companies are challenging the ways they do business. It is imperative that organizations innovate, adapt, shift and transform themselves. Every employee needs to exhibit leadership, make decisions and act on opportunities for an organization to succeed today. While facing constant changes, what are the keys that help to keep a person and an organization on track?

Among the various roles and skills of a CEO, the most important is perhaps his ability to observe things. He should be able to sit at the periphery of his organization and observe, and then get back and act upon his observation.

■ DEFINING LEADERSHIP

Bird's-eye view:

Leadership is the ability to positively influence people and systems under one's authority to have a meaningful impact and achieve important results.

Leadership is a process by which a person influences others to accomplish an objective and directs the organization in a way that makes it more cohesive and coherent. Leaders carry out this process by applying their leadership attributes such as beliefs, values, ethics, character, knowledge and skills.

"Leadership is the capacity to translate vision into reality."

—Warren Bennis

“Leadership is the only thing that differentiates successful organizations from others over the long run.”

—Stephen Haines

“Leadership is the result of communicating value in people so clearly that they come see it in themselves.”

—Stephen R. Covey

“Leadership is all about the courage to dream big.”

—N. R. Narayana Murthy

“Invisible leadership is exercising the vision to change the traditional role from commander to coach, from manager to mentor, from director to delegator and from one who demands respect to one who facilitates self-respect.”

—A. P. J. Abdul Kalam

■ QUALITY LEADERSHIP

The five primary traits of a successful leader are as follows¹:

1. **Leaders create vision:** One aspect common to all leaders is vision. Good leaders create a vision, passionately own it and relentlessly drive it till completion. Vision determines the direction of change in an organization and in the individual. It helps manage change in the organization. Organizational leadership plays a key role in developing vision and in inspiring and committing employees to it. Leaders should develop strategic planning in order to realise the vision.
2. **Leaders build teams:** Dynamic leaders know how to build groups into teams. They lead team building activities, help individuals understand the team process, and gather resources. They empower team members to share leadership. Leaders set the stage for success of the team and help them attain objectives by providing information and a positive atmosphere. When other team members have the skill and knowledge to take the lead, leaders become followers. The idea of synergy in teamwork, where the whole is more than the sum of its parts, is a key concept in TQM where it is used to promote collaboration, consensus, creative conflict and team winning.
3. **Leaders are role models:** At all levels leaders need to be conscious of the fact that they are role models for quality. They should “walk the talk” and stick to the values. The very best TQM programmes build in a system of feedback so that leaders get an idea about their performance as role models for quality.
4. **Leaders take decisions:** Leaders should ensure that the decisions made have merit and are framed within a scheduled time period. These decisions should be based on facts and figures.
5. **Leaders inspire:** An inspirational leader takes a workforce beyond compliance and into an environment where employees embrace and believe in the vision, want to achieve it, live the culture and seek to go beyond set targets.

 **Bird's-eye view:**
Effective leadership requires five core leadership skills: vision, team building, role model, taking decisions and value congruence.

■ LEADERSHIP FUNCTIONS²

1. Transactional functions
2. Transformational functions

■ 1. Transactional Functions

Leaders have an obligation to get things done, ensure achievement of targets and maximize efficiency and effectiveness of various groups. These can be achieved by paying attention to the following aspects:

- Policy making
- Planning
- Developing systems
- Monitoring performance
- Coordinating
- Rewarding
- Coaching

■ 2. Transformational Functions

Transactional functions are primarily concerned with the achievement of tasks. Transformational functions go beyond the immediate task and build individuals and groups and enable them to achieve targets that the organization or individual would never have expected. These functions empower various groups and individuals and enhance the organization's power as a whole. The following functions fall in this category:

- Creating and modeling a vision
- Setting standards
- Building culture and climate
- Boundary management
- Synergizing
- Searching and nurturing talent

A transformational leader brings about cultural change by “leading the organization toward a new, broader view of the world.” What distinguishes these “transformational” leaders from others is their use of symbolic management to relieve the anxiety that makes employees cling to irrelevant strategies of the culture. The key to their success is their passionate commitment to a new vision of the organization’s future and their ability to share that vision with all employees. While we cannot all become transformational leaders overnight, the good news is that managers can now learn and practise the skills that have enabled them to bring about change.

■ VISIONARY LEADERSHIP³

Bird's-eye view:

Visionary leaders not only position their organisations to make the most impending changes, they attempt to influence those changes by causing rather than merely reacting to them.

Visionary leaders work boldly with imagination and insight and are the builders of a new dawn. They present a challenge that brings the best out of people and binds them together around a shared sense of purpose. They work empowered by their intentions and an alignment with a higher purpose. Their eyes are firmly set on the horizon, not just on the target near at hand. They are social innovators and agents of change who see the big picture and think strategically.

There is a profound interconnectedness between the leader and the whole, and true visionary leaders serve the good of the whole. They recognize that there is some truth on

both sides of most polarized issues in our society today. They search for solutions that transcend the usual adversarial approaches and address the causal level of problems. They address the systemic root causes of problems to create real breakthroughs.

J. R. D. Tata built the Tata group from a small industrial shed in a remote area of Jamshedpur. He single-handedly created the most trusted and widely respected Tata business empire. He also contributed to the growth of aeronautics in India and was the first visionary leader who initiated aviation in India.

Dr Abdul Kalam, the previous president of India and a visionary leader, created a vision for this country after Mahatma Gandhi and termed it—Vision 2020, India, a developed nation.

Organizational leadership plays a key role in developing a vision, and inspiring and committing employees to it. Generally, vision is associated with the top leadership. Being at the helm of affairs, a CEO tends to have a holistic perspective of both the external business environment and the internal organizational environment, which then provides him with the information and insight to dream about the organization's future. Not all leaders are visionaries, but most visionaries can be great leaders. For example, great visionaries such as Mahatma Gandhi and Martin Luther King were inspiring leaders.

The following are the characteristics of a visionary leader:

- Have a strong concern and a guiding purpose. In other words, an overreaching vision.
- Be committed to the vision and its realisation, which is evidenced by thoughts and deeds and the ability to translate the vision into acceptable forms of action.
- Be creative and able enough to generate a number of ideas while encouraging others to do so, thereby integrating different ideas into constructive activity.
- Be an effective and meaningful communicator of the vision and motivate others to participate in its realisation.
- Be cognizant of the expectations and motives of people and seek ways of integrating them with the organization's futuristic goals while creating an environment in which people are receptive to new ideas.
- Be willing to examine the vision from time to time in the perspective of changes in the external environment and ensure continued support from everyone involved.
- Be unafraid of failure and take risks after a careful consideration of the consequences.
- Be willing to empower employees to be creative and to experiment without undue fear of punishment or failure.

 **Bird's-eye view:**
Senior leadership of an organization should set direction, create clear vision, inculcate customer focus, nurture values and set clear expectations to motivate employees and suppliers.

■ SIX NATURAL LEVELS OF LEADERSHIP COMPETENCIES

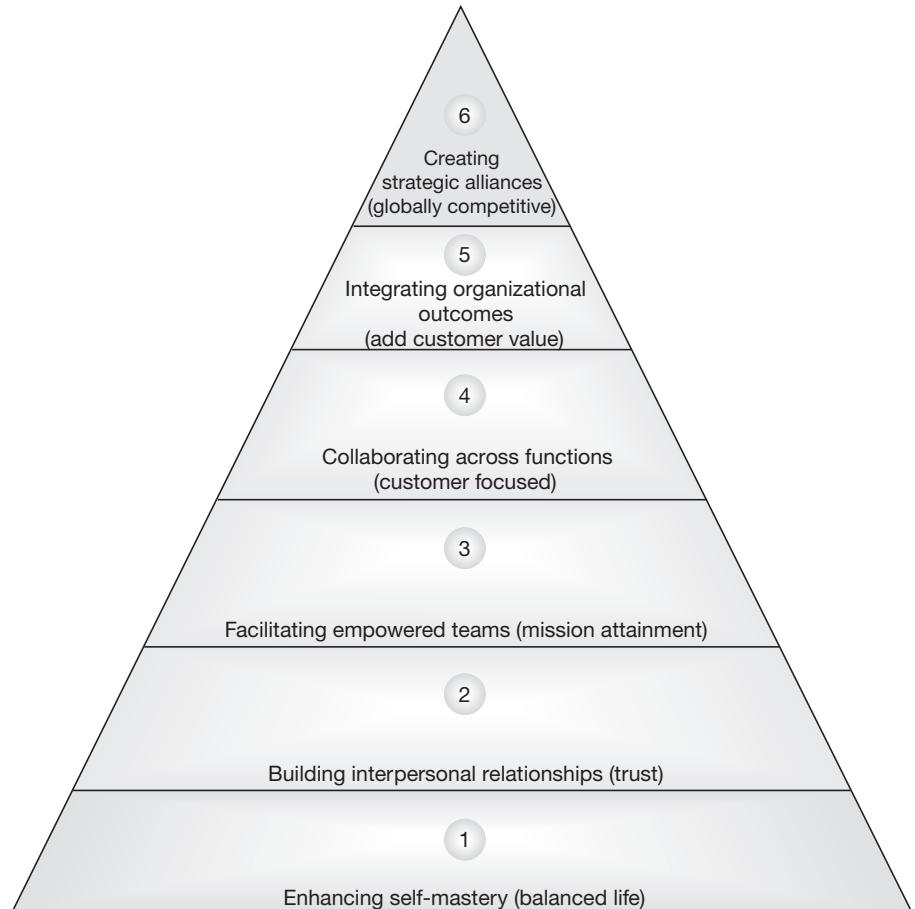
The six natural levels of leadership⁴ competencies (each having five skills) with a total of 30 skills are based on the science of systems thinking, which has been described as “the natural way the world works.” This is shown in Figure 4.1. These levels are:

■ Basic Leadership Competency Levels

Level 1: Enhancing self-mastery (My desire to grow and develop): Awareness of the self and a desire for self-mastery as a way to lead a balanced life (the outcome).

The five skills of level 1 are (a) goal setting, (b) integrating the development of “me” as a person, (c) acting with conscious intent, (d) being ethical and consistent or authentic with “my” character and (e) being accurate in “my” self-awareness.

 **Bird's-eye view:**
It is critically important that **leadership** and senior management demonstrates their commitment and involvement through their actions for the success of TQM.

Fig. 4.1 The Six Natural Levels of Leadership Competencies

Level 2: Building interpersonal relationships (My reputation for integrity): Desire for a reputation of integrity leading to trusted interpersonal relationships.

The five skills of level 2 are (a) caring and respect, (b) effectively and actively communicating, (c) monitoring, coaching and improving performance, (d) managing conflict and (e) being innovative, creative and passionate.

Bird's-eye view:

Effective governance and leadership is key if companies are to integrate sustainability into their operations for the long term.

Level 3: Facilitating empowered teams (My desire for teamwork with others): Awareness of and comfortable with being dependent on team members in order to attain team goals.

The five skills of level 3 are (a) practicing participative management, (b) facilitating groups, (c) delegating and empowering, (d) training and communicating and (e) building effective teams.

■ Advanced Leadership Competency Levels

Level 4: Collaborating across functions (My desire for serving others): Valuing service, diversity and serving others as a way to collaborate more effectively towards common customer-focused objectives.

The five skills of level 4 are (a) installing cross-functional teams and task forces, (b) integrating business processes, (c) institutionalizing systems thinking and learning, (d) valuing and serving others and (e) managing people processes.

Level 5: Integrating organizational outcomes (My understanding and agreement with the organization's vision, values and strategies): Believe in and desire for shared vision, values, and core strategies to cascade and integrate through the organization as a key, organization-wide effort to add customer value.

The five skills of level 5 are (a) organizing effectively, (b) mastering and implementing strategic communications, (c) cascading of planning and accountability, (d) leading cultural change and transformation and (e) organizing and designing.

Level 6: Creating strategic alliances or positioning (My desire for influence and collaboration with others): Desire to collaborate with and influence others in a synergetic way to define and achieve a winning strategy in the globally competitive market place.

The five skills of level 6 are (a) scanning the global environment, (b) strategic planning, (c) networking and managing alliances, (d) positioning the organization in the marketplace and (e) being effective internationally.

Box 4.1 discusses how leaders are developed at Infosys Technologies.

DISCUSSION FORUM

1. Define leadership and describe the functions of leadership.
2. Name the eight principles of visionary leadership.
3. Discuss the six natural levels of leadership.

■ CORPORATE SOCIAL RESPONSIBILITY⁵

Corporate social responsibility has much broader implications for the nation as a whole. Reduced dependency on the government for social change is the biggest implication. Most governmental programmes quickly become embroiled in political manipulation, corruption, communal overtones and bitter infighting. There is a need for public-private partnership with well-defined controls and processes for the best use of resources for initiating social change. Social reforms driven by the community brings people together, turn the attention of the masses to tasks that benefit society and reinforce peace and harmony.

Corporate social responsibility is about tradition and culture. Firms can institutionalize voluntary participation among employees through appropriate incentives and recognition. Internal performance evaluation of employees could recognize, for example, community work. Community work can take many forms such as teaching in government schools, supporting NGOs financially, empowering women, cleaning parks, planting trees, volunteering in orphanages and protecting the abused. Many corporations allow employees to write about their community service as part of their annual evaluation report. Even if companies do not reward community activities, at least, the idea that the company cares has a positive impact.

The role of corporations by and large has been understood in terms of a commercial business paradigm of thinking that focuses purely on economic parameters of success. As corporations have been regarded as institutions that cater to the market demand by providing

Bird's-eye view:

CSR relates to the responsibilities that corporations have towards the society within which they are based and operate in.

Box 4.1 Leadership at Infosys

The Infosys Leadership Institute (ILI) was established in early 2001 to help promising Infosysians develop into good leaders. The leadership programme is aimed at accelerating learning for those with high potential. The personal development plan is a three-to-five year time frame with at least three developmental change objectives, which prepares a person for the next role. Infosys aims at responding to the following specific challenges:

- To help people manage the phenomenal growth of the company
- To make the employees of Infosys ready for the complexities of the market and the dynamic external environment
- To create greater customer value through “thought leadership”

At Infosys, leadership is regarded as a journey and it begins with the selection of employees with high potential. The top management identifies a pool of candidates on the basis of their past performance. They are also assessed for leadership potential. Each high-potential employee has an ILI faculty assigned to him. The faculty members guide these employees by developing personal development plans (PDPs) and action plans for employees. Most high-potential employees are trained in one or more leadership skills. The duration of this training is three years and helps high-potential employees to develop into effective leaders. Infosys employs the “nine pillar” model of leadership development. This model was developed after a careful analysis of the processes followed by 18 highly successful global corporations. Each pillar in the model has a unique relevance to the development of an individual’s leadership competencies. The nine pillars in this model are (1) 360-degree feedback, (2) Development assignments, (3) Infosys culture workshops, (4) Developmental relationships, (5) Leadership skills training, (6) Feedback intensive programmes, (7) Systemic process learning, (8) Action learning and (9) Community empathy.

Source: Adapted from www.infosys.com, accessed February 2016.

products and services, and having the onus for creating wealth and jobs, their market position has traditionally been a function of financial performance and profitability.

However, over the past few years, as a consequence of rising globalization and pressing ecological issues, the perception of the role of corporations in the broader societal context within which it operates has been systematically altered.

Stakeholders (employees, community, suppliers and shareholders) today are redefining the role of corporations taking into account the latter’s broader responsibility towards society and environment, beyond economic performance, and are evaluating whether they are conducting their role in an ethical and socially responsible manner.

As a result of this shift (from purely economic to “economic with an added social dimension”), many forums, institutions and corporations are endorsing the term corporate social responsibility (CSR). They use the term to define an organization’s commitment to society and the environment within which it operates. The World Business Council on Sustainable Development (WBCSD) published a report titled Corporate Social Responsibility: Making Good Business Sense and the OECD Guidelines for Multi-National Enterprises, which includes a discussion on how CSR is emerging as a global business standard. Further, there is a global effort towards reinforcing CSR programmes and initiatives through local and international schemes that try to identify best-in-class performers.

**Bird's-eye view:**

Corporate social responsibility (CSR, also called corporate conscience, corporate citizenship or responsible business) is a form of corporate self-regulation integrated into a business model.

■ CSR—A Historical Perspective⁶

The concept of CSR in India is not new, though the term may be. The process has been followed since ancient times albeit informally. Philosophers like Kautilya from India and

pre-Christian era philosophers in the West preached and promoted ethical principles while doing business. The concept of helping the poor and the disadvantaged was cited in much of the ancient literature.

The idea was also supported by several religions whose texts have intertwined it with religious laws. *Zakaat*, followed by Muslims, is a donation from one's earnings, which is specifically given to the poor and the disadvantaged. Similarly, Hindus follow the principle of *Dharmada* and Sikhs the *Daashaant*.

In the global context, the history of the concept can be traced back to the eighteenth century when in the 1790s, England witnessed the first large-scale consumer boycott over the issue of slave-harvested sugar, which finally forced importers to have free-labour sourcing.

In India, in the pre-independence era, the businesses which pioneered industrialization along with fighting for independence also followed the same idea.

They put the idea into action by setting up charitable foundations, educational and healthcare institutions and trusts for community development. The donations either monetary or in kind were sporadic activities of charity or philanthropy that were taken out of personal savings, which neither belonged to the shareholders nor did it constitute an integral part of business.

The term CSR itself came into common use in the early 1970s although it was seldom abbreviated. By the late 1990s, the concept was fully recognized; people and institutions across all sections of society started supporting it. This can be corroborated by the fact that while in 1977 less than half of the *Fortune 500* firms even mentioned CSR in their annual reports, by the end of 1990, approximately 90 per cent *Fortune 500* firms embraced CSR as an essential element in their organizational goals, and actively promoted their CSR activities in annual reports.

According to "Altered Images: The 2001 State of Corporate Responsibility in India Poll," a survey conducted by Tata Energy Research Institute (TERI), the evolution of CSR in India has undergone a chronological evolution of four thinking approaches:

Ethical model (1930–1950s): One significant aspect of this model is the promotion of "trusteeship" that was revived and reinterpreted by Gandhiji. Under this notion, businesses were motivated to manage their business entities as a trust held in the interest of the community. The idea prompted many family run businesses to contribute towards socio-economic development. The efforts of the Tata group in particular were directed towards the well being of the society and so were in keeping with this model.

Statist model (1950–1970s): Under the aegis of Jawaharlal Nehru, this model came into being in the post-independence era. The era was driven by a mixed and socialist kind of economy. The important feature of this model was that state ownership and legal requirements decided corporate responsibilities.

Liberal model (1970–1990s): The model was encapsulated by Milton Friedman. As per this model, corporate responsibility was confined to its economic bottom line. This implied that it was sufficient for businesses to obey the law and generate wealth, which through taxation and private charitable choices could be directed to social ends.

Stakeholder model (1990s–present): This model came into existence during the 1990s as a consequence of the realisation that with growing economic profits, businesses also have certain societal roles to fulfill. The model expects companies to perform according to the "triple bottom line" approach. Businesses today are also focusing on accountability and transparency through several mechanisms.

Bird's-eye view:

CSR is about how companies manage the business processes to produce an overall positive impact on society.

■ Concept of CSR⁷

Today, CSR has become a world-wide concept whereby organizations consider the interests of society by taking responsibility for the impact of their activities on customers, employees, shareholders, communities and the environment in all aspects of their operations. It is one of the most important global issues with serious challenges and implications in almost all sectors. Surging economies, including India, are coping with issues related to poverty, child rights, community welfare, etc. and are a hotbed for an innovative CSR scenario which is still shaping up.

Although the concept of CSR has been developing since the early 1970s, there is no single, commonly accepted definition for it. Some examples of CSR definitions are provided below.

“CSR is defined as operating a business in a manner that meets or exceeds the ethical, legal, commercial and public expectations that society has of business. CSR is seen by leadership companies as more than a collection of discrete practices or occasional gestures, or initiatives motivated by marketing, public relations or other business benefits. Rather, it is viewed as a comprehensive set of policies, practices and programmes that are integrated throughout business operations, and decision-making processes that are supported and rewarded by top management.”

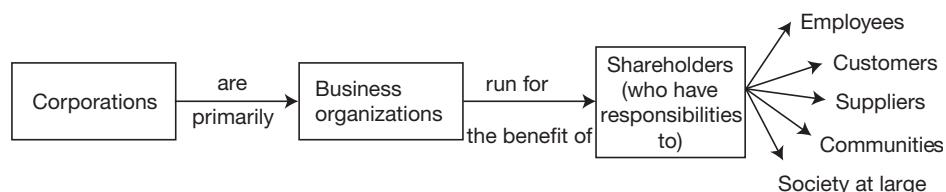
From the 1980s down to 2000, corporations generally recognized a responsibility to society and weighed against the demands of being competitive in a rapidly changing global economy. The social responsibility of corporations cannot be understood without an examination of the nature of corporations and their objectives as shown in Figure 4.2.

■ Defining CSR

The totality of CSR can be best understood by three words—“corporate,” “social” and “responsibility.” In broad terms, CSR relates to the responsibilities that corporations have towards the society within which they are based and from where they operate. This does not deny the fact that the purview of CSR goes much beyond this. CSR is comprehended differently by different people. Some perceive it to be a commitment of a company to manage its various roles in society, as producer, employer, customer and citizen in a responsible manner while for others it is synonymous with Corporate Responsibility (CR) or Corporate Citizenship or Social Action Programme (SAP). Of late, the term has also been linked with Triple Bottom Line Reporting (TBL), which essentially measures an enterprise’s performance against economic, social and environmental indicators.

Discourses on CSR suggest that many definitions of CSR exist within the business community, and CSR continues to evolve with no single definition that is universally accepted. Given below are some key definitions that have garnered wide acceptance and favour business circles.

Fig. 4.2 Corporations and its Objectives



Definition 1: Philip Kotler and Nancy Lee define CSR as “a commitment to improve community well-being through discretionary business practices and contributions of corporate resources” whereas Mallen Baker refers to CSR as “a way companies manage the business processes to produce an overall positive impact on society.”

Definition 2: According to the World Business Council for Sustainable Development, CSR is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large.”

Definition 3: Archie Carroll⁸ describes CSR as a multi-layered concept that can be differentiated into four interrelated aspects—economic, legal, ethical and philanthropic responsibilities. Carroll presents these different responsibilities as consecutive layers within a pyramid, such that “true” social responsibility requires the meeting of all four levels. This model probably is the most accepted and established and is shown in Figure 4.3.

Definition 4: According to CSR Wire, “CSR is a public movement, which has gained more momentum as citizens demand corporations to be accountable for their impacts. Consumers, investors and employees alike are recognizing the power held by corporations and efforts are being made on several levels to create global change with the hope that earth will become a better place.”

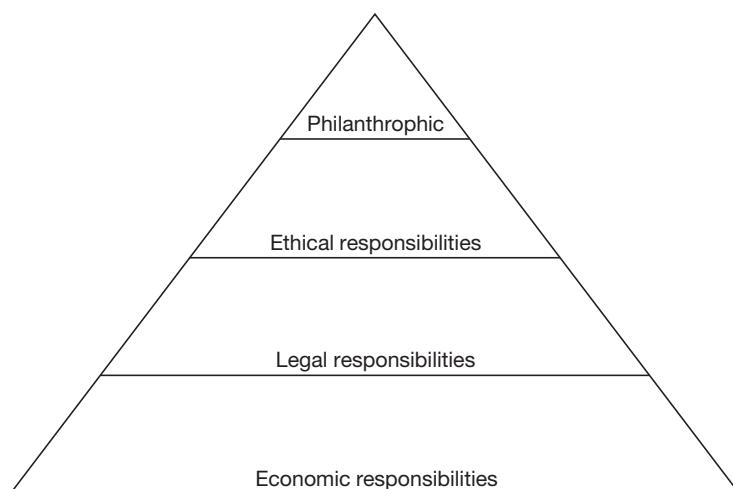
Definition 5: According to the European Union, “CSR is the concept that an enterprise is accountable for its impact on all relevant stakeholders. It is the continuing commitment by business to behave fairly and responsibly and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large.”

Definition 6: According to Ethics in Action, “CSR is a term describing a company’s obligation to be accountable to all of its stakeholders in all its operations and activities. Socially responsible companies consider the full scope of their impact on communities and the environment when making decisions, balancing the needs of stakeholders with their need to make a profit.”

 **Bird's-eye view:**

CSR may also be referred to as “corporate citizenship” and can involve incurring short-term costs that do not provide an immediate financial benefit to the company, but instead promote positive social and environmental change.

Fig. 4.3 CSR Model



Definition 7: According to Micheal Hopkins⁹, “CSR is concerned with treating the stakeholders of the firm ethically or in a socially responsible manner. Stakeholders exist both within a firm and outside. Consequently, behaving socially responsibly will increase the human development of stakeholders both within and outside the corporation.”

While the definitions of CSR may differ, there is an emerging consensus on some common principles that underline CSR:

Bird's-eye view:

The World Bank defines **Corporate Social Responsibility (CSR)** as “the commitment of businesses to contribute to sustainable economic development by working with employees, their families, the local community and society at large to improve their lives in ways that are good for business and for development”.

1. **CSR is a business imperative:** Whether pursued as a voluntary corporate initiative or for legal compliance reasons, CSR will achieve its intended objectives only if businesses truly believe that CSR is beneficial to them.
2. **CSR is a link to sustainable development:** Businesses feel that there is a need to integrate social, economic and environmental impact in their operations. CSR embodies the commitment of businesses to contribute to sustainable development, commonly understood as being the ability of the current generation to meet its needs without compromising the ability of future generations to meet theirs.
3. **CSR is a way to manage business:** CSR is not an optional add-on to business, but it is about the way in which businesses are managed. It is a collection of policies and practices linked to relationships with key stakeholders, values, compliance with legal requirements, respect for people, communities and the environment.
4. **Corporate citizenship:** Corporate citizenship, which is based on the concept of the corporation as a citizen, is also frequently used (sometimes interchangeably) while referring to CSR. According to this definition, the four key principles that define the essence of corporate citizenship are (i) minimize harm, (ii) maximize benefit, (iii) be accountable and responsive to key stakeholders and (iv) support strong financial results.

The interpretation of CSR influences the dialogue between governments, private sector and civil society. This results in different implications among various parties regarding the legitimacy, obligations and impact of corporate social responsibility standards. For example, one has to be careful in understanding and defining the term CSR because it is sometimes erroneously equated with either corporate philanthropy or simply compliance with law. Since the mid-1990s the business sector has gradually engaged in many actions, which have been traditionally assigned to the sphere of responsibility of the government, yet due to the latter's incapacity, businesses have taken the lead. Participation in such projects has revealed the business sector to be a strategic partner in the process of development working in close cooperation with the government and international institutions.

■ Components of Corporate Social Responsibility¹⁰

The concept of CSR is constantly evolving. The triple bottomline approach to CSR emphasizes a company's commitment to operating in an economically, socially and environmentally sustainable manner. The emerging concept of CSR goes beyond charity and requires the company to act beyond its legal obligations and to integrate social, environmental and ethical concerns into its business process. Though, there is no universal definition of CSR, there is a common understanding that it is concerned with how the profits are made and how they are used by the company, keeping in mind the interests of all stakeholders. The emerging concept of CSR advocates moving away from a “shareholder alone” focus to a “multi-stakeholder” focus. This would include investors, business partners, employees, regulators,

supply chain, customers, local communities, the environment and society at large. Therefore, the key components of CSR would include the following:

Business ethics: Business ethics mainly relates to value-based and ethical business practices. It defines how a company integrates core values such as trust, integrity and honesty into its policies, practices, procedures and decision making. It also involves a company's compliance with legal standards, adherence to internal rules and regulations.

Corporate governance: A good corporate governance policy would enable the company to realise its corporate objectives, protect shareholder rights, comply with legal requirements, ensure accountability and create transparency for all stakeholders.

Workplace and labour relations: Good CSR practices relating to workplace and labour relations can help in improving the workplace by providing safety, good employee relations and a healthy work-life balance. This would enable recruitment of people and make employees stay longer, thereby reducing the cost of employee turnover.

Good business practices: Some of the good business practices, which reflect the CSR initiatives of a company are equal opportunity employer, diversity of workforce including differently abled people, codes of conduct, employing local talent, battling sexual harassment at workplace, etc.

Customers: Today, customer satisfaction and loyalty does not depend only on the cost and quality of products produced. It also depends on how the company has produced the goods and services considering the social, environmental, supply chain and other such aspects.

Supply chain: Extending the CSR initiatives across the supply chain would have a positive impact on all stakeholders and improve the image of the company in the marketplace.

Community: A community-focused CSR strategy positively impacts the lives of people. The involvement of the community through deploying community projects improves the brand image of the company.

Environment: CSR initiatives go beyond meeting statutory and regulatory requirements. Some of the CSR strategies with respect to the environment may include finding sustainable solutions for natural resources, reducing adverse impacts on the environment, reducing pollutants or emissions and producing environment friendly goods and services.

■ Issues of Social Responsibility for Various Stakeholder Groups¹¹

The various stakeholders of a corporate entity are employees, the society, the government, customers and local communities. The social responsibility issues relating to each of the stakeholders is given below, which can be discussed under the following heads:

1. Society:

- (a) Corporate governance: Role of the Board of Directors, stockholders and employees.
- (b) Environment: Air/water/solid waste/visual pollution/chemical pesticides, noise, odours, exploitation of resources.

Bird's-eye view:

Corporate Social Responsibility has many benefits that can be applied to any business, in any region, and at a minimal cost.

Bird's-eye view:

The main benefits are: Improved financial performance, Enhanced brand image & reputation, Increased sales and customer loyalty, Increased ability to attract & retain employees, Reduced regulatory oversight and Easier access to capital.

2. **Employees:** Discrimination at the workplace (on the basis of race, colour, sex, religion, national origin and sexual preference), affirmative action, reverse discrimination, employees' right to freedom of speech, right to due process, right to privacy, right to safety, etc.
3. **Governments:** Complying with statutory and regulatory requirements, influencing governmental processes, lobbying, donations, improving business–government relations, etc.
4. **Customers:** Customer protection rights, product information on deceptive, misleading advertising, packaging, warranties or guarantees, product safety and quality.
5. **Local communities:** Charitable contributions and community involvement, community development, job training, volunteerism, working with local governments, impact on the environment due to hazards and issues listed under the heading "society".

■ Benefits of CSR¹²

"Companies are now recognizing that dealing with environment and social issues can provide business benefits when reputational risk is high and sustainable competitiveness and development becomes a key strategy."

—Susan Ariel Aaronson, Senior Fellow, National Policy Association

Bird's-eye view:

When an organization builds **ethical and social elements** in its operating philosophy and integrate them in its business model, it is said to have possessed a self-regulating mechanism that guides, monitor and ensure its adherence to law, ethics, and norms in carrying out business activities that ensures the serving the interest of all external and internal stakeholders.

Companies invest in CSR activities because they derive significant benefits from those activities. CSR activities help companies build their reputations, make the environment less vindictive, reduce litigation and attract talent. Additionally, companies that invest in CSR activities develop a good understanding of social culture and dynamics and identify social changes earlier than companies that are not involved in CSR activities. Visionary companies identify social undercurrents and latent social needs and often convert them into business opportunities. CSR is a very potent tool for managing reputational risks. Some of the benefits of CSR initiatives to corporations are mentioned below:

1. **Stakeholder model:** CSR is qualitatively different from the traditional concept of corporate philanthropy. In the traditional paradigm, most corporate bodies viewed CSR as the extension of a financial input for a humanitarian cause. The contemporary context is more complex. A company that undertakes activities aimed at communities but does not comply with business basics cannot be termed socially responsible. The emerging perspective on CSR focuses on responsibility towards the stakeholders (shareholders, employees, management, consumers and community) rather than on maximization of profit for shareholders. There is also more stress on long-term sustainability of business and environment and the distribution of well-being. This model enables engagement of stakeholders in the business and improves the quality of life resulting in an enhanced image of the company in the market.
2. **Sustainable competitiveness:** The triple bottom line theory encompassing three aspects, people, planet and profit is being increasingly recognized. The triple bottom line stresses the fact that the stakeholders in a business are not just the company's shareholders and corporate profits need to be analysed in conjunction with social prosperity, sustainable development and economic sustainability. To remain competitive, companies should undertake CSR initiatives to meet the expectations of stakeholders. The impact of CSR initiatives on sustainable competitiveness can result in enhancing reputations and brands, more efficient

operations, improved financial performance, increased sales and consumer loyalty, increased ability to attract and retain quality employees.

3. Creating new business opportunities: Transparency in operations and two-way communication with the stakeholders not only improves the company's reputation but also opens up new business opportunities. Integrating the corporate strategy with CSR strategies enables the organization to explore future challenges and opportunities. The experience gained through addressing CSR challenges also provide opportunities for companies, through consulting services, to sell their know-how to other companies.

4. Attracting and retaining quality investors and business partners: Sound CSR practices help companies attract and retain quality investors and business partners. The benefits that may be derived from CSR initiatives are increased shareholder value, lower cost of capital, access to socially responsible investment funds and reducing risks by bringing best practices to business partners across the supply chain.

5. Cooperation with local communities: The company's success depends on CSR practices that are designed as a response to the needs of the local communities within which it operates. This also enables the company to design community projects to improve the well-being of the people and engage the employees in the community projects. Cooperation with the local communities helps the company's long-term sustainability. This in turn improves the image of the company in the community.

6. Avoiding crisis due to CSR misconduct: Ignoring CSR practices can be very costly because the company might lose its reputation, market share and stock price. With the code of conduct in force, human actions are relatively in greater harmony with nature. Reputational risk should be considered as a set of threats that affect the long-term trust placed in the organization by its stakeholders. This includes risks not only to products, but goes beyond to the company itself and then on to the whole industry.

The best known brands and big companies are the first targets for CSR misconduct, and the consequences are potentially huge in terms of lost market share or market capitalization. A damaged reputation might require years to rebuild and may cost a large sum of money.

7. Support from the government and various agencies: The government gives financial incentives for sound CSR projects, including environmentally friendly and innovative undertakings. Companies that demonstrate engagement in such practices that satisfy and go beyond statutory and regulatory compliance requirements are less scrutinized and given a comparatively free hand by international, national and local government entities and other agencies. Box 4.2 provides an example of the benefits of CSR initiatives at Indian Tobacco Company (ITC).

8. Building political capital: Addressing CSR issues provides a chance to build political capital to improve the relationship with the government, political leaders and officials, to influence regulations, to reshape public institutions on which the company depends and to improve public image.

9. Ethical companies do better financially: A 1997 DePaul University study found that companies with a defined corporate commitment to ethical principles do better financially (based on annual sale/revenue) than companies that do not. A recent longitudinal Harvard University study found that stakeholder-balanced companies showed four times the

Bird's-eye view:

An important aspect of the **leadership system** is governance, which refers to the system of management and controls exercised in the stewardship of an organization.

Bird's-eye view:

Practicing **good citizenship** refers to leadership and support – within the limits of an organisation's resources – of publicly important purposes, including improving education, community health, environmental excellence, resource conservation, community service, and professional practices.

 **Bird's-eye view:**

A **strategy** is a pattern or plan that integrates an organisation's major goals, policies, and action sequences into a cohesive whole.

 **Bird's-eye view:**

A well formulated strategy helps to marshal and allocate an organisation's resources into a unique and viable posture based on its relative internal competencies and shortcomings, anticipated changes in the environment, and contingent moves by intelligent opponents.

growth rate and eight times the employment growth when compared to companies that are shareholder-only focused. A study by the University of Southwestern Louisiana on "The effect of published reports of unethical conduct on stock prices" showed that publicity about unethical corporate behaviour lowers stock prices for a minimum of six months.

DISCUSSION FORUM

1. Define CSR and trace its evolution in India.
2. Explain the main components of CSR.
3. What is corporate citizenship?
4. Discuss CSR issues for various stakeholders.
5. Describe the benefits of CSR.

■ STRATEGIC QUALITY MANAGEMENT

"Organizations are successful, not because of the hundred and one good little actions they take to save money on paper clips and telephone calls, but because of one or two major strategies that are brilliant."

—Dr Michael J. Kami

Box 4.2 ITC's Corporate Social Responsibility Initiatives

 **Bird's-eye view:**

Strategic Quality Management (SQM) is a structured process for establishing long-range quality goals, at the highest levels of the organisation and defining the means to be used to reach these goals.

Established in 1910, Indian Tobacco Company Limited (ITC) is an Indian conglomerate headquartered in Kolkata, West Bengal. Its diversified business includes five segments—fast-moving consumer goods (FMCG), hotels, paperboards and packaging, agribusiness, and information technology. The company has been able to generate sustainable livelihood opportunities for millions of people through its corporate social responsibility (CSR) initiatives. ITC has also achieved the unique global distinction of being carbon-positive, water-positive, and solid recycling positive for several years.

The biggest reason for ITC's CSR success is due to the major sustainability initiatives that have been wedged to the company's core business, either providing an input source for a business or backward integration. ITC's e-choupal initiative is designed to make the power of the Internet available to Indian farmers. The e-choupal initiative, led by the agribusiness division, is a market-led business model and has the potential to enhance the competitiveness of Indian agriculture and trigger a virtual cycle of higher productivity, higher incomes, enlarged capacity for farmer risk management, larger investments, and higher quality and productivity.

ITC is the first Indian company and among the first 10 companies in the world to publish its sustainability report in compliance (at the highest A+ level) **with the latest G3 guidelines** at the Netherlands-based Global Reporting Initiative (GRI), a UN-backed, multi-stakeholder international initiative to develop and disseminate globally applicable sustainability reporting guidelines. ITC won the 'Corporate Social Responsibility Award 2004' from the Tata Energy and Research Institute (TERI) for its e-choupal initiative. The curriculum of the Harvard Business School now includes a case study on ITC's e-choupal movement and the ways in which it is transforming Indian agriculture.

Source: Adapted from www.itcportal.com/rural development/echoupal.htm, accessed February 2016.

Strategy is the game plan or the course of action that moves a business in the desired direction. Strategy is one step in a logical continuum that moves an organization from a high-level mission statement to the work performed by front-line and back-office employees. The objective of strategic planning is to achieve a sustainable competitive advantage that will deliver healthy profits. Broadly, any strategy should be feasible considering internal and external constraints; lead to a long-term competitive advantage; add value for stakeholders; be sustainable in the long-term and be adaptable to cope with a changing environment.

The Strategy Process

The company must engage in strategic planning that clearly defines the objectives and assesses both internal and external situations to formulate strategies, implement them, evaluate the progress and make adjustments as necessary to stay on track. A simplified view of the strategic planning process is shown in Figure 4.4. A step-by-step approach of the strategic planning process is discussed below:

1. **Environmental scanning:** This includes internal and external analysis of the firm, along with an industry analysis, which is an important part of the strategic planning process. Environmental factors internal to the firm are strength (S) and weakness (W). Environmental factors external to the firm are opportunities (O) and threats (T). Such an analysis of the strategic environment is referred to as a SWOT analysis. The SWOT analysis provides information that is helpful in matching the firm's resources and capabilities to the competitive environment in which it operates. As such, it is instrumental in strategy formulation and selection.

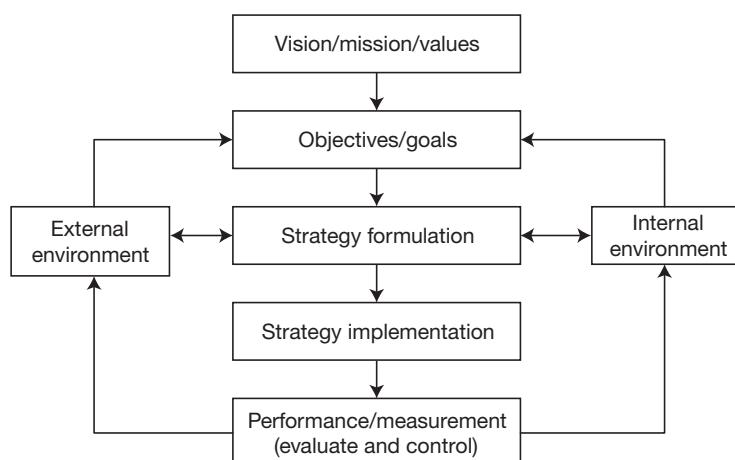
An industry analysis can be performed using a framework developed by Michael Porter known as Porter's Five Forces. This framework evaluates entry barriers, suppliers, customers, substitute products and industry rivalry. Environmental scanning involves looking beyond the organization to its customers and suppliers and industry trends for information on what is important to them. Involving the internal customers, the employees, is also an important part of the process.

2. **Vision, mission and values:** Vision is a tool in the form of a statement that tells us what the organization wants to do in the future. Creating this image requires the ability to

 **Bird's-eye view:**

The **mission** of a firm defines its reason for existence; it answers the question "Why are we in business"?

Fig. 4.4 The Strategy Process



expand one's sense of possibilities and then, focus on what new initiatives can lead to success. Mission is the core purpose for which a person, team or organization is created. It is summarized in a clear, short, inspiring statement that focuses attention in one clear direction by stating the purpose of the individual's, business's or group's uniqueness. Values are the principles, standards and actions that people in an organization represent, which they consider inherently worthwhile and of the utmost importance.

3. **Objectives and goals:** The mission statement describes the company's business vision, including the unchanging values and purpose of the firm and the forward-looking visionary goals that guide the pursuit of future opportunities. Guided by the business vision, the firm's leaders can define measurable financial and strategic objectives. Financial objectives involve measures such as sales targets and growth in earnings. Strategic objectives are related to the firm's business position, and may include measures such as market share and reputation. Goals are general statements about what one needs to accomplish to meet one's purpose, or mission and address major issues facing the organization.
4. **Strategy formulation:** Given the information from the environmental scan, the firm now tries to match its strengths to the opportunities that it has identified, while addressing its weaknesses and external threats. To attain superior profitability, the firm seeks to develop a competitive advantage over its rivals.
5. **Strategy implementation:** The selected strategy is implemented by means of programmes, budgets, and procedures. Implementation involves organization of the firm's resources and motivation of the staff to achieve objectives.
6. **Performance and measurement (evaluation and control):** The implementation of the strategy must be monitored and adjustments made as needed. Measurement consists of defining parameters to be measured, defining target values for those parameters, performing measurements, comparing measured results with the pre-defined standard and making the necessary changes.
7. **Strategic quality management:** This is a structured process for establishing long-range quality goals, at the highest levels of the organization and defining the means to be used to reach these goals. The concept of Strategic Quality Management (SQM) includes strategic planning, strategy development and strategy deployment. SQM is developed, deployed and led by the top management.¹³ It has been defined as "the process by which quality management activities focus towards the long-range direction and progress of quality enhancement strategies by ensuring the careful formulation through strategic quality planning, proper implementation through vital quality strategies and continuous evaluation through quality improvement and control."¹⁴

SQM has also been defined as "a comprehensive and strategic framework linking profitability, business objectives, and competitiveness to quality improvement efforts with the aim of harnessing the human, material and information resources organization wide in continuously improving products or services that will allow the delivery of customer satisfaction."¹⁵

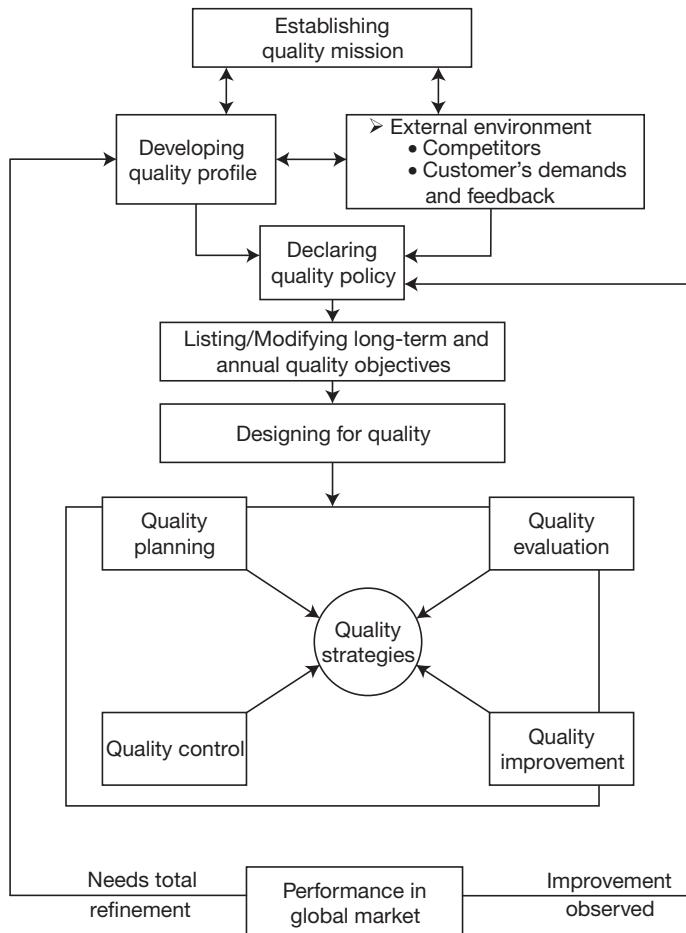
The purpose of SQM includes establishing guidelines for the action to be taken in order to reach the quality goals. The major tool for establishing such guidelines are "quality policies". Policy refers to a guide to managerial action. Published policy statements are the result of a good deal of deliberation, followed by approval at the highest level.

■ Five Phases of SQM

The fundamental nature of SQM is to ensure a continuous assessment of internal and external changes with regard to quality, and an adjustment of the competitive approach based on

Bird's-eye view:

The **vision** describes where the organization is headed and what it intends to be; it is a statement of the future that would not happen by itself.

Fig. 4.5 Five Phases of SQM

the assessment. Based on this concept, P. Aravindacm, S. R. Devadasan and V. Selladurai¹⁴ have identified five phases of SQM. This is depicted in Figure 4.5 and is explained as follows.

Phase I defines the beginning of SQM, during which the quality mission of the firm is established with the involvement of the manufacturer.

Phase II passes through the development of quality profiles keeping in mind the quality mission and external environment comprising customers' and competitors' perceptions. The quality policy is declared at the end of this phase.

Phase III is devoted to listing or modifying long-term and annual quality objectives also termed goals or targets.

Phase IV witnesses efforts made to infuse quality at the design stage.

Phase V constitutes the development of the SQM system, which signifies the whole process of SQM. The results obtained after this phase are compared with the desired performance at the global level. The outcome of this comparison determines the need for further

Bird's-eye view:
Values, or guiding principles, guide the journey to a vision by defining attitudes and policies for all employees, which are reinforced through conscious and subconscious behaviour at all levels of the organisation.

 **Bird's-eye view:**

Strategies are broad statements that set the direction for the organisation to take in realizing its mission and vision.

 **Bird's-eye view:**

Strategic objectives are what an organization must change or improve to remain or become competitive.

 **Bird's-eye view:**

Action Plans are things that an organization must do to achieve its strategic objectives.

 **Bird's-eye view:**

Strategy is a plan devised to achieve well defined goals.

Box 4.3 Tata Motors Quality Statements

Vision: Most admired by our customers, employees, business partners, and shareholders for the experience and value they enjoy from being with us.

Mission: To be passionate in anticipating and providing the best vehicles and experiences that excite our customers globally.

Culture

- Accountability
- Speed
- Customer and product focus
- Excellence

Values

- Inclusion
- Integrity
- Accountability
- Customer
- Concern for environment
- Innovation
- Passion for excellence
- Agility

Quality Policy: Tata Motors is committed to maximizing customer satisfaction and strives to achieve the goal of excellence by continual improvement through ongoing design development, manufacture, and sale of reliable, safe, cost-effective, quality products and services of international standards, by using environmentally sustainable technologies for improving the level of efficiency and productivity within its plant and ancillaries.

Tata Motors also has a commitment towards improving the quality of life of its employees, both within and outside its plants and offices, through improved work practices and social welfare schemes.

Source: www.tatamotors.com/investors/financials/70-ar.../mission-vision.html, accessed in March 2016.

refinement of the SQM process being followed presently. The practices followed during phases I to III are analogous to that of modern strategic management. Box 4.3 discusses the quality management policy of SAP.

■ Hoshin Kanri: The Japanese SQM Model¹⁶

The term “hoshin” is often used in place of “hoshin kanri.” The Japanese translation of “hoshin kanri” is as follows:

“Ho” means method.

“Shin” means shiny metal showing direction.

“Kanri” means planning.

Therefore, “hoshin kanri” means “focusing management and control of the firm in the right direction.” “Hoshin kanri” is a detailed action-oriented planning approach to align everyone in an organization to common goals, issues and priorities by translating corporate strategy into measurable and actionable objectives for all the functions at all the hierarchical levels of the organization.

The *hoshin* process is a systematic planning methodology for defining long-range key entity objectives. These are breakthrough objectives that typically extend from two to five years with little change. Second, the *hoshin* process does not lose sight of the day-to-day “business fundamental” measures required to run the business successfully. This two-pronged approach provides an extended period of time for the organization to focus its breakthrough effort while continuously improving key business processes day-to-day.

The hoshin methodology: In the *hoshin* process, strategic planning is systematized. The formats for the plans are unified by standards. Standardization provides a structured approach for developing and producing the organization’s strategic plan. The structure and standards also enable an efficient linkage of the strategic plan with the organization. This ultimately leads to an organization-wide understanding of not just the plan but also the planning process.

This also holds true for the methodology used to review and track the plan’s progress. This built-in standardization enables the organization to evaluate decisions made by the organization’s leaders and to gauge the effectiveness of selected strategies. Since the review process emphasizes not only results but also how decisions are reached, the organization can identify successful decision-making methods and practices. The review methodology is essentially a built-in benchmarking process for the organization’s decision-making. As an additional benefit, the review methodology can help identify areas of opportunity for the future. These opportunities can be used to modify failing strategies or point to the next *hoshin* objective to be pursued. This identifies the next mission to be accomplished as the organization strives for the vision. These opportunities for the future, coupled with the benchmarking aspect of the review methodology, are the vehicles for organizational learning at all levels.

The *hoshin* methodology provides:

- Breakthrough objective focus
- Development of plans that adequately support the objective
- Review of progress of these plans
- Changes to plans as required
- Continuous improvement of key business processes
- A vehicle for organizational learning

Hoshin ensures that everyone in the organization is working toward the same end. The plan is hierarchical, cascading down through the organization and to key business-process owners. Ownership of the supporting strategies is clearly identified with measures at the appropriate level or process owners within the organization.

The entire organization gets aligned towards the pursuit of business objectives so that a real synergy and its effect can be felt. It means the business objectives of the workers and operators of the company are the same as that of the top management of the company. All employees in the organization understand the strategic plans, mid-term plans and daily operational plans and are in a position to derive goals for their own benefit from the plan. They also know how each strategic goal fits into their own daily activities, affecting the overall organizational achievements.

Since the activities of the people throughout the company remain aligned with the key objectives, a company practising *hoshin kanri* can quickly respond to environmental pressures such as competition, new entrants, technology, dearth of resources, etc.

The *hoshin* process fits under the umbrella management philosophy of total quality management. The plan–do–study–act (PDSA) process improvement cycle enters repeatedly in the plan’s development, implementation and review.

Bird’s-eye view:

Strategy deployment refers to developing detailed action plans, defining resource requirements and performance measures, and aligning work unit, supplier, or partner plans with overall strategic objectives.

Bird’s-eye view:

Hoshin Kanri is the Japanese model for SQM. In the **hoshin process**, strategic planning is systematized. The format of the plans is unified standards. The standardization provides a structured approach for developing and producing the organisation’s strategic plan.

Using the PDSA cycle in strategic planning ensures that:

- Plans are developed more systematically.
- Progress on plans is carefully monitored.
- Changes to plans are made where necessary.
- Breakthrough objectives are attained.
- The planning process itself is standardized.
- The planning process is continuously improved.
- Organizational learning occurs.

The *hoshin* process, which has evolved somewhat since its inception, was first used at Hewlett-Packard in 1976 at YHP, the company's subsidiary in Japan. The Japanese words *hoshin kanri* can be generally interpreted as direction (setting) management for the entity. The words *nichijo kanri* can be interpreted as daily (fundamental) management for the entity. The blending of these two methods is the key to the success of the *hoshin* process.

The basic premise behind the *hoshin* plan is that the best way to obtain the desired result is to ensure that all employees in the organization understand the long-range direction and work according to a linked plan to make the vision a reality. The blending of these two methods is the key to the success of the *hoshin* process.

The process includes:

- Identifying critical business issues facing the organization.
- Establishing business objectives to address these issues.
- Setting overall goals.
- Developing supporting strategies.
- Determining goals for each strategy.
- Establishing process performance measures.
- Establishing business fundamental measures.

The review of the plan's progress follows the PDSA cycle, and it applies to all levels of leadership within the organization. In the *hoshin* process, there are two kinds of planned organizational activities—breakthrough activities and business fundamentals or key process-monitoring activities, also known as the business fundamentals table.

The organization should have a clear statement of purpose. In other words, it should examine the added value that customers receive via the products or services offered. Also necessary is a long-range vision—where is the organization headed in the next five to seven years?

The *hoshin* planning process is a very effective strategic planning process that follows the PDSA improvement cycle. For *hoshin* to succeed, the organization must undergo an effective analysis from the standpoints of both business fundamentals and strategic planning. These analyses provide inputs for the plan. In addition, they recognize that breakthrough activities can only occur when the Business Fundamental Table (BFT) is in reasonable control. The organization should make sure to identify critical business issues and select an objective and goal to overcome the issue. To develop a complete plan and to guide the organization, the organization must identify supporting strategies with measures and owners.

To implement the plan, the organization should take several steps. A detailed Annual Planning Table (APT) at all levels provides guidance along with linkage and drives the implementation plans. Assigning clear responsibility for each item in the implementation plan is equally crucial.

Bird's-eye view:

The basic premise behind the ***hoshin* plan** is that the best way to obtain the desired result is to ensure that all employees in the organization understand the long-range direction and work according to a linked plan to make the vision a reality.

Since significant projects usually require both intra-process and inter-process cooperation, develop plans in a cross-functional, cross-departmental and cross-process manner. Extensive discussions within and between departments and process owners are vital to the success of the overall plan.

After the plans have been finalized and rolled out, continually monitor each strategy's progress using the established strategic goal. Highlight any deviations from the plan on the review tables, which also record actions taken based on results. A strategy is completed when the strategic goal is obtained. Finally, summarize the PDSA cycle for the year in the annual review table.

The *hoshin* planning process helps an organization learn from both the problems solved and the business successes. This is fundamental to building a learning organization. *Hoshin* enables an organization to collect and study performance information about itself from both day-to-day and long-term measures. Lastly, it helps the organization think about where it is headed and the best way to get there, with both hands on the wheel.

■ BALANCED SCORECARD¹⁷

A new approach to strategic management was developed in the early 1990s by Drs Robert Kaplan (Harvard Business School) and David Norton. They named this system the "balanced scorecard." Recognizing some of the weaknesses and vagueness of previous management approaches, the balanced scorecard approach provides a clear prescription as to what companies should measure in order to "balance" the financial perspective.

The balanced scorecard is a management system (and not just a measurement system) that enables organizations to clarify their vision and strategy and translate them into action. It provides feedback around both the internal business processes and external outcomes in order to continuously improve strategic performance and results. When fully deployed, the balanced scorecard transforms strategic planning from an academic exercise into the nerve centre of an enterprise. Kaplan and Norton describe the innovation of the balanced scorecard as follows:

"The balanced scorecard retains traditional financial measures. But financial measures tell the story of past events, an adequate story for industrial age companies for which investments in long-term capabilities and customer relationships were not critical for success. These financial measures are inadequate, however, for guiding and evaluating the journey that information age companies must make to create future value through investment in customers, suppliers, employees, processes, technology and innovation."

The balanced scorecard suggests that we view the organization from four perspectives, and to develop metrics, collect data and analyse it relative to each of these perspectives as is shown in Figure 4.6. The four perspectives are:

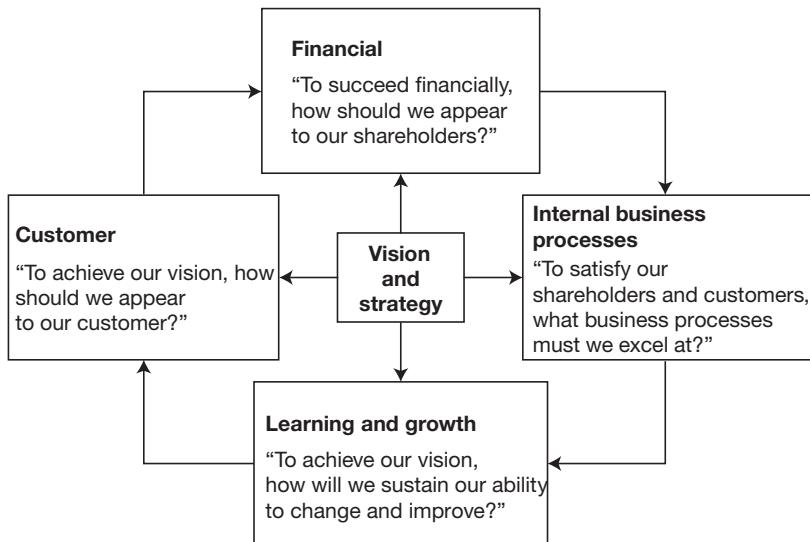
- The learning and growth perspective
- The business process perspective
- The customer perspective
- The financial perspective

■ The Learning and Growth Perspective

This perspective includes employee training and corporate cultural attitudes related to both individual and corporate self-improvement. In a knowledge-worker organization, people

Bird's-eye view:

The **balanced scorecard** is a management system (and not just a measurement system) that enables organizations to clarify their vision and strategy and translate them into action.

Fig. 4.6 Four Perspectives of Balanced Scorecard

■ Bird's-eye view:

The balanced scorecard suggests that we view the organization from four perspectives, and to develop metrics, collect data and analyse it relative to each of these perspectives. The four perspectives are:

- The learning and growth perspective
- The business process perspective
- The customer perspective
- The financial perspective

are the main resources. In the current climate of rapid technological change, it is becoming necessary for knowledge-workers to be in continuous learning mode. Government agencies often find themselves unable to hire new technical workers, and simultaneously, there seems to be a decline in the training of existing employees. This is a leading indicator of "brain drain" that must be reversed. Metrics can be put into place to guide managers in focusing training funds where they can help the most. In any case, learning and growth constitute the essential foundation for success of any knowledge-worker organization.

■ The Business Process Perspective

This perspective refers to internal business processes. Metrics based on this perspective allow managers to know how well their business is running, and whether its products and services conform to customer requirements (the mission). These metrics have to be carefully designed by those who know these processes most intimately, with unique missions that cannot be developed by external consultants.

In addition to the strategic management process, two kinds of business processes may be identified: (a) mission-oriented processes and (b) support processes. Mission-oriented processes are the special functions of government offices, and many unique problems are encountered in these processes. The support processes are more repetitive in nature and; hence, easier to measure and benchmark using generic metrics.

■ The Customer Perspective

Recent management philosophy has shown an increasing realisation of the importance of customer focus and customer satisfaction in any business. If customers are not satisfied, they will eventually find other suppliers who will meet their needs. Poor performance from this perspective is thus a leading indicator of future decline, even though the current financial picture may look good.

In developing metrics for satisfaction, customers should be analysed in terms of the kinds of customers and the kinds of processes for which a product or service is provided to those customer groups.

■ The Financial Perspective

Kaplan and Norton do not disregard the traditional need for financial data. Timely and accurate funding data will always be a priority, and managers will do whatever necessary to provide it. In fact, often there is more than enough handling and processing of financial data. With the implementation of a corporate database, it is hoped that more of the processing can be centralized and automated. However, the point is that the current emphasis on financials leads to the “unbalanced” situation with regard to other perspectives.

There is perhaps a need to include additional financial-related data, such as risk assessment and cost-benefit data, in this category. Box 4.4 provides information regarding Tata Motors, which was recipient of the prestigious Balanced Scorecard Collaborative Hall of Fame Award.

■ Benefits of Balanced Scorecard

The benefits of balanced scorecard are as follows:

- Translation of strategy into measurable parameters
- Communication of the strategy to everybody in the firm
- Alignment of individual goals with the firm's strategic objectives—the BSC recognizes that the selected measures influence the behaviour of employees
- Feedback of implementation results to the strategic planning process

Bird's-eye view:

The balanced scorecard is a set of financial and non-financial measures regarding a company's success factors.

DISCUSSION FORUM

1. Discuss strategic quality management (SQM).
2. Explain the five phases of SQM.
3. Describe Hoshin Kanri.
4. Explain balanced scorecard.

Bird's-eye view:

Balance scorecard reflects the essence of the organization's value-creating activities. While originally adopted by large organizations, it applies to organizations of any size or sector.

■ QUALITY CULTURE

Quality culture refers to an incorporation of quality in the overall system of an organization leading to a positive internal environment and the creation of delighted customers. A changed mindset at all levels of management is the basic tool for implementation of such a culture. The process of initiating quality culture starts with managers who understand the value of the systems view and also believe in its implications. This is achieved either through self-realisation at the top level or through trainings and workshops or following the stipulations laid down by the benchmark organizations.

■ Five Stages of Quality Culture¹⁸

Quality culture differs from company to company. In some companies this is very rudimentary, while in others it is well developed. According to Sandholm, there are five stages of quality culture.

Box 4.4 Tata Motors Awarded the Prestigious Balanced Scorecard Collaborative Hall of Fame Award

Tata Motors, India's largest automobile manufacturer, became the first Indian company to be inducted into the Balance Scorecard Hall of Fame, thus joining the 30-member elite club of organizations including Hilton Hotels, BMW Financial Services, US Army, Korea Telecom, Norwegian Air Force and the city of Brisbane for achieving excellence in company performance. The Commercial Vehicles Business Division of the company achieved a significant turnaround in its overall performance after it implemented the concept of balanced scorecard in its operations. It was also able to bring about transparency and alignment by implementing defining, cascading and communicating strategies. The scorecard incorporates SQDCM (Safety, Quality, Delivery, Cost and Morale) and VMCDR (Volume, Market Share, Customer Satisfaction, Dealer Satisfaction and Receivables).

While receiving the coveted Steuben crystal "Rising Star," Mr Ravi Kant, Executive Director, CVBU, Tata Motors, said, "While we were conscious of the benefits of the balanced scorecard when we began implementing it three years back, we are extremely pleased that it has helped us achieve significant improvements in our overall performance. I am quite positive that the BSC will play an important part in our objective to become a world-class organization."

Thousands of organizations worldwide have reaped enormous benefits from implementing the balanced scorecard (BSC) concept, which puts strategy at the centre of the management process, allowing organizations to implement strategies rapidly and reliably.

Source: Adapted from www.tatamotors.com, accessed February 2016.

Stage 1: Dormant stage: In this stage, there is no evident interest in becoming involved in quality or anything related to quality. This is the stage that the Indian domestic industry was in, particularly the public sector enterprises, during the License Raj. A similar situation was faced by the Western industries until around 1980.

Stage 2: Awakening stage: During this stage, a certain amount of competition develops in the industry. The Indian industry found itself in this scenario during the 1990s post liberalization. In the global markets, Japanese products began to compete with and perform better than Western products, which ushered in the awakening stage for industry in the West.

Stage 3: Groping stage: As the term suggests, this stage is one where very few managers at the top know exactly how to introduce quality into their activities. There is a culture of relying on trendy methods and approaches.

Stage 4: Action stage: During this stage, a strategic plan is conceived for the development of quality initiatives followed by their implementation.

Stage 5: Maturity stage: This stage is witness to quality being built into the system with a clear focus on customers. It is integrated into everything that is done in the organization.

■ Building Quality Culture¹⁹

Building a quality culture is no easy task. Developing a focus on quality seems very easy. However, organizations need to spend a lot of time, effort and money to achieve the goal. What is needed is to focus attention on the aspects described as follows:

- 1. Initiate quality:** When trying to initiate quality or make any improvements, one starts with gap analysis in terms of finding out where the organization is placed currently, what it wants

👁 Bird's-eye view:

Quality culture is a set of group values that guide how improvements are made to everyday working practices and consequent outputs.

👁 Bird's-eye view:

A quality culture is an organizational value system that results in an environment that is conducive to the establishment and continual improvement of Quality.

to achieve and finding out the gap. Though the organization may be very small, there will be some good points, which should be retained or enhanced further. After finding the gaps, lay down a plan to conquer these gaps. One will need to develop organization-wide quality standards. To do this, one will need to study what suits the organization and then apply the right balance. The model one selects should match the company's vision and corporate policy. There are many international models available, for example, ISO, CMM, CMMI, Six Sigma, etc.

2. Quality commitment: Commitment from the senior management is a must. In fact, it is the driving force. It has been observed that either the senior management allocates the budget for such activities and forgets about it or the senior management behaves in an autocratic way.

Neither results in successful implementation of quality processes. Procedures, tools and database are all useless if the senior management does not want to implement a quality culture in the organization. It is also going to fail if the management only wants a certification from a specific quality standard. Even if the certification is acquired, there is no guarantee that it will be practised. The employees of the organization may be indifferent to the whole process, and this coupled with a disinterested senior management may spell disaster for the organization.

3. Capabilities and maturity: Capability refers to having the skills to undertake work successfully. Maturity refers to the corporate understanding of why quality is important, and the provision of support for quality initiatives.

As is true with any successful implementation, you need the right blend of teams and capable people in it to execute these processes. Capabilities are needed in terms of skill sets and maturity. Skills without maturity cannot sustain the hurdles. People in quality groups are required to be highly mature and capable in terms of understanding quality. Only then can they lay down the plan, execute the plan and expect others to follow the plan.

There will be a need to raise and enhance the basic knowledge, understanding and maturity for each and every member of the organization. For this purpose, organization-wide training should be arranged. The experienced trainer should impart training that will convince the staff of the need to support quality initiatives. Effectiveness of training can be measured by mock interviews, quizzes, etc. This will ensure that people in the organization are on the same page when they are dealing with quality.

4. Motivation: However hard you try to bring change within the organization, it will turn to failure if its people are not motivated. Not all people are self-motivated. Therefore, the senior management and the quality groups need to provide a sufficient amount of motivation to push things. Budget cannot be a constraint for motivation. However, a certain amount of enforcement is also required to push the changes through the system. There should be a right mix of both.

5. Institutionalization: Training, group discussions, sharing of knowledge are some points that are essential to bring about change. Motivation, exchange of ideas, and quality awareness forums are critical to institutionalize the change.

Success will be achieved only if the importance of the change is understood at the lowest level. Many a time, knowledge flows horizontally whereas it is preferable to have the knowledge flow from top to bottom, i.e. vertically.

The quality assurance group should keep a check on all groups including the quality and senior management teams. As they come out with their findings, they need to share them with all other groups. This will help to bring out the best practices across the groups and teams.



Bird's-eye view:

Quality culture starts with leadership that understands and believes the implications of the systems view and knows the necessity of serving customers in order to succeed.

6. Focus groups: One of the right ways for the quality group to spread knowledge is to create focus groups and teams to carry out the activities related to quality. This will help in building the quality culture and consolidating it. In addition, people working in these groups will feel more involved and will be able to contribute to the quality efforts at the organizational level. The types of focus groups existing within the quality system are explained below.

1. Process improvement teams
2. Process review teams
3. Technology improvement teams
4. Knowledge transfer teams
5. Quality assurance teams (responsible for conducting audits)

The functions of these teams are explained by their names. However, responsibilities should be assigned without any ambiguity. The focus teams and the quality groups should meet regularly to track and coordinate their progress.

7. Automated tools: Automated tools can help ease the burden of implementing quality processes and standards. The organization that institutionalizes the tools used either for quality or any phase of the development lifecycle benefits greatly through the innovation and consistency in delivering the solution.

Bird's-eye view:

Management has an obligation to create an effective and sustainable quality culture.

Bird's-eye view:

Quality professionals, however, have a significant responsibility to help the organization accomplish this goal. Achieving this goal is challenging but not extremely difficult. It requires a sound philosophy supported by some basic beliefs.

■ CHANGE MANAGEMENT: LEADING THE CHANGE TO QUALITY CULTURE

Great leaders transform cultures and stimulate breakthroughs. It is vital to have a good number of them on one's side as champions of the renewal process.

There are various proactive steps one can take to move the organization's culture toward one based on quality values. To do that, one first must understand the utility of doing this. Then one can begin to work with others in the company to develop one's own articulation of values along with policies and procedures that are consistent with them. These can cover such areas as the implementation of teams, the development of open-door policies for communication and regular company meetings to keep everybody informed about the happenings in the organization.

Every organization needs to change with time, failing which, it stands the risk of being pushed into oblivion and being labeled as obsolete by the more enterprising competitors in the market. Change could be effected in the overall policy and procedure, in the infrastructure, in the structuring of staff, etc. Whatever the parameter being touched, one will surely face a challenge while implementing it. One will encounter resistance, which may be due to the apprehension of the unknown or could just be an internal inertia. To implement successful change, as a manager, one needs an overall leadership force that is greater than the combined force of resistance. One needs to use one's leadership skills to address the resistance. Change encompasses many aspects and forms, includes many concepts and due to the dynamics and consequences included, unleashes many varied responses from leaders, managers and the workforce in and around organizations.

There are many handbooks containing theories, models and blueprints about organizational change, strategic change, management and organizational development at large companies, mergers, acquisitions, outsourcing, downsizing, streamlining, restructuring, re-engineering, creating a new organizational landscape and architecture, transformation, transition, revolution, creating the winning organization, etc. This is almost old hat with most managers in any established organization. It is however important to take careful note

of some aspects pertaining to organizational changes before we focus on what we believe should be factored in any strategy for organizational change.

Change management is the process of developing a planned approach to change in an organization. Typically, the objective is to maximize the collective benefits for all people involved in the change and minimize the risk of failure in implementing the change. The discipline of change management deals primarily with the human aspect of change, and is therefore related to pure and industrial psychology.

■ Forces of Change²⁰

External and internal forces affect change management.

External forces: The external forces effecting change could be summarized as follows:

1. Demographic characteristics: This includes age, gender, race and more particularly the increase in diversity and the imperative urge to manage diversity.
2. Technological developments: Many organizations have utilized technology as a means to improve productivity and market competitiveness. Automation and computer technology are two well-known developments in this regard.
3. Market changes: The emerging global economy is a reality, which a number of companies and organizations are waking up to. This is forcing them to change the way in which they do business or the way they operate. The international demand for quality products, lower prices, after sales service, client satisfaction, etc. have forced many companies into collaborative arrangements, cooperative ventures and even alliances with former competitors.
4. Social and political pressures: Employee and public values, needs, priorities and motivation are influenced by political and social developments and events. Managers need to adjust their management styles to meet these values and needs.

Bird's-eye view:

Change management is a systematic approach to dealing with change both from the perspective of an organization and the individual.

Internal forces: Internal forces for change are operative from within the organization.

1. Human resource factors: Employee perceptions about working conditions, treatment and the alignment between individual and organizational needs are important in this regard. Progress is not possible without the commitment and dedication of employees. Therefore, stresses need to be removed, sources of conflict identified and eliminated, role conflict, overload and ambiguity need to be reduced.
2. Managerial behaviour and decisions: Excessive interpersonal conflict is often a clear sign that change is needed. Due to the important role of the manager in introducing and managing change in the organization, skills training and capacity building programmes for both managers and employees might be necessary.

■ Resistance to Change and Approaches to Deal with Resistance to Change²¹

People resist change owing to the following reasons:

1. **Lack of communication:** Change often does not take off because the people who execute it do not know what they are supposed to do. The manager has not communicated to them the detailed aspects of the change. So the workforce may only understand change in broad terms rather than its practical connotations. They may not see what they should do differently.

2. Procedure: Change may fall through because the staff does not know how it should go about it. They may lack the knowledge, skills and experience to implement the proposed change. Often, leaders may not be able to perceive the shortcomings in this area because the staff does not feel comfortable disclosing its lack of knowledge or skills. Thus, it may go about change in the wrong way as it does not possess the right skills or knowledge. With dismal results from the initial implementation of change, they may get frustrated and decide to go back to what they had been doing.

Bird's-eye view:

The forces of change are of two types – external and internal forces.

3. Goal-oriented: Another reason why the staff may resist change is because they cannot comprehend why they should undertake a specific change. They may not be convinced about the purpose of the change or they may not see the benefits of the change. Hence, they do not commit themselves to the change and cooperate to ensure its success.

Bird's-eye view:

The external forces effecting change could be: Demographic characteristics; Technological developments; Market changes; Social and political pressures.

4. Involvement of parties: Resistance may also arise if people are not clear about the participants specifically involved in the change. Too many parties involved in the change without a clear definition of their roles will only bring about confusion and frustration. It will lead to conflicts and affect the results of change programmes.

5. Proper support: Commitment to change from the top is critical. Many well-planned change programmes fail because leaders who plan the change do not provide the necessary support. Support in terms of resources, know-how, moral support and motivation is needed to ensure the smooth implementation of change. Often, one encounters teething problems along the way and; thus, continuous support is needed to ensure that the change effort stays on track.

Bird's-eye view:

The internal forces for change are operative from within the organization. They are: human resource factors and managerial behaviour and decisions.

6. Lack of courage: Change programmes often fail not because of lack of skills but because of a marked absence of courage to implement them. Managers do not create a safe environment for people to experiment or try new things. People; therefore, feel that it is risky to undertake any change.

7. Poor motivation: Poor motivation is a powerful resistance to change. There are more change programmes that failed due to the lack of motivation rather than the lack of knowledge. A clear and outright declaration on how people are going to be rewarded if they achieve successful results from change would go a long way.

To counter all these factors and implement the change successfully, as a manager one needs to create a compelling and dynamic vision to inspire people to change. The vision should incite a sense of challenge and pride for people to achieve it. It should create possibilities for a dynamic future where everyone has a stake. It should provide a clear picture of what the future will be like once this vision is achieved.

Leaders should communicate the vision of the change and its implications on a day-to-day basis for those involved in the process.

Katter and Schlesinger²² set out six change approaches to deal with this resistance: to change.

1. Education and communication: When there is a lack of information or inaccurate information and analysis, one of the best ways to overcome resistance to change is to educate people about the change effort beforehand. Up-front communication and education helps employees see the logic in the change effort, which reduces unfounded rumours concerning the effects of change in the organization.

2. Participation and involvement: When the initiators do not have all the information they need to design the change and others have considerable power to resist, then this

approach is likely to lower resistance. When employees are involved in the change effort, they are more likely to buy into change than resist it.

3. **Facilitation and support:** Where people are resisting change due to adjustment problems, managers can head-off potential resistance by being supportive of employees during such difficult times. Managerial support helps employees deal with fear and anxiety during a transition period. The basis of resistance to change is likely to be the perception that there may be some form of detrimental effect occasioned by the change in the organization. This approach looks into providing special training, counseling, time off from work, etc.
4. **Negotiation and agreement:** Where someone or some group may lose out in a change and where that individual or group has considerable power to resist, then, managers can combat resistance by offering incentives to the concerned employees so that they do not resist change. This can be done by allowing change resisters to veto elements of change that are threatening or by offering the change resisters incentives to leave the company through early buyouts or retirements to avoid having to experience the change effort. This approach will be appropriate where those resisting change are in a position of power.
5. **Manipulation and co-option:** Where other tactics will not work or are too expensive, Kotter and Schlesinger suggest that an effective manipulation technique is to co-opt with resisters. Co-option involves the patronizing gesture of bringing a person into a change management planning group for the sake of appearances rather than any substantive contribution. This often involves selecting leaders of the resisters to participate in the change effort. These leaders can be given a symbolic role in decision making without threatening the change effort. Still, if these leaders feel they are being tricked they are likely to push resistance even further than if they were never included in the change effort leadership.
6. **Explicit and implicit coercion:** This approach is used only when speed is essential. However, it needs to be used only as the last resort. Managers can explicitly or implicitly force employees into accepting change by making clear that resisting changing can lead to losing jobs, firing, transferring or not promoting employees.

The Six Change Approaches of Kotter and Schlesinger discussed above is a model to prevent, decrease or minimize resistance to change in organizations. Figure 4.7 shows how to manage change successfully in an organization. Box 4.5 provides an example of leading cultural change at Castrol.

■ Key Strategic Principles Pertaining to the Dynamics for Strategic Change²³

The following are the key strategic principles pertaining to the dynamics for strategic change:

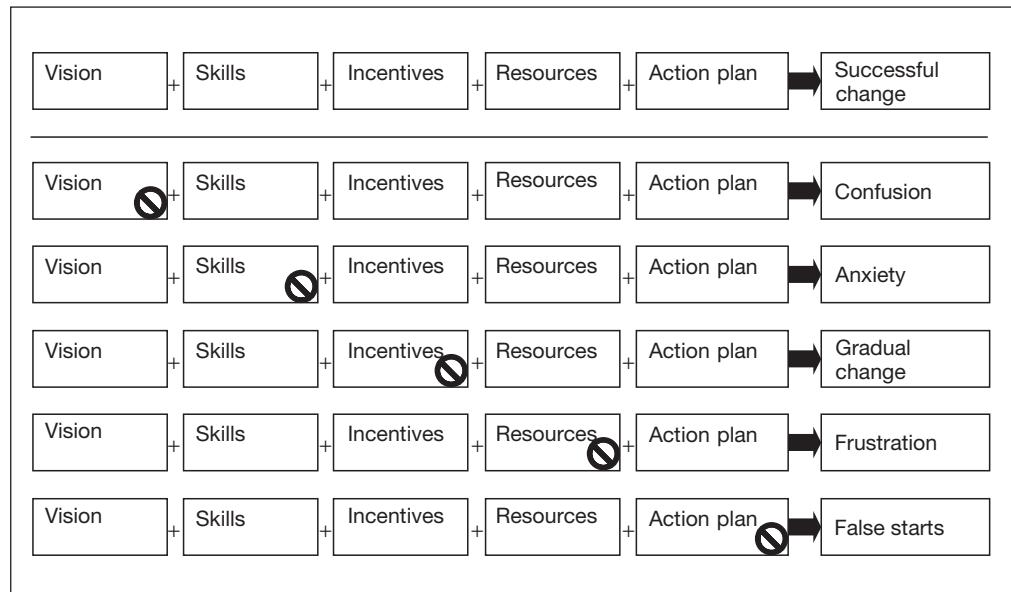
- Strategic change is the implementation of new strategies that involve substantive changes to the normal routine of the organization.
- In managing strategic change, it is useful to draw a distinction between prescriptive and emergent approaches.
- Prescriptive approaches involve the planned action necessary to achieve the changes. The changes may be imposed on those who will implement them.
- Emergent approaches involve the whole process of developing the strategy, as well as the implementation phase. This approach will also involve consultation and discussion with those who will subsequently be implementing the change.

Bird's-eye view:

People resist change for various reasons. As a manager one needs to create a compelling and dynamic vision to inspire people to change. The vision should incite a sense of challenge and pride for people to achieve it.

Bird's-eye view:

Change management is a structured approach for ensuring that changes are thoroughly and smoothly implemented, and that the lasting benefits of change are achieved.

Fig. 4.7 Managing Change**Box 4.5** Leading Cultural Change at Castrol

Naveen Kshatriya, the chief executive and managing director of Castrol India Ltd, has been at the forefront of bringing about a cultural change in the organization since he took over in May 2002. He has been striving hard to achieve a greater amount of openness and transparency and improving employee interface within the company.

Under his leadership, the company has been experimenting with new concepts such as surprise fun days during office hours on week days. The effort is to get the employees to mingle with greater spontaneity during activities besides encouraging them to give feedback about such events. Gifts and prizes are given for activities such as jokes and silly speeches. The company encourages social interaction without imposing it.

One-and-a-half years ago, the company introduced a whistle-blowing policy called "open talk" to bring into notice certain unethical practices within the organization. The objective was to give an avenue to people to express their concern and to share the information with the management, including the managing director or the chief internal auditor. Employees have the freedom to record anonymous complaints.

One of the strategies initiated by Mr Kshatriya has been to create a learning organization. An employee can choose to learn through various media such as self-learning modules on the Internet, classroom forums or individual specific programmes. The performance development plan of an employee is jointly done by the individual himself, his immediate superior and the superior of the superior, besides the HR. Anybody can nominate himself for the four-day first-level leadership programme. HR practitioners from all over the world and within the country are roped in to run the programme in a structured fashion. The philosophy is that once a person grows in an organization, one can decide on the right kind of developmental input.

Source: Adapted from www.castrol.com, accessed February 2016.

- Strategic change is concerned with people and their tasks. It is undertaken through the formal and informal structures of the organization. Understanding the pressure points for influencing change is important if such change is to be effective.
- Strategic change is important because it may involve major disruption and people may resist its consequences. Even where change is readily accepted, it will take time and careful thought. Strategic change carries important hidden costs.
- A distinction needs to be made between the pace of change, which may be fast or slow, and strategic change, which is the pro-active management of change in an organization.

DISCUSSION FORUM

1. Define quality culture.
2. Discuss the six values of quality culture.
3. Explain quality culture building in an organization.
4. Discuss the forces for change.
5. Explain the reasons for resistance to change.
6. Describe the six approaches to deal with resistance to change.
7. Explain the process of successful change deployment.

SUMMARY

- Leadership is a process by which a person influences others to accomplish an objective and directs the organization in a way that makes it more cohesive and coherent. Leaders carry out this process by applying their leadership attributes such as beliefs, values, ethics, character, knowledge and skills.
- The six natural levels of leadership competencies each having five skills are based on the science of systems thinking.
- The totality of CSR can be best understood by three words: “corporate”, “social” and “responsibility.” In broad terms, CSR relates to the responsibilities that corporations have towards the society within which they are based and operate in.
- Stakeholders (employees, community, suppliers and shareholders) today are redefining the role of corporations taking into account the broader responsibility that corporations have towards the society and environment, beyond economic performance and are evaluating whether they are conducting their role in an ethical and socially responsible manner.
- The evolution of CSR in India has followed a chronological evolution of four thinking approaches: Ethical model, statist model, liberal model and stakeholder model.
- Companies are now recognizing that dealing with environment and social issues can provide business benefits when reputational risk is high and sustainable competitiveness and development becomes a key strategy.
- Strategic quality management (SQM) is a structured process for establishing long-range quality goals, at the highest levels of the organization and defining the means to be used to reach these goals. The concept of SQM includes strategic planning, strategy development and strategy deployment. SQM is developed, deployed and led by the top management.

- “*Hoshin Kanri*” is the Japanese model for through SQM. In the *hoshin* process, strategic planning is systematized. The format of the plans is unified standards. The standardization provides a structured approach for developing and producing the organization’s strategic plan.
- An approach to strategic management was developed in the early 1990s by Drs Robert Kaplan (Harvard Business School) and David Norton. They named this system the “Balanced scorecard.” This has four perspectives—the learning and growth perspective, the business process perspective, the customer perspective and the financial perspective.
- Quality culture is basically an incorporation of quality in the overall system of an organization, which leads to a positive internal environment and the creation of delighted customers. There are six values of quality culture. There are various proactive steps one can take to move an organization’s culture toward one based on quality values.
- Change management is the process of developing a planned approach to change in an organization. Typically, the objective is to maximize the collective benefits for all people involved in the change and minimize the risk of failure of implementing the change. The discipline of change management deals primarily with the human aspect of change, and is, therefore, related to pure and industrial psychology.
- The forces of change are of two types—external and internal forces. People resist change for various reasons. Kotter and Schlesinger have developed the Six Change Approaches Model to deal with the resistance to change.

Key Terms

Balanced Scorecard	111	Liberal Model	97
Business Process Perspective	112	Mission	105
Change Management	116	Philanthropic Responsibilities	99
Corporate Social Responsibility	95	Quality Culture	113
Customer Perspective	112	Stakeholder Model	97
Economic Responsibility	99	Stakeholders	101
Ethical Model	97	Statist Model	97
Ethical Responsibility	99	Strategic Quality Management	106
Financial Perspective	113	Transactional Functions	91
<i>Hoshin Kanri</i>	122	Transformational Functions	91
Leadership	90	Values	105
Learning and Growth Perspective	111	Vision	105
Legal Responsibility	99	Visionary Leadership	92

Case Study

Corporate Social Responsibility at Amway Company

Amway is one of the world’s largest direct sales organizations with over 3 million Independent Business Owners (IBOs) in over 80 markets and territories worldwide. It is a family-owned business with a strong emphasis on family values. Its IBOs are often couples. Many of them

are raising families. They; therefore, have a strong bond with children. These families are more than happy to partner with Amway, who as part of its corporate social responsibility strategy works with the United Nations Children's Emergency Fund (UNICEF).

As a family company, Amway is committed to playing a part in improving the lives of children in need across the globe. In this way, the company is able to show its commitment to the support of global causes. Amway defines a global cause as "a social issue affecting many people around the world engaged in a struggle or plight that warrants a charitable response."

This case study shows how Amway is a business that does more than provide customers with good quality products. It shows the practical realities of Amway's global commitment and how it plays a key role in the communities in which it operates.

What Does Amway Do?

Amway was founded in Michigan, USA in 1959. Amway is a leading manufacturer of health, beauty, homecare and personal care products. In total, more than 450 different companies branded products and services are offered globally by Amway. Over 13,000 people are employed by Amway in 80 countries and territories around the world.

Amway distributes a range of branded products. These products are sold to IBOs worldwide. The IBOs are Amway's links with consumers and the communities in which they operate. The IBOs are self-employed and are highly motivated. They work within the guidelines of Amway's Rules of Conduct and Code of Ethics, which are about being honest and responsible in trading. IBOs sell to people that they know or meet. They can introduce others to the Amway business.

Typical products that IBOs sell include:

- Personal care—fragrances, body care
- Skin care and cosmetics
- Durables—cookware and water treatment systems
- Nutrition and wellness products—food supplements, food and drinks

IBOs play a key part in helping Amway to deliver its Global Cause Programme.

UNICEF

The United Nations Children's Fund (UNICEF) is the world's leading organization working specifically for children. UNICEF works with local communities and governments in 155 countries to provide emergency relief and long-term development programmes in areas such as health, education and child protection. All UNICEF programmes are entirely dependent on voluntary organizations. UNICEF provides assistance for the world's poorest children by raising funds through UNICEF programmes and advocating change on their behalf.

Amway and UNICEF

One effective model for CSR is when a company partners itself with a charity or humanitarian organization. Joint enterprises of this type are helpful in building the reputation of a company while supporting its partner. Amway's support to UNICEF is an example of socially responsible partnerships that illustrates how companies can make a difference in the world.

In 2001, Amway decided to support UNICEF as a major part of its CSR strategy called One by One. Since then, Amway, its staff and IBOs have been raising money for UNICEF across 25 European countries. Amway has pledged long-term funding focus and commitment. In 2005, Amway raised more than €320,000 in response to the Asian tsunami disaster. Amway launched the global One-by-One campaign for children in 2003 to give many of the world's children a chance to live a better life. The One-by-One programme:

- Helps Amway to bring its vision to life
- Declares what the company stands for
- Builds trust and respect in Amway brands
- Establishes Corporate Social Responsibility at a high level

Amway encourages staff and IBOs to support its One-by-One campaign for children. Since 2001, Amway Europe has been an official partner of UNICEF and has been able to contribute over €2 million (about £1.4 million).

Amway's financial contribution to UNICEF comes from five sources:

1. Corporate donations
2. Staff donations
3. Sales of UNICEF greeting cards
4. Donation from IBOs

The focus is on supporting the worldwide "Immunization Plus" programme. This involves, for example, providing measles vaccines to children across the globe. The "Plus" is about using the vehicle of immunization to deliver other life-saving services for children. It is about making health systems stronger and promoting activities that help communities and families to improve child-care practices. For example, the "Plus" could include providing vitamin A supplements in countries where there is vitamin A deficiency.

Since 2001, Amway and its IBOs across Europe have been supporting UNICEF's child survival programme. The need is great. One out of ten children in Kenya does not live to see his or her fifth birthday, largely because of preventable diseases. Malaria is the biggest killer with 93 deaths per day. Only 58 per cent of children under two are fully immunized.

The work of the One-by-One programme is illustrated by a field trip undertaken by Amway IBOs to Kenya. The IBOs travelled to Kilifi in 2006 to meet children and to find out what the problems were in various communities. They acted as champions spreading the message throughout their groups. In Kilifi, the focus was on trying to reach the most vulnerable children and pregnant mothers. The aim was to increase immunization from 40 per cent to 70 per cent. Other elements of the programme involved seeking to prevent the transmission of HIV/AIDS to infants.

Stakeholder Expectations

Stakeholders today are holding companies to high standards of social responsibility. Stakeholders do not want to do business with companies that pollute the environment, harm communities or exploit impoverished workers in third world countries. They want to feel that their business is making a positive contribution to their communities and the world as a whole. The expectations of the different stakeholders are given below:

Amway Global HQ/Amway Europe: Amway expects a good return on investment. It expects the company to act in a socially responsible way to benefit the business and its IBOs, and to provide a high quality business opportunity with high quality products.

Staff: The people working for Amway want fair wages and good working conditions for themselves. However, they also want the company to show care, concern and support for the charities and causes that they themselves support.

Suppliers: Suppliers expect prompt payment, fair terms and a reliable relationship based on solid business ethics.

Consumers: They want consistently high quality products and value for money. Those who are impressed by Amway's socially responsible arrangements are more likely to buy from Amway than from a competitor.

Community partners: Amway's community partners want the company to show respect, interest and concern, and for the company to promote and support community initiatives.

Developing CSR Strategies

A strategy is an organizational plan. Implementing a strategy involves putting that plan into action. The strategy thus enables an organization to turn its values into action. Values are what a company stands for. An important value for Amway is being a caring company. Amway believes in demonstrating this caring approach and this is why it has partnered with UNICEF.

Businesses have a responsibility to conduct their work ethically. They are responsible to their boards, employees, customers and to the society as a whole. A CSR strategy must reinforce the company's profit making strategy.

Effective strategies involve discussion and communication with others. The views of IBOs are influential in creating strategies for Amway. Amway's strategies for corporate social responsibility are cascaded through the organization.

Amway's Global Cause strategy involves creating responsible plans that make a difference. However, the strategy is flexible. In shaping the strategy, research was carried out to find out which global causes were supported largely by the IBOs. The results showed that many favoured a cause that helped children. There was a clear fit between Amway's aims to help children and UNICEF's "Immunization Plus" programme for children.

Objectives: From the outset, Amway set out some clear objectives for its strategy. These were to:

- Build loyalty and pride among IBOs and employees
- Enhance Amway's reputation as a caring organization
- Make a real difference to human lives

Child mortality is particularly high in developing countries because of infectious diseases. Many children could still be alive if they had been vaccinated. For under £12, a child can be vaccinated against these diseases and has a fighting chance to reach adulthood. UNICEF's world child "Immunization Plus" programme is a fitting focus for the activities of Amway UK and its IBOs.

In 2005, Amway UK's partnership was deepened when it became an official Corporate Partner of UNICEF UK. The corporate partnership is a closer longer-term relationship, which benefits both partners. The two parties raised money for UNICEF by working together.

Amway's corporate social responsibility strategy has been developed with the interests of the stakeholders in mind.

Communicating the Strategy

Good, clear communication is essential in making sure that the CSR strategy relates directly to the company's business objectives. Communication also helps in putting the strategy into practice.

A number of communications media are used in this regard:

1. Face-to-face communication: Regular meetings take place between UNICEF, Amway and its IBOs. Through meetings with UNICEF staff, Amway is able to discuss the vision and objectives. It then passes the message on by meeting with the IBOs.
2. Printed material: Amway produces a monthly magazine for all IBOs called Amagram.
3. Public relations materials: These are also important, particularly at launch events for initiatives.
4. E-mail communication: E-mail is very important in the company—it plays a significant part in keeping IBOs up-to-date.
5. Online activities: There is a micro-site dedicated to the Amway UK/UNICEF partnership on the UNICEF UK Web site.

Fundraising

The UK initiative is part of a Europe-wide fundraising campaign for children. It recognizes the importance of building good working relationships with UNICEF in each market in order to launch fundraising programmes through Amway's IBOs and their customers. The objective is to raise €500,000 (about £350,000) every year until 2010 across Amway Europe. Amway Europe provides support for fundraising to the extent of €500,000 (about £350,000) per year through selling items such as:

- Greetings cards
- Multi-cultural gifts and cards
- Stationery and wrapping paper
- Toys for children

However, Amway UK's support goes well beyond these activities. In addition, it involves staff fundraising events and raffles organized by the IBOs. UNICEF attends IBO major events (usually supported by 1,000 or more IBOs) where requested. A UNICEF stand outlines the work with speakers, literature and merchandise.

Conclusion

Amway is a family business with family values. Its IBOs are people who want to make a difference to the communities in which they operate and to the wider world community. The reason for Amway's success is the careful planning of its strategy and its involvement with many stakeholders in getting the strategy right. Of course, it is early days in the latest chapter of a strong relationship between Amway and UNICEF. The success of the initiative in terms of meeting fundraising goals is still being evaluated. Customer research is being carried out to test customers' views on the relationship and to find out how aware the general public is about what Amway is doing in the field of CSR.

Source: Adapted from www.unicef.org, accessed March 2010.

For Discussion

1. After reading this case study, what do you understand by the term corporate social responsibility (CSR)?
2. Explain two actions that Amway and its IBOs are currently taking that involve CSR.

3. Analyse the key ingredients in Amway's CSR strategy. Show how the strategy is designed to translate the vision into practical steps on the ground.
4. Recommend ways in which Amway could enhance and develop its impact on making every child matter.

Short-answer Questions

1. Define leadership.
2. Name the leadership functions.
3. What do you mean by CSR?
4. Name the four layers of CSR.
5. Define corporate citizenship.
6. Define SQM.
7. What is a vision statement?
8. What is a mission statement?
9. What do you understand by values?
10. Define quality policy.
11. What do you understand by the term "Hoshin Kanri"?
12. Name the four perspectives of a balanced scorecard.
13. Define quality culture.
14. What is change management?

Match the Following

a. Balanced scorecard	Market share
b. The learning and growth perspective	Customer loyalty
c. Business process perspective	Kaplan and Norton
d. Customer perspective	Process quality
e. Financial perspective	Knowledge-worker

Discussion Questions

1. Explain five traits of a successful leader.
2. Discuss visionary leadership with an example.
3. Describe six natural levels of leadership.
4. Explain the historical perspective of CSR.
5. What are the myths about CSR?
6. Discuss the benefits of CSR.
7. Using a schematic diagram, explain the five phases of SQM.

8. Explain the five stages of quality culture.
9. Explain the six values of quality culture.
10. What are the typical characteristics of “*hoshin kanri*”?
11. Explain balanced scorecard.
12. Explain how to build quality culture in an organization?
13. What are the various forces resisting change in the organization and the approaches used to deal with this?

Projects

1. Visit the Web sites of any five companies mentioning quality explicitly in their mission, vision and values.
2. Conduct an empirical survey of companies in your city to find out the number of companies having a strategic focus on quality management.

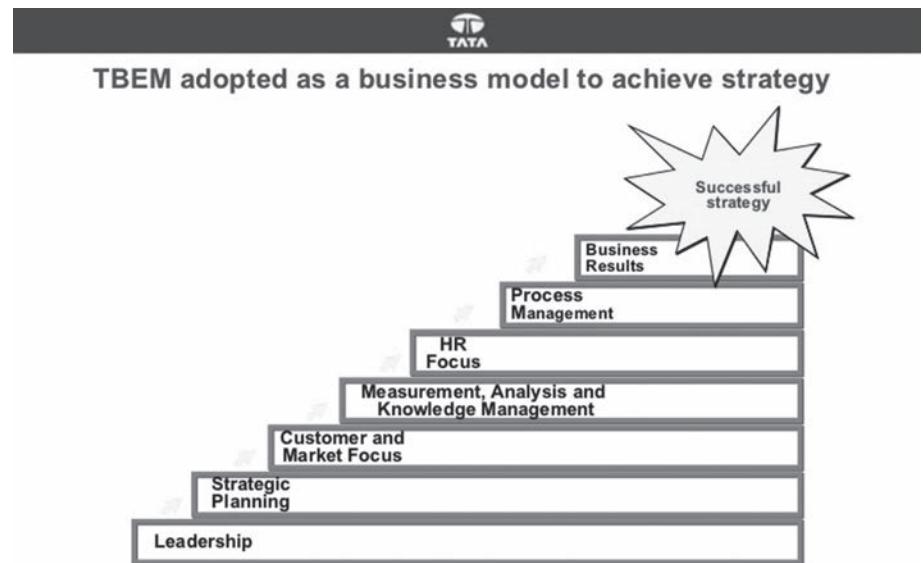
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5

TQM Kitemarks



TATA BUSINESS EXCELLENCE MODEL (TBEM)

Excellence is a continual quest at the Tata group. In 1995, the group adapted the Tata business excellence model (TBEM) from the renowned Malcolm Baldrige Model and has been following the same since then. TBEM has played a major role in bringing the Tata group of companies together, enabling them to define their philosophy and common purpose, and strengthening the Tata brand.

The TBEM initiative falls under the aegis of the Tata Business Excellence Group, an in-house organization mandated to help different Tata companies achieve business excellence and improvement goals. The TBEM methodology has been moulded to deliver strategic direction and drive business improvement. The Tata Business Excellence Convention is a forum that brings together the champions of excellence in Tata companies from all over the world to share their opportunities and challenges. It encompasses three major points—organizational profile, process descriptions, and results.

The transformation induced by TBEM is a result of the deep focus that Tata companies have brought to bear on critical aspects of business excellence such as leadership, strategic planning, customer focus, measurement, analysis and knowledge management, workforce focus, process management, and business results. The JRD Quality Value award was named after J.R.D. Tata, a vocal proponent of quality and excellence. Companies are scored on a scale of 1,000 points; if they cross 650 points, they bag the TBEM's grand prize—the JRD Quality Value award. The award is announced in a glittering ceremony held on 29 July every year, on J.R.D. Tata's birth anniversary.

“Practice does not make perfect, perfect practice makes perfect.”

Vince Lombardi

Upon completion of this chapter, you will be able to:

1. Explain the Deming Prize
2. Understand the Malcolm Baldrige National Quality Award and the Ramakrishna Bajaj National Quality Award
3. Discuss the European Quality Award and CII-EXIM Bank Award for Business Excellence
4. Understand the International Quality Maturity Model
5. Describe the highlights of Capability Maturity Model Integration (CMMI)

■ INTRODUCTION

Chapter 3 explains the five stages of the TQMEX Model. This model enables the organization to build a strong foundation and create a proactive environment for TQM. This is the right time for the management of an organization to consider obtaining nationally or internationally recognized total quality management (TQM) awards that act as TQM kitemarks.

TQM kitemarks are nationally or internationally recognized quality standards that provide discipline, external assessment and a clear process for moving towards TQM. They also have tremendous potential publicity value within the organization and with the general public. TQM kitemarks are useful because their underlying core quality values and principles as stipulated in the requirements of the particular awards are commonly perceived as being beneficial and relevant to the development of most organizations. Achieving TQM kitemarks entails making a decision on the most appropriate TQM award to adopt, and its effective implementation according to the requirements. The implementation of TQM kitemarks consists of two stages. The first stage requires a decision on the most appropriate kite-mark to achieve, and the second stage requires implementation of the chosen TQM award according to the requirements.¹

When an organization receives a TQM award, it conveys the important message to actual and potential shareholders that it takes quality seriously and that its policies and practices conform to national and international standards of quality. This can enhance the pride and reputation of the organization. These awards are models that can be used:

- As tools for self-assessment
- As ways to benchmark with other organizations

Bird's-eye view:

TQM awards are nationally or internationally recognized quality standards that provide discipline, external assessment and a clear process for moving towards TQM.

- As guides to identify areas for improvement
- As the basis for a common vocabulary
- As structures for the organization's management system

The best known TQM awards are as follows:

1. Japan's Deming Prize
2. USA's Malcolm Baldrige National Quality Award (MBNQA)
3. The European Quality Award (EQA)

■ JAPAN'S DEMING PRIZE

Bird's-eye view:

The **Deming Prize** is a global quality award that recognizes both individuals and organizations for their contributions to the field of Total Quality Management (TQM) and businesses that have successfully implemented TQM.

The Deming Prize is one of the highest awards given for TQM initiatives. The Union of Japanese Scientists and Engineers (JUSE) established it in December 1950 in honour of W. Edwards Deming (1900–1993). Deming contributed greatly to Japan's proliferation of statistical quality control after World War II. One of the foremost experts on statistical quality control in the United States, Dr W. E. Deming was invited to Japan by JUSE in July 1950 for a series of lectures. His message that quality improvement would reduce expenses and improve productivity helped Japanese companies build a strong foundation based on quality. The Deming Prize was originally designed to reward Japanese companies for major advances in quality improvement.

The Deming Prize for quality has grown under the guidance of JUSE to allow non-Japanese companies to participate and has also accorded recognition to individuals for having made major contributions to the advancement of quality.

■ Categories of the Deming Prize

As shown in Table 5.1, the Deming Prize has three award categories. They are the Deming Prize for individuals, the Deming Application Prize and the Quality Control Award for operations business units.

Table 5.1 Categories of the Deming Prize

The Deming Prize for Individuals	For individuals or groups. This award is given to those who have made outstanding contributions to the study of TQM or statistical methods used for TQM or made outstanding contributions in the dissemination of TQM.
The Deming Application Prize	For organizations or divisions of organizations that manage their business autonomously. Given to organizations or divisions of organizations that have achieved a distinct improvement in performance through the application of TQM in a designated year.
The Quality Control Award for Operations Business Units	For operations business units of an organization. Given to operations business units of an organization that have achieved a distinct improvement in performance through the application of quality management or control in the pursuit of TQM in a designated year.

Source: Adapted from www.juse.or.jp, accessed February 2010.

■ The Deming Application Prize—Checklist

The Deming Application Prizes are awarded to private or public organizations. These organizations are subdivided into small enterprises, divisions of large corporations and overseas companies. The Deming Application Prize checklist reveals important TQM areas ranging from policy, organization, information, standardizations, human resource development utilization, quality assurance activities, maintenance and control activities, improvement activities, effects and future plans. The Deming Prize checklist is shown in Table 5.2.

Table 5.2 Deming Prize—Checklist for Application

Sl No.	Criteria	Description
1.	Outline of the organization	Describe the outline, scale of operations, history, main products and characteristics, etc.
2.	Organization and management	Describe about the organization, main business, main committees, characteristics of organizational management, etc.
3.	TQM promotion	Describe the objectives behind introduction of TQM, issues at the time of introduction, focus areas for activities, progress of activities, implementation status, confirmation of effects, future issues, etc.
4.	Policy management	Describe the framework of systems built based on TQM
5.	Human resource development	In each chapter, describe the objectives, problems (issues), focal point of activities, progress of activities, implementation status, systems and mechanism built, effects, future issues, etc.
6.	Information management	
7.	Standardization	
8.	Implementation status of quality control	Describe function-wise (Q, C, D, S, M, etc.) implementation status of unique activities on quality control (choose the activities that you would like to emphasize on)
8.1	New product development	
8.2	Quality assurance	In each function, describe the problems (issues) at the beginning, focal point of activities, progress of activities, implementation status, systems and mechanism built, effects, future issues, etc.
8.3	Cost management	
8.4	Quantity and delivery management	
8.5	Safety management	
8.6	Marketing	
8.7	Environment management	
9.	Overall effects	Describe the overall effects of TQM promotion in a manner that its relation with the implementation status of TQM is understood. For tangible effects, show the trend graph using quantitative measures if at all possible
10.	Future plan	Explain about the plan to pursue TQM continuously even after winning the Deming Application Prize. Describe also the pending problems/issues as well as the new initiatives to be taken

Source: Adapted from www.juse.or.jp, reproduced with permission of the Deming Prize Committee and JUSE.

Bird's-eye view:

Five Effects of Deming Prize are:

1. New product development and launch will be promoted
2. New technology can be obtained
3. Sales target will be achieved continuously
4. Become capable of following a policy and fulfilling an objective
5. Organisation's functionality will be enhanced

Box 5.1 Effects of Winning the Deming Application Prize

The leading manufacturer of air braking systems in India, Sundaram-Clayton Ltd (SCL) is the flagship company of the TVS group. It has become the first Indian company and the fourth non-Japanese company to receive the Deming Prize for total quality management (TQM) in the 50-year history of the award.

In order to overcome the recessionary years of the late 1980s, tackle competition and to improve profit performance of the company, Sundaram-Clayton Ltd decided to implement the Japanese way of TQM. The TQM culture was established at SCL. The company challenged the Deming Prize to encourage employees to achieve higher standards and to motivate them. After successfully winning the Deming Prize in 1998, the performance of the company improved. Some of the tangible and intangible benefits as seen here were a reduction in defect rates, increase in profitability, reduction in customer line rejection, reduction in warranty claims, reduction in the lead time for introduction of new products and also substantial decrease in the time required to achieve break-even point. This resulted in improvement in customer and supplier satisfaction, improved new product development processes, employee/family fulfillment, change in organizational culture, excellent industrial relations, breakthrough achievement in industrial relations and a satisfied local community.

Source: Adapted from www.sundaram-clayton.com, accessed February 2010.

👁 Bird's-eye view:

The Deming Prize for quality has grown under the guidance of JUSE to allow non-Japanese companies to participate and has also accorded recognition to individuals for having made major contributions to the advancement of quality.

Four Indian companies figured in the Deming Prize list in 2007. Asahi India Glass Ltd, Rane Ltd, Reliance Industries Ltd and Mahindra & Mahindra Ltd were awarded the 2007 Deming Prizes for their commitment to quality. Awards for total quality management and quality innovation were also distributed at the ceremonies in Tokyo, Japan. The effects of winning the Deming Application Prize are discussed in Box 5.1.

DISCUSSION FORUM

1. What are TQM awards?
2. Name the best known TQM awards.
3. Discuss the three categories of the Deming Prize in small groups.

👁 Bird's-eye view:

The Deming Prize has three award categories. They are the Deming Prize for individuals, the Deming Application Prize and the Quality Control Award for operations business units.

■ MALCOLM BALDRIGE NATIONAL QUALITY AWARD (MBNQA)

The Malcolm Baldrige National Quality Award is given by the United States National Institute of Standards and Technology. This award is given through the action of the National Productivity Advisory Committee and American Society for Quality (ASQ). It was established by the Malcolm Baldrige National Quality Improvement Act of 1987, Public Law 100-07 and named after Malcolm Baldrige, who served as the United States Secretary of Commerce during the Reagan administration from 1981 until his death in 1987.

The MBNQA was established by the United States Congress in 1987 to recognize US companies that excelled in the achievement and management of quality. The award is designed to promote an awareness of quality, understanding the requirements of quality and sharing of information on successful strategies and the benefits derived from implementation. This award is America's highest honour for innovation and performance excellence.

The programme recognizes quality service in the manufacturing, service, small business, healthcare, education and non-profit sectors and was inspired by the ideas of total quality management. This is the only quality award that is annually awarded by the President of the United States.

■ Programme Impact

The Baldrige National Quality Programme has grown in stature and impact. Today, the Baldrige programme and the award's criteria for performance excellence are imitated worldwide. The Baldrige award recipients have admirers the world over.

The Malcolm Baldrige Model for Performance Excellence is shown in Figure 5.1. The criteria are built upon a set of core values and concepts that include visionary leadership, customer-driven excellence, organizational and personal learning, valuing employees and partners, agility, focus on the future, managing for innovation, management by fact, social responsibility, focus on results and creating value and systems perspective. These core values are embedded in the seven Baldrige Criteria.

Organizations that apply for the Baldrige Award are judged by an independent board of examiners. Recipients are selected based on achievement and improvement in seven areas known as the Baldrige Criteria for Performance Excellence. We shall present a brief summary of each of these clauses along with an organizational profile as shown in Figure 5.1.

■ Criteria for Performance Excellence

Organization profile: The organizational profile sets the context for the way the organization operates. It is divided into two parts—organizational description and organizational challenges. This includes organizational environment, key working relationships and strategic challenges.

The organization must give the details about products and services it provides, its vision, mission, values and its employee profile. The organization must state the kind of technology and equipment used in various processes, details of communication mechanisms used, role of various elements in its supply chain and the kind of statutory and regulatory requirements by which it is governed. It must try to find the key factors instrumental to its success in the market. The organization must highlight the steps taken by it to improve the key processes relating to the creation of products or services.

1. **Leadership (120):** This category examines how the organization's senior leaders guide and sustain the organization. It also examines the organization's governance and how it addresses its ethical, legal and community responsibilities. This criterion is assessed for 120 points out of 1,000 points.

Fig. 5.1 The Malcolm Baldrige Model for Excellence in Business Performance



Eye Bird's-eye view:

MBNQA award was established by the U.S. Congress in 1987 to raise awareness of quality management and recognize U.S. companies that have implemented successful quality management systems.

Eye Bird's-eye view:

Awards can be given annually in six categories: manufacturing, service, small business, education, healthcare and nonprofit. The award is named after the late Secretary of Commerce Malcolm Baldrige, a proponent of quality management. The U.S. Commerce Department's National Institute of Standards and Technology manages the award, and ASQ administers it.

2. **Strategic planning (85):** This category examines how an organization develops strategic objectives and action plans. It also examines how the chosen strategic objectives and action plans are deployed and changed if circumstances require, and how progress is measured. This criterion is assessed for 85 points out of 1,000 points.
3. **Customer and market focus (85):** This category examines how the organization determines the requirements, needs, expectations and preferences of customers and markets. It also examines how the organization builds relationships with customers and determines the key factors that lead to customer acquisition, satisfaction, retention, loyalty and bringing about business expansion and sustainability. This criterion is assessed for 85 points out of 1,000 points.
4. **Measurement, analysis and knowledge management (90):** This category examines how the organization select; gathers; analyses; manages; improves its data, information and knowledge assets and how it manages its information technology. It also examines how the organization reviews and uses reviews to improve its performance. This criterion is assessed for 90 points out of 1,000 points.
5. **Workforce focus (85):** This category examines how an organization engages, manages, and develops the workforce to utilize its full potential in alignment with its overall mission, strategy and action plans. It also examines the ability to assess workforce capability, capacity needs and to build a workforce environment conducive to high performance. This criterion is assessed for 85 points out of 1,000 points.
6. **Process management (85):** This category examines how the organization determines its core competencies and work systems and how it designs, manages and improves its key processes for implementing those work systems to deliver customer value and achieve organizational success and sustainability. It also examines an organization's readiness for emergencies. This criterion is assessed for 85 points out of 1,000 points.
7. **Results (450):** This category examines an organization's performance and improvement in key areas such as product and service outcomes, customer-focused outcomes, financial and market outcomes, workforce-focused outcomes, process effectiveness outcomes and leadership outcomes. It also examines performance levels relative to those of competitors and other organizations providing similar products and services. This criterion is assessed for 450 points out of 1,000 points.

Bird's-eye view:

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.

Bird's-eye view:

Three awards may be given annually in each of six categories: Manufacturing; Service Company; Small business; Education; Healthcare Nonprofit.

The award criteria are stated to have three important roles in strengthening competitiveness among companies in the US²:

- To help improve organizational performance practices, capabilities and results
- To facilitate communication and sharing of the best practice information among US organizations of all types
- To serve as a working tool for understanding and managing performance and for guiding planning and opportunities for learning

The criteria are designed to help organizations use an aligned approach to organizational performance management that results in:

- Delivery of ever-improving value to customers, contributing to market success
- Improvement in overall organizational effectiveness and capabilities
- Organizational and personal learning

Three awards may be given annually in each of six categories—manufacturing, service, small business, education, healthcare and non-profit. According to many winners applying for the MBNQA, this is an opportunity to examine the recipient of the organization critically and identify strengths and opportunities for improvement. The feedback helps the organization

prioritize scarce resources on the highest leverage areas for improvement, professional development, personal learning and achievement opportunities. It builds momentum and pride to be recognized as an industry leader. It also enables the organization to identify both external and internal value proposition.

Three versions are available in the Baldrige award.³ These are as follows:

1. **Criteria for performance excellence in business:** This is used by businesses and non-profit organizations. This includes organizations in the area of manufacturing, service and small businesses.
2. **Education criteria for performance excellence:** This is used by organizations that provide educational services in the United States and its territories.
3. **Healthcare criteria for performance excellence:** This is used by organizations that are primarily engaged in furnishing medical, surgical, or other health services directly to people.

Box 5.2 discusses Poudre Valley Health System (PVHS), a US-based healthcare unit, which received the 2008 Malcolm Baldrige National Quality Award in the healthcare sector. The categories and items along with point values are given in Table 5.3. Table 5.4 gives the recipients of MBNQA for the year 2006–2008.⁴

Box 5.2 TATA Business Excellence Model (TBEM)

“The pursuit of business excellence was not an extraneous activity; there was a close link between progress on business excellence and a company’s results, as Tata Steel had shown.”

—Dr J. J. Irani, Chairman, Executive Committee,
Tata Quality Management Services (TQMS)

“We seemed to have changed our mindset from thinking that we are the best and we have nothing to learn and in bringing this about a great deal of credit goes to the TBEM.”

—Ratan Tata, Chairman, The Tata Group

TBEM is a framework defining the quality movement within the TATA Group. It had been adapted in the early 1990s from the renowned Malcolm Baldrige archetype. The model works under the aegis of TATA Quality Management Services (TQMS), an in-house organization mandated to help different TATA companies achieve their business objectives through specific processes.

The TBEM methodology has been moulded to deliver strategic direction and drive business improvement. It contains elements that enable to capture the best of global business processes and practices. It translates into an ability to evolve and stay in step with ever-changing business performance parameters.

Source: Adapted from www.tal.co.in/about-us/tata-business-excellence-model.html, accessed February 2010.

Table 5.3 Point Values for Categories and Items for MBNQA for Performance Excellence

Category No.	Categories in Business	Categories in Education	Categories in Healthcare	Point Values
P	Preface: Organizational profile	Preface: Organizational profile	Preface: Organizational profile	—
P.1	Organizational description	Organizational description	Organizational description	—
P.2	Organizational challenge	Organizational challenge	Organizational challenge	—

(Continued)

Bird's-eye view:

Organizations that apply for the Baldrige award are judged by an independent board of examiners. Recipients are selected based on achievement and improvement in seven areas, known as the Baldrige Criteria for Performance Excellence.

Bird's-eye view:

The seven areas of excellence are: Leadership; Strategic planning; customer & market focus; human resource focus; Process management; Business results.

Table 5.3 (Continued)

Category No.	Categories in Business	Categories in Education	Categories in Healthcare	Point Values
1	Leadership	Leadership	Leadership	120
1.1	Senior leadership	Senior leadership	Senior leadership	70
1.2	Governance and social responsibilities	Governance and social responsibilities	Governance and social responsibilities	50
2	Strategic planning	Strategic planning	Strategic planning	85
2.1	Strategy development	Strategy development	Strategy development	40
2.2	Strategy deployment	Strategy deployment	Strategy deployment	45
3	Customer and market focus	Student, stakeholder and market focus	Focus on patients, other customers and market	85
3.1	Customer and market knowledge	Student, stakeholder and market knowledge	Patient, other customer, and healthcare market knowledge	40
3.2	Customer relationships and satisfaction	Student and stakeholder relationships and satisfaction	Patient and other customer relationships and satisfaction	45
4	Measurement, analysis and knowledge management	Measurement, analysis and knowledge management	Measurement, analysis and knowledge management	90
4.1	Measurement, analysis and improvement of organizational performance	Measurement, analysis and improvement of organizational performance	Measurement, analysis and improvement of organizational performance	45
4.2	Management of Information, Information Technology, and Knowledge Management	Management of Information, Information Technology, and Knowledge Management	Management of information, information technology, and knowledge management	45
5	Workforce focus	Workforce focus	Workforce focus	85
5.1	Workforce engagement	Workforce engagement	Workforce engagement	45
5.2	Workforce environment	Workforce engagement	Workforce engagement	40

(Continued)

Table 5.3 (Continued)

Category No.	Categories in Business	Categories in Education	Categories in Healthcare	Point Values
6	Process management	Process management	Process management	85
6.1	Work systems design	Work systems design	Work systems design	35
6.2	Work process management and improvement	Work process management and improvement	Work process management and improvement	50
7	Business results	Business results	Business results	450
7.1	Product and service outcomes	Student learning outcomes	Healthcare outcomes	100
7.2	Customer-focused outcomes	Student-and stakeholder-focused outcomes	Patient- and other customer-focused outcomes	70
7.3	Financial and market outcomes	Budgetary, financial and market outcomes	Financial and market outcomes	70
7.4	Workforce-focused outcomes	Workforce-focused outcomes	Workforce-focused outcomes	70
7.5	Process effectiveness outcomes	Process effectiveness outcomes	Process effectiveness outcomes	70
7.6	Leadership outcomes	Leadership outcomes	Leadership outcomes	70
Total Points				1,000

Source: Adapted from www.asq.org, accessed March 2010.



Bird's-eye view:

Baldridge Criteria for Performance Excellence have played a valuable role in helping U.S. organizations improve. The Criteria are designed to help organizations improve their performance by focusing on two goals: delivering ever-improving value to customers and improving the organization's overall performance.

Table 5.4 Malcolm Baldrige National Quality Award Winners

2015	2014	2013
• Midway USA, Columbia, Missouri (small business)	• PricewaterhouseCoopers Public Sector Practice, McLean, Va. (service)	• Pewaukee School District, Pewaukee, Wisconsin (education)
• San Diego, California (education)	• Hill Country Memorial, Fredericksburg, Texas (health care)	• Baylor Regional Medical Center at Plano, Plano, Texas (health care)
• Charleston Area Medical Center Health System, Charleston, West Virginia (health care)	• St. David's HealthCare, Austin, Texas (health care)	• Sutter Davis Hospital, Davis, California (health care)
• Mid-America Transplant Services, St. Louis, Missouri (nonprofit)	• Elevations Credit Union, Boulder, Colo. (nonprofit)	

Source: Adapted from www.asq.org, last accessed in June 2016.

 **Bird's-eye view:**

The IMC RBNQA criteria are similar to the Malcolm Baldrige criteria of USA and follows similar rigorous process of training and evaluation. All applicant organizations irrespective of winning an Award or not – receive a detailed feedback report – beneficial to map the quality journey of the Organization.

■ IMC RAMAKRISHNA BAJAJ NATIONAL QUALITY AWARD (IMC RBNQA)

To match the stature of international awards, the IMC Ramakrishna Bajaj National Quality Award (IMC RBNQA) criteria are the same as the Malcolm Baldrige criteria of the USA and follow a similar rigorous process of training and evaluation.

The IMC Ramakrishna Bajaj National Quality Award was instituted in 1996 by Indian Merchant's Chamber (IMC) to give special recognition to performance excellence by Indian companies.

The IMC Ramakrishna Bajaj National Quality Award Trust was created to foster the success of the awards programme. The main objective of the trust is to raise funds to permanently endow the awards programme. Prominent leaders from Indian organizations serve as trustees and ensure that the Trust's objectives are accomplished. The Trust confirms the selection of the winners based on the recommendations of the panel of judges.

The IMC Ramakrishna Bajaj National Quality Award, and its criteria for assessment have been developed by the Indian Merchants' Chamber to enable organizations to achieve business excellence. Consistent with the principles of continuous improvement, the award's criteria have been revised and improved every year. Many organizations, both large and small, use the IMC RBNQA as a guideline for achieving breakthroughs in performance and garnering effective business results. Some of these organizations also participate in the annual competition. The names of the past winners of IMC Ramakrishna Bajaj National Quality Award are furnished in Table 5.5. Box 5.3 briefly discusses the Tata Business Excellence Model, which has also been adapted from the MBNQA.

There are six applicant categories for the IMC Ramakrishna Bajaj National Quality Award as mentioned below. An annual trophy is awarded by the IMC for each of the categories. Manufacturing, service, small business and overseas are the four categories under Business Excellence. Education comes under Excellence in Business Education and Healthcare comes under the category Excellence in Healthcare.

The categories are:

1. Manufacturing organizations
2. Service organizations

Table 5.5 Past Winners of IMC Ramakrishna Bajaj National Quality Award

2015	2014	2013
Manufacturing Reliance Industries Ltd Hoshiarpur, Manufacturing division	Manufacturing JSW Steel Ltd, Bellary and BPCL Mumbai Refinery	Service Tata Housing Development Company Limited, Mumbai
Service Max Life Insurance Co. Ltd, Gurgaon	Education Thyagaraja College of Engineering, Madurai	
Education Thakur College of Engineering and Technology, Mumbai	Health Care Sankara Eye care Institutions,	
Health Care L.H. Hiranandani Hospital, Mumbai	Overseas Global Indian International School, East Coast Campus, Singapore	
Small Business Shree Vasu Logistics Pvt. Ltd, Raipur		
Overseas Overseas Spinning Bus (Indonesia)		

Source: Adapted from www.imcrbnqa.com, last accessed in June 2016.

Box 5.3 Rajiv Gandhi National Quality Award

The Rajiv Gandhi National Quality Award was instituted by the Bureau of Indian Standards in order to encourage Indian Industries to strive for excellence and to give special recognition to the leaders of quality movement in India. It is named after Rajiv Gandhi, the former Prime Minister of India, and was introduced in 1991 after his death. The award has been designed in line with similar awards in other developed countries such as the Malcolm Baldrige National Quality Award in USA, the Deming Prize in Japan, and the European Quality Award. This award is modelled based on the Malcolm Baldrige Award and the Deming Prize in Japan and is given to large, medium, and small-scale industries.

The award is presented to organizations in five broad categories—large-scale manufacturing, small-scale manufacturing, large-scale service sector, small-scale service sector, and the best overall performance. Furthermore, there are 14 commendation certificates for organizations showing excellence in various fields, including but not limited to biotechnology, chemicals, electronics, food and drugs, metallurgy, textiles, jewellery, education, finance, healthcare, and information technology.

The award-winning organizations are reckoned as champions of quality movement in India. Winning this award brings not only recognition to the organization but also earns the confidence of the public in the products or services provided by the organization. The award is given to recognize the fact that an organization has shown an outstanding system for managing its products, services, human resources, customer relationships, etc. As part of the evaluation, an organization is asked to describe its system for assuring the quality of its goods and services. It must also supply information on quality improvement and customer satisfaction efforts and results. However, this does not mean that a recipient's products or services are endorsed.

Source: bis.org.in/rgnqa/faq_rgnqa_09.pdf, last accessed on March 2016.

3. Small businesses
4. Indian overseas organizations
5. Education
6. Healthcare

The types of awards in the order of merit are given below.

1. IMC Ramakrishna Bajaj National Quality Award
2. Certificate of merit
3. Commendation certificate

Apart from this, an IMC Juran Quality Medal is awarded to chosen individuals. The recipients of the Juran medal are named in Table 5.6. The selected individual must serve as a role model for any one or more of the following ten criteria:

1. Demonstration of outstanding leadership in establishing customer-driven quality.
2. Demonstration of outstanding leadership in improving the human aspects of quality.

Table 5.6 Recipient of the Juran Medal by IMC RBNQA

Year	Name	Year	Name
2004	Verghese Kurien, father of the white revolution and the person behind Amul	2010	Anand Mahindra, Vice-chairman and Managing Director, Mahindra & Mahindra Ltd

Bird's-eye view:

The IMC Ramakrishna Bajaj National Quality Award was instituted in 1996 by Indian Merchant's Chamber (IMC) to give special recognition to performance excellence by Indian companies.

Bird's-eye view:

The IMC Juran Quality Medal was instituted by the IMC RBNQA Trust to recognize individual excellence on criteria articulated by Dr. J M Juran, the renowned Quality Guru.

(Continued)

 **Bird's-eye view:**

In 1996, J. M. Juran gave Suresh Lulla, Chairman, Indian Merchants' Chamber (IMC) Awards Committee, permission to use his name for a Juran Medal, which is awarded to a role model statesman for quality in India. His key condition was that his name could only be associated with a non-profit organization.

Table 5.6 (Continued)

Year	Name	Year	Name
2005	Rahul Bajaj, chairman, of the Indian conglomerate Bajaj Group and member of Parliament.	2011	B. K. S. Iyengar, Yogacharya, Founder of Iyengar yoga
2006	S. S. Badrinath, Founder and Chairman Emeritus of Sankara Nethralaya, Chennai	2012	Devi Shetty, Chairman, Narayana Hrudayalaya Group of Hospitals
2007	Dilip Shanghavi, Founder and Managing Director of Sun Pharmaceuticals	2013	Subramanian Ramadorai, Adviser to the Prime Minister of India in the National Council on Skill Development
2008	Deepak Parekh, Chairman of Housing Development Finance Corporation	2014	Bunker Roy, Founder, Barefoot College
2009	Mukesh Ambani, Chairman and Managing Director, Reliance Industries Limited	2015	Rani Bang and Abhay Bang, Founders, SEARCH, Gadchiroli

Source: Adapted from www.imcrbnqa.com, last accessed on June 2016.

3. Demonstration of outstanding leadership in combining statistical thinking and management, which results in high quality of products and services.
4. Demonstration of outstanding leadership in improving the supplier aspects of quality.
5. Evidence of distinct philanthropy dedicated to the promotions of quality management.
6. Evidence of substantial original quality management research that has social significance.
7. Evidence of effective quality management training and/or consulting in the manufacturing, service and small business sectors.
8. Evidence of successful design, development and marketing of quality management publications, books and instruction systems.
9. Evidence of furtherance of quality awareness through articles, conventions and other means.
10. Evidence of substantial original research on the processes, tools and techniques for quality management.

DISCUSSION FORUM

1. Discuss the set of core values on which the MBNQA criteria are built in small groups.
2. What are the three versions of criteria available in MBNQA?

■ THE EUROPEAN QUALITY AWARD

The European Quality Award is also known as the European Foundation for Quality Management (EFQM) Excellence Award. It is Europe's most prestigious award for organizational

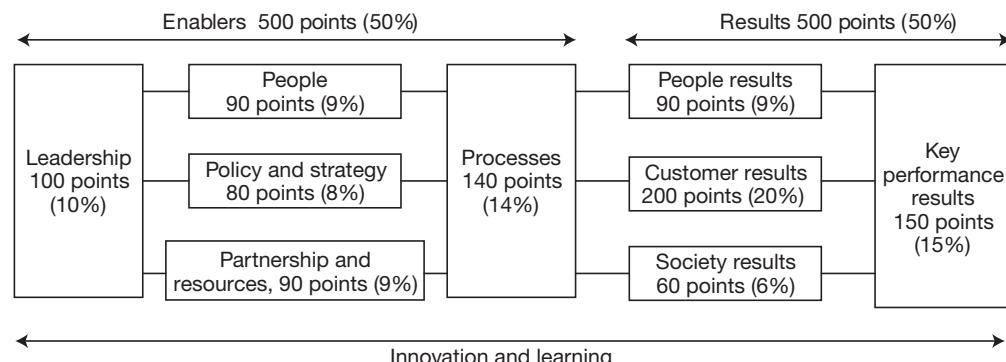
excellence and has been awarded annually by the European Foundation for Quality Management to Europe's best performing companies and not-for-profit organizations since 1992. The Award recognizes companies with an undisputable track record of success in turning strategy into action and continuously improving their organization's performance. The EFQM Excellence Award sits at the pinnacle of dozens of regional and national quality awards and applicants have often been successful in these before applying for European recognition.

EFQM Excellence Model is a non-prescriptive framework based on nine criteria. Five of these are "enablers" and four are "results." The "enabler" criteria cover what an organization does. The "results" criteria cover what an organization achieves. "Results" are caused by "enablers" and "enablers" are improved using feedback from "results." The EFQM Model is presented in Figure 5.2. The names of the winners of the EFQM Excellence Award are given in Table 5.7. The model, which recognizes the fact that there are many approaches to achieving sustainable excellence in all aspects of performance, is based on the premise that excellent results with respect to performance, customers, people and society are achieved

Bird's-eye view:

The European Quality Award (EQA) is now referred to as the EFQM Excellence Award. This distinction is awarded annually by the European Foundation for Quality Management to the organisation that is the best proponent in Europe of Total Quality Management.

Fig. 5.2 The EFQM Model for Excellence



Source: Adapted from www.cii-iq.in, accessed March 2010.

Table 5.7 Winners of EFQM Award

2009	EDF DCECL EST NXP Sound Solutions	Prize winner in leadership and constancy of purpose Prize winner in customer focus
2010	VAMED-KMB Bradstow School	Prize winner in succeeding through people Prize winner in leading with vision, inspiration & integrity and succeeding through people
2011	Bilim Pharmaceuticals Bosch Chassis Systems Control	Award winner and prize winner in adding value for customers; leading with vision, inspiration & integrity; managing by processes and achieving balanced results Prize winner in leading with vision, inspiration, and integrity
2012	Robert Bosch GmbH Bamberg Plant Coca Cola İçecek AŞ Ankara Plant	Award winner and prize winner in leading with vision, inspiration & integrity; and succeeding through people prize winner in taking responsibility for a sustainable future

(Continued)

Table 5.7 (Continued)

2013	Bosch Bari Plant BMW Plant Regensburg	Award winner & prize winner in creating a sustainable future, managing with agility and succeeding through the talent of people Prize winner in managing with agility
2014	BMW AG Werk Regensburg WDH	Award winner Award winner

Source: Adapted from www.efqm.org, accessed in June 2016.

through leadership-driving policy and strategy that is delivered through people, partnerships and resources and processes.

Enablers (50%) and results (50%): For the purpose of meaningful assessment for the award, a relative value must be ascribed to the nine criteria within the model. Enablers and results are each valued at 500 points. Leadership, policy and strategy, people, partnership and resources and processes are termed enablers. Results consist of customer results, people results, society results and key performance results. The model indicates that innovation and learning help improve enablers, which in turn leads to improved results.

■ The EFQM Excellence Model Criteria

The nine boxes represent the nine criteria, which are further divided into thirty-two criteria parts against which the organization's progress towards excellence is assessed.

A brief summary of the criteria under the five “enablers” is presented below:

Leadership(10%): It is expected that the top leadership of an excellent organization will develop and facilitate the achievement of the mission and vision statements. They are expected to develop organizational values and systems, which are required for sustainable development. Aiding this are the methods they use to take the employees of the organization into confidence and enable direct interaction with their other stakeholders. These leaders are expected to be instrumental in bringing about organizational change and emerge as role models of a culture of excellence.

Policy and strategy (8%): Excellent organizations are expected to have a long-term strategic plan keeping in view the expectations of all their present and future stakeholders. The strategy is delivered by developing and deploying policies, plans, objectives and processes. These are reviewed periodically for proper implementation and updated if needed.

People (9%): Excellent organizations are expected to manage, develop and unleash the full potential of their people to derive maximum advantage. They are expected to care, communicate, recognize and reward the employees' good performance for the benefit of the organization.

Partnerships and resources (9%): Excellent organizations are expected to have well-defined systems for managing their supply chain partnership and key resources such as finance, building, equipment, materials, technology, information and knowledge in support of its policy and strategy.

Processes (14%): Excellent organizations are expected to design, document, manage and improve various processes in order to fully satisfy and generate increasing value for customers and other stakeholders.

● Bird's-eye view:

EQA offers the market place the much needed framework to enable the quality of mentoring/coaching services to meet and be recognized for meeting high quality standards of the profession.

Box 5.4 Bosch Sanayi ve Ticaret A.Ş. and the EFQM Excellence Award

Bosch Bursa Diesel Plant received the EFQM Excellence Award for 2008 during the Awards Ceremony held in the Louvre Museum, Paris. The plant is now one of the few organizations that has received the most prestigious European Quality Award for business excellence twice.

Bosch Sanayi ve Ticaret A.Ş.-Bursa Diesel Systems Plant in Turkey won the EFQM Excellence Award in the category of large scope, private industry. RBTR-Bu is an important part of the Bosch production network with 4,800 employees, exporting more than 95 per cent of their output and supplying over 30 customers around the globe. It is a major competency centre for diesel injection systems within Bosch. The entire organization is strongly focused on processes and partnership development. A successful organization, highly responsive to customer needs with a robust approach to improvement with the involvement of all employees, the Robert Bosch Bursa Diesels Systems Plant is a clear role model that exemplifies the ethos of business excellence.

Source: Adapted from www.efqm.org, accessed February 2010.



Bird's-eye view:

The EFQM Excellence Model provides a holistic tool for assessing how effective you are in developing and delivering a stakeholder focused strategy. The 4 result areas focus on what's important to the 4 key stakeholder groups (Business, Customer, People, Society).



Bird's-eye view:

At its simplest level, the Model is a cause and effect diagram. If we want to achieve a different result, we need to change something we do within the organisation. The Model provides a framework for understanding which levers we need to pull in order to achieve the results we want.

A brief summary of the criteria under the five “enablers” group is presented below:

Customer results (20%): Excellent organizations are expected to comprehensively measure external customer perceptions in order to achieve outstanding results with respect to their external customers.

People results (9%): Excellent organizations are expected to comprehensively measure employee perceptions in order to achieve outstanding results with respect to their employees.

Society results (6%): Excellent organizations are expected to establish a system to monitor, understand, predict and improve in order to achieve outstanding results with respect to society.

Key performance results (15%): Excellent organizations are expected to comprehensively measure and achieve outstanding results with respect to the key performance outcomes of their strategy and policy. Key performance results can be financial or non-financial.

Box 5.4 profiles Bosch Sanayi ve Ticaret AS, the winner of the EFQM Excellence Award for 2008.

The EFQM Award and Prize categories are for the sectors mentioned below:

1. Small and medium scope: Private for profit
2. Large scope: Private for profit
3. Small and medium scope: Public not for profit
4. Large scope: Public not for profit

CII-EXIM BANK AWARD FOR EXCELLENCE

The Confederation of Indian Industry (CII) and the Export Import (EXIM) Bank of India jointly established the Award for Excellence in 1994 with the aim of enhancing the “competitiveness of India Inc.” The award is based on the EFQM Model for Excellence. The details of the criteria are furnished in Table 5.8. Each criterion is rated on a scale of 0 to 100. The total points will be awarded out of a maximum of 1,000 points.

 **Bird's-eye view:**

CII and Export-Import (EXIM) Bank of India jointly established the Award for Business Excellence in 1994 with the aim to enhance the 'Competitiveness of India Inc.' The Award is based on the EFQM (European Foundation for Quality Management) Model for Excellence.

Table 5.8 Criteria and Sub-criteria of CII-EXIM Bank Award for Business Excellence

Criteria	Description
1. Leadership (100)	This criterion examines how senior leaders drive the organization towards the achievement of organizational excellence
1a. Inspirational role of leadership	Leaders develop the mission, vision, values and ethics and are role models of a culture of excellence
1b. Institution building role of leadership	Leaders are personally involved in ensuring that the organization's management system is developed, implemented and continuously improved
1c. Networking with the outside world	Leaders interact with customers, partners and representatives of society
1d. Keeping in touch with the people inside	Leaders reinforce a culture of excellence with the organization's workforce
1e. Transformational role	Leaders identify and champion organizational change
2. Policy and strategy (80)	This criterion examines how the organization develops and deploys its vision, mission, values and strategies
2a. Basis for policy and strategy	Policy and strategy are based on the present and future needs and expectations of stakeholders
2b. Relevant information	Policy and strategy are based on information from performance measurement, research, learning and external activities
2c. Updating and improvement	Policy and strategy are developed, reviewed and updated
2d. Communication and deployment	Policy and strategy are communicated and deployed through a framework of key processes
3. People (90)	This criterion examines how the organization unleashes the full potential of its human resources
3a. Continuous improvement practices	People resources are planned, managed and improved
3b. Training, recruitment and career progression	People's knowledge and competencies are identified, developed and sustained
3c. Involvement and empowerment	People are involved and empowered
3d. Communication	People and the organization have a dialogue
3e. Reward and recognition	People are rewarded, recognized and cared for
4. Partnerships and resources (90)	This criterion examines the ways the organization manages its various partners in the supply chain and its key resources in support of its strategy and policy
4a. External partnership	External partnerships are managed
4b. Financial	Finances are managed
4c. Material	Building, equipment and materials are managed
4d. Technology	Technology is managed
4e. Information and knowledge	Information and knowledge are managed
5. Processes (140)	This criterion examines the ways the organizations design, develop, manage, review and improve processes in order to fully satisfy and create increasing value for all the stakeholders

(Continued)

Table 5.8 (Continued)

Criteria	Description
5a. Managing processes	Processes are systematically designed and managed
5b. Innovation	Processes are improved, as needed, using innovation in order to fully satisfy and create increasing value for all the stakeholders
5c. Measures, targets and reviews	Products and services are designed and developed based on customer needs and expectations
5d. Product and service delivery	Products and services are produced, delivered and serviced
5e. Customer relationship management	Customer relationships are managed and enhanced
6. Customer results (200)	This criterion examines the organization's achievements with respect to the satisfaction of its external customers These are external customers perception measures of the organization that may include image, products and services, sales and after sales support, loyalty, etc.
6a. Perception measures	These are external customers perception measures of the organization that may include image, products and services, sales and after sales support, loyalty, etc.
6b. Performance indicators	These measures are the internal ones used by the organization in order to monitor, understand, predict and improve the performance of the organization with respect to its external customers. The measures may include image, products and services, sales and after sales support, loyalty, etc.
7. People results (90)	This criterion examines the organization's achievement in relation to the satisfaction of its employees These are employee perception measures of the organization that may include motivation, satisfaction, etc.
7a. Perception measures	These are employee perception measures of the organization that may include motivation, satisfaction, etc.
7b. Performance indicators	These measures are the internal ones used by the organization in order to monitor, understand, predict and improve the performance of the organization with respect to its employees. The measures may include achievements, motivation and involvement, satisfaction, services to the organization's people, etc.
8. Society results (60)	This criterion examines the organization's achievements in satisfying the needs and expectations of the community at large
8a. Perception measures	This measure is the judgement of the community at large on the organization's impact on society
8b. Performance indicators	These measures are the internal ones used by the organization in order to monitor, understand, predict and improve the performance of the organization and to predict perceptions of society

**Bird's-eye view:**

The Excellence Model is based on universally accepted standards and practices prevalent across the world. Apart from recognition, the model provides a holistic management framework to achieve Excellence.

(Continued)

Table 5.8 (Continued)

 **Bird's-eye view:**

CII and Export-Import Bank of India (EXIM) jointly instituted the CII- EXIM Bank Award for Business Excellence, to recognize the organisations that have demonstrated outstanding performance supported by excellent practices, and present them as role models for others to emulate.

Criteria	Description
9. Key results (150) 9a. Perception measure 9b. Performance indicators	This criterion examines the organization's achievements in relation to its planned business performance in satisfying the needs of everyone with an interest in the organization and in achieving its planned business service objectives. This may include financial and non-financial outcomes These measures are key results defined by the organization and agreed in their policy and strategies. This may include financial and non-financial outcomes These measures are the operational ones used in order to monitor and understand the processes and predict and improve the organization's likely key performance outcomes. This may include financial and non-financial outcomes

Source: Adapted from www.cii-iq-in, accessed March 2010.

 **Bird's-eye view:**

The CII-EXIM Bank Award for Business Excellence encourages Organisations to strengthen their management to enhance its global competitiveness and sustain their competitiveness to become World-Class Organisations. The Award is administered by CII.

The excellence model is based on universally accepted standards and practices prevalent across the world. Apart from recognition, the model provides a holistic management framework to achieve excellence. A large number of organizations have successfully used this model to:

- Define excellence across the organization
- Develop an integrated approach for achieving sustainable competitiveness
- Measure progress on the journey towards excellence
- Review and improve strategy, processes and performance
- Identify and share good practices
- Provide learning opportunity to develop business leaders

DISCUSSION FORUM

1. Discuss the EFQM Model for Excellence in small groups.
2. Explain the CII-EXIM Bank Award for Excellence.

Table 5.9 Winners of CII-EXIM Bank award

Year	Awardee
2010	Crompton Greaves Limited
2011	Rallis, India
2012	Inteliment Technologies
2013	Bokaro Steel
2014	National Stock Exchange
2015	Steel Authority of India's Bhilai Steel plant

Source: Adapted from www.cii-iq-in, last accessed in June 2016.

■ Levels of Recognition

CII-EXIM Bank Award for Business Excellence has four levels of recognition, which signify the various milestones that the organization can aim for as it progresses on its journey towards excellence. The names of the winners of the CII-EXIM Bank Award are shown in Table 5.9. The levels of recognition start from the commendation certificate. The levels of recognition in the order of merit are given below:

1. Commendation for strong commitment to excel
2. Commendation for significant achievement
3. Prize
4. Award

■ Maturity Models

The maturity model is a benchmark to assess and evaluate the state of acceptance and level of maturity of any business initiative that can or has the potential to impact the business and delivery processes. Over the years, the industry has witnessed an explosion of maturity models. In this section, based on the relevance and scope of this chapter, two types of maturity models are presented.

1. International Quality Maturity Model (IQMM)
2. Capability Maturity Model Integration (CMMI)

■ International Quality Maturity Model

The International Quality Maturity Model (IQMM) shown in Figure 5.3 is a new-age tool for measuring, benchmarking, and certifying the quality of management performance. IQMM is based on world-class management models, such as the Malcolm Baldrige National Quality Award and the European Quality Award.

■ Structure

In terms of structure, there are 15 business elements that are the basic requirements for excellent quality management. The weightage assigned to these varies from one industry to another.

Each business element consists of ten sub-elements that represent world-class practices based on management models, such as the Malcolm Baldrige National Quality Award and the European Quality Award.

These sub-elements also meet the Quality Management System (ISO 9000) requirements and go much beyond. The weightage of each sub-element varies depending on the industry and company under consideration.

■ Manuals

The IQMM is documented as follows:

A. **IQMM Dipsticks:** Dipsticks are used to measure the levels of quality management of the organization. This is a compilation of the 15 business elements and 150 sub-elements. Each business element has ten sub-elements as given below:

1. **Leadership and strategic planning:** Leadership initiatives, strategic planning, values, management representative and champions, visible leadership, training and facilitation, management performance standards, societal responsibilities, documentation and records, best practices, etc.

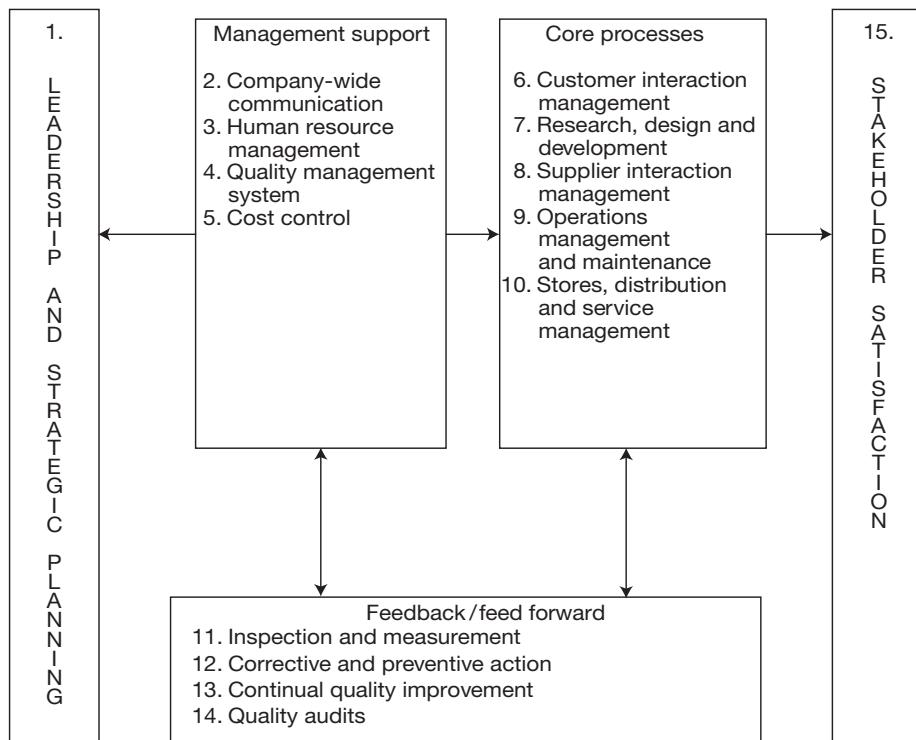
Bird's-eye view:

The recognition is based on International benchmarks and is a rigorous and transparent procedure, creating opportunities to benchmark against other organisations. The Assessment is done by a team of highly qualified and trained business professionals.

 **Bird's-eye view:**

The maturity model is a benchmark to assess and evaluate the state of acceptance and level of maturity of any business initiative that can or has the potential to impact the business and delivery processes.

Fig. 5.3 International Quality Maturity Model



Source: Adapted from www.qimpro.com, reproduced with the permission of Qimpro Standards Organization, Mumbai.

2. **Company-wide communication:** Leadership initiatives, communication capability, orientation programmes, task instruction, personal contacts, quality improvement activities, information channels, awards and recognition, documentation and records, best practices, etc.
3. **Human resource management:** Leadership initiatives, process focus, quality indicators, training, teamwork development, career development, employee appraisal, employee well-being, documentation and records, best practices, etc.
4. **Quality management system:** Leadership initiatives, scope, implementation, assessment, document control, document approval and issue, document changes, distribution of documents, quality records, best practices, etc.
5. **Cost control:** Leadership initiatives, process focus, quality indicators, internal failure costs, external failure costs, appraisal costs, prevention costs, hidden costs, documentation and record, best practices, etc.
6. **Customer interaction management:** Leadership initiatives, process focus, quality indicators, analysing the market environment, benchmarking and forecasting, marketing mix, customer relations, contract review, documentation and records, best practices, etc.
7. **Research, design and development:** Leadership initiatives, process focus, quality indicators, research, design and development planning, design input, design output, design changes, design techniques, documentation and records, best practices, etc.

8. **Supplier interaction management:** Leadership initiatives, process focus, quality indicators, critical supplies, selection and development of suppliers, purchase documents, supplied product verification, disputes, documentation and records, best practices, etc.
 9. **Operations management and maintenance:** Leadership initiatives, process focus, quality indicators, operations planning, process control, special processes, identification and traceability, statistical techniques, documentation and records, best practices, etc.
 10. **Stores distribution and service management:** Leadership initiatives, process focus, quality indicators, stores and handling, packaging, transport and delivery, service plans and standards, service contracts and records, documentation and records, best practices, etc.
 11. **Inspection and measurement:** Leadership initiatives, approach, inspection and measurement facilities, system scope, inspection and test status, control of non-conforming products, control of measuring equipment, certification and inspection by external agencies, documentation and records, best practices, etc.
 12. **Corrective and preventive action:** Leadership initiatives, system and responsibilities, system scope, quality indicators, registration and evaluation, root cause analysis, communication, tracking, documentation and records, best practices, etc.
 13. **Continual quality improvement:** Leadership initiatives, approach, responsibilities, system scope, project identification, team selection, training, project execution, documentation and records, best practices, etc.
 14. **Quality audits:** Leadership initiatives, approach, quality audit resources, quality audit planning, quality audit execution, system non-conformance management, audit reports, analysis of data and management review, documentation and records, best practices, etc.
 15. **Stakeholder satisfaction:** Leadership initiatives, stakeholder focus, quality indicators, customer satisfaction results, employee satisfaction results, community satisfaction results, financial measures, non-financial measures, documentation records, best practices, etc.
- B. **IQMM users' manual:** This document not only consists of dipsticks but also consists of guidelines for users for each of the 150 sub-elements.
- C. **IQMM auditors' manual:** This document gives instructions for auditors for all key sub-elements.
- ### **■ Self-assessment**
- The dipsticks can be used for a quick self-assessment of one's organization, based on one's own interpretation of the sub-elements, using a 10-point scale for each of these. The scorecard should be used to log one's scores.
- As a more formal alternative:
1. Obtain the top management's support for self-assessment.
 2. Identify key personnel for participation by business element.
 3. Distribute the IQMM dipsticks a week in advance to each of the participants.
 4. Discuss the 10 sub-elements for each business element with the relevant personnel.
 5. Score each sub-element on a 10-point scale for each business element.
 6. Log the scores on the scorecard.

 **Bird's-eye view:**

The International Quality Maturity Model (IQMM) is a new age tool for measuring, benchmarking, and certifying the quality of management performance.

Table 5.10 IQMM Scorecard

Sl No.	Business Element	Sub-elements										TOTAL
		1	2	3	4	5	6	7	8	9	10	
1.	Leadership and strategic planning											
2.	Company-wide communication											
3.	Human resource management											
4.	Quality management system											
5.	Cost of poor quality											
6.	Customer interaction management											
7.	Research, design and development											
8.	Supplier interaction management											
9.	Operations management and maintenance											
10.	Stores, distribution and service management											
11.	Inspection and measurement											
12.	Corrective and preventive action											
13.	Continual quality improvement											
14.	Quality audits											
15.	Stakeholder satisfaction											
Grand Total												
Maximum Score												1,500

Source: Adapted from www.qimpro.com, reproduced with the permission of Qimpro Standards Organization, Mumbai.

■ Scoring

The IQMM scoring software is copyrighted by Qimpro Standards Organization. The scoring leads to an overall rating of the quality of management system and performance on a scale of 1 to 10. The IQMM scorecard is shown in Table 5.10.

Bird's-eye view:

Capability Maturity Model Integration (**CMMI**) is a process improvement training and appraisal program. Administered by the **CMMI** Institute, a subsidiary of ISACA.

■ CAPABILITY MATURITY MODEL INTEGRATION (**CMMI**)

The Capability Maturity Model Integration (**CMMI**) is an integrated model to propel process improvements in system and software engineering. Organizations will be able to coordinate efforts to improve their capabilities in both disciplines using this model. **CMMI** is a model that consists of best practices for system and software development and maintenance.

CMMI was developed by the Software Engineering Institute (SEI) at Carnegie Mellon University and is an enhanced version of the Capability Maturity Model that integrates various other frameworks created by SEI. CMMI enables not only the strengthening of software engineering processes, but also those of risk management and structured decision-making. It also facilitates the effective integration of peoples' capability maturity aspects with the discipline of software engineering.

The CMMI model provides guidance for use when developing system and software processes. The model may also be used as a framework for appraising the process maturity of the organization. CMMI helps integrate traditionally separate organizational functions, sets process improvement goals and priorities, provides guidance for quality processes and provides a point of reference for appraising and documentation processes.

CMMI is a process improvement approach that provides organizations with the essential elements of effective processes. It can be used to guide process improvement across a project, a division or an entire organization.

The Capability Maturity Model (CMM)⁵ contains the essential elements of effective processes for one or more disciplines and describes an evolutionary path with improved quality and effectiveness. It focuses on improving processes in an organization. In software engineering, this model is used to identify and improve the maturity of the capability of certain business processes. A maturity model can be described as a structured collection of elements that describe certain aspects of maturity in an organization and aids in the definition and understanding of an organization's processes.

■ Benefits of Process Improvement

The following are some of the benefits and business reasons for implementing process improvement:

- The quality of a system is highly influenced by the quality of the process used to acquire, develop and maintain it
- Process improvement increases product and service quality as organizations apply it to achieve their business objectives
- Process improvement objectives are aligned with business objectives

Bird's-eye view:

A maturity level is a well-defined evolutionary plateau toward achieving a mature software.

■ Benefits of CMMI

The CMMI model improves the best practices of previous models in many important ways. CMMI best practices enable organizations to do the following⁶:

- Link management and engineering activities to their business objectives more explicitly
- Expand the scope of and visibility into the product lifecycle and engineering activities to ensure that the product or service meets customer expectations
- Incorporate lessons learned from additional areas of best practice (e.g. measurement, risk management and supplier management)
- Implement more robust high-maturity practices
- Address additional organizational functions critical to their products and services
- Fully comply with relevant ISO standards

Bird's-eye view:

Each maturity level provides a layer in the foundation for continuous process improvement. In CMMI models with a staged representation, there are five maturity levels designated by the numbers 1 to 5.

Infosys Technologies became the first company to achieve CMMI Level 5 for its offshore and onsite operations. Its development centre in Chennai won the prestigious honour. The details are furnished in Box 5.5.

Box 5.5 Infosys Technologies Ltd—First Company to Achieve CMMI Level 5

"We are proud to be the first Indian company to be assessed for our offshore as well as onsite processes", said Satyendra Kumar, Head of Quality for Infosys. "We believe that this model is helping us systematize our onsite operations as well as manage risk quantitatively, enabling us to enhance our global competitiveness."

"The appraisal team which used one of the most rigorous methods of assessment, looked at 24 process areas as applied to all aspects of work, including onsite teams and customer relationships. The organization is clearly customer-focused, with an uncompromising attitude towards quality and on-time delivery, which was evident throughout the appraisal process. Infosys is to be congratulated on achieving CMMI Level 5 in this appraisal," said Ed Weller of Software Technology Transition, who was the lead appraiser for the assessment.

Infosys has been a pioneer in implementing the practices of the CMMI model At various offsite and onsite centers. The Infosys development centre in Chennai has been using the CMMI-based processes since October 2001 and providing measurable business benefits to the organization.

Source: Adapted from www.freelibrary.com/infosys, accessed February 2010.

Bird's-eye view:

The Capability Maturity Model Integration, or CMMI, is a process model that provides a clear definition of what an organization should do to promote behaviors that lead to improved performance.

Bird's-eye view:

With five "Maturity Levels" or three "Capability Levels," the CMMI defines the most important elements that are required to build great products, or deliver great services, and wraps them all up in a comprehensive model.

■ Main Features of CMMI

The CMMI model has three important components:

1. Maturity or Capability levels
2. Process Area (PA)
3. Goals and practices
 - a. Specific Goals (SG) and Generic Goals (GG)
 - b. Specific Practices (SP) and Generic Practices (GP)

■ Maturity or Capability Levels

Capability levels apply to an organization's process improvement achievements in the individual process areas. These levels are a means for incrementally improving the processes corresponding to a given process area. Capability levels provide a scale for measuring an organization's processes against each process area in the CMMI model. There are six capability levels, which are numbered 0 through 5.

Maturity levels apply to an organization's process improvement achievements across multiple process areas. These levels are a means of predicting the general outcomes of the next project undertaken. The maturity level of an organization provides a way to predict the future performance of an organization within a given discipline or set of disciplines. The maturity level indicates the strength of the process implementation across the organization in all areas. There are five maturity levels, numbered 1 through 5.

There are two variants of the model—staged and continuous. The staged CMMI model is divided into maturity levels whereas continuous model is divided into capability levels.

■ Staged

The staged representation offers a view of the organization level and provides a standardized measure for the entire organization's maturity level. Organizations that like to improve their processes across various process areas to reflect a certain maturity are likely to choose the staged model. The overall maturity of the organization is measured by maturity levels one to five:

- Maturity level 1: Initial
- Maturity level 2: Managed
- Maturity level 3: Defined
- Maturity level 4: Quantitatively managed
- Maturity level 5: Optimizing

Maturity level 1—Initial

Level 1—Chaos: It is the lowest maturity level and any organization which does not belong to any of the other levels is considered to belong to Level 1. At maturity level 1, processes are usually chaotic and ad hoc. The organization usually does not provide a stable environment. There is no predictability in schedule, budget, scope or quality. The organization is mainly people-dependent rather than process-dependent. The success in these organizations depends on the competence and heroism of key people in the organization and not on the use of proven processes. Little documentation and few, if any, processes and procedures are in place.

Maturity level 1 organizations often produce products and services that work; however, they frequently exceed the budget and schedule of their projects. Maturity level 1 organizations are characterized by a tendency to over-commit, abandon processes in the time of crisis and may not be able to repeat their past successes. The disciplines of management and engineering are weak and inadequate. This may be used for projects with limited scope.

Maturity level 2—Managed

Level 2—Repeatability: It is termed as the “managed level.” At this level, an organization has achieved all the specific and generic goals of the maturity level 2 process areas. In other words, the projects of the organization have ensured that requirements are managed and that processes are planned, performed, measured and controlled. The process discipline reflected by maturity level 2 helps ensure that existing practices are retained during times of stress so that projects are performed and managed according to their documented plans.

At this level, the organization starts making realistic project commitment and key project elements like cost, schedule and scope are tracked. The organization defines a clear policy for project management and begins to plan the projects formally.

The status of the work products and the delivery of services are visible to the management at defined points. Commitments are established among relevant stakeholders and are revised as needed. Work products are reviewed with stakeholders and are controlled. The work products and services satisfy their specified requirements, standards and objectives. Enough documentation exists for the quality assurance process to be repeated. This may be used for any project that will be done again, whether as an upgrade or a somewhat similar variation. Even at level 2, although the organization builds project discipline, there is still no process discipline. Thus, the results of each project may vary to a large extent.

Maturity level 3—Defined

Level 3—Standardization: At maturity level 3, an organization has achieved all the specific and generic goals of the process areas assigned to maturity levels 2 and 3. At maturity level 3, processes are well characterized and understood and are described as standards, procedures, tools and methods.

A critical distinction between maturity levels 2 and 3 is the scope of standards, process descriptions and procedures. At maturity level 2, the standards, process descriptions and procedures may be quite different in each specific instance of the process (for example, in a

Bird's-eye view:

CMMI is comprised of a set of “Process Areas.” Each Process Area is intended to be adapted to the culture and behaviors of your own company.

Bird's-eye view:

The CMMI is not a process, it is a book of “whats” not a book of “hows,” and does not define how your company should behave. More accurately, it defines what behaviors need to be defined. In this way, CMMI is a “behavioral model” as well as a “process model.”

 **Bird's-eye view:**

CMMI was developed by a group of experts from industry, government, and the Software Engineering Institute (SEI) at CMU.

 **Bird's-eye view:**

CMMI models provide guidance for developing or improving processes that meet the business goals of an organization.

particular project). At maturity level 3, the standards, process descriptions and procedures for a project are tailored from the organization's set of standard processes to suit a particular project or organizational unit. The quality management system is generated which contains documentation regarding all processes. Quality assurance documentation and processes and procedures are standardized. Templates and a quality assurance system exist for all documentation. The organization's set of standard processes includes the processes addressed at maturity levels 2 and 3. As a result, the processes that are performed across the organization are consistent except for the differences allowed by the tailoring guidelines.

Another critical distinction is that at maturity level 3, processes are typically described in more detail and more rigorously than at maturity level 2. At maturity level 3, processes are managed more proactively using an understanding of the interrelationships of the process activities and detailed measures of the process, its work products and its services.

This is critical for a quality assurance department that must provide quality assurance for multiple projects. This avoids reinventing the wheel for each project.

Maturity level 4—Quantitatively managed

Level 4—Manageability: At maturity level 4, the organization focuses on managing the projects and processes through the usage of statistical tools. This brings into picture the usage of data that the organization has started to collect at level 3. At this level, the organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3 and 4 and the generic goals assigned to maturity levels 2 and 3.

At maturity level 4, sub-processes are selected which significantly contribute to the overall process performance. These selected sub-processes are controlled using statistical and other quantitative techniques. Threshold values are established for each process area. All projects need to ensure that requirements remain within the defined threshold values.

Quantitative objectives for quality and process performance are established and used as a criteria in managing processes. Quantitative objectives are based on the needs of the customer, end users, organization and process implementers. Quality and process performance is understood in statistical terms and is managed throughout the life of the processes.

For these processes, detailed measures of process performance are collected and statistically analysed. Special causes of process variation are identified and where appropriate, the sources of special causes are corrected to prevent recurrence in future. Quality and process performance measures are incorporated into the organization's measurement repository to support fact-based decision making in the future.

The exact time and resources required to provide adequate quality assurance for each product is known precisely. Therefore, timetables and quality levels are met consistently and without surprises. At this level, the quality of projects that the organization delivers is very high. All projects are managed and controlled using quantitative data.

A critical distinction between maturity levels 3 and 4 is the predictability of process performance. At maturity level 4, the performance of processes is controlled using statistical and other quantitative techniques and is quantitatively predictable. At maturity level 3, processes are only qualitatively predictable. This level can only be achieved by a well-documented experience.

Maturity level 5—Optimizing

Level 5—Optimization: It is a stage of continuous process improvement. At maturity level 5, an organization has achieved all the specific goals of the process areas assigned to maturity levels 2, 3, 4, and 5 and the generic goals assigned to maturity levels 2 and 3.

Since the entire organization works using a common process and collects common data, the only way to improve the organization is by improving the process itself. Processes are

continually improved based on a quantitative understanding of the common causes of variation inherent in processes. Maturity level 5 focuses on continually improving process performance through both incremental and innovative technological improvements.

Quantitative process-improvement objectives for the organization that are established are continually revised to reflect changing business objectives and used as criteria in managing process improvement. The areas of weakness are identified and the root cause is determined using causal analysis.

The effects of deployed process improvement are measured and evaluated against the quantitative process-improvement objectives. Both the defined processes and the organization's set of standard processes are targets of measurable improvement activities. At this level, quality assurance and procedures are understood well enough to be refined and streamlined.

Optimizing processes that are agile and innovative depend on the participation of an empowered workforce aligned with the business values and objectives of the organization. The organization's ability to rapidly respond to changes and opportunities is enhanced by finding ways to accelerate and share learning. Improvement of processes results in a cycle of continual improvement. Although all processes can be improved upon, the process having the highest priority is addressed first. The organization also depends on cost-benefit analysis to select the process area which is most painful.

A critical distinction between maturity levels 4 and 5 is the type of process variation addressed. At maturity level 4, processes are concerned with addressing special causes of process variation and providing statistical predictability of the results. Though processes may produce predictable results, the results may be insufficient to achieve the established objectives. At maturity level 5, processes are concerned with addressing common causes of process variations and changing the process (that is, shifting the mean of the process performance) to improve process performance (while maintaining statistical predictability) to achieve the established quantitative process-improvement objectives.

■ Continuous

We use the term capability level for representation of the continuous element. (For staged representation, we use the term maturity level.) The continuous representation offers a detailed image of an organization's processes. It allows an organization to evaluate process areas individually. It is the representation commonly used in process improvement because it allows for identifying and focusing on trouble spots and measuring improvement progress on a fine grained scale.

A capability level is a well-defined evolutionary plateau describing the organization's capability relative to a process area of related specific and generic practices for a process area that can improve the organization's processes associated with it. Each level is a layer in the foundation for continuous process improvement.

Organizations that like to improve their processes in one area at a time may be likely to choose the continuous model. The continuous model applies specific process improvements and achievements for each process area. These are measured by six capability levels from zero to five. The six capability levels are:

- Capability level 0: Initial
- Capability level 1: Performed
- Capability level 2: Managed
- Capability level 3: Defined

Bird's-eye view:

A capability level is a well-defined evolutionary plateau describing the organization's capability relative to a process area of related specific and generic practices for a process area that can improve the organization's processes associated with it.

Bird's-eye view:

Each capability level is a layer in the foundation for continuous process improvement.

- Capability level 4: Quantitatively managed
- Capability level 5: Optimizing

Each capability level corresponds to generic goals and specific goals. A set of generic practices help to achieve a general goal. Implementing a number of specific practices leads to meeting a specific goal.

In continuous representation, different process areas may have different capabilities. If an organization opts for continuous representation; it may have capability level 2 in process area A and capability level 4 in process area B. The continuous model is chosen by those enterprises that want to strengthen themselves in a chosen area as per their business model.

Bird's-eye view:

Each capability level corresponds to generic goals and specific goals. A set of generic practices help to achieve a general goal. Implementing a number of specific practices leads to meeting a specific goal.

Capability Level 0: Incomplete: Capability level 0 indicates an incomplete process. An “incomplete process” is a process that is either not performed or partially performed. One or more of the specific goals of the process area are not satisfied and no generic goals exist for this level since there is no reason to institutionalize a partially performed process.

Capability Level 1: Performed: This is the beginning of the process improvement. At this level, the process is expected to perform all of the specific and generic practices associated with capability level 1. Performance may not be stable and may not meet specific objectives such as quality, cost and schedule. However, useful work can be done. It means that one is doing something but one cannot prove that it is really working for one.

Capability Level 2: Managed: Capability level 2 has the processes actively managing the way things are done in the organization. Metrics are collected and used at all levels of the CMMI in both the staged and continuous representations.

At this level, a managed process is planned, performed, monitored and controlled for individual projects, groups, or stand-alone processes to achieve a given purpose. Managing the process achieves both the model objectives for the process as well as other objectives such as cost, schedule and quality.

Capability Level 3: Defined: Capability level 3 processes are characterized as “defined processes.” A defined process is a managed (capability level 2) process that is tailored from the organization’s set of standard processes according to the organization’s tailoring guidelines and contributes work products, measures and other process-improvement information to the organizational process assets.

Capability Level 4: Quantitatively Managed: Capability level 4 focuses on establishing baselines, models and measurements for process performance. Capability level 4 processes are characterized as “quantitatively managed processes.” A quantitatively managed process is a defined (capability level 3) process that is controlled using statistical and other quantitative techniques. Quantitative objectives for quality and process performance are established and used as criteria in managing the process. Quality and process performance is understood in statistical terms and is managed throughout the life of the process.

Capability Level 5: Optimizing: Capability level 5 focuses on studying performance results across the organization or the entire enterprise, finding common causes of problems in how the work is done (the processes used) and fixing the problems in the process. This would include updating the process documentation and training involved where the errors were injected.

An optimizing process is a quantitatively managed process that is improved based on an understanding of the common causes of process variation inherent in the process. It focuses on continually improving process performance through both incremental and innovative improvements. Both the defined processes and the organization’s set of standard processes are targets of improvement activities.⁷

Table 5.11 Comparison of Capability and Maturity Levels

Level	Continuous Representation Capability Levels	Staged Representation Maturity Levels
Level 0	Incomplete	Not applicable
Level 1	Performed	Initial
Level 2	Managed	Managed
Level 3	Defined	Defined
Level 4	Quantitatively managed	Quantitatively managed
Level 5	Optimizing	Optimizing

A comparison of capability and maturity levels is given in Table 5.11.

■ Process Area (PA)

A process area is a cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making significant improvements in that area. All CMMI process areas are common to both the continuous and staged representations.

Each maturity level, except maturity level 1, has a set of “process areas” (PA) associated with it. A process area represents an organized set of activities to achieve one specific aspect of the model. For example, Configuration Management Process Area is aimed at providing a sequence of activities to maintain proper configuration of products and work products of a project. There are 22 process areas in the CMMI Version 1.2. The CMMI Process Areas (PAs) can be grouped into four categories such as process management, project management, engineering, support to understand their interactions and links with one another regardless of their defined level. The Capability Maturity Model Integrated (CMMI) is shown in Figure 5.4.

 **Bird's-eye view:**

A process area is a cluster of related practices in an area that, when implemented collectively, satisfies a set of goals considered important for making significant improvements in that area.

 **Bird's-eye view:**

All CMMI process areas are common to both the continuous and staged representations.

DISCUSSION FORUM

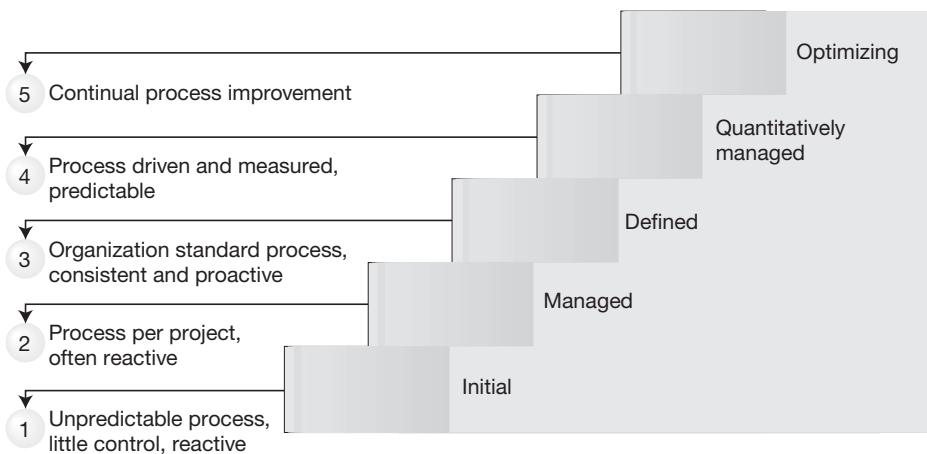
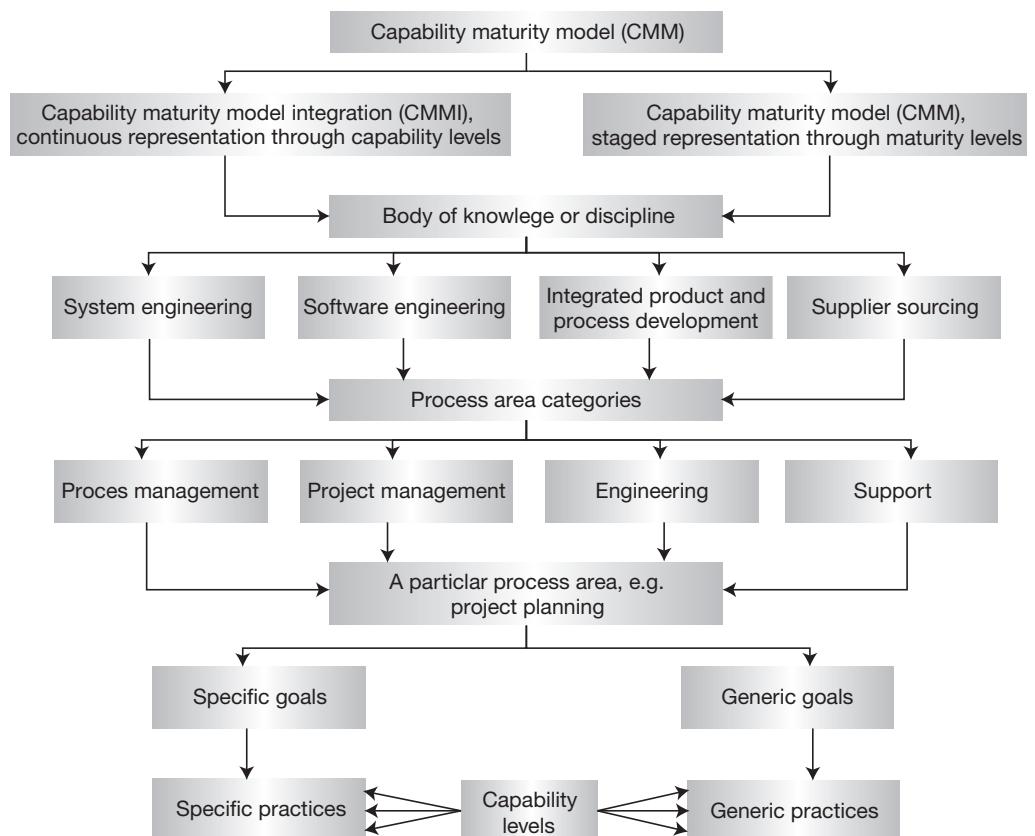
1. Discuss IIQM.
2. Explain the CMMI model.

■ Goals and Practices

Goals and practices are the model elements used to realise the values on both the capability and process dimensions. Each process area is defined by a set of goals and practices. There are two categories of goals and practices:

1. **Generic goals and generic practices:** They are part of every process area. They realise the capability dimension. Therefore, they are applied across all process areas.
2. **Specific goals and specific practices:** They are specific to a given process area. They realise the process dimension. Therefore, they are applied to a particular process area.

A process area is satisfied when company processes cover all the generic and specific goals and practices for that process area. The Capability Maturity Model is shown in Figure 5.5.

Fig. 5.4 Maturity Levels**Fig. 5.5 Capability Maturity Model**

SUMMARY

- TQM awards are nationally or internationally recognized quality standards that provide discipline, external assessment and a clear process for switching to TQM. They also have tremendous potential publicity value within the organization and with the public.
- The best known TQM awards are Japan's Deming Prize, USA's Malcolm Baldrige National Quality Award and the European Quality Award. These awards are models and act as a practical tool that can be used in a number of different ways. They can be used as a tool for self-assessment, as a way to benchmark with other organizations, as a guide to identify areas for improvement, as the basis for a common vocabulary and a way of thinking and as a structure for the organization's management system.
- The Deming Prize is one of the highest awards given for TQM initiatives in the world. It was established by JUSE in December 1950 in honour of W. Edwards Deming. Deming contributed greatly to Japan's proliferation of statistical quality control after World War II.
- The Deming Prize has three award categories—Deming Prize for Individuals, the Deming Application Prize and the Quality Control Award for Operations Business Units. The Deming application prizes are awarded to private or public organizations and are subdivided into small enterprises, divisions of large corporations and overseas companies.
- MBNQA is given by the NIST of United States and administered by the ASQ. The award is presented annually to organizations within the United States by the President of the United States. Both IMC RBNQA and TBEM are adapted from the MBNQA.
- The criteria of MBNQA for Business Excellence are built on a set of core values and concepts, and these core values are embedded in the seven Baldrige criteria. There are three versions of the criteria for performance excellence and these are in the sectors of business, education and healthcare.
- The European Quality Award, referred to as European Foundation for Quality Management (EFQM) Excellence Award, is Europe's most prestigious award for organizational excellence and has been awarded annually by the European Foundation for Quality Management to Europe's best performing companies and not-for-profit organizations since 1992.
- EFQM Excellence Model is a non-prescriptive framework based on nine criteria. Five of these are "enablers" and four are "results." The "enabler" criteria cover what an organization does. The "results" criteria cover what an organization achieves. "Results" are caused by "enablers" and "enablers" are improved using feedback from "results."
- The CII and EXIM Bank of India jointly established the Award for Excellence in 1994 with the aim to enhance the "Competitiveness of India Inc." The Award is based on the EFQM Model for Excellence.
- The IQMM is a new age tool for measuring, benchmarking and certifying the quality of management performance. It is based on world-class management models, such as RBNQA, MBNQA and EFQM.
- The Capability Maturity Model (CMM) in software engineering is a model of the maturity of the capability of certain business processes. CMMI is a model that consists of best practices for system and software development and maintenance. CMMI provides an interconnected and, hence, stable model with more detailed coverage of the product lifecycle than other process improvement alternative products.

Key Terms

Capability Levels 154	International Quality Maturity Model (IQMM) 149
Capability Maturity Model (CMM) 153	Malcolm Baldrige National Quality Award (MBNQA) 134
Capability Maturity Model Integration (CMMI) 152	Maturity Levels 154
CII-EXIM Bank Award for Excellence 145	Practices 159
Deming Prize 162	Process Area 159
Enablers 144	Results 136
European Foundation for Quality Management (EFQM) Model 142	TATA Business Excellence Model (TBEM) 134
European Quality Award 142	TQM Awards 131
Goals 159	Union of Japanese Scientists and Engineers (JUSE) 132
IMC Ramakrishna Bajaj National Quality Award (RBNQA) 140	W. Edwards Deming 132

Case Study

The Deming Prize and Sona Koyo

Dr Surinder Kapur, the chairman of Sona Koyo Steering Systems Limited, the passenger car and utility vehicle steering systems and columns manufacturer, looked worried as he pored over the production data.

It was only in November 2003 that Sona Koyo had won the prestigious Deming Prize, awarded by the Union of Japanese Scientists and Engineers (JUSE), widely considered the equivalent of the Nobel for manufacturing companies.

What bothered him was a minuscule increase in plant level rejects. Dr Kapur didn't want the smooth workflow to be disturbed because Sona Koyo was targeting export revenues of Rs 1 billion through global automobile manufacturers who were looking at India as their base for sourcing components.

According to Dr Kapur, "After we received the medal, the organization slackened a bit. This will be true of all companies and each one will find its own ways of tackling the issue." The slackening was the signal that the systems and procedures had yet to be assimilated fully within the organization, necessitating a back-to-basics programme even after being awarded the prestigious prize.

The Company

Sona Koyo Steering Systems Limited is located in Gurgaon in the outskirts of Delhi and their factory manufactures steering systems. In June 2004, the owner of this company, Dr Surinder Kapur stepped on to a glittering stage in Tokyo to receive an award from the Chairman of Toyota Corporation. Sona Koyo Systems was awarded the Deming Prize in 2003.

Sona Steering Systems (SSS) limited was established in 1987 in partnership with Maruti Udyog Limited (MUL) and technical collaboration with M/s Koyo Seiko Company, Japan. It started with a team of 25 employees with a business model that invited the customer to become an equity partner with the company. In 1988, the company with 27 employees achieved a turnover of Rs 70 million. Today, the company employs over 1,000 people and has a turnover of Rs 8,273 million.

The company initially was in the business of manufacturing steering systems for all passenger cars and medium utility vehicles made by MUL. Subsequently, M/s Koyo Seiko also participated financially in the company and today it has an equity of 21.5% in Sona. Due to this, the name SSS Limited was changed to Sona Koya Steering Systems Limited (SKSSL).

The company started with a portfolio of three products in 1988. Presently, it has expanded its business of steering manufacturing to include drive line products and components for off-road vehicles. It has a portfolio of 57 products as well as the skills to re-engineer existing products to save costs. It also has a strong clientele base. Sona Koyo's customers include major vehicle manufacturers in India such as Maruti Suzuki, Toyota, Hyundai, Tata Motors, Mahindra & Mahindra, General Motors and Mahindra-Renault. Independently, as well as through its network of overseas joint-venture partners, it exports high-quality precision products to the US, Europe and Japan.

The achievements of Sona Koyo are significant. SKSSL, the flagship company of the Sona Group is currently the largest manufacturer of steering systems for the passenger car and utility vehicle market in India.

It took five years of hard work and a single-minded focus to create quality systems that won it the Deming Prize. Second, Sona Koyo is the first steering system manufacturer in the world to win this award. Most importantly, the prize which was awarded by the Union of Japanese Scientists and Engineers established the company's bona fide among international automotive majors.

Performance of the Deming Prize Winners

Firms in the auto component sector have made significant advances in quality since 1990. This would not have been visible but for the ten Deming awards that were given to firms in this sector from 1998 to 2004 (see Exhibit 5.1). This is the highest number of firms from any country across all industries outside Japan to win this award.

Exhibit 5.1 Deming Prize Winners List (1998–2004)

Award	Firm	Year
Deming Application Prize	Sundaram-Clayton Ltd, Brake Division	1998
	Sundaram Brake Linings Ltd,	2001
	TVS Motor Company Ltd,	2002
	Brakes India Ltd, Foundry Division	2003
	Mahindra and Mahindra Ltd, Farm Equipment sector	2003
	Rane Brake Linings Ltd,	2003
	Sona Koyo Steering Systems Ltd,	2003
	Lucas-TVS Ltd,	2004
	Hi-Tech Carbon GMPD	2002
	Sundaram-Clayton Ltd, Brakes Division	2002

Source: Adapted from www.juse.or.jp, accessed April 2010.

Sona's Quality Journey

The country's premier car manufacturer, Maruti Suzuki, through its cluster approach in the early nineties, was the first to set the quality movement in motion among the domestic auto ancillary companies in India. Maruti got 11 of its vendors to adhere to quality systems and processes. Sona was one of them.

Companies like Sona Koyo and a clutch of others had taken this as a challenge. The company's in-house rejection levels, supplier rejection levels and customer return levels decreased considerably after the implementation of TQM initiatives.

Sona Koyo's TQM initiative began in 1998 as a part of a cluster of companies promoting group learning under the quality guru Professor Tsuda. In 2000, the group was dismantled. However, Professor Tsuda provided further mentoring to Sona, and in course of time, the company seamlessly integrated the various elements of quality management.

It has been an exciting journey of transformation into a strong TQM organization. Dr Kapur, however, feels that every company today needs to perform Kaizen activities as part of TQM. They must recognize that every business and product has a lifecycle and before it dies, it needs to be re-invented. Therefore, breakthroughs in organizations are very critical.

"The Deming process is like getting a doctorate. In Ph.D. there is no syllabus. One has to choose an area that has not been researched previously by somebody else and come out with your own findings," says Dr Surinder Kapur, chairman and managing director, Sona Koyo Steering Systems Limited. On the award itself, he says, "These are wonderful benchmarks. I wish more and more companies will try and follow these benchmarks. The practices are so robust, the processes are so clear and it's a great enjoyment in managing an organization with these."

Sona is surging ahead in its TQM journey. It is also developing its core competence and aligning its objectives at all levels so as to realise synergy in operations. An initiative of improving the most important resources, the human resource as well as plant equipment has been initiated. The technique total productive maintenance (TPM) has been adopted to improve performance through the philosophy of prevention. SKSSL aims to achieve zero accidents, zero defects and zero breakdowns by using the Koyo Production System (an adopted version of Toyota Production Systems) as the foundation of all change programmes.

These initiatives have fashioned a new culture in the organization. They have also played a major role in bringing the company's medium term management objectives and annual policies in line with its long-term customer-oriented vision of becoming a "supplier of choice" to global customers by 2010.

Literature suggests a positive relationship between winning a quality award and subsequent firm performance. SKSSL had a significant risk of putting undue pressure on organizational resources or focusing too narrowly on winning and neglecting other aspects of their business, thereby leading to performance shortfalls. Significant experience in TQM/TQC prior to competing for a quality award was seen as perhaps helping to moderate these risks.

Source: Adapted from www.sonagroup.com and www.innovationjournalism.org, accessed February 2010.

For Discussion

1. Does winning a quality award lead to competitive advantages for a firm?
2. What were the preparations made by SKSSL for challenging the Deming Prize?
3. Comment on the performance of the winners of the Deming Prize with reference to Exhibit 5.1.

Short-answer Questions

1. Name the best known TQM awards.
2. Which are the three award categories of the Deming Prize?
3. What is MBNQA?
4. Name the core values of MBNQA.
5. Which are the seven Baldrige Criteria for Business Excellence?
6. Name the three versions of the Baldrige award.
7. What is EQA?
8. Name the criteria of the EFQM Excellence Model.
9. Name the two awards in India adopted from MBNQA.
10. Which award in India is based on the EFQM Model?
11. What is IQMM?
12. Which industry sector uses the CMMI model?

Match the Following

a. Deming Prize	Adapted from MBNQA
b. MBNQA	Adapted from EFQM
c. EFQM	JUSE
d. IQMM	Administered by ASQ
e. CII-EXIM Bank Award	Based on world-class management models
f. TBEM	Software Quality Management
g. CMMI	European Quality Award

Discussion Questions

1. Explain the Deming Prize.
2. What is the CII-EXIM Bank award for Business Excellence? Briefly explain the various clauses of the EFQM model.
3. What is the Ramakrishna Bajaj National Quality award (RBNQA)? Briefly explain the various clauses of the Malcolm Baldrige Criteria for Business Excellence.
4. Using a schematic diagram briefly explain the International Quality Maturity Model.
5. Briefly explain the six capability levels in CMMI.
6. Give an overview of the Capability Maturity Model using a schematic diagram.

Projects

1. In small groups, visit any organization that has won any of the awards mentioned in the chapter. Analyse the difference the award has made to the organization. Prepare a report and present it in the class.

2. Visit the National Quality Programme Web site (www.baldridge.org) and prepare a report using the information available on the Web site.
3. Trace the journey of Sundaram-Clayton Limited, Brakes division in its journey towards the Deming Prize.
4. Visit the Web site of the Software Engineering Institute, Carnegie Mellon University, Download the People's Capability Maturity Model (PCMM). Analyse PCMM with CMMI for differences and similarities.

End Notes

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6

Statistical Concepts in Quality Management



QUALITY ASSURANCE AT APOLLO HOSPITALS

The healthcare industry and the technology used in the healthcare sector are changing rapidly to meet the varying needs of patients. With international accreditation like the Joint Commission International (JCI) making sweeping changes on the medical landscape, the concepts of quality and excellence form an essential pillar of healthcare delivery. Apollo Hospitals keeps itself abreast with new technology and increases the scope of its services to cater to the overall requirements of patients and focuses on quality patient care. The hospital's quality steering committee, comprising representatives from senior leadership and leaders of the medical staff, lead the Apollo Quality Program.

The Apollo Quality Program is aimed at the standardization of processes for clinical handovers, medication safety, surgical safety, patient identification, verbal orders, and hand washing compliance and falls prevention across hospitals in the group. Around 32 hospitals across the group in rural and semi-urban, urban, and metropolitan settings implemented the programme and demonstrated visible improvement to comply with processes to ensure consistency, reliability, safety, and quality across the entire organization over a period of one year.

The quality program in the hospital addresses various challenges such as identifying and balancing the competing perspectives of major participants in the healthcare delivery system, establishment of an accountability framework, formation of explicit criteria by which the health system performance is judged, development of indicators for routine reporting, and mobilization of medical and nursing staff to provide quality care to patients. The programme also identifies factors that inhibit progress in improving and assessing performance.

“If you can’t measure it, you don’t understand it.”

Lord Kelvin

Upon completion of this chapter, you will be able to:

1. Understand variation
2. Explain mean, range, standard deviation and normal distribution
3. Explain measurement system analysis (MSA)
4. Describe process capability
5. Discuss sampling
6. Understand quality assurance, quality policy and quality manual

Bird's-eye view:

Common and special causes are the two distinct origins of variation in a process, as defined in the statistical thinking and methods of Walter A. Shewhart and W. Edwards Deming.

■ INTRODUCTION

The quality control function that is now referred to as total quality management (TQM) emphasizes the strategic importance of quality to the whole organization and not just the factory floor. TQM involves a never ending process of continuous improvement with the objective of achieving perfection. The two main approaches to quality control are:

- (1) Acceptance sampling
- (2) Statistical process control

■ VARIATION

Variation¹ is the enemy of quality. The less variation there is in a product or process, the greater the number of items that will work as designed. One must measure variation to reduce it. The concept of variation states that no two items will be perfectly identical even if extreme care is taken to make them identical in some respect. All processes are subject to a certain degree of variability. Usually, variations are of two types:

- a. Natural (common)
- b. Assignable (special)

These variations are caused by two types of factors.² Natural variations are due to “common causes” and assignable variations are due to “special causes.” Common cause variation is natural and exists in every process. It can be reduced by process improvement

activities, but not eliminated. In other words, it is the variation that is inherent in a process that is operating as designed. Special cause variation, on the other hand, is an unnatural variation in a process. It should be identified, and the reasons may be assigned and addressed. Control charts enable us to determine the type of variation that exists in a process.

■ Variation Due to Natural Causes

The variations due to natural causes are inevitable in any process or product. They are difficult to trace and difficult to control even under best conditions. These variations may be due to some inherent characteristics of the process which functions at random.

■ Variation Due to Assignable Causes

These variations possess greater magnitude as compared to those caused by chance and can be easily traced or detected. The variations due to assignable causes may occur because of the following factors:

1. Differences among materials
2. Differences among machines
3. Differences among workers
4. Differences in each of these factors over time
5. Differences in their relationship to one another

These variations may also be caused due to changes in working conditions, human errors, lack of knowledge about quality, etc.

■ Statistical Process Control (SPC)³

SPC is the application of statistical methods to the measurement and analysis of variation in any process. It is used to measure the performance of a process and thereby ensure that the process is meeting the specified standards. It is a methodology for monitoring a process to identify special causes of variation and signaling the need to take corrective action when appropriate. The process is deemed to be out of control when special causes are present and responsible for the situation. If the variation in the process is due to common causes alone, then the process is said to be under statistical control. A practical definition of statistical control is that both the process averages and variances are constant over time.

SPC relies on control charts, one of the basic quality improvement tools, which will be introduced under the seven statistical tools in Chapter 8.

Bird's-eye view:

Statistical process control (SPC) is a method of quality control which uses statistical methods.

Bird's-eye view:

SPC is applied in order to monitor and control a process. Monitoring and controlling the process ensures that it operates at its full potential.

■ Quality Control Measurements⁴

Quality control measurements and indicators fall into one of the following two categories:

1. Attribute
2. Variable

A useful thumb rule would be to say that data obtained by counting are attributes (discrete data), while data obtained by actual measurement are variables (continuous).

Bird's-eye view:

Both variable data and attribute data measure the state of an object or a process, but the kind of information that each describes differs.

Attribute (discrete data): An attribute is a performance characteristic that is either present or absent in the product or service under consideration. Attributes data are discrete and indicate whether the characteristics conform to specifications. Attributes can be measured by visual inspection or by comparing dimensions to specifications. Attributes measurements are typically expressed as proportions or rates. In this system, each item is classified into one of the two categories such as acceptable or defective, good or bad, conforming or not conforming, etc. Examples of attributes are:

- Surface finish of furniture
- The number of defective pieces found in a sample
- Cracks in sheets by spot welds

Bird's-eye view:

Variable data involve numbers measured on a continuous scale, while attribute data involve characteristics or other information that you can't quantify.

Variable (continuous data): Variable measurements are concerned with the degree of conformance to specifications. Variable measurements are generally expressed through such statistics as averages and standard deviations. Examples of variables are:

- A dimension of a part measured
- Temperature in degree centigrade
- Weight of a part in kg
- Tensile/compressive strength in kg/cm²

It is usually easier to collect attribute data than variable data because the assessment can be done quickly by a simple inspection or count. Variable data require the use of some type of measuring instrument. In a statistical sense, attributes inspection is less efficient than variables inspection; that is, it does not yield as much information. This means that attributes inspection requires a larger sample than variables inspection to obtain the same amount of statistical information pertinent to the quality of the product. This difference can become significant when inspection of each item is time consuming or expensive. Most quality characteristics in services are attributes.

DISCUSSION FORUM

1. Which are the two main approaches to quality control?
2. Discuss variability.
3. Name two types of variations.
4. Describe SPC.

■ PROBABILITY DISTRIBUTIONS⁵

Probability is the chance that something will occur. Probabilities are expressed as fractions or decimals. If an event is assigned a probability of 0, it means that the event can never happen. If the event is given a probability of 1, then it indicates that it will always happen. Classical probability defines the probability that an event will occur, given that each of the outcomes are equally likely, as explained below:

$$P(\text{event}) = \text{Number of Ways that the Event can Occur} / \text{Total Number of Possible Outcomes}$$

Probability is always a fraction, which may vary from 0 to 1. A probability of 1 indicates certainty because it denotes that something will happen 100 times out of 100. A probability of zero means impossibility.

■ Laws of Probability

The three main laws of probability are:

1. Additional law of probability
2. Multiplication law of probability
3. Theorem of conditional probability

There are many different probability distributions, both discrete and continuous. The four most commonly used distributions are as follows:

1. Binomial distribution
2. Poisson distribution
3. Exponential distribution
4. Normal distribution

The normal distribution is discussed below.

■ Normal Distribution

In probability theory and statistics, the normal distribution or Gaussian distribution is a continuous probability distribution that describes data that clusters around a mean or average. The graph of the associated probability density function is bell-shaped, with a peak at the mean, and is known as the Gaussian function or bell curve.

A normal distribution is a very important statistical data distribution pattern occurring in many natural phenomena such as height, blood pressure, lengths of objects produced by machines, etc. Certain data when graphed as a histogram (data on the horizontal axis, amount of data on the vertical axis), creates a bell-shaped curve known as a normal curve or normal distribution.

Normal distributions are symmetrical with a single central peak at the mean (average) of the data. The shape of the curve is described as being bell-shaped with the graph falling off evenly on either side of the mean. Fifty per cent of the distribution lies to the left of the mean and 50 per cent to the right of the mean. The spread of a normal distribution is controlled by the standard deviation (σ). The smaller the standard deviation, the more concentrated the data. The mean and the median are the same in a normal distribution.

Mean: The mean is just the average of the numbers.

Standard deviation: The standard deviation (σ) is a measure of the spread of the numbers in a data set. The standard deviation is the square root of the variance.

Variance: The average of the squared differences from the mean. It is the square of the standard deviation, i.e. σ^2 .

Exercise 1

The heights of five males are:

180, 160, 170, 175, 165

Find out the mean, variance and the standard deviation.

Answer:

$$\text{Mean} = \frac{180+160+170+175+165}{5} = 850/5 = 175 \text{ cm}$$

The average height is 175 cm.

Bird's-eye view:

A **probability distribution** is a mathematical description of a random phenomenon in terms of the probabilities of events.

Bird's-eye view:

A probability distribution is defined in terms of an underlying sample space, which is the set of all possible outcomes of the random phenomenon being observed.

Bird's-eye view:

A probability distribution whose sample space is the set of real numbers is called univariate, while a distribution whose sample space is a vector space is called multivariate.

To calculate the variance, take the difference of each height with the average height, square it and then average the result:

$$\text{Variance} = \sigma^2 = 5^2 + (-15)^2 + (-5)^2 + 0^2 + (-10)^2 / 5 = 375 / 5 = 75$$

So, the variance is 75.

The standard deviation is just the square root of variance.

$$\text{Standard deviation: } \sigma = \sqrt{75} = 8.66$$

Now it is possible to identify the heights that are within one standard deviation (8.66 cm) of the mean.

Bird's-eye view:

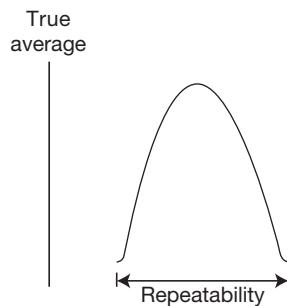
Measurement system analysis (MSA) is an experimental and mathematical method of determining how much the variation within the **measurement** process contributes to overall process variability. There are five parameters to investigate in an MSA: bias, linearity, stability, repeatability and reproducibility.

■ MEASUREMENT SYSTEM ANALYSIS (MSA)⁶

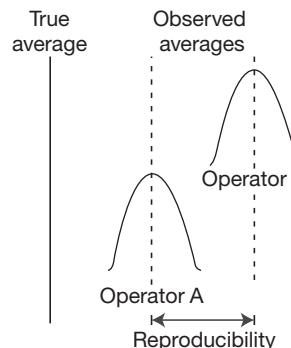
A measurement system analysis (MSA) is an experimental and mathematical method of determining how much the variation within the measurement process contributes to overall process variability.

There are five parameters to investigate in an MSA—bias, linearity, stability, repeatability and reproducibility. Measurement system variation can be characterized by location (stability, bias, linearity) and width or spread (repeatability and reproducibility). These are shown in Figures 6.1, 6.2, 6.3, 6.4 and 6.5.

Fig. 6.1 Repeatability



6.2 Reproducibility



6.3 Bias

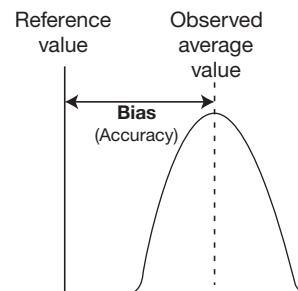


Fig. 6.4 Stability

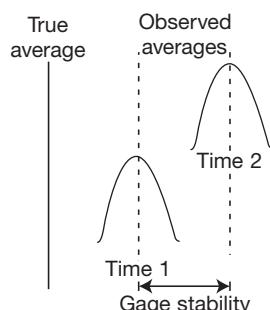
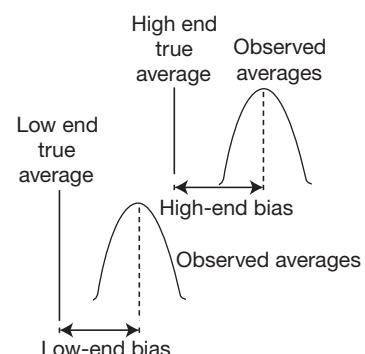


Fig. 6.5 Linearity



MSA analyses the collection of equipment, operations, procedures, software and personnel that affect the assignment of a number to a measurement characteristic.

An MSA considers the following:

- Selecting the correct measurement and approach
- Assessing the measuring device
- Assessing procedures and operators
- Assessing any measurement interactions
- Calculating the measurement uncertainty of individual measurement devices and/or measurement systems

Common tools and techniques of MSA include calibration studies, fixed effect ANOVA, components of variance, attribute gage study, gage R&R, ANOVA gage R&R, destructive testing analysis and others. The tool selected is usually determined by characteristics of the measurement system itself.

Precision and Accuracy of the Method of Measurement

Precision is the degree to which identically performed measurements agree with each other. Precision carries no meaning for only one measurement. It exists when repeated measurements are made on a single quality characteristic of one particular article under identical conditions. The observations will be scattered about the mean in such a set. The less the scattering, the more precise the measurement.

Precision or measurement variation can be broken down into two components—repeatability and reproducibility. It is important to determine the magnitude of any error in the resulting measurements for measurement systems that result in quantitative measurements such as weight, concentration or strength. If the error is large, it may be impossible to determine whether or not an individual sample is within specification. Additionally, designed experiments rely on the ability to separate real effects of making changes from the background noise and can be sabotaged by an inadequate measurement system. When quantifying measurement error, it is common to separate the error into repeatability (error due to the instrument or measurement procedure) and reproducibility (error due to the appraiser).

Repeatability is the variation due to the measuring device. It is the variation observed when the same operator measures the same part repeatedly with the same device as shown in Figure 6.1.

Reproducibility is the variation due to the measurement system. It is the variation observed when different operators measure the same parts using the same device. It is shown in Figure 6.2.

The reproducibility of measurement refers to the consistency of its pattern of variation. This may be judged through control charts where repeated measurement shows erratic patterns of variation. Therefore, the method used may not be reproducible. Any statement regarding the precision of the method of measurement implies that the method of measurement is reproducible.

The precision of an instrument is the extent to which the instrument repeats its results when making repeated measurements on the same unit of the product. A numerical measure of precision is the standard deviation of the frequency distribution that would be obtained from such repeated measurements. The lower the value of σ , the more “precise” is the instrument.



Bird's-eye view:

Accuracy and precision are used in context of measurement. **Accuracy** refers to the degree of conformity and correctness of something when compared to a true or absolute value, while **precision** refers to a state of strict exactness — how consistently something is strictly exact.

Factors affecting measurement systems: The factors affecting measurement systems include:

- Equipment: Measuring instruments, calibration, fixturing, etc.
- People: Operators, training, education, skill, care
- Process: Test methods, specification
- Samples: Materials, items to be tested (sometimes called “parts”), sampling plan, sample preparation, etc.
- Environment: Temperature, humidity, conditioning, pre-conditioning
- Management: Training programmers, meteorology system, support of people, support of quality management system, etc.

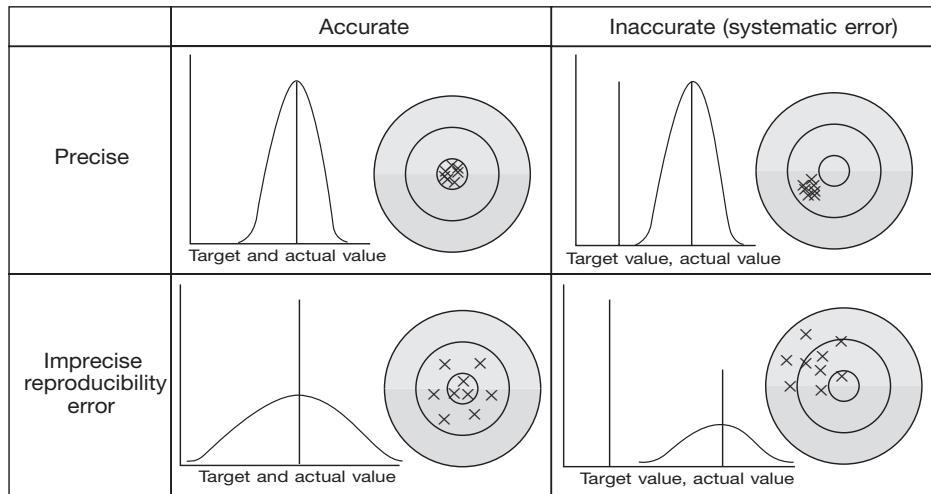
These can be plotted in a “fishbone” Ishikawa diagram (discussed in Chapter 8) to help identify potential sources of measurement variation.

Accuracy: The accuracy of a measurement system is usually broken into three components:

- **Bias:** Bias refers to the probability of the presence of certain factors in a system that can influence deviation from the standards in the system. Bias can lead to sampling of data, which on analysis appear to be different from the actual or anticipated data set. A process called calibration is undertaken to measure the process measurement bias. In case of indeterminate measurement process owing to constraints, the data average values are compared with the standard values. It is the difference between the observed average measurement and a master value. It is shown in Figure 6.3.
- **Stability:** Stability refers to processes that are normally free from special cause variations. Analysing a system for stability typically involves the standard statistical processes such as statistical process control (SPC), scatter plots, ANOVA techniques and other standard deviation measurement tools. The determination of stability standards in a system requires data sampled to cover a wide range of possible variation factors and intensive piece-meal statistical tests covering variations in human resources, tools, parts, time, space and location factors. It is a measure of how accurately the system performs over time. It is the total variation obtained with a particular device, on the same part, when measuring a single characteristic over time. It is shown in Figure 6.4.
- **Linearity:** Linearity refers to different statistical results from measurements when subjected to different metric spaces. Linearity in a system is determined using higher levels of calibrations in measurement standards, which are often guided by inferences drawn from various interactive factors influencing a system. For instance, non-linearity in a system may result from equipment (or tools) not calibrated for various levels of operating range or poor design of the system or any other system constraint. It is a measure of how the size of the part affects the accuracy of the measurement system. It is the difference in the observed accuracy values through the expected range of measurements. It is shown in Figure 6.5.

Measurement system errors can be classified into two categories—accuracy and precision. Accuracy is very often confused with precision. Accuracy is the degree to which the measured value of the quality characteristic agrees with the true value. Accuracy is how close a measured value is to the actual (true) value. Precision, on the other hand, refers to how close the measured values are to each other. Figure 6.6 shows the difference between precision and accuracy.

- Accuracy describes the difference between the measurement and the part’s actual value.
- Precision describes the variation one sees on measuring the same part repeatedly with the same device.

Fig. 6.6 Difference Between Precision and Accuracy

Within any measurement system, you can have one or both of these problems. For example, you can have a device which measures parts precisely (little variation in the measurements) but not accurately. You can also have a device that is accurate (the average of the measurements is very close to the accurate value), but not precise, that is, the measurements have large variance. You can also have a device that is neither accurate nor precise.

The difference between the measured value and the true value is known as the error of measurement. A practical difficulty in judging accuracy is that the method employed to determine the true value should be a method of high precision. It is practically difficult to measure the true value of quality exactly. Some examples of precision and accuracy are discussed in Box 6.1.

Box 6.1 Examples of Accuracy and Precision

Accuracy is defined as the ability of a measurement to match the actual value of the quantity being measured. In reality, if it is 34.0 F outside and a temperature sensor reads 34.0 F, then that sensor is accurate.

Precision is defined as (1) the ability of a measurement to be consistently reproduced and (2) the number of significant digits to which a value has been reliably measured. If on several tests, the temperature sensor matches the actual temperature while the actual temperature is held constant, then the temperature sensor is precise. As per the second definition, the number 3.1415 is more precise than the number 3.14.

An example of a sensor with bad accuracy and bad precision: Suppose a lab refrigerator holds a constant temperature of 38.0 F. A temperature sensor is tested 10 times in the refrigerator. The temperatures from the test yield the temperatures of 39.4, 38.1, 39.3, 37.5, 38.3, 39.1, 37.1, 37.8, 38.8 and 39.0. This distribution shows no tendency toward a particular value (lack of precision) and does not acceptably match the actual temperature (lack of accuracy).

An example of a sensor with good accuracy and bad precision: Suppose a lab refrigerator holds a constant temperature of 38.0 F. A temperature sensor is tested 10 times in the refrigerator.

The temperatures from the test yield the temperatures of 37.8, 38.3, 38.1, 38.0, 37.6, 38.2, 38.0, 38.0, 37.4 and 38.3. This distribution shows no impressive tendency toward a particular value (lack of precision). However, each value does come close to the actual temperature (high accuracy).

An example of a sensor with bad accuracy and good precision: Suppose a lab refrigerator holds a constant temperature of 38.0 F. A temperature sensor is tested 10 times in the refrigerator. The temperatures from the test yield the temperatures of 39.2, 39.3, 39.1, 39.0, 39.1, 39.3, 39.2, 39.1, 39.2 and 39.2. This distribution does show a tendency toward a particular value (high precision). However, every measurement is well off from the actual temperature (low accuracy).

An example of a sensor with good accuracy and good precision: Suppose a lab refrigerator holds a constant temperature of 38.0 F. A temperature sensor is tested 10 times in the refrigerator. The temperatures from the test yield the temperatures of 38.0, 38.0, 37.8, 38.1, 38.0, 37.9, 38.0, 38.2, 38.0 and 37.9. This distribution does show a tendency toward a particular value (high precision) and is very near the actual temperature each time (high accuracy).

The goal of any meteorological instrument is to have high accuracy (sensor matching reality as close as possible) and to also have a high precision (being able to consistently replicate results and to measure with as many significant digits as appropriately possible). Meteorological instruments, including radars, need to be calibrated so that they sustain high accuracy and high precision.

Source: Adapted from www.micquality.com, accessed June 2016.

Relationship between variability of measured values and the precision of the method of measurement: The variability observed in measured values of the quality characteristic is partly due to the variability of the product and partly due to variability inherent in the method of measurement.

The standard deviation of the measured value is given by the formula:

$$\sigma_{\text{Measured Value}} = \sqrt{(\sigma_{\text{True Value}})^2 + (\sigma_{\text{Error of Measurement}})^2}$$

DISCUSSION FORUM

1. Describe probability.
2. What are the different types of probability distributions?
3. Name the five parameters used to investigate measurement system analysis.

Bird's-eye view:

Process capability compares the process output with the customer's specification. The purpose of a process capability study is to compare the process specification to the process output and determine statistically if the process can meet the customer's specification. The less variation there is in a process, the more capable it will be of meeting the customer's specification.

■ PROCESS CAPABILITY⁷

Process capability is crucial for industrial managers. The challenge in today's competitive markets is to produce high quality products at minimum costs. This cannot be done without a systematic approach. This approach is contained within what has been called "statistical quality control" or "industrial statistics." Being in control of a manufacturing process using SPC is not enough. An "in-control" process can produce bad or out-of-specification products. Manufacturing processes must meet or be able to achieve product specifications. Further, product specifications must be based on the customer's requirements.

Process capability is defined as "the performance of a process over a certain period of time while in the statistically controlled state." Process capability is the repeatability and consistency of a manufacturing process relative to the customer requirements in terms of specification limits of a product parameter. This measure is used to objectively measure the degree to which one's process is meeting or not meeting the requirements. This allows one to quantify

how well a process can produce an acceptable product. Process capability studies indicate that if a process is capable of producing virtually an all-conforming product, then statistical process controls can be used to monitor the process and conventional acceptance efforts can be reduced or eliminated entirely. This not only yields great cost savings in eliminating non-value added inspections but also eliminates scrap, rework and increases customer satisfaction. The benefits of performing process capability studies are certainly worth the effort in the long run.

Process capability studies are used to assess the ability of a process to meet specifications. Process capability must be adequate to produce quality products and services that can be purchased by the customer with satisfaction. If processes are not sufficiently capable, improvements must be made and maintained to attain desired quality levels.

Process capability compares the output of an in-control process to the specification limits by using capability indices. The comparison is made by forming the ratio of the spread between the process specifications (the specification "width") to the spread of the process values, as measured by six process standard deviation units (the process "width").

An understanding of all processes right from design to selling is very important for implementing quality management activities. This is made possible by process capability studies. Process capability studies facilitate various business functions in the following ways:

Design department: To get basic information for determining tolerances or engineering targets.

Purchase department: To establish reference data for selecting suppliers, evaluation of purchased materials and confirmation of delivery dates.

Production department: To get basic information for preparation of the quality plan, determining the methods of process control, process analysis and assured quality levels.

Inspection department: Reference information for preparation of inspection standards and inspection methods.

Quality control: Basic information for planning, controlling and evaluation of product and service quality.

■ Process Capability Study

A process capability study is a systematic procedure for determining the capability of a process. The process capability study may include studies to improve the process and in turn the capability of the process. Process capability studies are usually performed as part of a process certification effort or a process optimization effort for two primary reasons:

1. To predict future capability of the process to produce products within specifications
2. To identify process improvement opportunities

Steps for conducting a process capability study: A process capability study measures the capability of a specific piece of equipment or a process under specific operating conditions. It is important to identify and record this information prior to the beginning of the process capability study. Critical parameters usually correlated to the product function need to be selected before the study begins. The steps for conducting a process capability study are discussed below:

Step 1: Preparing for the study. This involves (a) defining the processing conditions, (b) selecting a representative operator, (c) ensuring that sufficient raw materials are available and (d) ensuring that the measurement system is reliable.

Step 2: Determining the process output. The process output can be determined by (a) running the process and collecting data, (b) ensuring simultaneously that the process

Bird's-eye view:

A capable process is:

- Stable and not changing.
- Can fit within the customer's specification with a little extra room (usually 25%) to spare.

is stable using the same methods as for setting up a control chart, (c) since common process capability calculations are based on a stable, normally distributed process, if the process is not stable, one should not conduct a process capability study and (d) calculating the process mean and process variation for the measured output.

Step 3: Comparing the process output to the specification. A specification normally consists of the nominal or ideal measure for the product and the tolerance, which is the amount of variation acceptable to the customer. The total tolerance is the distance between the upper specification limit (USL) and the lower specification limit (LSL). The C_{pk} for a process is determined by calculating the C_{pu} and the C_{pl} . The C_{pk} is the lower of those two numbers.

Step 4: Taking action to improve the process. There are a variety of activities that can be undertaken to improve a process such as 8D problem solving or mistake proofing.

The following three types of process capability studies are conducted:

1. **A peak performance study:** To determine how a process performs under ideal conditions.
2. **A process characterization study:** To determine how a process performs under actual operating conditions.
3. **A component variability study:** This assesses the relative contributions of the different sources of total variation.

Bird's-eye view:

The **process capability** is a measurable property of a **process** to the specification, expressed as a **process capability index** (e.g., C_{pk} or C_{pm}) or as a **process performance index** (e.g., P_{pk} or P_{pm}).

■ Process Capability Indices⁸

Process capability can be expressed as the percentage that is non-conforming or in terms of the natural spread related to the specification spread. Capability indices have been developed to graphically portray that measure. Capability indices let you place the distribution of your process in relation to the product specification limits. Capability indices should be used to determine whether the process, given its natural variation, is capable of meeting established specifications. It is also a measure of the manufacturability of the product with the given processes.

Capability indices⁹ can be used to compare product/process matches and identify the poorest match (lowest capability). The poorest matches can then be targeted on a priority basis for improvement.

If we sample a group of items periodically from a production run and measure the desired specification parameter, we will get sub-group sample distributions that can be compared to that parameter's specification limits. Two examples of this are represented in Figure 6.7.

Fig. 6.7 Process Capability Indices

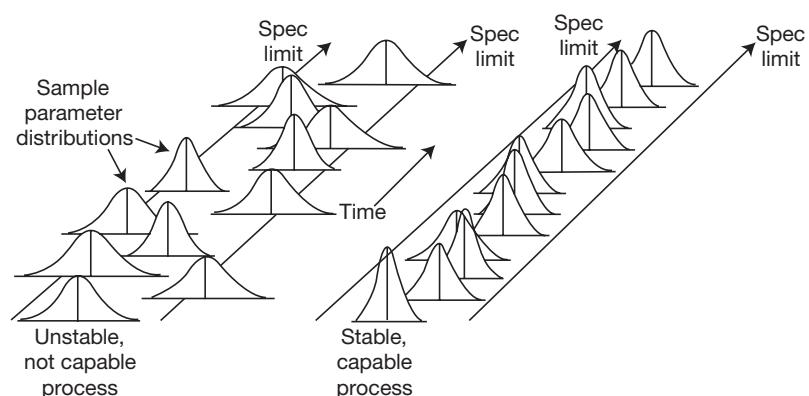
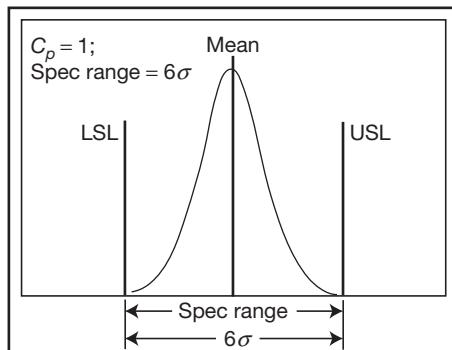


Fig. 6.8 Process Capability Index (C_p)

The left side of Figure 6.7 shows a series of sample distributions that fall inside and outside of the specification limit. This is an example of an unstable or a not-capable process. The right side of the figure shows all the distributions falling within the specification limits. This is an example of a capable process.

Process capability can be expressed with an index. Two widely used process capability indices are C_p and C_{pk} which are also known as process capability estimates. They show how capable a process is of meeting its specification limits when used with continuous data.

- C_p index:** This is a process capability index that indicates the potential performance of a process by relating the natural process spread to the specification (tolerance) spread. It is often used during the product design and pilot production phases. This measures the potential or inherent capability of the production process. It evaluates the ability of a process to meet two-sided specification limits.
- C_{pk} index:** These measures realise the process capability relative to actual production. It is used to summarize the ability of a process to meet two-sided specification limits.

Process capability index (C_p): The process capability index (C_p) can be used when one assumes that the mean of the process is centered on the target value. C_p is a simple process capability index that relates the allowable spread of the specification limits (specification range or the difference between the upper specification limit (USL) and the lower specification limit (LSL)) to the measure of the actual, or natural, variation of the process, represented by Six Sigma, where "sigma" is the estimated process standard deviation and is shown in Figure 6.8.

If the process is in statistical control, via "normal" SPC charts, and the process mean is centered on the target, then C_p can be calculated as below. Processes are evaluated by using the C_p value as indicated in Table 6.1.

$$\text{Process Capability Index} = C_p = (\text{USL} - \text{LSL})/\text{Six Sigma}$$

Table 6.1 C_p Value

C_p Value	Evaluation	Action
$C_p > 1.67$	Too much capability	No concern of measure in product variation. Consider process simplification and cost reduction
$1.67 > C_p > 1.33$	Sufficient capability	Ideal condition, maintain it
$1.33 > C_p > 1.00$	Moderate capability	Process control has to be firm. When C_p is close to 1, rejections can occur

Bird's-eye view:

A process capability index is a numerical summary that compares the behaviour of a product or process characteristic to engineering specifications. These measures are also often called capability or performance indices or ratios.

(Continued)

Table 6.1 (Continued)

C_p Value	Evaluation	Action
$1.00 > C_p > 0.67$	Insufficient capability	Rejections are there. 100 per cent inspection is required. Process needs to be controlled and improved.
$0.67 > C_p$	Capability very much insufficient	Quality not satisfactory. Standards and processes need immediate review and improvement.

✉ Bird's-eye view:

A capability index is convenient because it reduces complex information about the process to a single number.

Upper and lower capability indices: While C_p relates the spread of the process relative to the specification width, it does not address how well the process average, X , is centered to the target value. C_p is often referred to as process “potential” and is shown in Figure 6.9.

$$C_{pl} = (X - LSL)/3 \text{ Sigma, where } X \text{ is the process mean}$$

$$C_{pu} = (USL - X)/3 \text{ Sigma, where } X \text{ is the process mean}$$

It is desirable to have both C_{pu} and $C_{pl} \geq 1$.

■ Process Performance Capability Ratio

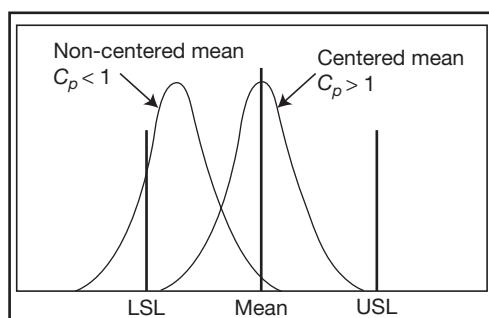
C_{pk} measures not only the process variation with respect to allowable specifications; it also considers the location of the process average. C_{pk} is taken as the smaller of either C_{pl} or C_{pu} .

Many companies are establishing process-specific capability targets. They may typically start with 1.33 for supplier qualification and have an expected goal of 2.0. If the process is near normal and in statistical control, then C_{pk} can be used to estimate the expected percentage of defective material.

Process capability studies are designed to see what the process is “capable” of doing under controlled conditions over a short period of time (such as one hour to twenty-four hours.) A process engineer is the individual who is mainly responsible for a process capability study. The process engineer must keep in mind the following considerations when conducting the study:

- Eliminate or minimize special causes of variation, for example, using the same operator, same batch of material, same machine, etc.
- Collect a minimum of 50 consecutive pieces in at least 10 subgroups of five.

The process capability study enables one to determine the short term stability and capability of a process.

Fig. 6.9 Upper and Lower Capability Indices

Process performance studies are conducted to identify how well a process that is in statistical control performs in the long term (for example, one week or longer). Two types of variations within the process are statistically measured—variation within subgroups and variations between subgroups. Variables should include different operators, material, tool changes and adjustments, etc. The process engineer must ensure the following for the process performance study to be successful:

- Data are obtained over an extended period of time (a minimum of 5 days of data) under normal conditions
- A minimum of 100 pieces in 20 subgroups of five is gathered

Six Sigma concept of process capability¹⁰: “Sigma” is a capability estimate typically used with attribute data (i.e. with defect rates). Six Sigma is a breakthrough strategy developed by the famous American company Motorola. It is a statistical measurement of the quality of products provided by any company. Today, it is synonymous with the term world-class. The Six Sigma strategy is applicable to any product, process, transaction or service.

As per one of the definitions, quality is conformance to specification. A defect occurs each time we fail to meet the specifications. Quality can be improved by the elimination of defects. It is important to know the causes of defects to prevent defects.

Variation is the cause of defects. Let us take an example from the production of steel bolts. If we make the products using the material having the same quality on identical machines and work methods, and inspect the quality of each product in the same way, no matter how many products we make, all of them would be identical if the four conditions mentioned above are kept unchanged. All the products may be either conforming or non-conforming to the specifications. If there are variations in the material, machines, production methods and inspection methods, all of them may be defective.

To make the product defect-free, it is essential to minimize the variation of a process to the minimum possible level with a target of zero variation. The main objective of quality management is to eliminate defects in every input, process and output that is possible, by controlling the variation. To do so, the first step is to make the measurement of variability a part of the process.

Every quality feature has its own unit of measure. For example, temperature is measured in units of degree celsius, speed is measured in terms of meters per second, weight is measured in units of grams, etc. Similarly, variability is measured statistically in terms of standard deviation and denoted by the Greek alphabet σ (sigma).

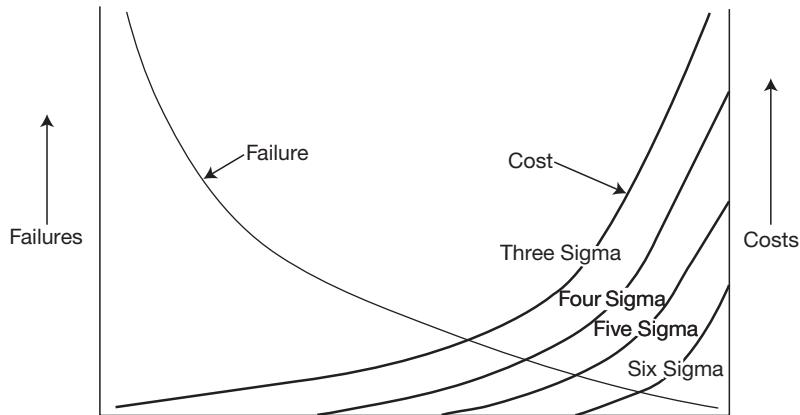
The sigma value indicates how often defects are likely to occur. The higher the sigma value, the less likely a process will produce defects. Consequently, as sigma increases, product reliability improves and the need for testing and inspection comes down, cost reduces, inventory reduces and profit and customer satisfaction goes up.

The average product, regardless of how simple or complex, has a quality performance value of four sigma. Today, world-class companies providing the best products have improved their business processes to a level of excellence, where they are able to have as few as 3.4 defects in a million opportunities to make defects. This is termed as Six Sigma quality. The Six Sigma strategy measures the degree to which any business process has deviated from its goal.

Motorola's Six Sigma process changed the relationship between quality and cost. In fact, a “family” of relationships rather than a single relationship best represents the quality/cost relationship. As Figure 6.10 clearly reveals, the greater the increase in quality, the greater the reduction in costs. Improving quality reduces the so-called

Bird's-eye view:

In the Six Sigma quality methodology, process performance is reported to the organization as a sigma level. The sigma value indicates how often defects are likely to occur. The higher the sigma level, the better the process is performing.

Fig. 6.10 Actual Quality Cost Relationships

"hidden plant" costs such as people, floor space and equipment that are used to find and fix things that should have been done right the first time itself.

Table 6.2 presents the various levels of sigma capabilities and the implications of each level.

Bird's-eye view:

The main focus of Six Sigma, like most other quality initiatives, is the reduction of waste and cost, improvement in yields, increased capacity utilization, reduction in cycle time with the ultimate objective of satisfying customer needs.

Bird's-eye view:

The Six Sigma breakthrough strategy involves a series of five basic steps that are specifically developed for making the improvements. These steps are Define, Measure, Analyse, Improve and Control.

Practical impact of quality process capability: The Six Sigma strategy is aimed at reducing the defects at the breakthrough level through a disciplined and practical application of statistical methods by reducing variations. The application of Six Sigma begins with taking a practical problem and then translating it into a statistical problem. Statistics then helps in finding the optimal solution, which is implemented as a practical solution in a real life situation.

The main focus of Six Sigma, like most other quality initiatives, is the reduction of waste and cost, improvement in yields, increased capacity utilization, reduction in cycle time with the ultimate objective of satisfying customer needs.

The Six Sigma breakthrough strategy involves a series of five basic steps that are specifically developed for making the improvements. These steps are Define, Measure, Analyse, Improve and Control. The implementation stresses leadership at the highest level of the company. When these five steps are completed for all the key processes within a business, one can see breakthrough improvement occurring in profitability and customer satisfaction.

As Motorola continues to press toward its goal of Six Sigma or fewer than four defects per million, a profound change in its understanding of the relationship between marketing and quality is clearly visible. As a result, Motorola views its approach to marketing research, product development and design, and its advertising and corporate communications very differently.

Table 6.2 Levels of Six Sigma

Sigma	Defects Per Million	Cost of Poor Quality	Product Status
Six Sigma	3.4	< 10 per cent of sales	World-class
Five Sigma	233	10–15 per cent of sales	Industry average
Four Sigma	6,210	15–20 per cent of sales	
Three Sigma	66,807	20–30 per cent of sales	
Two Sigma	308,537	30–40 per cent of sales	Non-competitive
One Sigma	690,000	40–70 per cent of sales	

Motorola began with two major quality targets in mind—defect prevention and reduced cycle time. Initially, Motorola's total quality efforts were “internal” in nature, and they looked only at defects on printed circuit boards manufactured in the factory. Now, Motorola is establishing quality criteria directly from the aspect of customer value. Its definition of a defect today is “if the customer doesn't like it, it's a defect.”

Next, Motorola aimed at reducing cycle time. First, the product development and design engineers made sure that the internal specifications matched the customer specifications when introducing new products. A “design-for-quality” approach has contributed significantly to linking quality with marketing at Motorola. Design for quality is a process that Motorola has applied to services as well. For example, a “dropped” call is a defect for a cellular phone customer.

The result of design for quality is a product design process that emphasizes more on efforts to produce systems that are robust or very continuous. Products are also developed faster because the process provides an explicit way upfront to figure out what the customer wants. Finally, this process has helped Motorola's field salespeople to focus on selling benefits identified by the customer, that is, what the product accomplishes from the buyers standpoint. The Six Sigma quality programme combines the following key ingredients:

1. A superordinate goal of “total customer satisfaction.”
2. Common and uniform quality metrics for all areas of the business.
3. Identical improvement rate goals for all areas of the business based on uniform metrics.
4. Goal-directed incentives for both management and employees.
5. Coordinated training in “why” and “how” to achieve the goal.

DISCUSSION FORUM

- 1. What is process capability?
- 2. Discuss process capability studies.
- 3. Name two widely used process capability indices.
- 4. Explain the practical impact of quality process capability.

■ SAMPLING¹¹

The main assumption made in the theory of sampling is that the samples are drawn at random, (without showing any favour or bias). For this purpose, suitable measures or procedures may be laid down and adopted according to the nature and configuration of items under inspection for ensuring complete randomness in sample selection. In order to ensure the reliability of sampling inspection, proper planning of the sampling scheme is absolutely essential. A good sampling plan should select a sample at the lowest cost that will provide the best possible representation of the population, consistent with the objectives of precision and reliability that have been determined for the study.

There are generally two ways in which inspection is carried out:

1. 100 per cent inspection
2. Sampling inspection

In 100 per cent inspection, all the parts or products are subjected to inspection, whereas in sampling inspection only a sample is drawn from the lot and inspected.

Bird's-eye view:

Sampling is the process of selecting units (e.g., people, organizations) from a population of interest so that by studying the **sample**, We may fairly generalize our results back to the population from which they were chosen.

Sampling inspection can be defined as a technique to determine the acceptance or rejection of a lot or population on the basis of the number of defective parts found in a random sample drawn from the lot. The lot is accepted if the number of defective items do not exceed a pre-defined level. Otherwise, it is rejected.

The advantages of sampling inspections are as follows:

1. Sampling inspection must only inspect the items that are subjected to the destructive test.
2. The cost and time required for sampling inspection is quite less as compared to 100 per cent inspection.
3. The problem of inspection fatigue that occurs in 100 per cent inspection is eliminated.
4. Smaller inspection staff is necessary.
5. Less damage to products because only a few items are subject to handling during inspection.
6. The problem of monotony and inspector error introduced by 100 per cent inspection is minimized.
7. The most important advantage of sampling inspection is that it exerts more effective pressure on quality improvement since the rejection of the entire lot on the basis of sampling brings greater pressure on quality improvement than the rejection of individual articles.

Bird's-eye view:

A good sampling plan should select a sample at the lowest cost that will provide the best possible representation of the population, consistent with the objectives of precision and reliability that have been determined for the study.

Sampling methods: Sampling methods are broadly classified into:

1. **Non-probability sampling**
 - (a) Judgemental sampling
2. **Probability sampling the different types of probability sampling methods are:**
 - (a) **Simple random sampling:** Simple random sampling selects samples by methods that allow each possible sample to have an equal probability of being picked and each item in the entire population of having an equal chance of being included in the sample.
 - (b) **Systematic sampling:** In systematic sampling, elements are selected from the population at a uniform interval that is measured in time, order or space.
 - (c) **Stratified sampling:** In stratified sampling, we divide the population into relatively homogenous groups termed "strata." Then, we use one of two approaches. Either we select at random from each stratum, a specified number of elements corresponding to the proportion of that stratum in the population as a whole or we draw an equal number of elements from each stratum, and assign weight to the results according to the stratum's proportion of the total population.
 - (d) **Cluster sampling:** Here, we divide the population into the groups or clusters, and then select a random sample from these clusters. We assume that these individual clusters are representative of the population as a whole.
 - (e) **Two-stage sampling:** When the lot submitted for inspection consists of a larger number of packages each consisting of a number of items, it may not be economical to select and inspect all the items in these packages. In such cases, the sample is selected in two stages. In the first stage, a desired number of packages (primary units) are selected at random, and in the second stage, the required number of items is chosen at random from the selected primary units.

■ **Acceptance Sampling¹²**

Acceptance sampling is an important field of statistical quality control that was popularized by Dodge and Romig and originally applied by the US military for the testing of

bullets during World War II. If every bullet was tested in advance, no bullets would be left to ship. If, on the other hand, none were tested, malfunctions in the battlefield would be highly likely with potentially disastrous results.

A decision may be made to accept or reject a lot or consignment of items sent by a vendor depending upon the number of defective (non-conforming) items found in the sample drawn at random from the lot. This process of using sampling in incoming or outgoing inspection is called acceptance sampling.

Dodge reasoned that a sample should be picked at random from the lot. On the basis of information that has been yielded by the sample, a decision should be made regarding the disposition of the lot. In general, the decision is either to accept or reject the lot. This process is called lot acceptance sampling or just acceptance sampling.

Acceptance sampling is “the middle of the road” approach—between no inspection and 100 per cent inspection. There are two major classifications of acceptance plans by attributes (“go, no-go”) and by variables. A point to remember is that the main purpose of acceptance sampling is to decide whether or not the lot is likely to be acceptable and not to estimate the quality of the lot.

Acceptance sampling is employed when one or several of the following hold true:

- Testing is destructive
- The cost of 100 per cent inspection is very high
- 100 per cent inspection takes too long

It was pointed out by Harold Dodge in 1969 that acceptance quality control is not the same as acceptance sampling. The latter depends on specific sampling plans, which when implemented indicate the conditions for acceptance or rejection of the immediate lot that is being inspected. The former may be implemented in the form of an acceptance control chart. The control limits for the acceptance control chart are computed using the specification limits and the standard deviation of what is being monitored.

Acceptance sampling is less expensive and provides better outgoing quality as well as incoming lots of raw materials. Modern acceptance sampling involves a system of principles and methods. Their purpose is to develop decision rules to accept or reject products based on sample data. The factors coming into play here are:

1. The quality requirements of the product in the marketplace
2. The capability of the process
3. The cost and logistics of taking samples

Acceptance sampling by attributes: In acceptance sampling by attributes, each item tested is classified as conforming or non-conforming. A sample is taken and if it contains too many non-conforming items the batch is rejected, otherwise it is accepted.

Acceptance sampling by variables: Acceptance sampling can be carried out by measuring a variable rather than by classifying an item as conforming or non-conforming. Variables such as thickness, strength or weight can be measured. A typical plan would be to take a sample of size n and reject the batch if the mean measurement, \bar{x} is less than k . This would be appropriate for, say, the strength of a batch of climbing ropes where a large value is desirable. If the variable was, for instance a percentage of impurity in raw material, where a small value was desirable, the plan would be of the form to take a sample of size n and reject the batch if the mean measurement, \bar{x} , is greater than k .

Usually, it is easier and quicker to classify an item as conforming or non-conforming than to make an exact measurement. However, the information gained from an exact measurement is greater and so smaller sample sizes are required. A decision as to whether to use attributes

 **Bird's-eye view:**
Acceptance sampling is a major component of quality control and is useful when the cost of testing is high compared to the cost of passing a defective item or when testing is destructive. It is a compromise between doing 100% inspection and no inspection at all.

Table 6.3 Symbols and Terms Used in Connection with Acceptance Sampling

Symbol	Terms Used
N	Number of pieces in a given lot size
N	Number of pieces in a sample size
M	Number of defective pieces in a given lot size N
M	Number of defective pieces in a given sample of size n
C	Acceptance number, the maximum allowable number of defective pieces in a sample of size n
P	Fraction defective in a given lot $p = M/N$ in a given sample $p = m/n$
p'	True process average fraction defective of a product submitted for inspection
$p_{\bar{}}$	Average fraction defective in observed samples
p_a	Probability of acceptance
p_c	Consumer's risk, the probability of accepting product of some stated quality. The probability of rejecting product of some stated quality is referred to as producer's risk $(1 - P_a)$

or variables will depend on the particular circumstances of each case. The symbols used in relation to sampling acceptance are given in Table 6.3.

Quality indices for acceptance sampling plans: There are four main quality indices for acceptance sampling plans:

1. Acceptable quality level (AQL)
2. Rejectable quality level (RQL)
3. Indifference quality level (IQL)
4. Average outgoing quality (AOQ)

Bird's-eye view:

Acceptance sampling uses statistical sampling to determine whether to accept or reject a production lot of material. It has been a common quality control technique used in industry.

(1) **Acceptable quality level (AQL):** It represents the maximum proportion of defectives that the consumer finds definitely acceptable. AQL can also be defined as the maximum percentage of defectives that for the purpose of sampling inspection can be considered satisfactory as a process average. It is the fraction of defectives that can be tolerated without any serious effect upon further processing or customer relations.

Acceptable quality levels offer a diametrically opposed mindset to total quality. Instead of getting it right the first time and focusing on zero defects, the company encourages the adoption of AQLs. In reality, as quality improves, defects are reduced and costs decline.

Out of dual performance standards arises a willingness to put up with acceptable quality levels at work. The concept is illustrated by a real case. An IBM firm in Windsor, Ontario, ordered a shipment of components from a Japanese firm specifying the AQL as three defective components for every 10,000 parts. In a covering letter from the Japanese supplier to the IBM firm (which was reprinted in *The Toronto Sun*) that accompanied the order, the Japanese company explained how difficult it was to produce the defective parts and said, "We Japanese have a hard time understanding North American business practices. But the 3 defective parts per 10,000 have been included and wrapped separately."

If one sets an AQL of 99 per cent, the results are:

- At least 200,000 wrong drug prescriptions each year
- More than 30,000 newborn babies accidentally dropped by doctors/nurses each year
- No electricity, water and heating for about 15 minutes each day

- No telephone service or television transmission for nearly 15 minutes each day
 - Newspapers not delivered four times each year
 - At least one misspelled word on every page of a book
- (2) **Rejectable quality level (RQL):** It is also termed lot tolerance per cent defective (LTPD). This is a definition of unsatisfactory quality. It represents the proportion of defectives that the consumer finds definitely unacceptable. As RQL is an unacceptable quality level, the probability of acceptance for an RQL lot should be low. The probability of accepting a lot at RQL level represents a risk for the consumer.
- (3) **Indifference quality level (IQL):** This is a quality level somewhere between AQL and RQL. It is frequently defined as the quality level having a probability of acceptance of 0.50 for a given sampling plan.
- (4) **Average outgoing quality (AOQ):** It represents the average per cent defectives in the outgoing products after inspection, including all accepted and all rejected lots, which have been 100 per cent inspected and the defectives replaced by non-defectives.

Average outgoing quality level (AOQL): It is the maximum possible value of the average percentage defectives in the outgoing products after inspection and rectification.

Using the symbols and terms mentioned in Table 6.3, the formula for calculating

$$AOQ = P_a p'(N-n/N)$$

If the sample size is much less compared to lot size, then:

$$AOQ = P_a p'$$

Operating characteristic curve (OC curve)¹³: Operating characteristic curves are a graphical means for comparing SQC sampling plans. They display the relationship between lot size and the number of defectives. OC curves plot the proportion of defectives in the lot p and the probability of acceptance P_a . In this case, the number of non-conforming items in a batch will follow the binomial distribution. The application of OC curves is given below:

1. **Applying OC curve to evaluate sampling plans:** The operating characteristic (OC) curve in Figure 6.11 shows the probability of acceptance, P_a for lot quality of any level. In Figure 6.11, the quality characteristic is on the horizontal axis.

Producer's point and consumer's point are the two points on the operating characteristics curve. The producer's point (alpha risk, α) is the risk that emerges due to sampling variations in a lot having the proportion of defectives less than the acceptable quality level (AQL). This will be rejected by the consumer. Consumer's point (β = beta risk) is a risk that emerges due to sampling variations in a lot having the proportion of defectives more than the limiting quality level (LQL). This will be accepted by the consumer. These two points define the acceptable and unacceptable quality levels for the purpose of acceptance sampling. The two points also determine the risks associated with the acceptance/rejection decision. The OC curve enables one to evaluate the probability of acceptance for any true lot quality level on a what-if basis. This way, one can design sampling plans that perform the way one wants.

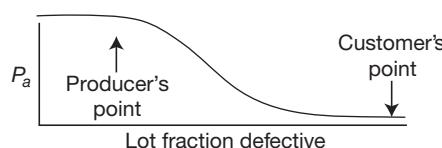
Bird's-eye view:

The **operating characteristic (OC) curve** depicts the discriminatory power of an acceptance sampling plan. The **OC curve** plots the probabilities of accepting a lot versus the fraction defective.

Bird's-eye view:

When the **OC curve** is plotted, the sampling risks are obvious. You should always examine the **OC curve** before using a sampling plan.

Fig. 6.11 OC Curve to Evaluate Sampling Plans



Interpret the curve according to the example below:

1. If the lot quality is 0.093 fraction defective, then the probability of acceptance, P_a , is 0.05.
2. If the lot quality is 0.018 fraction defective, then the probability of acceptance, P_a , is 0.95.
2. **Applying the OC curve to compare sampling plans:** OC curves can be used to compare alternative plans (Figure 6.12). Choose between the plans by studying their relative ability to detect rejectable lots. The steeper the curve, the larger the sample size. Complete this picture by comparing the costs of the sampling with the resulting performance.
3. **Applying the OC curve to design and develop the sampling plan:** The two-point method for developing acceptance sampling plans requires one to specify two points of the operating characteristic curve (OC curve).

Bird's-eye view:

OC Curve is used in quality control to determine the probability of accepting production lots when using different sampling schemes. It shows percentage-defectives along the horizontal ('X') axis and probability of acceptance along the vertical ('Y') axis. Lots having more than the acceptable percentage of defectives are rejected.

Producer's point: The producer's point controls the acceptance of lots that are at an acceptable quality level as shown in Figure 6.13. The goal here is to prevent good lots from being rejected.

Consumer's point: The consumer's point controls the rejection of lots that are at a rejectable quality level as shown in Figure 6.13. The goal here is to prevent bad lots from being accepted.

An OC curve helps to address the producer's and consumer's points in a visual, right brain way. On the other hand, the decision table defines the situation in a logical, left brain way. The type I and type II errors correspond logically to the two points on the OC curve.

Type I error—wrongful rejection: A type I error is associated with the producer's point—to reject when the true value of the quality characteristic is AQL. The risk of rejecting an AQL lot falls on the producer (α risk).

Type II error—wrongful acceptance: A Type II error is to accept the lot when the true value of the quality characteristic is RQL, which puts the risk on the consumer. The risk of accepting a lot if it is an RQL lot is; therefore, on the consumer (β = beta risk).

■ Sampling Plans¹⁴

There are three types of acceptance sampling plans.

- I. Single sampling plan (Figure 6.14)
- II. Double sampling plan (Figure 6.15)
- III. Multiple sampling plan

Fig. 6.12 Comparing Alternative Plans A and B

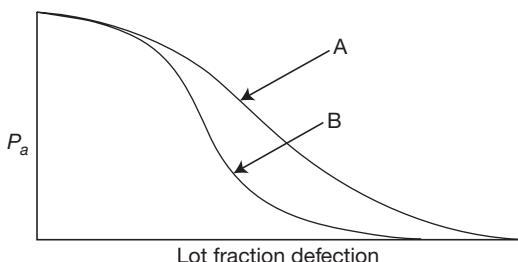


Fig. 6.13 The Two Point Method

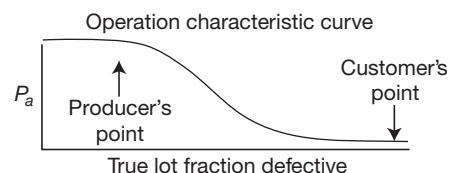
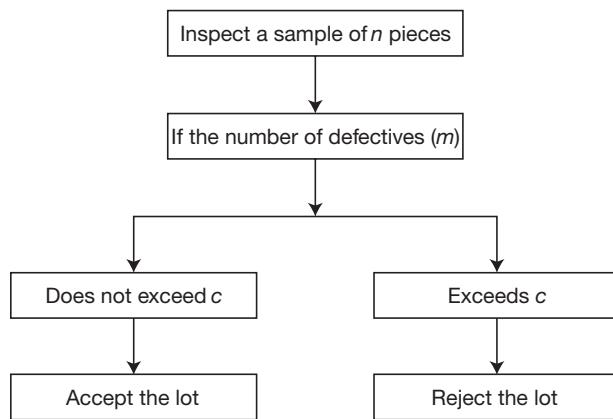
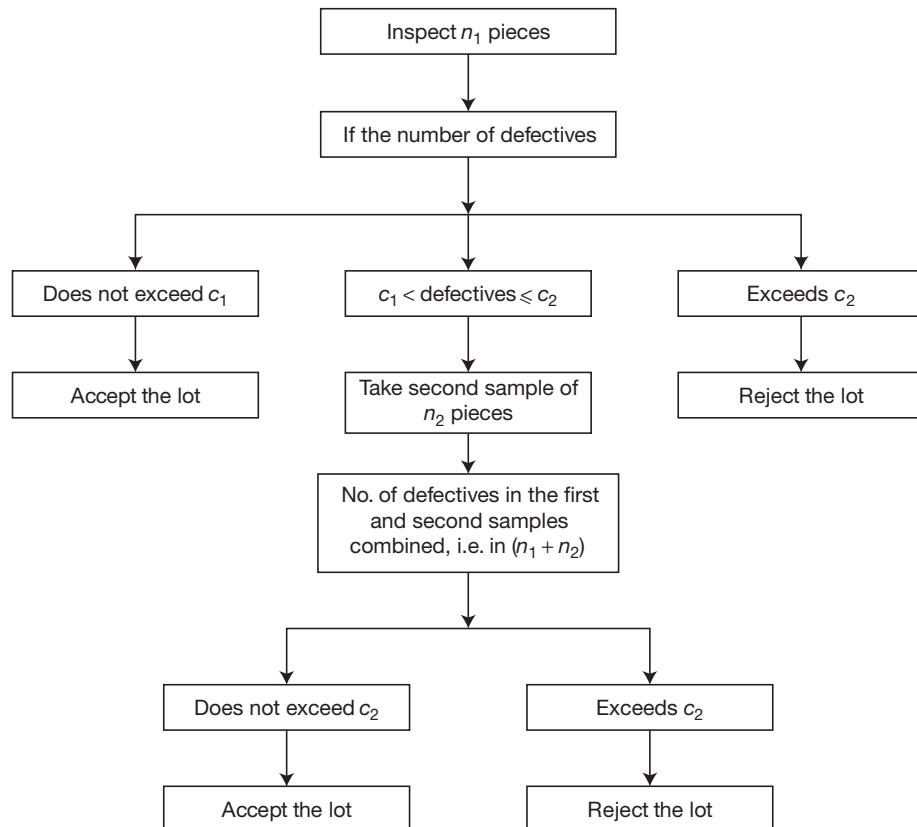


Fig. 6.14 Single Sampling Plan
 Bird's-eye view:

A sampling plan is a detailed outline of which measurements will be taken at which time, on which material, in what manner, and by whom.

Fig. 6.15 Double Sampling Plan
 Bird's-eye view:

Sampling plans should be designed in such a way that the resulting data will contain a representative sample of the parameters of interest and allow for all questions, as stated in the goals, to be answered.

1. Single sampling plan: When a decision on acceptance or rejection of the lot is made on the basis of only one sample, the acceptance plan is known as a single sampling plan.

If N is the lot size from which the sample is drawn, n the sample size, c the number of allowable defectives in the sample, then the sampling plan shown in Figure 6.14 is applicable.

 **Bird's-eye view:**

Acceptance sampling plans provide criteria and decision rules for determining whether to accept or reject a batch based on a sample. They are therefore widely used by manufacturers, suppliers, contractors and subcontractors, and service providers in a wide range of industries.

Example: In the sampling plan, if $N = \text{lot size} = 50$, $n = \text{sample size} = 5$, $c = \text{acceptance number} = 1$, it means that if we take a sample of 5 items from a lot of 50, and if the sample contains more than 1 defective item then the lot gets rejected, otherwise the lot is accepted.

2. Double sampling plan: In a double sampling plan, the decision on acceptance or rejection of the lot is based on two samples. We take a second sample if we are not in a position to arrive at a decision about accepting or rejecting the lot on the basis of a single sample. This is shown in Figure 6.15.

Parameters: n_1 = Number of pieces in the first sample

c_1 = Acceptance number for the first sample

n_2 = Number of pieces in the second sample

$n_1 \times n_2$ = Number of pieces in the two samples combined

c_2 = Acceptance number for the two samples combined

Example: $N = 500$, $n_1 = 25$, $n_2 = 40$, $c_1 = 1$, $c_2 = 4$

This may be interpreted as follows:

1. Take a first sample of 25 items from a lot of 500 and inspect it
2. Accept the lot on the basis of the first sample if it contains 0 or 1 defective item
3. Reject the lot on the basis of the first sample if it contains more than 4 defective items
4. Take a second sample of 40 items if the first sample contains 2, 3 or 4 defective items
5. Accept the lot on the basis of the first and second sample combined, if the combined sample of 75 items contains 4 or less defective items
6. Reject the lot on the basis of the combined sample if the combined sample contains more than 4 defective items

The lot may be accepted in the following ways:

- 0 or 1 defective item in the first sample (without taking second sample)
- 2 defective items in the first sample followed by 0, 1 or 2 defective items in the second sample
- 3 defective items in the first sample followed by 0 or 1 defective item in the second sample
- 4 defective items in the first sample followed by 0 defective items in the second sample

The probability of accepting the lot is the sum of the probabilities of the different ways in which it may be accepted.

3. Multiple sampling plan: In this plan, a decision to accept or reject a lot is taken after inspecting more than two samples. In other words, one is to resort to sequential or many samplings for an infinite number of stages to arrive at a decision. In practice the multiple sampling plans are quite complicated and rarely used. The comparison between single, double and multiple sampling plans is shown in Table 6.4.

Characteristics of a good acceptance plan: The characteristics of a good acceptance plan are as follows:

- The index AQL, AOQL, etc. used to define "quality" should reflect the needs of the consumer and the producer and not be chosen primarily for statistical convenience.
- The sampling risks should be known in quantitative terms (the OC curve). The producer should have adequate protection against the rejection of good lots, and the consumer should be protected against the acceptance of bad lots.

Table 6.4 Comparison Between Single, Double and Multiple Sampling Plans

Criteria	Single Sampling Plan	Double Sampling Plan	Multiple Sampling Plan
Average number of pieces inspected per lot	Largest	In between single and multiple plans	Lowest
Cost of administration	Lowest	In between single and multiple plans	Largest
Information available regarding prevailing quality level	Largest	In between single and multiple plans	Least
Acceptability to producers	Less (gives only one chance of passing the lot)	Most acceptable	Indecision is continued for a long term

- The plan should minimize the total cost of inspection.
- The plan should be flexible enough to reflect changes in lot size, quality of product submitted and any other pertinent factors.
- The measurements required by a plan should provide information useful in estimating individual lot quality and long-run quality.

Industrial applications of acceptance sampling: Acceptance sampling can be used in industries to:

1. To determine the quality and acceptability of incoming raw materials, component parts, products, etc.
2. To decide the acceptability of semi-finished products for further processing as it undergoes the operations from machine to machine or section to section within the factor.
3. To determine the quality of outgoing products.
4. For improving, maintaining and controlling the quality of the products manufactured.

DISCUSSION FORUM

1. What is sampling?
2. What is a good sampling plan?
3. What are the two ways in which inspection is carried out?
4. Name the two broad classification of sampling methods.
5. Discuss acceptance sampling.
6. Explain operating characteristic curves.
7. Name the three types of acceptance sampling plans.
8. Name the quality indices for acceptance sampling.

 **Bird's-eye view:**
Quality assurance (QA) is a way of preventing mistakes or defects in manufactured products and avoiding problems when delivering solutions or services to customers; which ISO 9000 defines as "part of quality management focused on providing confidence that quality requirements will be fulfilled".

■ QUALITY ASSURANCE¹⁵

ISO 8402 defines "quality assurance" as, "all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality."

 **Bird's-eye view:**

Many quality assurance activities provide protection against quality problems through early warnings of trouble ahead. The assurance comes from evidence, which is a set of facts.

 **Bird's-eye view:**

For simple products, the evidence is usually some form of inspection or testing of the product. For complex products, the evidence is not only inspection and test data but also reviews of plans and audits of the execution of plans.

Quality assurance is based upon a proactive approach rather than a reactive one. It emphasizes prevention of failure rather than failure detection. It is an organization-wide policy. Quality assurance is the activity of providing the evidence needed to establish confidence, among all concerned, that the quality-related activities are being performed effectively. Quality assurance is often the name of a department that is concerned with many quality-related activities such as quality planning, quality control, quality improvement, quality audit and reliability.

Many quality assurance activities provide protection against quality problems through early warnings of trouble ahead. The assurance comes from evidence, which is a set of facts. For simple products, the evidence is usually some form of inspection or testing of the product. For complex products, the evidence is not only inspection and test data but also reviews of plans and audits of the execution of plans. Many assurance techniques are available to cover a wide variety of needs. Quality assurance can be achieved in an organization by developing, operating and maintaining a well-documented quality system. Box 6.2 discusses quality assurance at Indapoint Technologies.

In quality assurance, we identify processes that are “critical to quality (CTQ)” of the final product or service. These activities are subjected to systematic controls based upon documented procedures. Thus, quality assurance is based on the following three principles:

Box 6.2 Quality Assurance at IndaPoint Technologies Pvt. Ltd

The success of any project depends on the quality and consistency of its team effort, and it takes great effort to deliver the highest quality. Therefore, IndaPoint endeavours to achieve and maintain the highest standards of quality in every venture.

Established in 2005, Indapoint Technologies Pvt. Ltd is one of the leading IT services companies in India with wide experience in all types of Web development, e-marketing business, Web applications, Web portals, entertainment sites and e-commerce.

IndaPoint's chief objective is the swift delivery of state-of-the-art mission-critical business services. The company has a highly skilled, professional delivery team, which adheres to the most stringent standards while delivering complete, excellent IT solutions.

IndaPoint delivers optimal solutions that add value to organizations and increases their return on investment while requiring minimal support, maintenance and attention. IndaPoint's independent quality management group continuously monitors team progress while developing new techniques to improve various processes and quality assurance techniques.

IndaPoint's methodology and process includes auditing each project at every step of the way, checking for adherence to timeline, quality assurance and process compliance. IndaPoint's quality assurance group monitors all project activities, ensuring compliance with all aspects of QA—reviews, testing, final release audits, UATs and QA audits.

IndaPoint's extensive and in-depth experience in software development, maintenance, enhancement and migration assignments sets them apart from competitors. IndaPoint's approach includes the application of tried and tested methodologies, strict adherence to established industry standards and incorporation of the best practices in the project management capabilities, thereby ensuring sustainable quality.

IndaPoint's quality methodology allows the company to achieve prompt, reliable and quality results in all undertakings. IndaPoint's comprehensive and structured methodology is applied to all its internal and external customer-oriented business processes. Thus, IndaPoint ensures that its customers are provided solutions and services of utmost quality.

Source: Adapted from www.indapoint.com, accessed June 2016.

1. **Quality is organization-wide:** Each functional department and activity must be assigned specific quality-related responsibilities.
2. **Right first time:** Failure prevention rather than failure detection.
3. **Proper communication and cooperation:** Every employee in the organization must understand his role in terms of ensuring quality in his sphere of activity and also, his role in interfacing with other departments/people in achieving the same objective.

■ Quality Assurance System¹⁶

Quality assurance is a system of management activities to ensure that a process, item or service is of the type and quality needed by the user.

Each offeror, as a separate and identifiable part of its technical proposal, shall submit a quality assurance (QA) programme plan setting forth the offeror's capabilities for quality assurance. The plan shall address the following:

- (a) A statement of policy concerning the organization's commitment to implement a quality control/quality assurance programme to assure the generation of measurement data of adequate quality to meet the requirements of the statement of work.
- (b) An organizational chart showing the position of a QA function or person within the organization. It is highly desirable that the QA function or person be independent of the functional groups that generate and measure data.
- (c) A delineation of the authority and responsibilities of the QA function or person and the related data quality responsibilities of other functional groups of the organization.
- (d) The type and degree of experience in developing and applying quality control/quality assurance procedures to the proposed sampling and measurement methods needed for performance of the statement of work.
- (e) The background and experience of the proposed personnel relevant to accomplish the QA specifications in the statement of work.
- (f) The offeror's general approach for accomplishing the QA specifications in the statement of work.

A QA project plan is a specific delineation of an offeror's approach for accomplishing the QA specifications in a statement of work. When offerors are required to submit a project plan, a programme plan may or may not be required. The project plan may be a part of an offeror's technical proposal, or a deliverable under the contract. The offeror, as a separate and identifiable part of the technical proposal, shall submit a quality assurance (QA) project plan, which shall describe specific procedures and responsibilities needed to accomplish the QA specifications in the statement of work. The project plan must consist of the following content:

1. A title page with provision for approval signatures.
2. Table of contents.
3. Project description.
4. Project organization(s) and responsibilities.
5. Quality assurance objectives for measurement of data, in terms of precision, accuracy, completeness, representativeness and comparability.
6. Sampling procedures.
7. Sample custody.
8. Calibration procedures, references and frequency.



Bird's-eye view:

Quality assurance is a system of management activities to ensure that a process, item or service is of the type and quality needed by the user.

9. Analytical procedures.
10. Data reduction, validation and reporting.
11. Internal quality control checks and frequency.
12. Quality assurance performance audits, system audits and frequency.
13. Quality assurance reports to management.
14. Preventive maintenance procedures and schedules.
15. Specific procedures to be used in routinely assessing data precision and accuracy, representativeness, comparability and completeness of the specific measurement parameters involved.
16. Corrective action.

A QA project plan is a specific delineation of an offeror's approach for accomplishing the QA specifications in a statement of work. A programme plan may or may not be required when offerors are required to submit a project plan.

Bird's-eye view:

In quality management system, a **quality policy** is a document jointly developed by management and quality experts to express the quality objectives of the organization, the acceptable level of quality and the duties of specific departments to ensure quality.

■ Designing the Quality Assurance System

The management is responsible for defining, documenting and supporting the quality policy of an organization. Typically, a quality policy identifies key objectives of products and services such as fitness for use, performance, safety and dependability.

Quality policy: The quality policy is a guide for everyone in the organization as to how they should provide products and services to the customers. It should be written by the CEO with feedback from the workforce and should be approved by the quality council. The common characteristics of the quality policy are:

- Quality is first among equals
- Meets the needs of internal and external customers
- Equals or exceeds the competition
- Continually improves quality
- Includes business and production procedures
- Utilizes the entire workforce

A quality policy is a basic requirement of the quality management system. Box 6.3 discusses the quality policy in place at G5 Solution.

Box 6.3 Quality Policy and Quality Objectives of G5 Solution Private Limited

Quality Policy

- The company will at all times at all levels, attend to customer needs, enquiries, and complaints with promptitude, courtesy diligence.
- Meet and exceed the expectations of customers with speed, ensuring reliable and consistent customer's service.
- Provide a work environment and culture that promotes initiative, innovation and team work.
- Associate with clients to ensure high quality of inputs through proactive partnership
- Practice process that are defined and measurable and adopt continual improvement in all our process.
- Improve effectiveness of quality management system with emphasis on in-process control

- We commit ourselves to take the leadership both in development and technology of e-commerce solution
- Foster team work, educate, train, motivate and involve employees in achieving the quality innovations.
- Provide value for money and be globally competitive.

Quality Objectives

- Enhance customer satisfaction
- Upgrade employee skills
- Efficient utilization of resources
- Continual improvement in our processes

Source: www.g5solution.org, accessed June 2016, reproduced with permission.

Quality manual: A quality system, which is defined as an assembly of components such as the organizational structure, responsibilities, procedures, processes and resources for implementing quality management, must be documented in the form of a quality manual. The quality manual includes such matters such as:

1. Who should be responsible for the functions affecting quality?
2. Once installed, how should the system be audited and reviewed to remain effective.
3. The planning considerations involved in setting up the quality system.
4. The documented work instructions required.
5. The records that will be required.
6. How should problems be identified and corrected?
7. Which are the design functions that need to be controlled?
8. The kind of system required for the control of documentation and changes.
9. The control of verification equipment required.
10. The control of purchased materials and services.
11. The controls required during production and operations.
12. The requirements at final inspection.
13. Any sampling procedure that should be used.
14. The control of non-conforming materials or services.
15. The identification of inspection status of materials in the production process.
16. The procedure required to protect and preserve product or service quality.
17. The need for training.

Bird's-eye view:

Quality manual is an official document produced by a business that details how its quality management system operates.

Bird's-eye view:

A typical quality manual will include the company's quality policy and goals, as well as a detailed description of its quality control system that might include staff roles and relationships, procedures, systems and any other resources that relate to producing high quality goods or services.

DISCUSSION FORUM

1. Define quality assurance.
2. What is a quality policy?
3. Explain the meaning of a quality manual.

SUMMARY

- The quality control function that is now referred to as total quality management (TQM) emphasizes the strategic importance of quality to the whole organization and not just the factory floor. TQM involves an unending process of continuous improvement with the objective of achieving perfection.
- The two main approaches to quality control are (1) acceptance sampling and (2) statistical process control (SPC).
- All processes are subject to a certain degree of variability. Usually, variations are of two types—natural (common) and assignable (special). Common cause variation is natural and exists in every process. It can be reduced by process improvement activities, but not eliminated. It is the variation that is inherent in a process that is operating as designed. Special cause variation is the unnatural variation in a process. It should be identified and the reasons may be assigned and addressed.
- SPC is the application of statistical methods to the measurement and analysis of variation of any process. It is used to measure the performance of a process and thereby ensure that the process is meeting specified standards. It is a methodology for monitoring a process to identify special causes of variation and signaling the need to take corrective action when it is appropriate. SPC relies on control charts.
- Probability is the chance that something will happen. Probability is always a fraction, which may vary from 0 to 1. A probability of 1 indicates certainty because it denotes that something will happen 100 times out of 100. A probability of zero means impossibility—it denotes something will happen zero times out of hundred.
- There are many different probability distributions, both discrete and continuous. The four most commonly used distributions are (1) the binomial distribution, (2) the Poisson distribution, (3) the exponential distribution and (4) the normal distribution.
- Measurement system analysis (MSA) is a specially designed experiment that seeks to identify the components of variation in the measurement. There are five parameters to investigate in an MSA—bias, linearity, stability, repeatability and reproducibility.
- Process capability is defined as “the performance of a process over a certain period of time while in the statistically controlled state.” A process capability study is a systematic procedure for determining the capability of a process.
- Process capability can be expressed as the percentage non-conforming items or in terms of the natural spread related to the specification spread. Capability indices have been developed to graphically portray that measure.
- Process capability can be expressed with an index. Two widely used process capability indices are C_p and C_{pk} . These are process capability estimates. They show how capable a process is of meeting its specification limits when used with continuous data.
- The Six Sigma strategy is aimed at reducing the defects at the breakthrough level through a disciplined and practical application of statistical methods by reducing variations.
- The main assumption made in the theory of sampling is that the samples are drawn at random. For this purpose, suitable measures or procedures may be laid down and adopted according to the nature and configuration of the items under inspection for ensuring complete randomness in sample selection.
- A good sampling plan should select a sample at the lowest cost that will provide the best possible representation of the population, consistent with the objectives of precision and

reliability that have been determined for the study. There are generally two ways in which inspection is carried out—100 per cent inspection and sampling inspection. Sampling methods are broadly classified into non-probability sampling and probability sampling.

- Acceptance sampling is the process of evaluating a portion of the product/material in a lot for the purpose of accepting or rejecting the lot as either conforming or not conforming to quality specifications. There are three types of acceptance sampling plans—single sampling plan, double sampling plan and multiple sampling plan.
- Operating characteristic curves are a graphical means for comparing sampling plans. They enable SQC plans to be compared. They show the relationship between lot size and number of defectives. The quality indices for acceptance sampling plans are acceptable quality level (AQL), rejectable quality level (RQL), indifference quality level (IQL) and average outgoing quality (AOQ).
- ISO 8402 defines “quality assurance” as all those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy the given requirements for quality. Quality assurance is a system of management activities to ensure that a process, item or service is of the type and quality needed by the user.
- The quality policy is a guide for everyone in the organization as to how they should provide products and services to the customers. A quality system, which is defined as an assembly of components such as the organizational structure, responsibilities, procedures, processes and resources for implementing quality management must be documented in the form of a quality manual.

Key Terms

100 Per Cent Inspection	180	Multiple Sampling Plan	190
Acceptable Quality Level (AQL)	186	Natural	168
Acceptance Sampling	184	Non-probability Sampling	184
Accuracy	173	Normal Distribution	171
Assignable	168	Operating Characteristic Curve (OCC)	187
Attribute	170	Poisson Distribution	171
Average Outgoing Quality (AOQ)	186	Precision	173
Average Outgoing Quality Level (AOQL)	187	Probability Distribution	170
Bias	174	Probability Sampling	184
Binomial Distribution	171	Process Capability Indices	178
Consumer's Point	188	Process Capability	176
C_p Index	179	Producer's Point	188
C_{pk} Index	179	Quality Assurance	191
Double Sampling Plan	190	Quality Manual	195
Exponential Distribution	171	Quality Policy	194
Indifference Quality Level (IQL)	187	Rejectable Quality Level (RQL)	187
Linearity	174	Repeatability	172
Mean Standard Deviation	171	Reproducibility	172
Measurement System Analysis	172	Sampling	183

Single Sampling Plan	188	Variable	169
Six Sigma	181	Variance	171
Stability	174	Variation	168
Statistical Process Control	169		

Case Study

Statistical Process Control at Motorola

Traditional quality control methods identify variation as the enemy of ensuring quality. However, the control of variation by itself can never achieve the remarkably low non-conformance rates of world-class quality leaders. The best methods for controlling variation, mistakes and complexity are each forms of mistake proofing. Using these mistake-proofing techniques, virtually every mistake and non-conformance can be controlled at a fraction of the cost of traditional quality control methods.

The FZU-48 fuze initiator (for the FMU-139 bomb fuze) programme in the Tactical Electronics Division (TED) of Motorola moved quickly and smoothly from the design stage to the full-scale high-volume production stage by utilizing statistical process control (SPC) techniques.

Virtually all phases of product manufacturing (design, assembly, tooling, machines, test equipment and inspection) used SPC and problem-solving techniques (PST). The result was a system capable of delivering excellent product quality and achieving a high volume production output.

All machinery, tooling and fixtures were carefully designed with a zero defect approach. A team of engineers trained in SPC carefully reviewed the design prints in a brainstorming/failure analysis and correction mode to minimize design flaws during production. After the machines, test equipment, tools and other peripherals arrived, they underwent carefully planned machine capability studies.

The machine capability studies comprised two phases. First, a capability index (C_{pk}) and a capability potential (C_p) were calculated for all critical variables followed by tests for statistical control. Next, reduction of variation was performed when the capability index failed to meet the planned target C_{pk} index of greater than 1.0 (factored by a four sigma spread). During the reduction of variation, variables contributing to variation were identified and either removed or reduced to a controllable level.

The capability studies helped to predict the performance of the equipment with a level of certainty and to collectively determine whether the process had sufficiently low variability to meet process specifications. It also served to uncover areas of potential problems before production and encouraged efforts to prevent production of non-conformance products.

Seventy per cent of the machines (test equipment, tools, etc.) had a capability index C_{pk} higher than 2.0 (planned goal C_{pk}) and the other 30 per cent exceeded a C_{pk} of 1.0. The Final Lanyard Pin Press experienced seven cycles of machine capability studies and redesign before it was considered unsuitable for production and replaced by a new machine.

During the various stages of production, many problems arose and were aggressively corrected utilizing PST and SPC techniques. PST techniques included brainstorming sessions, cause-and-effect diagrams and Pareto diagrams. SPC techniques included variable search and statistically designed single-factor and full factorial experiments.

Ishikawa (cause-and-effect) diagrams, design of experiments (DOE) and brainstorming were used to solve complex problems such as the epoxy leakage through the end cap towers,

Exhibit 6.1 FZU-48 Bomb Fuze Initiator—Opening Force

	Specification
Distribution No. 1	
Average: 101.63	LSL: 30
Standard Deviation: 34.58	Nominal: 65
$C_p = 0.34$	USL: 100
$C_{pk} = 0.00$	
PPM = 539130	
Distribution No. 2	
Average: 60.7	
Standard Deviation: 4.7	
$C_p = 2.48$	
$C_{pk} = 2.18$	
PPM = 5.199E - 05	

reducing the defective rate from 68 per cent to less than 0.1 per cent. The use of DOE was also effective in correcting the problem of high shearing force for lanyard separation, which failed to shear at a force of 148 + 20 lbs-f. A two by three (three factors, two levels) full factorial experiment was designed and conducted yielding accountability for 96 per cent of the variation. The standard deviation of the shearing force prior to experimentation was 34 and was successfully reduced to 3.3.

After the completion of the first 115 deliverable FZU-48 units, an unforeseen design flaw resulted in the failure of the First Article Acceptance Test. Aggressive utilization of PST and DOE techniques by a team comprising design, manufacturing, quality assurance and test engineers corrected the problem.

In a period of five weeks, 14 consecutive statistically designed experiments were conducted, leading to product design changes and reduction of product performance variability. The standard deviation of the cover opening force of the unit prior to experimentation was 34.58. It was reduced to 4.70, thereby achieving a C_{pk} equal to 2.20 and exceeding Motorola's Six Sigma design objective (see Exhibit 6.1).

Since production began in early August 1987, the FZU-48 programme has increased its production by ten times, from 50 units per day initially to 550 units per day. During this period, eight consecutive lot acceptance tests (LATs) have been conducted and passed. Of all the units tested during the LATs, one unit failed. That unit was later found to have a piece part out of tolerance that caused the failure.

The team of SPC experts responsible for applying the SPC techniques consisted of Adi K. Bhote, TED SPC coordinator for the Manufacturing Board Assembly Area; Jim Blanden, TED Manufacturing SPC specialist; and Mario Perez-Wilson, Divisional SPC manager, Small Signal & Sensor Products Division, Semiconductor Products Sector, and former SPC coordinator for the FZU-48 and FMU-139 programmes.

Contributing their engineering expertise and support were Jim Gardner, senior test equipment engineer, Ron Meyer, lead design engineer, and Pete Rendek, lead design engineer. Management commitment and support to implement SPC from the design stages was provided by Kevin Mulroy, then a quality assurance team member and Ray Beliveau, manufacturing team member.

"The FZU-48 programme is probably the first programme in Motorola that utilized SPC techniques from the very beginning. This programme has been quoted by the customer as

being their first programme to go from design to full-scale production in a fast and smooth manner. The major ingredient for this success has been the implementation of SPC," Mario said. No blueprint exists for the successful implementation of SPC in a production system. However, the SPC techniques used on the FZU-48 programmed can facilitate a smooth transition from design to full-scale production on other programmes if they are performed as early as possible prior to production.

On the FZU-48 programme, potential problems were detected using machine/process capability studies, statistically quantified using descriptive statistics and probabilities and statistically corrected with statistically designed experiments. After implementation, the corrections were statistically validated. The end result was a high-quality output.

Source: Adapted from www.motorola.com, accessed March 2010.

For Discussion

1. Why was SPC introduced in the FZO-48 fuze initiator programme?
2. How did process capability studies help the division?
3. Comment on the results given in Exhibit 6.1.

Exercises

1. The standard error of measurement of the mean of measurement of a certain electrical characteristic of a product is determined to be 8 units. A sample consisting of 42 units of the product is taken under consideration. From this information, what is your estimate of the true standard deviation of the quality characteristic?
2. A sampling plan may be specified in this way:

$$N = 200, \quad n = 20, \quad c = 1.$$

Interpret the results.

3. A sampling plan may be specified in this way:

$$N = 500, \quad n_1 = 20, \quad c_1 = 1, \quad n_2 = 60, \quad c_2 = 4.$$

Interpret the results.

4. For a sampling plan, $N = 1,200$, $n = 64$ and $c = 1$, determine the probability of acceptance of the following lots:

- (a) 0.5 per cent defective
- (b) 0.8 per cent defective
- (c) 1 per cent defective
- (d) 2 per cent defective
- (e) 4 per cent defective
- (f) 10 per cent defective

Also, draw an OC curve.

5. Draw an OC curve of a double sampling plan given that $N = 1,000$, $n_1 = 50$, $c_1 = 1$, $n_2 = 25$, $c_2 = 2$.
6. A manufacturer receives large batches of components daily and decides to institute an acceptance sampling scheme. Three possible plans are considered, each of which requires a sample of 30 components to be tested:

Plan A: Accept the batch if non-conforming components are not found, otherwise reject.

Plan B: Accept the batch if not more than one non-conforming component is found, otherwise reject.

Plan C: Accept the batch if two or fewer non-conforming components are found, otherwise reject.

- (a) For each plan, calculate the probability of accepting a batch containing
 - (i) 2 per cent non-conforming components
 - (ii) 8 per cent non-conforming components
- (b) Sketch the operating characteristic of each plan on the same axes without further calculation.
- (c) Which plan would be most appropriate in each of the circumstances listed below?
 - (i) There should be a high probability of accepting batches containing 2 per cent non-conforming items.
 - (ii) There should be a high probability of rejecting batches containing 8 per cent non-conforming items.
 - (iii) A balance is required between the risk of accepting batches containing 8 per cent defective items and the risk of rejecting batches containing 2 per cent non-conforming items.

Short-answer Questions

1. Define variation.
2. Name the two main approaches to quality control.
3. What are the two types of variation?
4. Define SPC.
5. What are the two types of quality control measurements?
6. What are probability distributions?
7. What is measurement system analysis (MSA)?
8. Name the five parameters of MSA.
9. What is the difference between precision and accuracy?
10. Define process capability.

Match the Following

a. Six Sigma	233
b. Five Sigma	6,210
c. Four Sigma	3.4
d. Three Sigma	690,000
e. Two Sigma	66,807
f. One Sigma	308,537

Discussion Questions

1. What is statistical process control? What are random causes and assignable causes of variation? What are the two ways of monitoring the variation?
2. Explain the various steps involved in a process capability study.
3. What is acceptance sampling? What are the reasons for acceptance sampling?
4. How many types of sampling plans are there? Briefly explain by giving examples.
5. What is an OC curve? How can we make an acceptance sampling plan stricter?
6. What is an ideal OC curve? Explain the producer's and consumer's risk.
7. How many types of OC curves are there? Briefly explain the situations in which these different types of OC curves are used.
8. Explain quality assurance with an example.

Projects

1. Visit any industrial unit near you. Find out from the concerned managers about the kind of acceptance sampling plans they use for incoming material and outgoing inspection.
2. Visit the production units near you and look out for the types of SPC practices there. Ask the concerned managers about the most common type of assignable causes detected by them resulting in the process showing variation.

End Notes

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7

Six Sigma



LEAN SIX SIGMA

Lean Six Sigma is a methodology that relies on collaborative team effort to improve performance by systematically removing waste and combining lean manufacturing/lean enterprise and Six Sigma to eliminate eight kinds of waste (*muda*)—time, inventory, motion, waiting, over production, over processing, defects, and skills. Lean Six Sigma combines lean manufacturing (originally developed by Toyota) and Six Sigma (originally developed by Motorola). It is a management approach to improve business performance that has blended the two individual specialisms of lean and Six Sigma. Both management strategies are widely used globally and have experienced proven success in various industries and services.

Six Sigma is a data-driven approach to solve complex business problems and is undertaken only after a lean commitment has been implemented by the organization. It uses a methodical five-phase approach—define, measure, analyse, improve, and control—to help understand the variables that affect a process in order to better optimize it. Lean Six Sigma is a powerful, proven method of improving business efficiency and effectiveness. The key principles of lean Six Sigma business transformation are focus on the customer; identify and understand how the work gets done (the value stream); manage, improve, and smooth the process flow; remove non-value added steps and waste; manage by fact and reduce

variation; involve and equip the people in the process; and undertake improvement activity in a systematic way.

Lean Six Sigma can help bring about rapid improvements, whether in a manufacturing or in a service-based context. The excellence it fosters permeates the entire operation, and leads to customer and employee satisfaction. This fact is evidenced by many companies—from accounting firms to human resources agencies—who achieve dramatic results by following the approach. These are 100-percent service firms without a single product to design, engineer, build, finish or repair, and yet lean Six Sigma is meaningful to them.

“The ability to simplify means to eliminate the unnecessary so that the necessary may speak.”

Hans Hofmann

Upon completion of this chapter, you will be able to:

1. Explain Six Sigma
2. Describe the Six Sigma quality level
3. Understand the fundamentals of the Six Sigma strategy
4. Explain the steps in implementing Six Sigma (DMAIC, DMADV and DFSS)
5. Discuss the Six Sigma training programme

■ INTRODUCTION

Sigma (σ) is a letter in the Greek alphabet used to denote the standard deviation of a process. The term Six Sigma is derived from the field of statistics. Sigma quality level is sometimes used to describe the output of a process. A Six Sigma quality level is said to equate to 3.4 defects per million opportunities. However, the term in practice is used to denote more than simply counting defects. Six Sigma stands for six standard deviations from the mean. The Six Sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

The pioneer of Six Sigma, Motorola, initiated its quality programme in 1987. It took the company five full years to experience significant results from Six Sigma. Six Sigma has been adopted as a quality philosophy by companies such as Texas Instruments, Allied signal, Eastman Kodak and ICICI in India.

Six Sigma is a statistical term that measures how far a given process deviates from perfection. Six Sigma is named after the process that has six standard deviations on each side of the specification window. It is a disciplined, data-driven approach and methodology for eliminating defects. The central idea behind Six Sigma is that if you can measure how many “defects” you have in a process, you can systematically figure out how to eliminate them and get as close to “zero defects” as possible. Six Sigma starts with the application of statistical methods for translating information from customers into specifications for products or services being developed or produced.

Bird's-eye view:

Manufacturing and Service capability has been growing globally with an exponentially competitive advantage.

Bird's-eye view:

The organizations need to perfect its processes for improving market penetration and organizational speed and reducing cost of doing business.

Six Sigma incorporates the basic principles and techniques used in business, statistics and engineering. These three form its core elements. The Six Sigma methodology improves any existing business process by constantly reviewing and retuning the process. In order to achieve this, Six Sigma uses a methodology known as define opportunities, measure performance, analyse opportunity, improve performance and control performance (DMAIC). The Six Sigma methodology can also be used to create a brand new business process from scratch using design for six sigma (DFSS) principles. Typically, it's easier to define a new process with DFSS principles than refining an existing process to reduce the defects. Today, Six Sigma quality programmes are used both in manufacturing and non-manufacturing sectors. These are also used in many business process management initiatives.

It would be a mistake to think that Six Sigma is about quality in the traditional sense. Quality, defined traditionally as conformance to internal requirements, has little to do with Six Sigma. In fact it is about helping the organization make more money. To link this objective of Six Sigma with quality mandates a new definition for quality. For Six Sigma purposes, quality is defined as the value added by a productive endeavour. There are two types of quality—potential quality and actual quality. Potential quality is the known, maximum possible value added per unit of input. Actual quality is the current value added per unit of input. The difference between potential and actual quality is termed as waste. Six Sigma focuses on improving quality (i.e., reducing waste) by helping organizations produce products and services better, faster and cheaper. Six Sigma focuses on defect prevention, cycle-time reduction and cost savings. Unlike cost-cutting programmes that reduce value and quality, Six Sigma identifies and eliminates costs, which provide no value to customers. The cost of poor quality (COPQ) is directly proportional to the level of sigma. In other words, the COPQ is directly connected to the number of defects per million opportunities. Supposing your sigma level is four, and then, across the industry, the standard cost of poor quality for you is 15 per cent. It goes on decreasing with the increase in the sigma level till it becomes equal to six. At this point (Six Sigma), the cost of poor quality will be less than 5 per cent. This means you have reduced the number of defects from around 60,000 to 3.4 per million opportunities. For non-Six Sigma companies, these costs are often extremely high. Companies operating at three or four sigma typically spend between 25 and 40 per cent of their revenues fixing problems.

Bird's-eye view:

Six Sigma is a disciplined, data-driven approach and methodology for eliminating defects (driving toward **six** standard deviations between the mean and the nearest specification limit) in any process – from manufacturing to transactional and from product to service.

Bird's-eye view:

A Six Sigma quality level is said to equate to 3.4 defects per million opportunities. However, the term in practice is used to denote more than simply counting defects.

Bird's-eye view:

Six Sigma stands for six standard deviations from the mean. The Six-Sigma methodology provides the techniques and tools to improve the capability and reduce the defects in any process.

■ KEY SIX SIGMA CONCEPTS

At its core, Six Sigma revolves around the following key concepts:

1. **Critical to quality (CTQ):** Attributes most crucial for the customer
2. **Defect:** Failing to deliver what the customer wants
3. **Process capability:** What one's process can deliver
4. **Variation:** What the customer sees and feels
5. **Stable operations:** Ensuring consistent, predictable processes to improve what the customer sees and feels
6. **Design for Six Sigma:** Designing to meet customer needs and process capability

■ THE SIX SIGMA QUALITY LEVEL

According to Harry and Schroeder,¹ Six Sigma quality fundamentally means a breakthrough strategy that can be interpreted as “a disciplined method of using extremely rigorous data

Table 7.1 Comparison of Sigma Level Errors

Sigma Level of Error	Spelling Mistakes in a Book	Time Error in a Century
3σ	1.5 misspelled words per page per book	3.5 months/century
4σ	1 misspelled word/30 pages/book	2.5 days/century
5σ	1 misspelled word/set of encyclopedias	30 minutes/century
6σ	1 misspelled word/per small library	6 seconds/century

Source: Adapted from Dinesh Seth, *Global Management Solutions: Demystified* (Thomson Publishing: 2004).

gathering and statistical analysis to identify the sources of errors and ways of eliminating them.” Sigma is a letter in the Greek alphabet used by statisticians to measure the variability in any process. Most commonly, it represents standard deviation, a statistic for measurement of dispersion, i.e. spread about a mean or target value. A simple comparison of this dispersion² is given in Table 7.1. Six σ is about 20,000 times better than three σ . An important aspect of the Six Sigma programme is total process characterization, which involves optimizing all processes to a very high C_p and C_{pk} value. In fact, Six Sigma represents a near defect free situation or precisely 3.4 defects per million opportunities ($C_p = 2.0$, $C_{pk} = 1.5$).

■ SIX SIGMA VERSUS THREE SIGMA

In contrast to Six Sigma quality, the Three Sigma quality standard of 99.73 per cent translates to 2,700 parts per million (PPM) failures, even if we assume zero drift. For processes with a series of steps, the overall yield is the product of the yields of the different steps. For example, if we had a simple two-step process where step one had a yield of 80 per cent and step two had a yield of 90 per cent, then the overall yield would be $0.8 \times 0.9 = 0.72 = 72$ per cent. Note that the overall yield from processes involving a series of steps is always less than the yield of the step with the lowest yield. If Three Sigma quality levels (99.97 per cent yield) are obtained from every step in a ten-step process, then the quality level at the end of the process will contain 26,674 defects per million! Considering that the complexity of modern processes is usually far greater than ten steps, it is easy to see that Six Sigma quality isn’t optional; it’s required if the organization is to remain viable. The requirement of extremely high quality is not limited to multiple-stage manufacturing processes. Consider what Three Sigma quality would mean if applied to other processes:

- Virtually no modern computer would function.
- 4,050 invoices would be sent out incorrectly each month by a modest-sized telecommunications company.
- 18,900 US savings bonds would be lost every month.
- 54,000 checks would be lost each night by a single large bank.
- 540,000 erroneous call details would be recorded each day from a regional telecommunications company.
- 10,800,000 healthcare claims would be mishandled each year.
- 270,000,000 (270 million) erroneous credit card transactions would be recorded each year in the United States.

With numbers like these, it’s easy to see that the modern world demands extremely high levels of error free performance. Six Sigma arose in response to this realisation. Box 7.1 discusses the Six Sigma journey undertaken by Motorola.



Bird's-eye view:

Sigma is a letter in the Greek alphabet used by statisticians to measure the variability in any process. Most commonly, it represents standard deviation, a statistic for measurement of dispersion, i.e. spread about a mean or target value.



Bird's-eye view:

Six Sigma is a set of techniques and tools for process improvement. It was introduced by engineer Bill Smith while working at Motorola in 1986.



Bird's-eye view:

Motorola set a goal of “six sigma” for all of its manufacturing operations, and this goal became a by-word for the management and engineering practices used to achieve it.



Bird's-eye view:

Jack Welch made it central to his business strategy at General Electric in 1995. Today, it is used in many industrial sectors.



Bird's-eye view:

One of Motorola’s most significant contributions was to change the discussion of quality from one where quality levels were measured in percent (parts-per-hundred), to a discussion of parts-per-million or even parts-per-billion.

 **Bird's-eye view:**

Six Sigma seeks to improve the quality of the output of a process by identifying and removing the causes of defects and minimizing variability in manufacturing and business processes.

 **Bird's-eye view:**

Six Sigma uses a set of quality management methods, mainly empirical, statistical methods, and creates a special infrastructure of people within the organization, who are experts in these methods.

 **Bird's-eye view:**

Each Six Sigma project carried out within an organization follows a defined sequence of steps and has specific value targets, for example: reduce process cycle time, reduce pollution, reduce costs, increase customer satisfaction, and increase profits.

 **Bird's-eye view:**

The International Organization for Standardization (ISO) has published in 2011 the first standard "ISO 13053:2011" defining a Six Sigma process. Other "standards" are created mostly by universities or companies that have so-called first-party certification programs for Six Sigma.

Box 7.1 Six Sigma at Motorola

Motorola, the originator of Six Sigma, had to adopt it for reasons of pure survival. It was being consistently beaten in the competitive marketplace by foreign firms that were able to produce higher quality products at a lower cost. A Japanese firm that took over a Motorola factory that manufactured Quasar television sets in the United States in the 1970s immediately set about making drastic changes in the way the factory operated. The factory was soon producing TV sets with 1/20th the number of defects they had produced under Motorola management. They did this using the same workforce, technology and designs, making it clear that the problem was Motorola's management. Eventually, even Motorola's own executives were forced to admit that the company's quality policy needed a complete overhaul.

In the mid-1980s, the top management under the leadership of the CEO, Bob Galvin, decided to take quality seriously. He started the company on the quality path known as Six Sigma and became a global icon due to his efforts. The Motorola management focused on quality leadership in a number of ways including top-level meetings to review quality programmes with results passed on through the organization. All levels of the company were involved. Non-executive employees contributed directly through Motorola's Participative Management Programme (PMP). PMP teams, composed of employees who work in the same area were assigned to achieve a specific aim. These teams meet often to assess progress toward meeting quality goals, to identify new initiatives and to work on problems. Savings that stem from team recommendations are shared to reward high-quality work.

Today, Motorola is known worldwide as a quality leader and a profit leader. The secret of their success became public knowledge after Motorola won the Malcolm Baldrige National Quality Award in 1988.

Source: Adapted from www.qualitydigest.com, accessed June 2016.

■ SHIFTS AND ITS ROLE

Six Sigma promotes the idea that the distribution of output for a stable, normally distributed process (voice of the process) should be designed to take up no more than half of the tolerance allowed by the specification limits (voice of the customer). Although processes may be designed to be at their best, it is assumed that over time the variation may increase. This increase in variation may be due to small variations in process inputs, the way the process is monitored, changing conditions, etc. The increase in process variation is often assumed for sake of descriptive simplicity to be similar to temporary shifts in the underlying process mean. The increase in process variation has been shown in practice to be equivalent to an average shift of 1.5 standard deviations in the mean of the originally designed and monitored process. If a process is originally designed to be twice as good as a customer demands (i.e., the specifications representing the customer requirements are six standard deviations from the process target), then even with a shift in the distribution of output the customer demands are likely to be met. In fact, even if the process shifts off target by 1.5 standard deviations, there are 4.5 standard deviations between the process mean ($\mu + 1.50\sigma$) and its closest specification ($\mu + 6.00\sigma$). This results in, at worst 3.4 defects per million opportunities (DPMO) at the time the process has shifted or the variation has increased to have similar impact as a 1.5 standard deviation shift.

The characteristics of a process can be categorized as variables and attributes. For each process, the desired value of a characteristic is specified as its mean value. The allowed range of variation of the variable is specified as the tolerance range (or specification width) and is set by the lower specification limit (LSL) and the upper specification limit (USL).

■ Unshifted Processes

If the LSL and the USL are placed symmetrically around the mean value and the mean of a process variable equals the (desired) nominal or mean value, the process is called a centered process or an unshifted process.

■ Three Sigma Process with a 0.0 Shift in the Mean

Figure 7.1 shows the “voice of the process” for an accounting function with an average of seven days, a standard deviation of one day and a stable normal distribution. It also shows a nominal value of seven days, a lower specification limit of four days and an upper specification limit of ten days. The accounting function is referred to as a Three Sigma process because the process mean plus or minus three standard deviations is equal to the specification limits. In other terms, $USL = \mu + 3\sigma$ and $LSL = \mu - 3\sigma$. This scenario will yield 2,700 defects per million opportunities or one early or late monthly report in 30.86 years $[(1/0.0027)/12]$.

■ Six Sigma Process with a 0.0 Shift in the Mean

Figure 7.2 shows the same scenario as Figure 7.1 except the “voice of the process” only takes half the distance between the specification limits. The process mean remains the same as in Figure 7.1, but the process standard deviation has been reduced to one half-day through application of the DMAIC model. In this case, the resulting output will exhibit 2 defects per billion opportunities or one early or late monthly report in 41,666,667 years $[(1/0.00000002)/12]$.

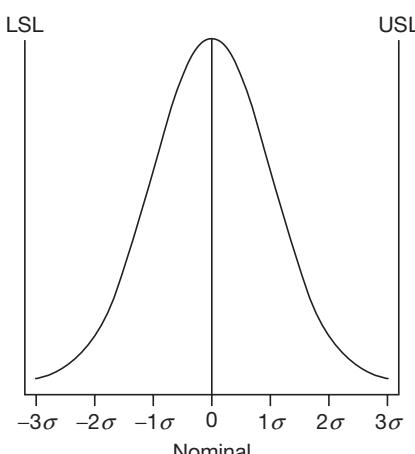
■ Shifted Processes

It is difficult in a real process environment to control a process in a manner that the mean exactly hits the nominal target mean. Therefore, a shift in the process has to be allowed for. Motorola’s Six Sigma quality level allows an off-centering of the process up to 1.5 Sigma.

■ Three Sigma Process with a 1.5 Sigma Shift in the Mean

Figure 7.3 shows the same scenario as Figure 7.1, but the process mean shifts by 1.5 standard deviations (the process average is shifted up or down by 1.5 standard deviations [or 1.5 days]

Fig. 7.1 Three Sigma Process with 0.0 in the Mean



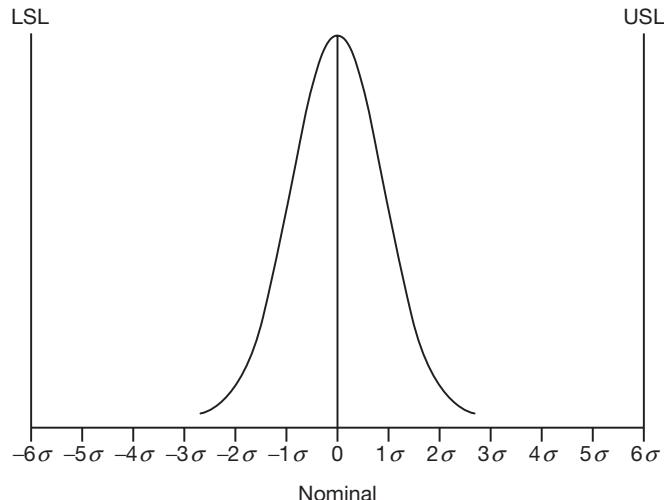
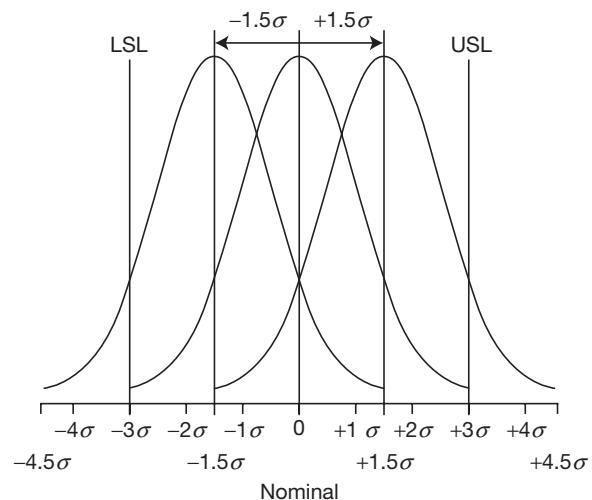
Bird's-eye view:

The characteristics of a process can be categorized as variables and attributes. For each process, the desired value of a characteristic is specified as its mean value.



Bird's-eye view:

The allowed range of variation of the variable is specified as the tolerance range (or specification width) and is set by the lower specification limit (LSL) and the upper specification limit (USL).

Fig. 7.2 Six Sigma Process with a 0.0 Shift in the Mean**Fig. 7.3** Three Sigma Process with a 1.5 Sigma Shift in the Mean

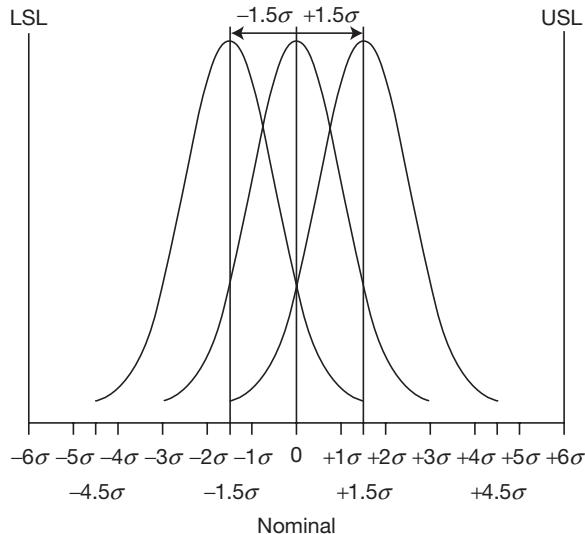
Bird's-eye view:

If the LSL and the USL are placed symmetrically around the mean value and the mean of a process variable equals the (desired) nominal or mean value, the process is called a centered process or an unshifted process.

from 7 days to 5.5 days or 8.5 days) over time. This is not an uncommon phenomenon. The 1.5 standard deviation shift in the mean results in 66,807 defects per million opportunities at the nearest specification limit, or one early or late monthly report in 1.25 years $[(1/0.066807)/12]$.

■ Six Sigma Process with a 1.5 Sigma Shift in the Mean

Figure 7.4 shows the same scenario as Figure 7.3, but the process average shifts by 1.5 standard deviations (the process average is shifted up or down by 1.5 standard deviations [or 0.75 days = 1.5×0.5 days] from 7.0 days to 6.25 days or 7.75 days) over time. The 1.5 standard deviation shift in the mean results in 3.4 defects per million opportunities or one early or

Fig. 7.4 Six Sigma Process with a 1.5 Sigma Shift in the Mean

late monthly report in 24,510 years [(1/0.0000034/12]. This is the definition of Six Sigma level of quality.

Motorola's Six Sigma quality level allows an off-centering of the process upto 1.5 Sigma. The Six Sigma quality level is measured in terms of defectives per million opportunities (DPMO).

Table 7.2 shows the number of defective parts per million opportunities for specified off-centering of the process and quality levels. Note that in the table the first row shows the DPMO when there is no off-centering of the process. At Three Sigma quality level, it shows the DPMO as 2,700, while at Six Sigma quality level the DPMO is 0.002, i.e. 2 defects per billion. For an off-centering of 1.5 Sigma and Sigma quality level, the DPMO is shown as 3.4. Thus, Motorola has quality levels such that 3.4 defects per million are allowed. For a process without off-centering, 3.4 defects per million lie somewhere between 4.5 and 5 Sigma quality levels. For zero off-centering, the 4.5 Sigma quality level has a DPMO of 6.8, while 5 Sigma quality level has a DPMO of 0.57. Thus, the DPMO of 3.4 lies in between DPMO of 0.57 and 6.8, i.e. between 4.5 and 5 Sigma quality levels without off-centering.

Bird's-eye view:

Motorola's Six Sigma quality level allows an off-centering of the process upto 1.5 Sigma. The Six Sigma quality level is measured in terms of defectives per million opportunities (DPMO).

Table 7.2 The Number of DPMO for Specified Off-centering of the Process and Quality Levels

Off-centering	3 Sigma	3.5 Sigma	4 Sigma	4.5 Sigma	5 Sigma	5.5 Sigma	6 Sigma
0	2,700	465	63	6.8	0.57	0.034	0.002
0.25 sigma	3,577	666	99	12.8	1.02	0.1056	0.0063
0.5 sigma	6,440	1,382	236	32	3.4	0.71	0.019
0.75 sigma	12,288	3,011	665	88.5	11	0.02	0.1
1.0 sigma	22,832	6,433	1,350	233	32	3.4	0.39
1.25 sigma	40,111	12,201	3,000	577	88.5	10.7	1
1.5 sigma	66,803	22,800	6,200	1,350	233	32	3.4
1.75 sigma	105,601	40,100	12,200	3,000	577	88.4	11
2.0 sigma	158,700	66,800	22,800	6,200	1,300	233	32

 **Bird's-eye view:**

Defects per million opportunities (**DPMO**) is the average number of defects per unit observed during an average production run divided by the number of opportunities to make a defect on the product under study during that run normalized to one million.

■ DEFECTS PER MILLION OPPORTUNITIES (DPMO)

To achieve Six Sigma quality, a process must produce no more than 3.4 defects per million opportunities. An opportunity is defined as a chance for non-conformance or not meeting the required specifications. This means one needs to be nearly flawless in executing key processes. The process and culture is conditioned for zero defects rather than being one that accepts that it is inevitable, and acceptable that mistakes will occur.

Hence, Six Sigma delivers substantial cost reductions, enhanced efficiencies, sustainable improvement and increased stakeholder value.

A defect is defined as any part of a product or service that does not meet customer specifications or requirements or causes customer dissatisfaction or does not fulfill the functional or physical requirements. It should be noted that the term customer refers to both internal and external customers.

Opportunities are the total number of chances per unit to exhibit a defect. Each opportunity must be independent of other opportunities and must be measurable and observable. The final requirement of an opportunity is that it directly relates to the CTQ. The total count of opportunities indicate the complexity of a product or service.

A unit is something that can be quantified by a customer. It is a measurable and observable output of the business process. It may manifest itself as a physical unit. In case of a service, it may have specific start and stop points.

Defects per unit (DPU) are defined as the number of defects in a given unit of product or process.

Defects per million opportunities (DPMO) are calculated as:

$$\text{DPMO} = \frac{\text{DPU} \times 1,000,000}{\text{Opportunity for Error}}$$

$$\text{DPMO} = \frac{\text{Total Number of Defects Detected}}{\text{Number of Units Produced} \times \text{Opportunities of Defects Per Unit}} \times 1,000,000$$

There may be different approaches to calculate the sigma level of the processes. Table 7.3 shows the sigma levels for various DPMO.

Table 7.3 Sigma Conversion Table

Sigma Level	DPMO
1.00	697,672
2.00	308,772
3.00	66,811
3.10	54,811
3.25	38,810
3.50	22,812
3.60	18,796
3.75	11,810
4.00	6,210
4.25	2,950
4.50	1,400
4.75	530

(Continued)

Table 7.3 (Continued)

Sigma Level	DPMO
5.00	232
5.25	85
5.50	33
6.00	3.4
6.50	0.29

 **Bird's-eye view:**

To achieve Six Sigma quality, a process must produce no more than 3.4 defects per million opportunities.

 **Bird's-eye view:**

An opportunity is defined as a chance for non-conformance or not meeting the required specifications. This means one needs to be nearly flawless in executing key processes.

Example 1:

A purchase order has 50 opportunities for errors. The operator who enters data to prepare the purchase order makes one defect on an average. The DPMO in this case will be:

$$\frac{1 \times 1,000,000}{50} = 20,000$$

Example 2:

Area: Receptionist attending to phone calls for a company.

Customer complaint: "I have to generally wait too long to speak to a representative in this company."

CTQ name: Responsiveness of the receptionist.

CTQ measure: Time on hold (seconds).

CTQ specification: Less than 60 seconds from call connection to the automated response system.

Defect: Telephone calls with hold-time equal to or greater than 60 seconds

Unit: A telephone call.

Opportunities of defects per unit: 1 per call.

Number of defects: 99 telephone calls.

Total number of units (calls) in the duration considered: 1,482 calls.

$$DPMO = \frac{\text{Total Number of Defects Detected}}{\text{Number of Units Produced} \times \text{Opportunities of Defects Per Unit}} \times 1,000,000$$

$$DPMO = \frac{99 \times 1,000,000}{1,482 \times 1} = 66,802$$

From Table 7.3, this value of DPMO corresponds to a sigma level of 3σ approximately.

 **Bird's-eye view:**

A defect is defined as any part of a product or service that does not meet customer specifications or requirements or causes customer dissatisfaction or does not fulfill the functional or physical requirements. It should be noted that the term customer refers to both internal and external customers.

DISCUSSION FORUM

1. Define Six Sigma.
2. What are the key concepts of Six Sigma?
3. Explain shift and its role with reference to Six Sigma.
4. How do you measure Six Sigma quality levels?

■ SIX SIGMA STRATEGY³

Six Sigma is probably one of the best methodologies to pervade the world of improvements. Its measurement orientation, rigorous training scheme, process centricity and stakeholder involvement differentiate it from other quality methodologies. The tools in Six Sigma are not new, but its direct linkages to business objectives and priorities make it a powerful strategy in business.

Six Sigma is the business strategy and a philosophy of one working smarter not harder. One Sigma gives a precision of 68.27 per cent, Two Sigma of 95.45 per cent and Three Sigma of 99.73 per cent, whereas Six Sigma gives a precision of 99.9997 per cent. Although 99.73 per cent sounded very good, it slowly dawned on companies that there was a tremendous difference between 99.73 per cent and 99.9997 per cent. For example, for every million articles of mail, the difference was between 66,738 lost items and 3.4 lost items.

Six Sigma is a data-driven structured problem-solving methodology for solving chronic issues facing a business. It is a breakthrough management process that is used to improve a company's performance by variation reduction. The method encompasses breaking down the customer's requirements into steps to pinpoint pains in a process. This results in the reduction of defects and sustenance of process improvement.

The Six Sigma methodology essentially has two elements, which comprise the voice of the customer and the voice of process. It essentially entails reducing the gap between the two voices and ensuring that they both match. What differentiates Six Sigma from other quality methodologies is that it can be used to solve key pain areas in business.

Six Sigma as a business strategy increases customer responsiveness, builds customer relationships, improves organizational resilience to respond to market conditions and aligns people and processes behind agreed objectives.

A gauge of quality and efficiency, Six Sigma is also a measure of excellence. Embarking on a Six Sigma programme means delivering top-quality service and products while virtually eliminating all internal inefficiencies. A true Six Sigma organization produces not only excellent products but also maintains highly efficient production and administrative systems that work effectively with the company's other service processes. However, not every organization takes this holistic approach. A manufacturer, for instance, may concentrate instead on implementing Six Sigma for outgoing product quality—through 100 per cent final inspection, for example—thereby assuring that quality level for its customers. However, production processes still may run at low yields with high scrap ratios and defects.

That is the typical scenario. A better strategy optimizes the production process, bringing it to Six Sigma (i.e. plus or minus six standard deviations within specifications) and assuring high yields with little or no scrap or defects. Any product made by such a process also will fall within the specification limits.

Thus, implementing a Six Sigma programme in manufacturing entails much more than delivering a defect-free product after a final test or inspection. It also entails concurrently maintaining in-process yields around 99.999998 per cent, defective rates below 0.002 parts per million and virtually eradicating defects, rework and scrap.

Other Six Sigma characteristics include operating processes under statistical control, controlling input process variables rather than the usual output product variables, maximizing equipment uptime and optimizing cycle time.

In administrative processes, Six Sigma may mean not only the obvious reduction of cycle time during production but, more importantly, optimizing response time to inquiries, maximizing the speed and accuracy with which inventory and materials are supplied and fool proofing such support processes from errors, inaccuracies and inefficiency.

Implementing Six Sigma requires more than simply explaining what Six Sigma means and expecting everyone to begin doing it immediately. Such an approach leaves numerous questions unanswered, directions undefined and everybody—particularly those

inexperienced with the concept—scrambling to invent their own version of the programme. The inevitable free-for-all that ensues yields few successes, thereby lowering the programme's acceptance rate and endangering its very existence. Box 7.2 discusses the Six Sigma Excellence Award received by ICICI Prudential for its quality initiatives.

IMPLEMENTING SIX SIGMA⁴

Six Sigma is a rigorous, focused and highly effective implementation of proven quality principles and techniques. A company's performance is measured by the sigma level of their business processes. Traditionally, companies accepted Three or Four Sigma performance levels as the norm, despite the fact that these processes created between 6,200 and 67,000 problems per million opportunities! The Six Sigma standard of 3.4 problems per million opportunities is a response to the increasing expectations of customers and the increased complexity of modern products and processes.

Six Sigma relies on tried and true methods that have been around for decades. In fact, Six Sigma discards a great deal of the complexity that characterized TQM. By one expert's count, there were over 400 TQM tools and techniques. Six Sigma takes a handful of proven methods and trains a small cadre of in-house technical leaders, known as the Six Sigma black belts, to a high level of proficiency in the application of these techniques. To be sure, some of the methods used by the black belts are highly advanced, including the use of up-to-date computer technology.

Box 7.2 ICICI Prudential Life Awarded at the 10th Asian Six Sigma Excellence Awards

ICICI Prudential Life Insurance Company is a joint venture between ICICI Bank and Prudential PLC. It was one of the first players to commence operations when the insurance industry was opened to the private sector in 2000. For the first quarter ended 30 June 2009, the company garnered Rs 2,844 crores of total premiums and has underwritten over 9 million policies since inception. The company has a network of 2,079 offices and 225,668 advisors. For the past eight years, ICICI Prudential has maintained its dominant position amongst life insurers in the country, with a wide range of flexible products that meet the needs of the Indian customer at every step in life.

In keeping with its belief that a happy customer is the best endorsement, ICICI Prudential is one of a handful of companies in the service industry, which had the mettle to take up the Six Sigma initiative. An exercise that begins and ends with the customer from capturing his voice to measuring and responding to his experiences. The company has utilized the Six Sigma approach as the preferred methodology to measure the impact on key performance metrics across customers, distributors and employees. This initiative is helping the company improve processes, turnaround times and customer satisfaction levels. Since then the company has cut down cost and process inefficiencies and grown beyond expectations.

ICICI Prudential Life Insurance Company was awarded the 1st Runner in the Best Defect Elimination in Service and Transaction category at the 10th Asian Six Sigma Excellence Awards 2009, held at Singapore. The Six Sigma Excellence Award is a testimony to company's quest for excellence using a structured methodology to resolve critical business problems. Through such unique initiatives the company will continue to provide world-class service to our customers.

The Best Defect Elimination in Service and Transaction category in the Six Sigma Excellence Awards recognizes companies with strong Six Sigma practices, operational excellence, and greater customer efficiency amongst other critical aspects. The submissions for the Excellence Awards were evaluated on a varied range of qualifications by some of the Six Sigma most experienced practitioners.

Source: Adapted from www.icicibank.com, accessed June 2016.



Bird's-eye view:

Six Sigma is a rigorous, focused and highly effective implementation of proven quality principles and techniques. A company's performance is measured by the sigma level of their business processes.

There are many ways to explain how Six Sigma works. However, the two most common approaches are:

1. Define, measure, analyse, improve and control (DMAIC)
2. Define, measure, analyse, design and verify (DMADV)

DMADV (define, measure, analyse, design and verify) along with DMAIC (define, measure, analyse, improve and control) are the two approaches used in Six Sigma. Both the processes have a lot of commonality, but their disparity also means that one cannot be used for the other.

Both methodologies are used to decrease the number of defects to 3.4 for every one million opportunities. In order to achieve this, both methodologies use facts and statistical tools for finding solutions to common problems—problems which are always related to quality. Finally, the methodologies are similar in that they both focus on increasing the objectives of an organization, both financially and in business.

There are some differences in the two methodologies. DMADV helps clarify client needs as it relates to services or products. It also assists in matching the requests of the client by creating business models. DMAIC is utilized to clarify the work processes and how they fit with the organizational goals. In addition, it creates work process enhancement to lessen or completely eliminate defects.

The contrast shows that DMADV generally comes into the picture when the product is in the initial stages and requires a maturing process in order to develop into what the customer desires. DMAIC is useful when there is a service or commodity already established but not rising to customer demands.

■ **DEFINE, MEASURE, ANALYSE, IMPROVE AND CONTROL (DMAIC)**

Bird's-eye view:

DMAIC (an acronym for Define, Measure, Analyze, Improve and Control) refers to a data-driven improvement cycle used for improving, optimizing and stabilizing business processes and designs. The **DMAIC** improvement cycle is the core tool used to drive Six Sigma projects.

DMAIC can be described as follows:

- D** **Define** the goals of the improvement activity. At the top level, the goals will be the strategic objectives of the organization such as a higher ROI or market share. At the operations level, a goal might be to increase the throughput of the production department. At the project level, goals might be to reduce the defect level and increase throughput. Apply data mining methods to identify potential improvement opportunities.
- M** **Measure** the existing system. Establish valid and reliable metrics to help monitor progress towards the goal(s) defined in the previous step. Begin by determining the current baseline. Use exploratory and descriptive data analysis to help you understand the data.
- A** **Analyse** the system to identify ways to eliminate the gap between the current performance of the system or process and the desired goal. Apply statistical tools to guide the analysis.
- I** **Improve** the system. Be creative in finding new ways to do things better, cheaper or faster. Use project management and other planning and management tools to implement the new approach. Use statistical methods to validate the improvement.
- C** **Control** the new system. Institutionalize the improved system by modifying compensation and incentive systems, policies, procedures, MRP, budgets, operating instructions and other management systems. You may wish to utilize systems such as ISO 9000 to ensure that documentation is correct.

D
Define

M
Measure

A
Analyze

I
Improve

C
Control

What is the problem?	What data is available?	What are the root causes of the problem?	Do we have the right solutions?	What do we recommend?
What is the scope?	Is the data accurate?	Have the root causes been verified?	How will we verify the solutions work?	Is there support for our suggestions?
What key metric is important?	How should we stratify the data?	Where should we focus our efforts?	Have the solutions been piloted?	What is our plan to implement?
Who are the stakeholders?	What graphs should we make?	What clues have we uncovered?	Have we reduced variation?	Are results sustainable?

■ Phase 1—Define

Define the priorities of the customers with respect to quality: In this phase, those attributes of the product/service that are considered most important by the customers in evaluating the quality of the product are identified. These attributes are called critical to quality characteristics (CTQ). The customer's perception about quality attributes are updated from time to time by conducting customer surveys. Quality function deployment (QFD) discussed in Chapter 9 is a powerful tool used in this phase. Key questions, key issues and important tools used in this phase are given below:

Key questions: The key questions that arise are:

- What are the problems and their scope?
- What is its criticality and importance to the customer?
- What is the benchmark?
- How should resources be allocated?
- What are the independent and dependent variables affecting the project?
- Is the voice of the customer being captured directly?

Key issues: The key issues are:

- Which team is to handle the issue?
- What will they accomplish?
- What is the clear definition of project scope, including operational details?
- What are the various milestones of the project?
- What are the roles of team members?
- What are critical to quality (CTQ) parameters?
- Identification of critical success factors (CSF)

Important tools used: The main tools used are as follows:

- Brainstorming
- QFD
- Project management fundamentals to ensure scope
- Pareto analysis
- Process mapping

■ Phase II—Measure

Measure the processes and the defects arising in the product due to the process: The important processes influencing the CTQs are identified and performance measurement



Bird's-eye view:

DMAIC is an acronym for the five phases that make up the process:

- Define
- Measure
- Analyze
- Improve
- Control

 **Bird's-eye view:**

DMAIC is an iterative process that gives structure and guidance to improving processes and productivity in the workplace. Project managers and Six Sigma practitioners apply the DMAIC steps and appropriate analysis tools under each step, to analyze and improve key metrics of a business.

 **Bird's-eye view:**

The DMAIC steps work because they are understandable and make sense. These steps can be applied to any process, any industry, any company to help guide a process improvement team.

techniques are established for these processes. Measurement of processes and thus the defects arising in the product due to the processes is undertaken.

Key questions: The key questions are:

- What are the performance variables and their impact?
- What is the gap between benchmark and existing status?
- What is the performance capability of the process/processes?

Key issues: The key issues are:

- What does the customer really want?
- Validation of measurement schemes
- Development of key input, process and output measures

Important tools used: The important tools used are:

- Process mapping
- QFD
- Cause and effect matrix
- Creativity techniques
- 7 QC tools
- Calculation of process sigma and process capability studies
- Gauge R and R studies
- ANOVA

■ Phase III—Analyse

Analyse the process to determine the most likely causes of defects: The key variables most likely to be responsible for variation in the process are identified to find the reasons for generation of defects.

Key questions: The key questions are:

- What are the success factors?
- What is the performance goal?
- What are the sources of real variation?
- What is the target percentage for improvement?

Key issues: The key issues are:

- What is the company's ability to make/deliver it?
- What is the characterization of the problem (means/spread)?
- Selection of performance variable and their quantification

Important tools used: The important tools used are:

- Gap analysis and improvement goals
- Process map analysis

- Data stratification
- Advanced analytical tools
- Regression analysis
- ANOVA
- Tests of hypothesis

■ Phase IV—Improve

Improve the performance of the process and remove the causes of the defects: The specification limits of the key variables are fixed and the system established for measuring the deviations of the variables is validated. Improvisations in the process are undertaken to keep the variables within the specification limits.

Key questions: The key questions are:

- How is variable performance diagnosed?
- How is the interaction between various factors studied?
- How are operating limits and new process capability established?
- How is optimum solution selected?
- How is implementation planned?

Key issues: The key issues are:

- What really affects the company's ability to make/deliver it?
- How is performance improvement verified?
- Action plans
- Generation of solutions to address root causes and the criteria to screen and select
- Establishment of operating tolerances

Important tools used: The important tools used are:

- DOE techniques
- Tests of hypothesis
- Confirmation or validation studies

■ Phase V—Control

Control to ensure that the improvements are maintained over time: The modified process is subjected to vigil at regular intervals of time to ensure that the key variables do not show any unacceptable variations (beyond the specification limits).

■ DEFINE, MEASURE, ANALYSE, DESIGN AND VERIFY (DMADV)

There are certain situations where the project team members may feel that a process needs to be replaced by a new process rather than simply improving the existing process. The demands of the customers with regard to quality cannot be satisfied by the existing process. At times, an organization may decide to launch a new product or service to grab a new business opportunity offered by the environment. In all such situations, the last two steps in the

 **Bird's-eye view:**
The Six Sigma processes that look at the customer service aspects of a business are outlined in the acronym "DMADV" which refers to Define, Measure, Analyze, Design, and Verify.

 **Bird's-eye view:**
The DMADV methodology should be applied:
1. When a non-existent product or process needs to be developed at a company and
2. When an existing process or product already exists but still needs to meet a Six Sigma level or customer specification.

 **Bird's-eye view:**

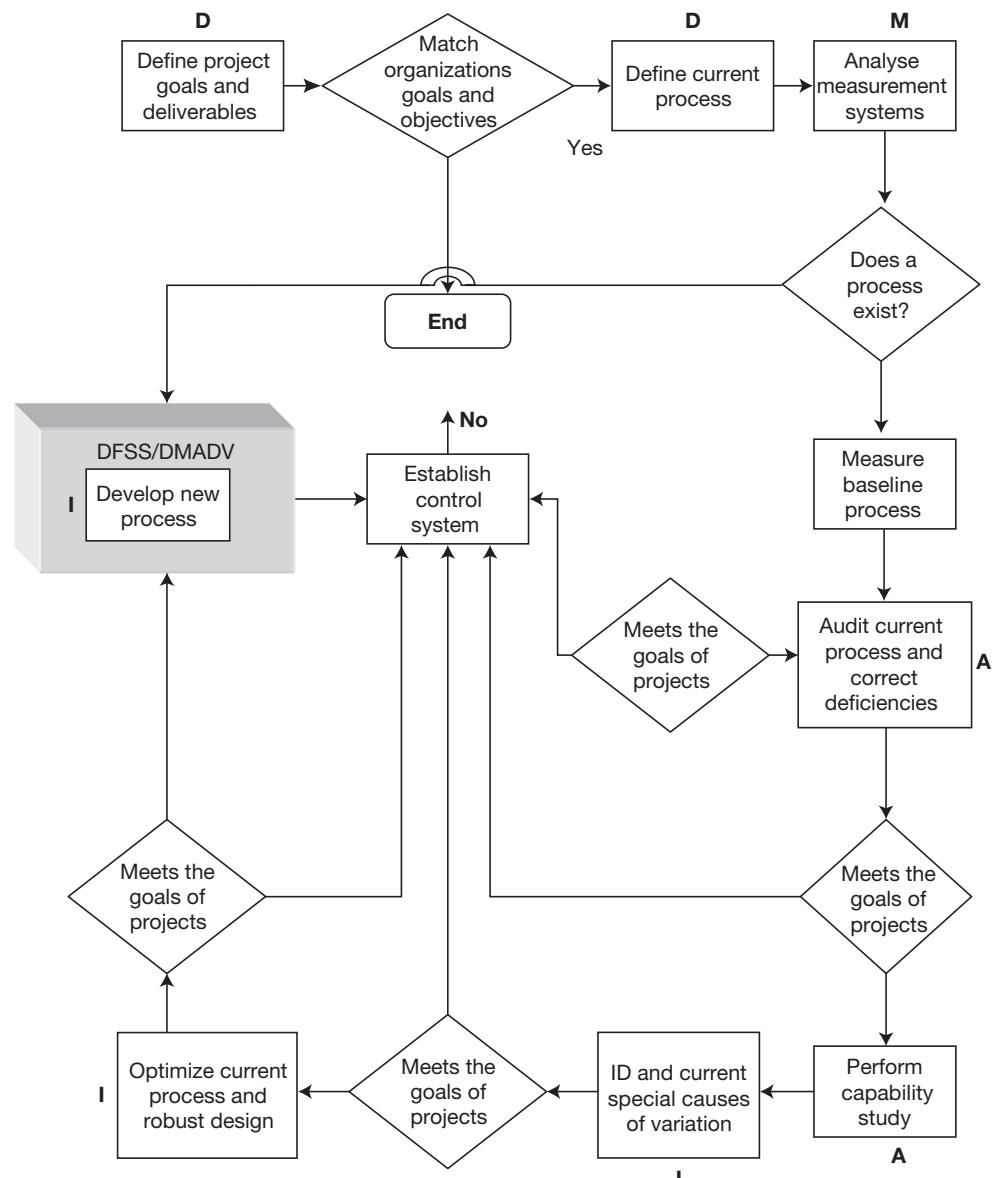
The two most widely used Six Sigma methodologies are DMAIC and DMADV. Both methods are designed so a business process will be more efficient and effective.

DMAIC, namely, “improve” and “control” have to be replaced by “design” and “verify” so that it becomes DMADV. The design of new processes or redesign of existing processes using DMADV is known as “Design for Six Sigma” (DFSS) or “Six Sigma Design” (SSD). The map of Six Sigma project flow⁵ is given in Figure 7.5.

Thus, the very essence of Six Sigma lies in the following four factors:

1. Proper definition and scope of engineering or management problems
2. Conversion of an engineering or management problem into a statistical problem
3. Seeking a statistical solution to this problem
4. Conversion of the statistical solution into business or engineering solutions

Fig. 7.5 Map of Six Sigma Project Flow



 **Bird's-eye view:**

DMAIC concentrates on making improvements to a business process in order to reduce or eliminate defects; DMADV develops an appropriate business model destined to meet the customers' requirements.

Box 7.3 Mumbai's Dabbawalas and Six Sigma

Mumbai's 5,000-plus *dabbawalas* who deliver lunch everyday to hungry Mumbaikars have become world-famous for their impeccable service standards. They have been featured in a Harvard Business School case study and even had an audience with Britain's Prince Charles.

The majority of the *dabbawalas* are almost illiterate. They face the same crowded pavements, on-road dense vehicular traffic and overloaded suburban trains that normal office goers often give as excuses for getting late to work. They also do it with minimal technology, processes or structure.

The *dabbawalas* deliver 175,000 lunches everyday and take the empty lunch boxes back. The *dabbas* are collected by collecting *dabbawalas* usually from homes. All the *dabbas* have some sort of distinguishing mark on them such as a color or symbol. The *dabbawala* then takes them to a designated sorting place, where he and other collecting *dabbawalas* sort the lunch boxes into groups. The grouped boxes are put in the coaches of trains, with markings to identify the destination of the box (usually there is a designated car for the boxes). The markings include the rail station to unload the boxes and the building address where the box has to be delivered. At each station, boxes are handed over to a local *dabbawala*, who delivers them. The empty boxes, after lunch, are again collected and sent back to the respective houses.

They make one mistake in 2 months. This means there is one error for every 16 million transactions. This 99.99999 per cent accuracy qualifies them to join the ranks of Six Sigma companies such as Motorola and GE, which are world-famous for their quality.

Source: Adapted from www.mydabbawala.org, accessed June 2016.

Box 7.3 discusses the impeccable service provided by Mumbai's *dabbawalas*.

SIX SIGMA TRAINING PROGRAMMES⁶

Six Sigma involves changing major business value streams that cut across organizational barriers. It is the means by which the organization's strategic goals are to be achieved. Six Sigma must be implemented from the top-down. This needs the efforts of the top leaders in the organization particularly the CEO who is responsible for the performance of the organization as a whole.

Champions and Sponsors

Six Sigma champions are high-level individuals who understand Six Sigma and are committed to its success by removing the road blocks on the path. Champions must be proficient in four other areas—business and operations interface, project selection, pace mediation and result implementation. In larger organizations, Six Sigma is led by a full time, high-level champion such as a vice-president. Champions have a larger role in deploying Six Sigma. Sponsors are owners of processes and systems that help initiate and coordinate Six Sigma improvement activities in their areas of responsibilities.

Master Black Belt

The certified Master Black Belts are experts responsible for the strategic deployment of Six Sigma within an organization. They promote and support improvement activities in all business areas of their organization as well as at the suppliers and customers ends. Their main responsibilities include:

- Providing mentoring and support to Black Belts, Green Belts, and Six Sigma teams to use the improvement tools appropriate to a specific problem.

Bird's-eye view:

Companies without previous Six Sigma experience may want to enlist help from professionals such as Six Sigma Black Belts and Master Black Belts, professionals who can help make the best choice between DMAIC and DMADV.

Bird's-eye view:

Master Black belts are at the highest level of technical and organizational proficiency. Master Black Belts provide technical leadership to the Six Sigma programme.

Bird's-eye view:

Six-sigma is perceived as an expensive initiative with a huge potential from return on investment. However risks are associated with it.

- Helping to develop and deploy organizational metrics and dashboards.
- Developing, maintaining and revising the Six Sigma curriculum, delivering classroom training and serving as liaison with external agencies in the delivery of Six Sigma training.
- Networking with other Master Black Belts.

■ Black Belt

The certified Six Sigma Black Belt is a professional who can explain Six Sigma philosophies and principles including supporting systems and tools. A Black Belt should demonstrate team leadership, understand team dynamics and assign roles and responsibilities to team members. Black Belts have a thorough understanding of all aspects of the DMAIC model in accordance with Six Sigma principles. They have basic knowledge of lean enterprise concepts, are able to identify non-value-added elements and activities and use specific tools. As part of their training, black belts receive 160 hours of classroom instruction, plus one-to-one project coaching from Master Black Belts and consultants.

■ Green Belt

Six Sigma Green Belts are project leaders capable of forming and facilitating Six Sigma teams and managing Six Sigma projects from concept to completion. Green Belt training consists of five days of classroom training and is conducted in conjunction with Six Sigma projects. Training covers project management, quality management tools, quality control tools, problem solving and descriptive data analysis. The Six Sigma Green Belt operates in support of or under the supervision of a Six Sigma Black Belt, analyses and solves quality problems and is involved in quality improvement projects. A Green Belt is someone with at least three years of work experience who wants to demonstrate his or her knowledge of Six Sigma tools and processes.

Six Sigma champions should attend Green Belt training. Usually, Six Sigma Black Belts help Green Belts define their projects prior to the training, attend training with their Green Belts and assist them with their projects after the training.

■ Yellow Belt

Six Sigma Yellow Belt is an introductory training in the fundamentals of Six Sigma. Yellow Belt certification provides an overall insight to the techniques of Six Sigma, its metrics, and basic improvement methodologies. A Yellow Belt must know how to integrate Six Sigma methodologies for the improvement of production and transactional systems to better meet customer expectations and bottom-line objectives of the organization. A Yellow Belt typically has a basic knowledge of Six Sigma, but does not lead projects on his own. Yellow Belts are often responsible for the development of process maps to support Six Sigma projects. A Yellow Belt participates as a core team member or subject matter expert (SME) on a project or projects. In addition, Yellow Belts may often be responsible for running smaller process improvement projects using the PDCA (Plan, Do, Check, Act) methodology.

■ Implementation of Six Sigma⁷

The goal of Six Sigma is to achieve fewer than 3.4 defects per million opportunities by training internal leaders to apply established techniques. Six Sigma has been adopted by organizations of all sizes and types. The following is a step-by-step approach for implementing Six Sigma.

■ Step 1

Successful performance improvement must begin with senior leadership. Make sure all top-level management is on board and that financial and managerial resources are available. Systems are developed for establishing close communication with customers, employees and suppliers. Policies and guidelines are established. Training needs are rigorously assessed and training programmes are conducted for employees. Commitment is made to the project.

■ Step 2

Define the project scope and goals based on customer feedback and needs. Inspiration for Six Sigma projects can come from surveys, studies or existing projects. Set goals for the whole organization or for a specific level of the organization that needs improvement.

■ Step 3

Analyse the system to identify defects and problems. Measure the defects in the current system and performance. Identify the possible causes of problems. Explore possible solutions and assess their possible effect on the organization. Use statistical data analysis.

■ Step 4

Improve the system by finding ways to do things faster, cheaper or better. Use management and planning tools to put the improvement projects into place. Test the improvement with statistical data.

■ Step 5

Control the new process by modifying systems and measuring processes to continue to achieve results. Use customer feedback and statistical tools. State what was done to improve performance. Document methods to recognize and solve future problems.

Box 7.4 discusses the benefits of Six Sigma implementation at Bharti.

Box 7.4 Bharti Broadband Saves with Six Sigma

Bharti Broadband Networks Limited (BBNL), a leading integrated broadband service provider operating in the broadband, Internet and VSAT markets, provides customized and integrated solutions to corporate customers. The company embraced Six Sigma in order to realise its objective of providing error-free services to customers by doing the job right the first time, every time.

After the quality objectives were finalized, an executive committee (EC) comprising nine officials, including the CEO, was formed. Before deciding on Six Sigma, the committee studied various other quality tools and processes such as ISO and TQM. Six Sigma was finally selected as it was closely aligned with the outlined quality objective. The top management was confident that by implementing Six Sigma in its processes, it would be able to meet customer requirements and the requirements of the dynamic telecom industry.

Within six months of implementation, complaint resolution had gone up 66 per cent from the baseline, timely order implementation had gone up 70 per cent from the baseline and invoice submission had gone up 51 per cent from the baseline. The Six Sigma process improvements have resulted in productivity enhancements, improved customer satisfaction and process effectiveness. Almost 100 per cent of the employees of BBNL are involved in the Six Sigma journey.

Source: Adapted from www.airtel.in, accessed June 2016.

DISCUSSION FORUM

1. Explain Six Sigma as a business strategy.
2. What are the two main approaches to explain the working of Six Sigma?
3. Discuss Six Sigma champions, sponsors, Master Black Belt, Black Belts and Green Belts?

SUMMARY

- Sigma (σ) is a letter in the Greek alphabet used to denote the standard deviation of a process. Sigma quality level is sometimes used to describe the output of a process. A Six Sigma quality level is said to equate to 3.4 defects per million opportunities; however, the term in practice is used to denote more than simply counting defects. Motorola pioneered the implementation of Six Sigma.
- Six Sigma incorporates the basic principles and techniques used in business, statistics and engineering. These three form the core elements of Six Sigma. Six Sigma improves the process performance, decreases variation and maintains consistent quality of the process output. This leads to defect reduction and improvement in profits, product quality and customer satisfaction.
- At its core, Six Sigma revolves around a few key concepts—critical to quality, defect, process capability, variation, stable operations and design for Six Sigma.
- According to Harry and Schroeder, Six Sigma quality fundamentally means a breakthrough strategy that can be interpreted as “a disciplined method of using extremely rigorous data gathering and statistical analysis to identify the sources of errors and ways of eliminating them.”
- Six Sigma promotes the idea that the distribution of output for a stable normally distributed process (voice of the process) should be designed to take up no more than half of the tolerance allowed by the specification limits (voice of the customer). Although processes may be designed to be at their best, it is assumed that over time the variation may increase in the processes.
- Motorola’s Six Sigma quality level allows an off-centering of the process up to 1.5 Sigma. The Six Sigma quality level is measured in terms of defectives per million opportunities (DPMO).
- Six Sigma as a business strategy increases customer responsiveness, builds customer relationships, improves organizational resilience to respond to market conditions and aligns people and process behind agreed objectives.
- There are many ways to explain how Six Sigma works. However, the two most common approaches are define, measure, analyse, improve and control (DMAIC) and define, measure, analyse, design and verify (DMADV).
- Six Sigma champions are high-level individuals who understand Six Sigma and are committed to its success. Sponsors are owners of processes and systems that help initiate and coordinate Six Sigma improvement activities in their areas of responsibilities.
- Master Black belts are at the highest level of technical and organizational proficiency. Master Black Belts provide technical leadership to the Six Sigma programme. Black Belts are technically-oriented individuals held in high regard by their peers. They should be actively involved in the process of organizational change and development. Green Belts are Six Sigma project leaders capable of forming and facilitating Six Sigma teams and managing Six Sigma projects from concept to completion.

Key Terms

7 QC Tools	218	Green Belt	222
ANOVA	218	Master Black Belt	221
Black Belt	222	Mean	205
Brainstorming	217	Pareto Analysis	217
Cause and Effect Matrix	218	Process Capability	206
Champions	221	Process Mapping	217
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Case Study

Six Sigma at Wipro Technologies

Wipro Limited was founded in 1945 and commenced operations in 1946 as a vegetable oil company. In the early 1980s, Wipro diversified into the Information Technology sector when India witnessed waves of liberalization sweeping across various sectors of the economy. It has been a fascinating transformation from a vegetable oil manufacturing company to a global IT services giant.

Today, Wipro Technologies has become a global service provider delivering technology-driven business solutions that meet the strategic objectives of clients. Wipro has more than 40 “Centres of Excellence” that create solutions related to specific needs of industries. Wipro can boast of delivering unmatched business value to customers through a combination of process excellence quality frameworks and service delivery innovation.

A strong emphasis upon building a professional work environment, leaders from within and having a global outlook for business and growth has led to innovation of people processes on a continued basis. Over the years, Wipro has significantly strengthened its competency-based people processes and demonstrated innovative practices in talent acquisition, deployment and development, based on strategic needs.

A leading provider of communication networks in the US required improvements in the product performance of a telecom application using Six Sigma methodologies. Thus, with the growing importance on aligning business operations with customer needs and driving continuous improvement, Wipro began moving towards focusing on quality, thereby creating a learning environment that led to the implementation of Six Sigma.

Integrating Six Sigma concepts was also intended to bring rigour in effective upstream processes of the software development lifecycle. Implementation of Six Sigma methodologies brought in quantitative understanding, cost savings and performance improvement towards product quality.

Some of the key challenges involved were:

- Reduce the data transfer time
- Reduce the risk
- Avoid interruption due to LAN/WAN downtime
- Parallel availability of the switch for the other administrative tasks during the same period

Evolution of Six Sigma at Wipro

Wipro was the first Indian company to adopt Six Sigma. Today, Wipro has one of the most mature Six Sigma programmes in the industry ensuring that 91 per cent of the projects are completed on schedule, much above the industry average of 55 per cent. As the pioneers of Six Sigma in India, Wipro has already put around 10 years into process improvement through Six Sigma. Along the way, it has scaled the Six Sigma ladder while helping to roll out over 1,000 projects. The Six Sigma programme spreads across verticals and impacts multiple areas such as project management, market development and resource utilization.

Six Sigma at Wipro simply means a measure of quality that strives for near perfection. It is an umbrella initiative covering all business units and divisions so that it can transform itself into a world-class organization. At Wipro, it means:

1. Having products and services that meet global benchmarks
2. Ensuring robust processes within the organization
3. Consistently meeting and exceeding customer expectations
4. Making quality a culture within

Difficulties Encountered by Wipro and Learnings

Building the Culture

The implementation of Six Sigma required support from higher level managers. It meant restructuring of the organization to provide the infrastructure, training and the confidence in the process. Wipro had build this culture painstakingly.

Project Selection

The first year of deployment was extremely difficult for Six Sigma success. They decided to select the projects on the basis of high probability of their success and aimed at completing them in a short period to assess the success. These projects were treated as pilot projects with a focus to learn. To select the right project, field data was collected, a process map was developed and the importance of the project was judged through the eyes of customers.

Training

After the set up was complete, the first step of implementation required building a team of professionals and training them for various stages of Six Sigma. The training was spread across five phases—defining, measuring, analysing, improving and controlling the process and increasing customer satisfaction. These phases consisted of statistics, benchmarking

and design of experiments. It was difficult to find the right kind of people and to train them. This motivated Wipro to start its own consultancy to train people.

Resources

It was difficult to identify resources that would be required on a short-term and long-term basis as it would vary from project to project. Resources were identified based on the importance of the project.

Project Reviews

As timely reviews played a very crucial role in judging the success of a project, Wipro had to develop a team of experts for this purpose. The task assigned was to check the timeliness, find out gaps and weak areas and check the outcome as per the plan.

Implementation of Six Sigma at Wipro

Wipro has adopted the project approach for Six Sigma, where projects are identified on the basis of the problem areas under each of the critical business processes that adversely impact the business significantly. Wipro has evolved following the Six Sigma methodologies:

(I) For developing new processes

- (i) DSSS+ methodology: Wipro employs DSSS methodology for software development. The methodology uses rigorous in-process metrics and cause analysis throughout the software development lifecycle for defect-free deliveries and lower customer cost of application development.
- (ii) DSSP methodology: Used for designing new processes and products.
- (iii) DCAM methodology: Used for designing processes that focus on customer satisfaction and manufacturability.

(II) For improving existing processes

- (i) TQSS methodology: Used for defect reduction in transactional processes.
- (ii) DMAIC methodology: Used for process improvement in non-transactional processes.

(III) For re-engineering

CFPM methodology: Used for cross-functional process mapping. The list of players at Wipro is as below:

- Executive management
- Six Sigma champions and deployment leaders
- Financial executives
- Black Belts
- Green Belts
- Yellow Belts

Six Sigma projects at Wipro are (Exhibit 7.1):

- (i) Driven by business heads, also called Champions for the projects
- (ii) Led by Green Belts (GB)
- (iii) Assisted by Black Belts (BB)

Exhibit 7.1: Six Sigma Experts

Green Belts (GB) are trained in Six Sigma. They spend a portion of their time completing projects, but maintain their regular work role and responsibilities. Depending on their workload, they can spend anywhere from 10 per cent to 50 per cent of their time on their project(s).

Black Belts (BB) are experts in Six Sigma methodologies and its usage. Black Belts are the heart and soul of the Six Sigma quality initiative. Their main purpose is to lead quality projects and work full-time until they are complete. Black Belts can typically complete four to six projects per year with savings of approximately USD 230,000 per year.

Champions: Facilitate the leadership, implementation and deployment of the Six Sigma philosophy.

The management responsible for the project at Wipro follows the following tools for the implementation of Six Sigma:

- Ideation
- Definition
- Selection
- Tracking
- Reporting

More than 15,000 employees have been trained in Six Sigma methodologies. Wipro has also built up a Six Sigma skill base of over 180 certified Black Belts while helping to roll out over 1,000 projects (Exhibit 7.2).

Six Sigma Consultancy at Wipro

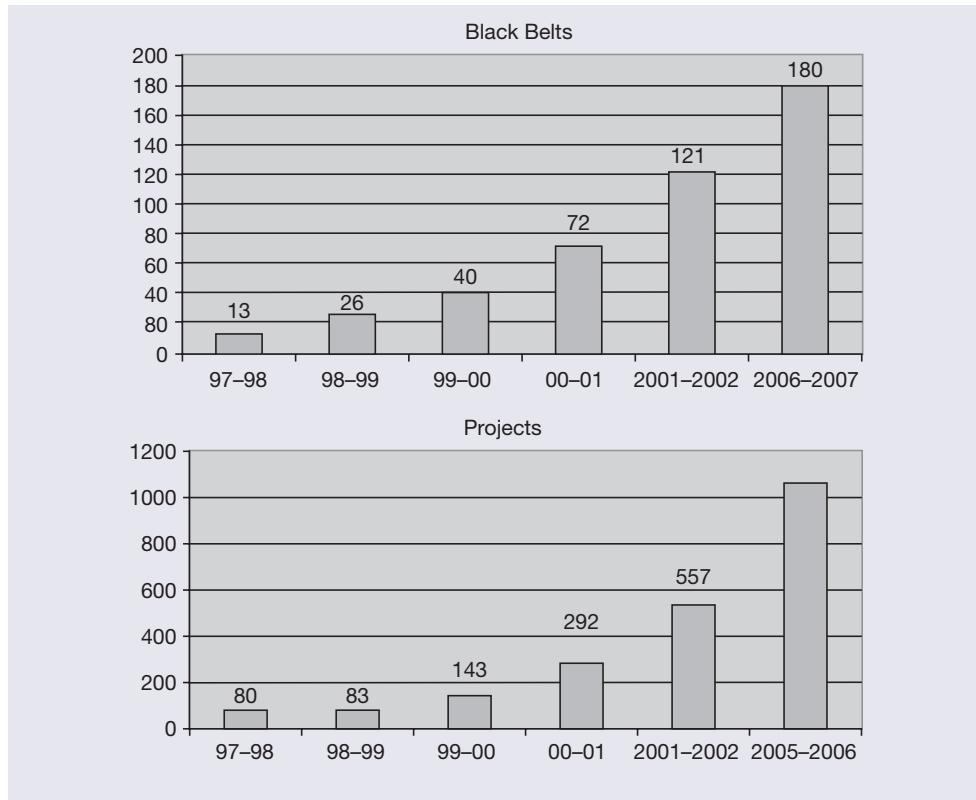
Wipro's Six Sigma consulting experience has peaked with the indigenous development of new methodologies that it takes to its customers. As Wipro continues its Six Sigma consulting journey, it builds on its expertise and experience to provide enterprise-class coverage of topics in business process management and information technology systems integration. The focus is on supporting the project needs and is also integrated with other methods to support process needs. Currently, there are over 200 PMI certified consultants at Wipro.

The Wipro quality consulting group trains in achieving the precision of Six Sigma with Wipro's own methodologies, training capabilities and global experience. Wipro also helps in institutionalizing Six Sigma across the organization for transformation.

Wipro provides consulting in institutionalizing an organization-wide Six Sigma programme that specializes in implementation across IT development, production support and core business operations.

Wipro offers the following Six Sigma consulting services (Exhibit 7.3):

- Six Sigma institutionalization
- Problem solving using Six Sigma
- Six Sigma training

Exhibit 7.2: Resources Invested in Six Sigma**Exhibit 7.3:** Six Sigma Consulting Services

Six Sigma institutionalization: Here, the Wipro consultants work with the senior management of the client team in identifying pain areas and critical business processes. The Wipro consultants then create a programme of implementing Six Sigma throughout the organization. They create Six Sigma teams, provide the necessary training to the Green Belts and Black Belts, identify projects to be run, help manage change and identify the benefits.

Problem-solving using Six Sigma: Here, Wipro's consultants work with the process action team at the client organization to identify the problem areas, determine the root causes of problems and establish necessary recommendations for corrective/preventive actions.

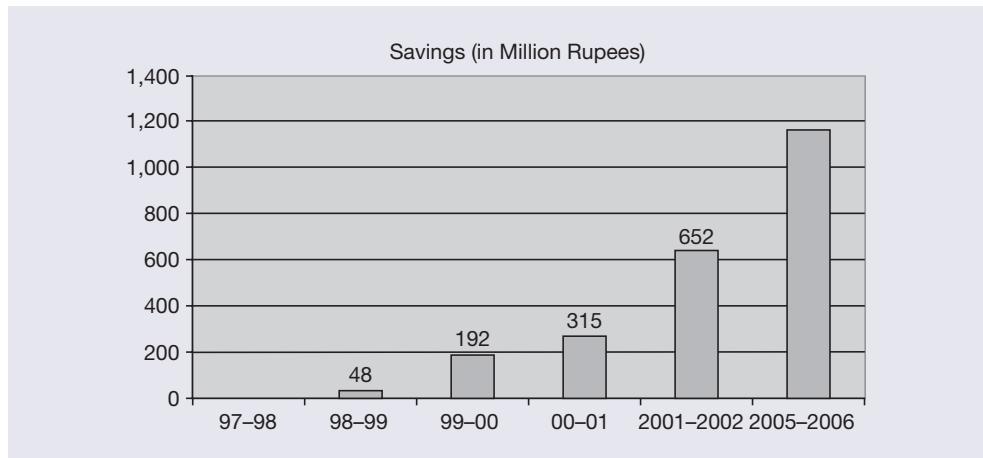
Six Sigma training: Wipro provides training on various Six Sigma methodologies (DMAIC/DMADV/DSSS+) and statistical tools (control charts/QFD, etc.), use of Minitab, etc.

Reaping the Benefits

The financial gain that Wipro has achieved by using Six Sigma has been one of the high points (Exhibit 7.4).

As the Six Sigma initiative started maturing, Wipro identified two major phenomena:

- The biggest projects had all been completed.
- The Yellow Belt culture had cured the small problems before they became big ones.

Exhibit 7.4: Six Sigma and Financial Gains

At this point, the project-oriented Six Sigma culture began to give way to the sustaining culture.

The Six Sigma process resulted in an achievement of close to 250 per cent, six minutes for 1 MB transfer and 18 minutes for average data transfer. The set target was 200 per cent. Since quality is customer driven, the objective of Six Sigma implementation at Wipro has continuously been on integrating and implementing approaches through a simultaneous focus on defect reduction, timeliness and productivity. This has translated to lower maintenance costs, schedule-overrun costs and development costs for customers. Measurements and progress indicators have been oriented towards what the customer finds important and what the customer pays for. Six Sigma concepts have played an important role in:

- Improving performance through a precise quantitative understanding of the customer's requirements, thereby bringing in customer focus.
- Improving the effectiveness in upstream processes of the software development lifecycle by defect reduction (software defects reduced by 50 per cent) and cycle time reduction (rework in software down from 12 per cent to five per cent).
- Waste elimination and increased productivity up to 35 per cent.
- Cost of failure avoidance (installation failures down from 4.5 per cent to one per cent in hardware business).
- Tangible cost savings due to lower application development cost for customers.

Analysts remarked that Six Sigma was an indisputable success at Wipro whether in terms of customer satisfaction, improvement in internal performance or in the improvement of shareowner value.

The results of achieving Six Sigma are rapid and overwhelming at Wipro. Its unique methodology provides Six Sigma knowledge and skills to the client, enabling the client to create ownership, generate results and sustain success. The maturity of Wipro's quality processes takes the benefits to another level, ensuring that the customers benefit from:

- 30–40 per cent lower total cost of ownership
- 20–30 per cent higher productivity

- On-time deliveries (93 per cent projects completed on time)
- Lower field defect rates (67 per cent lower than industry average)

The performance enhancement enables the client to have an improved product with the overriding benefit that the end customer perception about the quality of the client's product is improved.

Future Focus and Challenges

Six Sigma certainly produces breakthrough improvement. However, to sustain this, Wipro will have to combine the power of the Six Sigma method and tools with stretch goals—goals that almost seem too aggressive, too optimistic. Wipro will also have to benchmark itself against the competition on the level of performance achieved by rivals. This focus will lead to the adaptation of newer dimensions of the quality management framework towards embodying a totality of process, people, product and technology for achieving high process capability.

Six Sigma projects require continuous change. Black Belts and Green Belts develop improvements to systems and processes for which they are not accountable. When these participants are done with their project, they ask the real system or process owner to implement and sustain their solution. Hence, the challenge before Wipro lies in bringing the commitment towards continuing its process optimization theory.

The challenge will be to transform Six Sigma from a tool for improving product quality to an overall business improvement methodology. The company's aim will be at having 100 per cent of its management trained in Six Sigma.

To summarize, the quality system will continue to be based on incremental optimization, with rigorous implementation and sustenance of the same. The goal will be to make quality as the No. 1 objective for all employees.

Source: Adapted from www.wipro.com and the Wipro Annual Report, 2002–2006.

For Discussion

1. What led Wipro to implement the Six Sigma programme?
2. What is the objective of Wipro in providing Six Sigma consultancy?
3. What are the other business benefits apart from profit?

Short-answer Questions

1. Define Six Sigma quality with respect to defect expectations.
2. What would Three Sigma quality mean if applied to processes? Give examples.
3. What is a centered process?
4. What is a shifted process?
5. What is a defect?
6. Define opportunities with reference to Six Sigma.
7. Define DPU.
8. Name the two main approaches to implementing Six Sigma.
9. Discuss the role of Master Black Belts in a Six Sigma programme.
10. Discuss the role of Green Belts in a Six Sigma programme.

Mutiple-choice Questions

1. For a normal distribution, two standard deviations on each side of the mean would include what percentage of the total population?
 - a. 47 per cent
 - b. 68 per cent
 - c. 95 per cent
 - d. 99 per cent
2. Which of the following is the most important in evaluating and understanding design intent?
 - a. Identifying the functional requirement
 - b. Brainstorming failure modes
 - c. Conducting computer simulations
 - d. Developing FMEA
3. For consumer products, an increase in the percentage of returned goods most likely equates to an increase in:
 - a. Product not meeting specifications
 - b. End-user dissatisfaction
 - c. Internal reject rates
 - d. Non-conforming material costs
4. In measurement system analysis, which of the following pairs of data measures is used to determine total variance?
 - a. Process variance and reproducibility
 - b. Noise system and repeatability
 - c. Measurement variance and process variance
 - d. System variance and bias
5. All of the following are effective when a team leader is giving feedback to the team except:
 - a. Describing the behaviour in context
 - b. Describing the reasons for giving feedback
 - c. Giving feedback when it is convenient
 - d. Providing actionable guidance
6. Process data being used in the initial set-up of a process are assumed to have a normal distribution. If the nominal (target) is set at the centre of the distribution, and the specification limits are set at ± 3 from the center, the C_{pk} is equal to
 - a. 0.25
 - b. 1.00
 - c. 1.33
 - d. 1.67

7. A Green Belt is going to monitor the number of defects on different size samples. Which of the following control charts would be most appropriate?
 - a. u
 - b. np
 - c. c
 - d. p
8. Compared to a two-level factorial experiment, which of the following is an advantage of an experiment in three levels?
 - a. Interaction effects can be estimated
 - b. Curvature can be characterized
 - c. The design can be augmented
 - d. Efficiency is maximized in the experimental effort
9. Which of the following is the best technique for improving the precision of a designed experiment when the experimental material is not homogeneous?
 - a. Blocking
 - b. Confounding
 - c. Randomization
 - d. Fractionalizing
10. Which of the following most influences consumer perception of quality?
 - a. Industry standards
 - b. Company's financial performance
 - c. Audit results
 - d. Service and repair policies
11. Correction, overproduction, inventory and motion are all examples of:
 - a. Waste
 - b. 5 S target areas
 - c. Noise
 - d. Value-added activities
12. A randomized, paired-comparison design was used to test the wear rate of two products. The data from this test are as follows:
 - Average difference = 20.8 mm
 - Sum of differences = 208
 - Sum of squared differences = 3,910
 - Number of paired observations = 20
13. What is the calculated value for the test statistic?
 - a. 0.46
 - b. 1.01
 - c. 2.17
 - d. 9.70

14. The primary factor in the successful implementation of Six Sigma is to have:
 - a. The necessary resources
 - b. The support/leadership of top management
 - c. Explicit customer requirements
 - d. A comprehensive training programme
15. All of the following experimental designs could be used to investigate interactions except:
 - a. Half-fraction
 - b. Half-fraction with replication
 - c. Full-factorial with replication
 - d. Saturated screening with replication
16. The most important aspect of functional requirements is that they:
 - a. Describe a single, measurable performance
 - b. Describe how a product or service should operate
 - c. Be traceable to the voice of the customer
 - d. Provide upper and lower performance limits
17. Which of the following types of variation is least likely to occur in sequential repetitions of a process over a short period of time?
 - a. Cyclical
 - b. Positional
 - c. Temporal
 - d. Seasonal
18. The primary reason that most companies implement Six Sigma is to:
 - a. Reduce defects
 - b. Improve processes
 - c. Improve profit
 - d. Increase customer satisfaction
19. According to Deming, which of the following is not a key element of quality leadership?
 - a. Establishment of an organizational goal to meet or exceed customer needs
 - b. The use of displays and awards to promote employee motivation
 - c. Continual education and training that elevate the level of technical and professional expertise
 - d. Elimination of barriers and distrust to create an organizational culture that fosters teamwork
20. What is the standard deviation of a process that operates to an exponential distribution with a mean of 25 units?
 - a. 0.4
 - b. 5.0
 - c. 12.5
 - d. 25.0

21. The term used to describe the risk of a type I error in a test of hypothesis is:
- Power
 - Confidence level
 - Level of significance
 - Beta risk
22. Which of the following techniques can be used in regression analysis to reduce higher-order terms in the model?
- Large samples
 - Dummy variables
 - Transformations
 - Blocking
23. Which of the following tools has the highest resolution?
- A feeler gage
 - A gage block
 - A caliper
 - A micrometer
24. Which of the following best describes internal failure costs?
- The economic costs associated with a catastrophic failure of an internal subsystem
 - The unavoidable quality system costs associated with the production of any product or service
 - The opposite of external failure costs
 - The costs resulting from a non-conformance detected before a product or service is provided
25. In order for a problem to be solved correctly, which of the following must occur first?
- The problem must be defined
 - Relevant data must be gathered
 - The measurement system must be validated
 - The process must be mapped
26. One characteristic of attributes data is that it is always:
- Continuous
 - Discrete
 - Expensive to collect
 - Read from a scale of measurement

Match the Following

- | | |
|-------------------------|---|
| a. Critical to quality | Failing to deliver what the customer wants |
| b. Defect | What your process can deliver |
| c. Process capability | What the customer sees and feels |
| d. Variation | Attributes most important to the customer |
| e. Stable operations | Designing to meet customer needs and process capability |
| f. Design for Six Sigma | Ensuring consistent and predictable processes |

Discussion Questions

1. What do you understand by Six Sigma? How is it different from Three Sigma?
2. Explain the DMAIC process using a suitable example.
3. What are the Six Sigma training hierarchies?
4. What is cost of poor quality (COPQ)? Explain the concept of defects per million opportunities (DPMO) by taking a suitable example.
5. An airline wants to compare two processes, landing and take-off against the baggage handling. If average number of bags per customer is 1.5 and the airline recorded 3 lost bags for 9,000 passengers in one month, calculate the DPMO and the related sigma quality level.

Projects

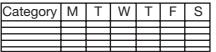
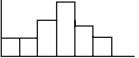
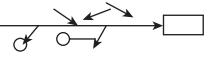
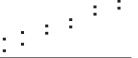
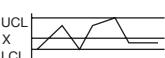
1. Visit a company that has implemented a Six Sigma programme. What changes have they made in the organization in order to develop their Six Sigma approach?
2. Identify the number of opportunities of defects a computer can have. Find the DPMO and the related sigma quality level for the computers in the laboratory of your institute.

End Notes

1. Mikel Harry and Richard Schroeder, *Six Sigma: The Breakthrough Management Strategy Revolutionizing the World's Top Corporations* (Doubleday: 2000).
2. Dinesh Seth and Subhash C. Rastogi, *Global Management Solutions* (Thomson Publishing, 2004).
3. Dean H. Stamatis, *Six Sigma and Beyond: Design of Experiments* (Boca Raton: St. Luice Press, 2002).
4. Mike Harry, *The Vision of Six Sigma* (Sigma Publishing, 1997).
5. Thomas Pyzdek, *The Six Sigma Project Planner: A Step-by-Step Guide to Leading a Six Sigma Project Through DMAIC* (New Delhi: Tata McGraw-Hill, 2004).
6. Thomas Pyzdek, *The Six Sigma Handbook: A Complete Guide for Green Belts, Black Belts and Managers at all Levels* (New York: McGraw-Hill, 2001).
7. David Hutton, *Change Agent's Handbook: A Survival Guide for Quality Improvement Champions* (ASQC Quality Press, 1994).

8

Quality Improvement Tools

Checksheet	
Graphs	
Histogram	
Pareto chart	
Cause and effect diagram	
Scatter diagram	
Control chart	

SEVEN QC TOOLS

The seven QC tools used to solve quality problems are Pareto diagram, cause and effect diagram, histogram, control charts, scatter diagrams, graphs, and check sheets. These are simple statistical tools used for problem-solving. These tools were developed in Japan and introduced by quality gurus such as Deming and Juran. In terms of importance, these are the most useful tools. Kaoru Ishikawa has stated that these tools can be used to solve 95% of all problems. They have been the foundation of Japan's astonishing industrial resurgence after World War II. These tools are used widely to monitor the overall operation and the continuous process improvement while manufacturing products. They are used to find out the root causes and eliminate them, thus improving the manufacturing process. The modes of defects in the production line are investigated through direct observation on the production line and statistical tools.

In 1976, the Union of Japanese Scientists and Engineers (JUSE) felt the need for tools to promote innovation, communicate information, and successfully plan major projects.

The research team developed seven new quality control tools, often called the seven management and planning (MP) tools, or simply, the seven management tools. The seven MP tools, listed in an order that moves from abstract analysis to detailed planning, are affinity diagram, relations diagram, tree diagram, matrix diagram, matrix data analysis, arrow diagram, and process decision program chart.

“Quality is free, but only to those who are willing to pay heavily for it.”

Philip Crosby

Upon completion of this chapter, you will be able to:

1. Explain the seven quality control tools
2. Describe the seven new management and planning tools

👁 Bird’s-eye view:

Seven QC tools are fundamental instruments to improve the quality of the product. They are used to analyze the production process, identify the major problems, control fluctuations of product quality, and provide solutions to avoid future defects.

👁 Bird’s-eye view:

Statistical literacy is necessary to effectively use the seven QC tools. These tools use statistical techniques and knowledge to accumulate data and analyze them.

👁 Bird’s-eye view:

Seven QC tools are utilized to organize the collected data in a way that is easy to understand and analyze. Moreover, from using the seven QC tools, any specific problems in a process are identified.

■ INTRODUCTION

This chapter is divided into two parts. The first part deals with the seven statistical tools and the second, with the seven new management and planning tools.¹ The following seven QC tools were identified by the Japanese Union of Scientists and Engineers (JUSE) as being crucial to continuous improvement:

1. Pareto chart
2. Cause-and-effect diagram
3. Check sheet
4. Histogram
5. Scatter diagram
6. Control charts
7. Graphs

■ THE PARETO CHART

The Pareto chart is also termed as the Pareto diagram. A Pareto chart may be a weighted Pareto chart or a comparative Pareto chart. A Pareto chart is a special bar graph, the lengths of which represent frequency or cost (time or money) and are arranged with the longest bars on the left and the shortest to the right. Thus, the chart visually depicts the relative importance of problems or conditions. In 1950, Joseph M. Juran rephrased the theories of the Italian economist, Vilfredo Pareto (1848–1923), which form the crux of the Pareto principle. These are often referred to as the 80–20 Rule. Pareto analysis is a statistical technique in decision making that is used for the selection of a limited number of tasks that produce a significant overall effect.² The Pareto effect also operates in the domain of quality improvement. According to the Pareto effect, 80 per cent of the problems usually stem from 20 per cent of the causes. This is also termed as the theory of the vital few and the trivial many.

■ Steps in Constructing a Pareto Chart

The following steps can be used to construct a Pareto chart:

1. List the activities or causes in a table and their frequency of occurrence.
2. Place these in descending order of magnitude in the table.
3. Calculate the total for the whole list.
4. Calculate the percentage of the total that each cause represents.
5. Add a cumulative percentage column to the table.
6. Draw a Pareto chart plotting the causes on the X-axis and the cumulative percentage on the Y-axis. The cumulative percentage from all causes can be shown by drawing a cumulative curve.
7. On the same chart, plot a bar graph with the causes on the X-axis and the percentage frequency on the Y-axis.
8. Analyse the diagram. Look for the break-point on the cumulative per cent graph. It can be identified by a marked change in the slope of the graph. This separates the significant few from the trivial many.

Bird's-eye view:

A Pareto chart, named after Vilfredo Pareto, is a type of chart that contains both bars and a line graph, where individual values are represented in descending order by bars, and the cumulative total is represented by the line.

■ Applications of the Pareto Chart

The Pareto chart is one of the key tools used in total quality control and Six Sigma. It may be difficult to arrive at a consensus while working in a team. Different opinions may lead to different courses of action. The Pareto chart enables to concentrate on the critical factors. It has many potential uses for decision making such as (1) calculating the relative frequency of categories of occurrences, (2) identifying which 20 per cent of sources caused 80 per cent of the errors, (3) relative costs incurred in producing different types of defectives and (4) determining which category or categories should be the focus of improvement efforts.

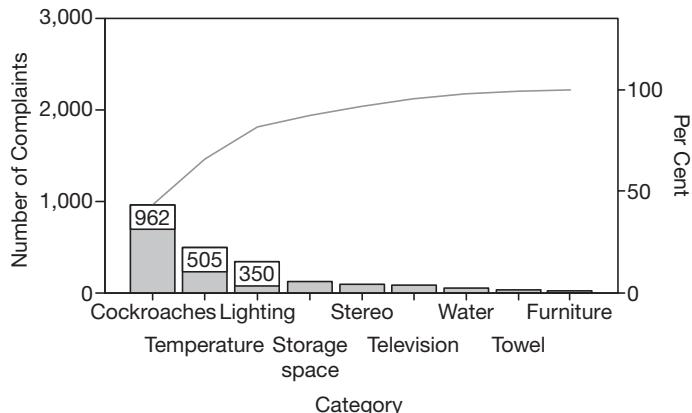
Bird's-eye view:

Pareto Chart is used to define problems, to set their priority, to illustrate the problems detected, and determine their frequency in the process.

Example: You are part of an executive guest house where in-house executive development programmes are conducted. You have received complaints from executives who have attended the programme this year. You want to improve the service but are not sure of where to begin or where to concentrate efforts. The data relating to complaints from executives are given in Table 8.1 and the corresponding Pareto chart is shown in Figure 8.1.

Table 8.1 Complaints from Executives

Category	Number of Complaints	Percentage	Cumulative Percentage
Cockroaches	962	43.2	43.2
Room temperature	505	22.7	65.9
Lighting	350	15.7	81.6
Storage space	127	5.7	87.3
Stereo noise	97	4.4	91.7
Television broadcasting	83	3.7	95.4
Water	54	2.4	97.8
Towels	32	1.4	99.2
Furniture	15	0.8	100.0
Total	2,225		

Fig. 8.1 Pareto Chart

Bird's-eye view:

A **Pareto chart** is a bar graph. The lengths of the bars represent frequency or cost (time or money), and are arranged with longest bars on the left and the shortest to the right. In this way the **chart** visually depicts which situations are more significant.

■ CAUSE-AND-EFFECT DIAGRAM

The cause-and-effect diagram, also termed as the fishbone diagram or the Ishikawa diagram, was the brainchild of Kaoru Ishikawa. The fishbone diagram identifies many possible causes for a problem or an effect. It can be used to structure a brainstorming session. It immediately sorts ideas into useful categories. This diagram is used to explore all the potential or real causes (or inputs) that result in a single effect (or output). The causes are arranged according to their levels of importance or detail, resulting in a depiction of relationships and hierarchy of events. This diagram can also be used to search for root causes, identify areas where there may be problems and compare the relative importance of different causes.

■ Steps in Constructing a Cause-and-effect Diagram

1. Write the issue (problem or process condition) on the centre-right side of the cause-and-effect diagram.
2. Identify the major cause categories and write them in the four boxes on the cause-and-effect diagram. The causes may be summarized under various categories.
3. The potential causes of the problem need to be brainstormed. Decide where to place the possible causes on the cause-and-effect diagram. It is acceptable to list a possible cause under more than one major category.
4. Review each major cause category. Circle the most likely causes on the diagram.
5. Review the causes that are circled and question, "why?" Asking "why" will help to get to the root of the problem.
6. Arrive at an agreement on the most probable cause(s).

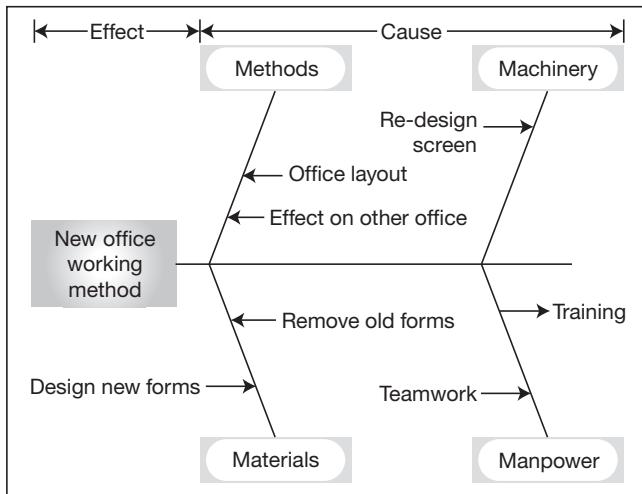
An example of a cause-and-effect diagram is shown in Figure 8.2.

■ Applications of the Cause-and-effect Diagram

The cause-and-effect diagram can be used to identify possible causes of a problem. The collective brainstorming helps to prevent a team's thinking from falling into a rut.

Bird's-eye view:

Cause-and-Effect Diagram also known as Ishikawa Diagram or Fishbone diagram (because a completed diagram can look like the skeleton of a fish). It is used to figure out any possible causes of a problem. After the major causes are known, we can solve the problem accurately.

Fig. 8.2 Cause-and-effect Diagram

■ CHECK SHEET

Check sheets are also termed as defect concentration diagrams. A check sheet is a structured, prepared form for collecting and analysing data.³ This is a generic tool that can be adapted for a wide variety of purposes. The function of a check sheet is to present information in an efficient, graphical format. This may be accomplished with a simple listing of items. However, the utility of check sheets may be significantly enhanced in some instances by incorporating a depiction of the system under analysis into the form. A sample check sheet is shown in Figure 8.3.

Bird's-eye view:

The **check sheet** is a form (document) used to collect data in real time at the location where the data is generated.

■ Steps to Create a Check Sheet

The following steps can be used to create a check sheet:

- Clarify the measurement objectives. Raise questions such as "What is the problem?", "Why should data be collected?", "Who will use the information being collected?", "Who will collect the data?"
- Prepare a form for collecting data. Determine the specific things that will be measured and write this down on the left side of the check sheet. Determine the time or place being measured and write this across the top of the columns.

Bird's-eye view:

The data the check sheet captures can be quantitative or qualitative. When the information is quantitative, the **check sheet** is sometimes called a **tally sheet**. Decision-making and actions are taken from the data.

Fig. 8.3 Sample Check Sheet

Reason	Day					
	Mon	Tue	Wed	Thu	Fri	Total
Wrong number						20
Info request						10
Boss						19
Total	12	6	10	8	13	49

3. Collect the data for the items being measured. Record each occurrence directly on the check sheet as it happens.
4. Tally the data by totaling the number of occurrences for each category being measured.

■ Applications of a Check Sheet

Check sheets can be used to:

1. To distinguish between fact and opinion (for example, how does the community perceive the efficacy of a school in preparing students for the world of work?)
2. To gather data about how often a problem occurs (for example, how often are students missing classes?)
3. To gather data about the type of problems that occur (for example, what is the most common type of word-processing error committed by students—grammar, punctuation, transposing letters, etc.?)
4. When data can be observed and collected repeatedly by the same person or at the same location.
5. When collecting data on the frequency or patterns of events, problems, defects, defect location, defect causes, etc.
6. When collecting data from a production process.

Bird's-eye view:

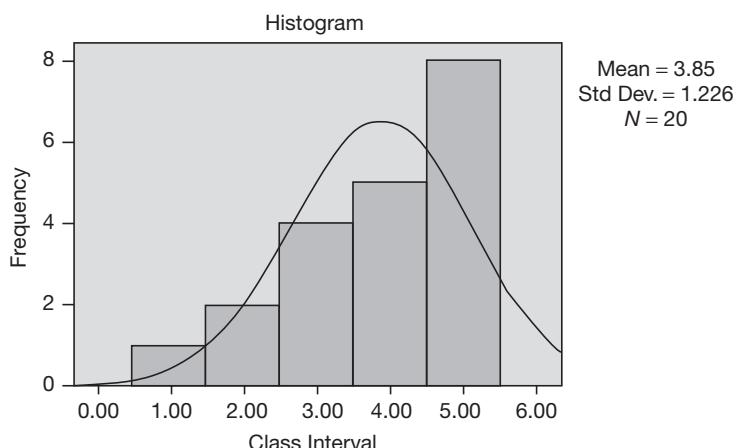
A **histogram** is a graphical representation of the distribution of numerical data. It is an estimate of the probability distribution of a continuous variable (quantitative variable) and was first introduced by Karl Pearson.

■ HISTOGRAM

Histograms provide a simple graphical view of accumulated data, including its dispersion and central tendency. It is the most commonly used graph to show frequency distributions. In addition to the ease with which they can be constructed, histograms provide the easiest way to evaluate the distribution of data. A frequency distribution graph shows how often each different value in a set of data occurs.

A histogram is a specialized type of bar chart. Individual data points are grouped together in classes, so that one can get an idea of how frequently data in each class occur in the data set. High bars indicate more points in a class, and low bars indicate fewer points. In Figure 8.4, the peak lies in the segment 4.0–4.9 classes where there are four points.

Fig. 8.4 Histogram



Bird's-eye view:

Histogram shows a bar chart of accumulated data and provides the easiest way to evaluate the distribution of data.

Table 8.2 Frequency Distribution

Class	Lower Limit	Upper Limit	Frequency
1	35	38	1
2	38	41	2
3	41	44	4
4	44	47	5
5	47	50	8

The strength of a histogram lies in the easy-to-read picture it projects of the location and variation in a data set. There are, however, two weaknesses of histograms that need to be understood. Histograms can be manipulated to show different pictures. It can prove to be misleading if too many or too few bars are used. This is an area that requires some judgement and perhaps some experimentation, based on the analyst's experience.

Histograms can also obscure the time differences among data sets. For example, if one looked at data for the number of births/day in India in 1996, one would miss any seasonal variations, e.g. peaks around the times of full moons. Likewise, in quality control too, a histogram of a process run tells only one part of a long story. There is a need to keep reviewing the histograms and control charts for consecutive process runs over an extended time to gain useful knowledge about a process.

There are five types of histograms based on five different types of distributions. Each indicates a very different type of behaviour. The various types of distributions are bell-shaped distribution, double-peaked distribution, plateau distribution, comb distribution and skewed distribution.

Example: The spelling test scores for 20 students on a 50-words spelling test are given below. The scores (number correct) are 48, 49, 50, 46, 47, 47, 35, 38, 40, 42, 45, 47, 48, 44, 43, 46, 45, 42, 43, 47. The largest number is 50 and the smallest is 35. Thus, the range, $R = 15$. We will use 5 classes, so $K = 5$. The interval width $i = R/K = 15/5 = 3$.

Then, we will construct our lower limit. The lower limit for the first class is 35. Thus, the first upper limit is $35 + 3$ or 38. The second class will have a lower limit of 38 and an upper limit of 41. Table 8.2 displays the tabulated frequencies and the completed histogram is shown in Figure 8.4.

 **Bird's-eye view:**
The Scatter Diagram is a graphical tool that plots many data points and shows a pattern of correlation between two variables.

■ Applications of a Histogram

A histogram can be used:

- When the data are numerical and you want to see the shape of the distribution, especially to determine whether the output of a process is distributed normally
- To analyse whether a process can meet the customer's requirements
- To analyse what the output from a supplier's process looks like
- When seeing whether a process change has occurred from one time period to another
- To determine whether the outputs of two or more processes are different
- When you wish to communicate the distribution of data quickly and easily to others

 **Bird's-eye view:**
The scatter diagram graphs pairs of numerical data, with one variable on each axis, to look for a relationship between them. If the variables are correlated, the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line.

■ SCATTER DIAGRAM

A scatter diagram is also termed the scatter plot or the X-Y graph. It is a quality tool used to display the type and degree of relationship between variables. If the variables are correlated,

the points will fall along a line or curve. The better the correlation, the tighter the points will hug the line. The scatter diagram also shows the pattern of relationships between two variables. Some examples of relationships are cutting speed and tool life, breakdowns and equipment age, training and errors, speed and gas mileage, production speed and number of defective parts. Scatter diagrams are used to investigate a possible relationship between two variables that both relate to the same event. A straight line of best fit (using the least-squares method) is often included in this.

■ Steps in Constructing a Scatter Diagram

The following steps can be used to construct a scatter diagram:

1. Collect data on causes and effects for variables
2. Draw the causes on the X-axis
3. Draw the effect on the Y-axis
4. Plot the data pairs on the diagram by placing a dot at the intersection of the X and Y coordinates for each data pair
5. Interpret the scatter diagram for direction and strength

■ Interpreting the Strength of a Scatter Diagram

Data patterns, whether in a positive or negative direction, should also be interpreted for strength by examining the “tightness” of the clustered points. The more the points are clustered to look like a straight line, the stronger the relationship. Figure 8.5 shows how the strength of a scatter diagram can be interpreted.

Example: A market research team is examining the relationship between the demand for a commodity and its price. The data collected by the market research team is provided in Table 8.3. Draw a scatter diagram to show the relationship between the two variables.

Figure 8.6 shows the relationship between the price and demand for a commodity.

Fig. 8.5 Interpretation of the Strength of a Scatter Diagram

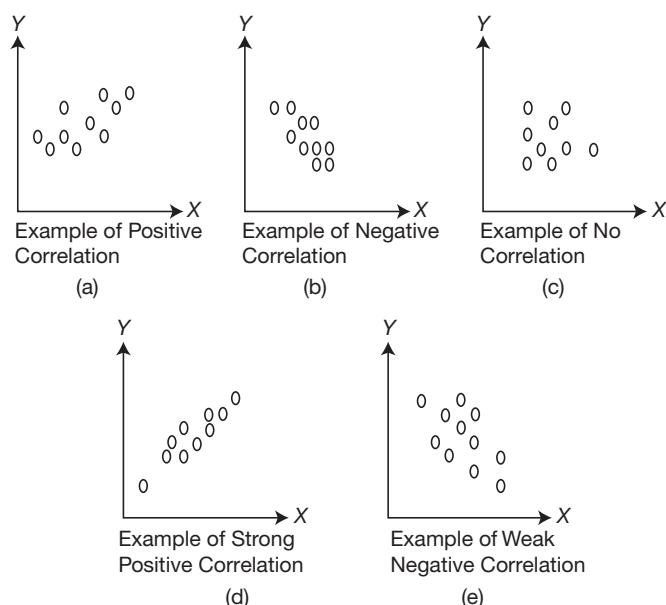
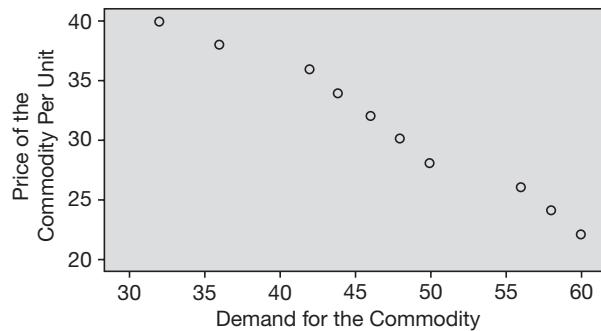


Table 8.3 Data Collected by Market Research Team

Price of the commodity/kg in Rs	22	24	26	28	30	32	34	36	38	40
Demand for the commodity in kg	60	58	56	50	48	46	44	42	36	32

Fig. 8.6 Scatter Diagram

■ Applications of a Scatter Diagram

Scatter diagrams can be used to analyse the relationship between paired numerical data.

- They are useful in cases when the dependent variable has multiple values for each value of the independent variable.
- They can be used when trying to determine whether the two variables are related such as:
 - When trying to identify the potential root causes of problems.
 - To determine objectively whether a particular cause and effect are related after brainstorming causes and effects using a fishbone diagram.
 - When determining whether two effects that appear to be related can both occur with the same cause.
 - When testing for autocorrelation before constructing a control chart.
- Validating “hunches” about a cause-and-effect relationship between types of variables (for example, is there a relationship between production speed of an operator and the number of defective parts made? Is there a relationship between typing speed and errors made?)
- Displaying the direction of the relationship (positive, negative, etc.) (For example, will test scores increase or decrease if the students spend more time in the study hall? Will increasing assembly line speed increase or decrease the number of defective parts made? Do faster typists make more or fewer typing errors?)
- Displaying the strength of the relationship (for example, how strong is the relationship between measured IQ and grades earned in Chemistry? How strong is the relationship between assembly line speed and the number of defective parts produced? How strong is the relationship between typing faster and the number of typing errors made?)

Bird's-eye view:

The **control chart** is a graph used to study how a process changes over time. Data are plotted in time order.

Bird's-eye view:

A **control chart** always has a central line for the average, an upper line for the upper **control limit** and a lower line for the lower **control limit**. These lines are determined from historical data. Some degree of variation will naturally occur in any process.

Bird's-eye view:

Natural variation is the natural or expected variation in a process. **Assignable variation** is unexpected variation that results from unusual occurrences. It is important to identify and try to eliminate assignable variation.

Bird's-eye view:

Out-of-control points and nonrandom patterns on a control chart indicate the presence of assignable variation.

■ CONTROL CHARTS

The control chart is a fundamental tool of statistical process control (SPC), 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.

SPC is used to measure the performance of a process.⁴ It relates to the application of statistical techniques to determine whether the output of a process conforms to the product or service design. All processes are subject to a certain degree of variability. Usually, variations are of two types—natural variations and assignable variations.

■ Natural Variations

Natural variations affect almost every production process and are to be expected as inherent in the process. These variations are due to common causes, which are purely random, or unidentifiable sources of variation. These causes are unavoidable in the current processes, which are in statistical control. As long as the output measurements remain within specified limits, the process is said to be “in control” and natural variations are tolerated.

■ Assignable Variations

Assignable variations in a process can be traced to a specific reason known as assignable cause variation. Factors such as machine or tool wear, maladjusted equipment, a fatigued or untrained worker or new batches of raw materials are potential sources of assignable variations.

A process is said to be operating under statistical control when common causes are the only source of variations. The process is said to be “out of control” when assignable causes of variation enter the process. The process must be brought into statistical control by detecting and eliminating special or assignable causes of variation. Only then the ability of the process to meet customer expectations can be assessed.

Control charts are prepared to look at variation, seek assignable causes and track common causes. Assignable causes can be spotted using several tests such as one data point falling outside the control limits, six or more points in a row steadily increasing or decreasing, eight or more points in a row on one side of the central line and 14 or more points alternating up and down. A control chart is a line chart with control limits. By mathematically constructing control limits at three standard deviations above and below the average, one can determine which variation is due to normal ongoing causes (common causes) and which is produced by unique events (assignable causes). Eliminating the assignable causes first and then reducing common causes can improve quality.

The bounds of the control chart are marked by upper and lower control limits that are calculated by applying statistical formulas to data derived from the process. Data points that fall outside these bounds represent variations due to special causes that can typically be found and eliminated. On the other hand, improvements in common cause variation require fundamental changes in the process.

All control charts have the following three basic components:

1. A central line, usually the mathematical average of all the samples plotted.
2. Upper and lower statistical control limits that define the constraints of common cause variations.
3. Performance data plotted over time.

In charts that pair two charts together, anomalies in both the charts should be analysed. The simplest interpretation of the control chart is to use only the first test listed. The others may be useful. However, as you apply more tests, the chances of making type I errors, i.e. getting false positives go up significantly.

■ Types of Errors⁵

Control limits on a control chart are commonly drawn at Three Sigma from the central line because Three Sigma limits are a good balance point between two types of errors:

- Type I or alpha errors occur when a point falls outside the control limits even though no special cause is operating. This results in a witch hunt for special causes and adjustment of things. The tampering usually distorts a stable process as well as wastes time and energy.
- Type II or beta errors occur when you miss a special cause because the chart isn't sensitive enough to detect it. In this case, you will go along unaware that the problem exists and thus will be unable to root it out.

All process control is vulnerable to these two types of errors. The reason that Three Sigma control limits balance the risk of error is that for normally distributed data, data points will fall inside the Three Sigma limits 99.7 per cent of the time when a process is in control. This makes the witch hunts infrequent but still makes it likely that unusual causes of variation will be detected.

■ Steps in the Construction of Control Charts

Step 1: Draw the X-axis. This axis represents the time order of subgroups. Subgroups represent samples of data taken from a process. It is critical that the integrity of the time dimension be maintained when plotting control charts.

Step 2: Draw the Y-axis. This axis represents the measured value of the quality characteristic under consideration when using variables charts. This axis is used to quantify defectives or defects when attributes charts are used.

Step 3: Draw the central line on the chart. The central line represents the process average value of the quality characteristic corresponding to the in-control state.

Step 4: Draw two other horizontal lines called the upper control limit (UCL) and the lower control limit (LCL), typically appearing at ± 3 -Sigma from the process average.

Step 5: The next step is analysis and interpretation. As long as the points fall within the control limits, the process is assumed to be in control and no action is necessary. In case, the points are outside the control limits, there is evidence that the process is out of control, and investigation and corrective action is required to find and eliminate them.

Step 6: Use the control chart data to determine process capability if desired.

■ Analysis of Patterns on Control Charts

A control chart may indicate an out-of-control condition either when one or more points fall beyond the control limits, or when the plotted points exhibit some non-random patterns of behaviour. A control chart that has not triggered any out-of-control condition is considered stable, predictable and operating in a state of statistical control. The variation depicted on the chart is due to common-cause variation.



Bird's-eye view:

In statistical hypothesis testing, a **type I error** is the incorrect rejection of a true null hypothesis (a "false positive"), while a **type II error** is incorrectly retaining a false null hypothesis (a "false negative"). Briefly:

- Type I errors happen when we reject a true null hypothesis.
- Type II errors happen when we fail to reject a false null hypothesis.

Points falling outside the limits are attributed to special cause variations. Such points, regardless of whether they constitute “good” or “bad” occurrences, should be investigated immediately while the cause-and-effect relationships and access to documentation for process changes is readily available.

Many quality characteristics cannot be conveniently represented numerically. In such cases, each item inspected is classified as either conforming or non-conforming to the specifications of that quality characteristic. Quality characteristics of this type are called attributes. Examples are non-functional semiconductor chips, warped connecting rods, etc.

Bird's-eye view:

Variable is a product characteristic that can be measured and has a continuum of values (e.g., height, weight, or volume).

■ Types of Control Charts

Control charts are broadly classified into two types:

1. Control charts for variables:
 - (a) Mean chart— \bar{X} chart
 - (b) Range chart—R chart
 - (c) Standard deviation chart— σ chart
2. Control charts for attributes:
 - (a) p Chart
 - (b) np Chart
 - (c) c Chart
 - (d) u Chart

Bird's-eye view:

Attribute is a product characteristic that has a discrete value and can be counted.

■ Control Charts for Variables

Many quality characteristics can be expressed in terms of a numerical measurement. A variable is a single measurable quality characteristic, such as a dimension, weight or volume. Variable quality characteristics can be measured on the variable scale of values. Some common examples of variable characteristics are temperature, pressure, tensile strength and hardness. Control charts for variables are used extensively. They usually lead to more efficient control procedures and provide more information about process performance than attribute control charts.

Bird's-eye view:

X-bar chart is a control chart used to monitor changes in the mean value of a process.

Individual charts (\bar{X}) and moving range control charts: It is a type of variable chart that takes into account a single variable value. It takes the variability and mean value for single measurements into consideration.

While dealing with a quality characteristic that is a variable, it is standard practice to control both the mean value and its variability. Control of the process average or mean quality level is usually with the mean chart for means or the \bar{X} chart. Control chart for range or the R chart is used to show the control of the process range.

\bar{X} and R charts: The \bar{X} chart and R chart go hand in hand when monitoring variables because they measure two critical parameters—central tendency and dispersion. The central limit theorem is the theoretical foundation for these charts. The \bar{X} chart is developed from the average of each subgroup data. The R chart is developed from the ranges of each subgroup data, which is calculated by subtracting the maximum and the minimum value in each subgroup. They are used when the subgroups consist of two to 10 measurements.

The advantages of \bar{X} and R charts are as follows:

- They establish whether the process is in statistical control, in which case the variations are attributed to chance. The variability that is inherent in the process cannot be removed unless there is a change in the basic conditions under which the process is operating.

- They guide the production engineer in determining whether the process capability is compatible with the specifications.
- They detect trends in the process so as to assist in planning, adjustment and resetting of the process, or to show when the process is out of control in which case an effort must be made to trace the causes for this phenomenon.
- The \bar{X} chart provides useful guidelines for resetting processes. The R chart controls the uniformity of the product.
- A process cannot be considered to be in control unless both the mean and the range values are inside their control lines. Due to this requirement, mean and range charts are used simultaneously.

Construction of \bar{X} and R charts: The following steps can be used in the construction of \bar{X} and R charts:

1. A number of samples of components of a process are taken over a period of time and each sample consisting of a number of units are taken at random.
2. The average value, \bar{X} of all the measurements and the range R , which is the difference between the highest and the lowest reading are calculated for each sample.
3. The grand average $\bar{\bar{X}}$, which is the average value of the entire averages \bar{X} and the average range \bar{R} , which is the average of all the ranges R are then found.
4. From the above values, we can calculate the central line, upper control limit (UCL) and lower control limit (LCL) of the \bar{X} and R charts.

$$\begin{aligned}\bar{X} \text{ Chart: } \text{UCL } \bar{X} &= \bar{\bar{X}} + A_2 \bar{R} \\ \text{LCL } \bar{X} &= \bar{\bar{X}} - A_2 \bar{R}\end{aligned}$$

$\bar{\bar{X}}$ Value = Central Line (CL)

$$\begin{aligned}\text{R Chart: } \text{UCL } R &= D_4 \bar{R} \\ \text{LCL } R &= D_3 \bar{R}\end{aligned}$$

\bar{R} Value = Central Line (CL)

The factors A_2 , D_3 and D_4 depend on the number of items per sample. Table 8.4 gives the values for these factors for various sample sizes based on the assumption that the distribution is normal. The process is said to be under statistical control as long as the \bar{X} and R values for each sample are within the control limits.

Table 8.4 Factors Used in the \bar{X} , S and R Quality Control Charts

No. of Items in Sample	A_2	B_3	B_4	D_3	D_4
2	1.88	0	3.27	0	3.27
3	1.02	0	2.57	0	2.57
4	0.73	0	2.27	0	2.28
5	0.58	0	2.09	0	2.11
6	0.48	0.03	1.97	0	2.00
7	0.42	0.12	1.89	0.08	1.92
8	0.37	0.19	1.82	0.14	1.86
9	0.34	0.24	1.76	0.18	1.82

Bird's-eye view:

Control charts are one of the most commonly used tools in statistical process control. **Control charts** are broadly classified into two types: Control charts for variables and Control charts for attributes.

Bird's-eye view:

Range (R) chart is a control chart that monitors changes in the dispersion or variability of process.

(Continued)

Table 8.4 (Continued)

No. of Items in Sample	A ₂	B ₃	B ₄	D ₃	D ₄
10	0.31	0.28	1.72	0.22	1.78
11	0.29	0.32	1.68	0.26	1.74
12	0.27	0.35	1.65	0.28	1.72
13	0.25	0.38	1.62	0.31	1.69
14	0.24	0.41	1.59	0.33	1.67
15	0.22	0.43	1.57	0.35	1.65

Example: Table 8.5 provides the measurements of the axles of bicycle wheels. Twelve samples with each sample consisting of the measurements of four axles were taken. Draw \bar{X} and R charts and comment on the results.

Bird's-eye view:

A control chart for variables is used to monitor characteristics that can be measured and have a continuum of values, such as height, weight, or volume.

Construction of R chart: The means and the ranges of each sample are calculated. The mean of the sample means and the sample ranges are also calculated. The mean for the ranges gives the central line for the R chart. Use $n = 4$ from the table for calculating the control limits,

$D_3 = 0$ and $D_4 = 2.28$, $n = 4$, $k = 12$. Therefore, the control limits for the R chart are: $CL = \bar{R}/k = 49/12 = 4.083$, $LCL = D_3 \times \bar{R} = 0 \times 4.083 = 0$, $UCL = D_4 \times \bar{R} = 2.282 \times 4.083 = 9.317$

The R chart is drawn with the 12 sample ranges plotted on the chart. The control limits and the central line are also drawn. This is shown in Figure 8.7. All the points are within the control limits and no particular pattern can be observed. Therefore, the process variability is in control.

Construction of \bar{X} chart: Since the R chart indicates that the process variability is in control, the \bar{X} chart is now constructed. The central line is the mean of the sample means. Using the same table and taking $n = 4$, the control limits are calculated as follows:

$$\text{Central line} = \bar{\bar{X}}/k = 1,705.5/12 = 142.125$$

$$LCL = \bar{\bar{X}} - A_2 \times \bar{R} = 142.125 - (0.729) 4.083 = 139.148$$

$$UCL = \bar{\bar{X}} + A_2 \times \bar{R} = 142.125 + (0.729) 4.083 = 145.102$$

The \bar{X} chart is drawn with the 12 sample means plotted on the chart. The control limits and the central line are drawn too. This is shown in Figure 8.8. The chart shows that the process is out of control and corrective actions are required.

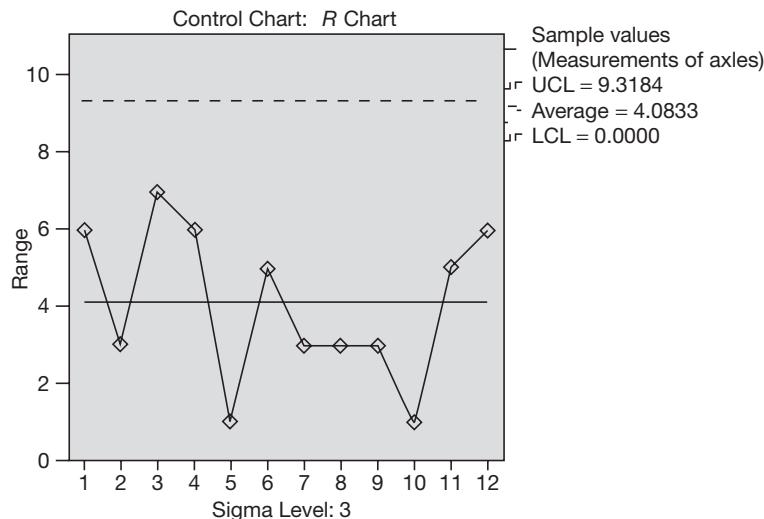
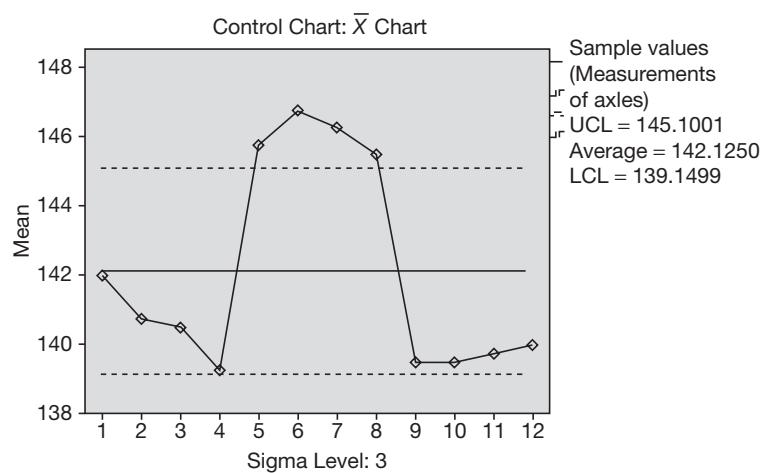
Table 8.5 Measurements of the Axles of Bicycle Wheels

Sample No.	Sample Values	Total	Sample Mean (\bar{X})	Sample Range (R)
1	139, 140, 145, 144	568	142	6
2	140, 142, 142, 139	563	140.75	3
3	142, 136, 143, 141	562	140.5	7
4	136, 137, 142, 142	557	139.25	6
5	145, 146, 146, 146	583	145.75	1
6	146, 148, 149, 144	587	146.75	5
7	148, 145, 146, 146	585	146.25	3
8	145, 146, 147, 144	582	145.50	3

(Continued)

Table 8.5 (Continued)

9	140, 139, 141, 138	558	139.50	3
10	140, 140, 139, 139	558	139.50	1
11	141, 137, 142, 139	559	139.75	5
12	139, 140, 144, 138	560	140.00	6
$\sum \bar{X} = 1,705.5$			$\sum R = 49$	

Fig. 8.7 R Chart**Fig. 8.8** \bar{X} Chart

■ Special Control Charts for Variables Data (\bar{X} and S Charts)

An alternative to using the R chart along with the \bar{X} chart is to compute and plot the standard deviation s of each sample. Although the range has traditionally been used, (since it involves

Bird's-eye view:
Control charts for variables are: Mean chart; Range chart and Standard deviation chart.

less computational effort and is easier for shop-floor personnel to understand), using s rather than R has its advantages. The sample standard deviation is a more sensitive and better indicator of process variability, especially for larger sample sizes when the subgroups consist of more than ten measurements. Thus, when tight control of variability is required, the s chart should be used.

The sample standard deviation is computed as:

$$S = \sqrt{\frac{\sum_{i=1}^n (X_i - \bar{X})^2}{n-1}}$$

To construct an s chart, compute the standard deviation for each sample. Next, compute the average standard deviation s bar by averaging the sample standard deviations over all samples. Control limits for the s chart are given by:

$$UCL_s = B_4 \bar{S} \quad \text{and} \quad LCL_s = B_3 \bar{S}, \text{ here } \bar{S} = \frac{\sum S}{k}$$

Where B_3 and B_4 , A_2 are constants found in standard deviation table. For the associative X bar chart, the control limits derived from the overall standard deviation are:

$$\bar{X} \text{ Chart: } UCL \bar{X} = \bar{\bar{X}} + A_2 \bar{R}$$

$$LCL \bar{X} = \bar{\bar{X}} - A_2 \bar{R}$$

$\bar{\bar{X}}$ Value = Central line (CL)

Using the data given in Table 8.5, a standard deviation chart is constructed and is shown in Figure 8.9.

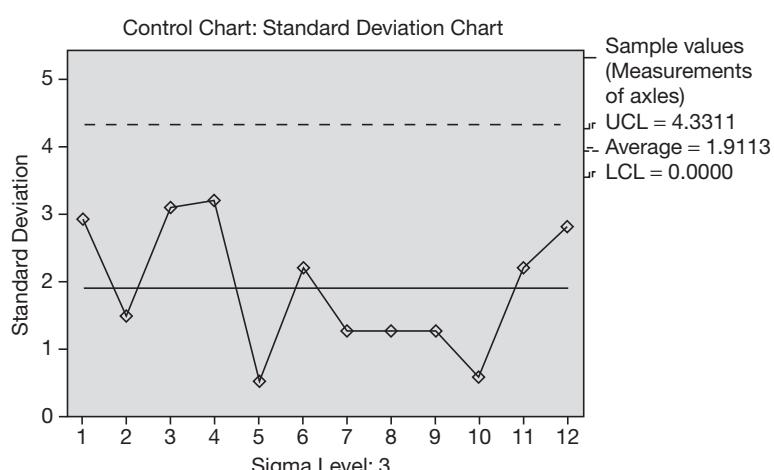
■ Control Charts for Attributes

Bird's-eye view:

A **control chart for attributes**, on the other hand, is used to monitor characteristics that have discrete values and can be counted. Often they can be evaluated with a simple yes or no decision. Examples include color, taste, or smell. The monitoring of attributes usually takes less time than that of variables because a variable needs to be measured.

Many quality characteristics cannot be conveniently represented numerically. In such cases, each item inspected is classified as either conforming or non-conforming to the

Fig. 8.9 Standard Deviation Chart



specifications of that quality characteristic. The attributes data assume only two values—good or bad, pass or fail, defective or non-defective and so on. Attributes usually cannot be measured but they can be observed and counted and are useful in many practical situations.

Attribute control charts are used when items are compared with some standard and are then classified as to whether they meet the standard or not. The control chart is used to determine if the rate of the non-conforming product is stable and detects when a deviation from stability has occurred. The argument can be made that a LCL should not exist, since rates of non-conforming product outside the LCL is a good thing. We want low rates of non-conforming products. However, if we treat these LCL violations as simply another search for an assignable cause, we may learn the reason for the drop in the rate of non-conformities and be able to permanently improve the process.

The two major types of control charts for attributes are:

1. “Number of defectives” charts
2. “Number of defects” charts

The “number of defective charts” are of two types—(a) *p* chart or fraction defectives chart for varying sample size or constant samples size and (b) *np* chart or chart for the number for constant sample size only.

p Charts

The *p* chart is an attribute control chart. It is designed to control the percentage or proportion of defectives per sample. This chart is best suited in cases where inspection is carried out with a view to classifying an article as accepted or rejected. This chart shows the fraction of non-conforming or defective products produced by a manufacturing process. It is also termed the control chart for fraction non-conformance. *p* Charts can be used when the subgroups are not of equal size. The *np* chart is used in the more limited case of equal subgroups.

Bird's-eye view:

Control charts for attributes are: chart for defectives (*p* chart, *np* chart); chart for defects (*c* chart and *u* chart)

Steps in the construction of a *p* chart: The following steps can be used to construct a *p* chart.

1. Determine the size of the subgroups needed. The size, $n(i)$, has to be sufficiently large to have defects present in the subgroup. If we are aware of the historical rate of non-conformance, p , we can use the following formula to estimate the subgroup size:

$$n = 3/p$$

2. Record the data for each subgroup on the number inspected and the number of defectives
3. Determine the rate of non-conformities in each subgroup by using:

$$\hat{P}(i) = x(i)/n(i)$$

where $\hat{P}(i)$ = The rate of non-conformities in subgroup i

$x(i)$ = The number of non-conformities in subgroup i and $n(i)$ = the size of subgroup i

4. Find \bar{p} ; there are k subgroups:

$$\bar{p} = \frac{1}{k} \sum \hat{p}(i)$$

5. Estimate $\hat{\sigma}_p$ if needed and determine the UCL and LCL:

$$\hat{\sigma}_p = \sqrt{\frac{\bar{p}(1-\bar{p})}{n}}$$

Bird's-eye view:

P-charts are used to measure the proportion of items in a sample that are defective. P-charts are appropriate when both the number of defectives measured and the size of the total sample can be counted. A proportion can then be computed and used as the statistic of measurement.

$$\begin{aligned} \text{UCL} &= \bar{p} + 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n(i)}} \\ &= \bar{p} + 3 \hat{\sigma}_p \\ \text{LCL} &= \bar{p} - 3 \sqrt{\frac{\bar{p}(1-\bar{p})}{n(i)}} \\ &= \bar{p} - 3 \hat{\sigma}_p \end{aligned}$$

6. Plot the central line, \bar{p} , the LCL and UCL and the process measurements, the \hat{p} s.
7. Interpret the data to determine if the process is in control. Points outside the control limits signify an out of control situation. Patterns and trends should also be sought to identify special or assignable causes. However, a point on a p chart below the LCL or the development of a trend below the central line indicates that the process might have improved since the ideal is zero defectives.

Example: Table 8.6 provides the data of the number of defectives in 20 samples, each sample containing 2,000 items. Construct a control chart for fraction defectives and interpret the results.

Solution: Since we are given a fraction defective, the suitable chart will be p chart.

Here, d = number of defectives, p = fraction defectives, n = 2,000, k = 20, $p = d/n$

Control limits for p chart: Central line = $\bar{p} = \sum d/nk = 6,148/2,000 \times 20 = 0.154$

$$\hat{\sigma}_p = \sqrt{\bar{p}(1-\bar{p})/n} = \sqrt{0.154(1-0.154)/2,000}$$

$$\text{UCL} = \bar{p} + 3\hat{\sigma}_p = 0.154 + 3 \sqrt{0.154(1-0.154)/2,000} = 0.154 + 0.024 = 0.178$$

$$\text{LCL} = \bar{p} - 3\hat{\sigma}_p = 0.154 - 3 \sqrt{0.154(1-0.154)/2,000} = 0.154 - 0.024 = 0.13$$

Conclusion: The process is out of control and is shown in Figure 8.10.

👁 Bird's-eye view:

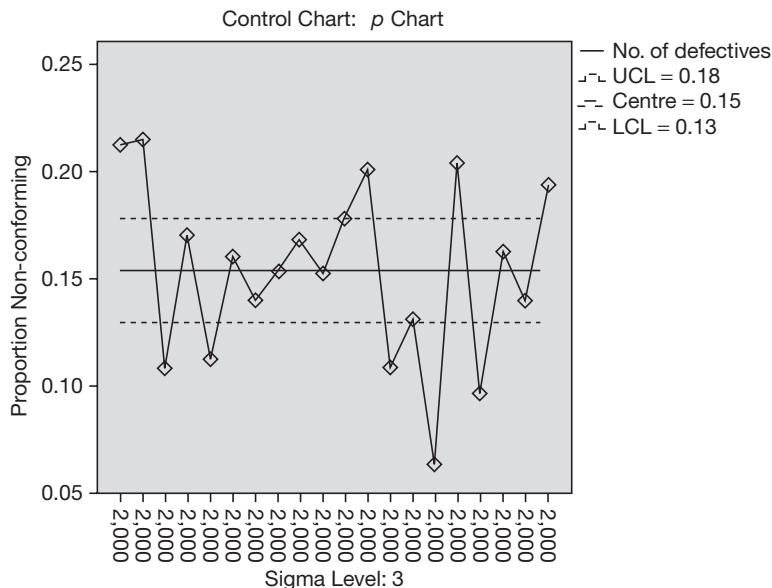
The primary difference between using a **p-chart** and a **c-chart** is: A p-chart is used when both the total sample size and the number of defects can be computed. A c-chart is used when we can compute only the number of defects but cannot compute the proportion that is defective.

■ np Chart

The np chart is a useful alternative to the p chart because it is often easier for production personnel to understand that the number of non-conforming items is more meaningful than

Table 8.6 Data on Number of Defectives

No. of Defectives = d	Fraction Defectives $p = d/n$	No. of Defectives (d)	Fraction Defectives $p = d/n$
425	0.213	356	0.178
430	0.215	402	0.201
216	0.108	216	0.108
341	0.170	264	0.132
225	0.113	126	0.063
322	0.161	409	0.205
280	0.140	193	0.097
306	0.153	326	0.163
337	0.169	280	0.140
305	0.153	389	0.195

Fig. 8.10 *p* Chart

a fraction. The computations are also simpler. The *p* chart displays the fraction with the characteristic of interest, while the *np* chart displays the number of items with that characteristic of interest. The *np* chart permits the data to be entered as whole numbers rather than as the ratio of non-conforming items to the subgroup size. The *np* chart can be used for special cases when the subgroups are of equal size. This means that the size of the sample must be constant to use the *np* chart. It is not necessary to convert non-conforming counts into proportions \bar{p} (i). Rather, one can directly plot the counts $x(i)$ versus the subgroup number *i*.

Steps in constructing an *np* chart: The following steps can be used to construct an *np* chart.

1. Determine the size of the subgroups needed. The size, *n*, has to be sufficiently large to have defects present in the subgroup most of the time. If we are aware about the historical rate of non-conformance, *p*, then we can use the following formula to estimate the subgroup size: $n = 3/p$.
2. Find \bar{p} .
3. Find the UCL and LCL where:

$$UCL = np + 3\sqrt{np(1-p)}$$

$$LCL = np - 3\sqrt{np(1-p)}$$
4. Plot the central line \bar{p} , the LCL and UCL and the process non-conforming counts, the $x(i)$'s.
5. Interpret the control chart. The process is considered to be out of control only if a point is outside the ± 3 Sigma range.

Example: Table 8.7 refers to data on visual defects found in the inspection of the first 10 samples of size 400. Use the data to obtain upper and lower control limits for percentage defectives in samples of size 400. Draw a suitable control chart.

Table 8.7 Data Showing Number of Non-conformities

1	2	3	4	5	6	7	8	9	10
17	15	14	26	09	04	19	12	09	15

Solution: Since we are given fraction defectives, with a constant sample size, the suitable chart will be np chart.

Here, $n = 400$, $k = 10$ and $d = \text{No. of defectives} = \sum d = 140$

$$\bar{p} = \sum d/nk = 140/400 \times 10 = 0.035$$

$$CL = n \bar{p} = 400 \times 0.035 = 14$$

$$UCL = n \bar{p} + 3 \sqrt{n \bar{p} (1 - \bar{p})}$$

$$= 400 \times 0.035 + 3 \sqrt{400 \times 0.035 \times (1 - 0.035)}$$

$$= 14 + 11.03 = 25.03$$

$$LCL = n \bar{p} - 3 \sqrt{n \bar{p} (1 - \bar{p})}$$

$$= 400 \times 0.035 - 3 \sqrt{400 \times 0.035 \times (1 - 0.035)}$$

$$= 14 - 11.03 = 2.97$$

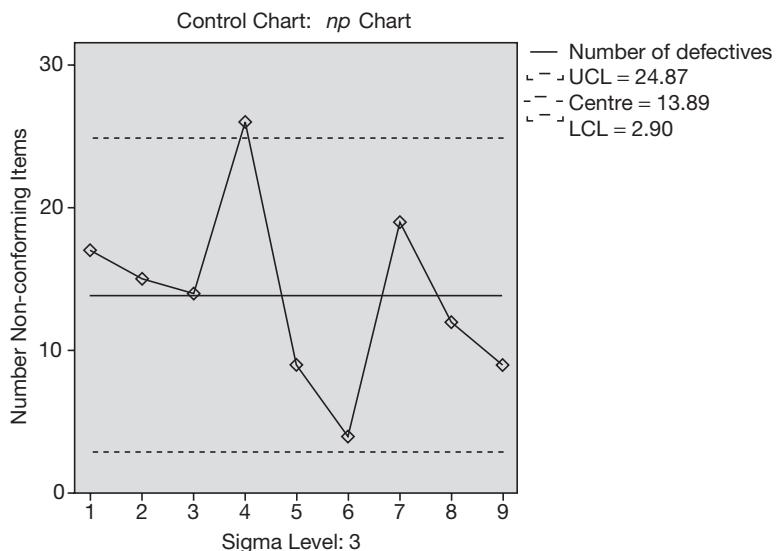
The np chart is shown in Figure 8.11.

👁 Bird's-eye view:

A **defect** is a single non-conforming characteristic of an item. A defective product has one or more defects. In some situations, quality assurance personnel may be interested in knowing not only whether an item is defective, but also how many defects it has. Two charts can be applied in such situations:

■ Charts for Defects

A defect is a single non-conforming characteristic of an item. A defective product has one or more defects. In some situations, quality assurance personnel may be interested in knowing not only whether an item is defective, but also how many defects it has. Two charts can be applied in such situations:

Fig. 8.11 np Chart

1. The c chart that is used to control the total number of defects per unit, when the subgroup size is constant.
2. The u chart that is used to control the average number of defects per unit, when the subgroup sizes are constant or variable. When the subgroup size is constant, the c chart is preferred over the u chart.

c Charts: The control chart for defects, generally called the c chart, has a much more restricted field of usefulness as compared to \bar{X} and R charts and p charts. However, there are certain manufacturing and inspection situations in which the c chart is definitely needed. The c chart technique helps to keep the defects per unit at the lowest limit.

Construction of c charts: The c chart is based on the Poisson probability distribution. To construct a c chart, first estimate the average number of defects per unit (\bar{c}) by taking at least 25 (K) samples of equal size (n) counting the number of defects per sample (c) and finding the average, \bar{c} . The standard deviation of Poisson distribution is the square root of the mean.

The number of subgroups = K , sample size per subgroup = n

Number of defects in subgroups = c_1, c_2, \dots, c_k .

$$\text{Average no. of defects } \bar{c} = \frac{c = c_1 + c_2 + \dots + c_k}{k} = \text{Central Line (CL)}$$

$$\text{Standard deviation} = \sqrt{\bar{c}} = \text{Central Line (CL)}$$

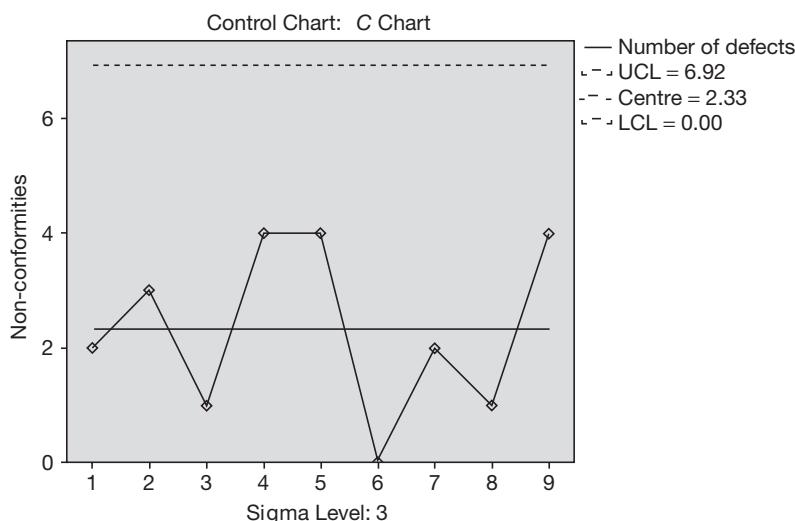
$$\text{UCL} = \bar{c} + 3\sqrt{\bar{c}} \quad \text{and} \quad \text{LCL} = \bar{c} - 3\sqrt{\bar{c}}$$

Example: Surface defects have been counted on 10 rectangular steel plates and the data are shown in Table 8.8. Draw the control chart for non-conformities using this data.

Table 8.8 Data Showing Surface Defects

Sheet No.	1	2	3	4	5	6	7	8	9	10
No. of Defects	2	3	1	4	4	0	2	1	4	2

Fig. 8.12 c Chart



$$\text{Central Line} = \bar{c} = \sum c/k = 23/10 = 2.3$$

$$\text{UCL} = \bar{c} + 3\sqrt{\bar{c}} = 2.3 + 3\sqrt{2.3} = 6.85$$

$$\text{LCL} = \bar{c} - 3\sqrt{\bar{c}} = 2.3 - 3\sqrt{2.3} = -2.251, \text{ which is taken as 0.}$$

The c chart is drawn with the plate number on the X-axis and the number of conformities on the Y-axis. The lines showing the upper control limit, the lower control limit and the mean are also drawn. Figure 8.12 shows the c chart. It can be seen from this figure that the process is under control.

■ u Charts

This chart shows the non-conformities per unit produced by a manufacturing process. The u chart is used when it is not possible to have an inspection unit of a fixed size (e.g. 12 defects counted in one square foot). The number of non-conformities is per inspection unit where the inspection unit may not be exactly one square foot. Rather, it may be an intact panel or other object, different in size than exactly one square foot. When it is converted into a ratio per square foot, or some other measure, it may be controlled with a u chart.

Steps in constructing a u chart: The following steps can be used to construct a u chart:

1. Find the number of non-conformities, $c(i)$ and the number of inspection units, $n(i)$, in each sample i .
2. Compute $u(i) = c(i)/n(i)$
3. Determine the central line of the u chart:

$$\bar{u} = \frac{\text{Total Non-conformities in } k \text{ Subgroups}}{\text{Total Number of Inspection Units}}$$

$$\bar{u} = \frac{c_1 + c_2 + \dots + c_k}{n_1 + n_2 + \dots + n_k}$$

4. The u chart has individual control limits for each subgroup i .

$$\text{UCL} = \bar{u} + 3\sqrt{\frac{\bar{u}}{n(i)}}$$

$$\text{LCL} = \bar{u} - 3\sqrt{\frac{\bar{u}}{n(i)}}$$

5. Plot the central line, \bar{u} , the individual LCLs and UCLs and the process measurements, $u(i)$.
6. Interpret the control chart.

Example: Construct the u chart for the data given in Table 8.9.

Table 8.9 Number of Non-conformities

Day	Number Inspected	Number of Defects	Defects Per Unit (u)	UCL	LCL
1	110	120	1.091	1.514	0.887
2	82	94	1.146	1.563	0.838
3	96	89	0.927	1.536	0.865
4	115	162	1.409	1.507	0.894

(Continued)

Table 8.9 (Continued)

5	108	150	1.389	1.517	0.884
6	56	82	1.464	1.640	0.761
7	120	143	1.192	1.501	0.900
8	98	134	1.367	1.533	0.868
9	102	97	0.951	1.530	0.875
10	115	145	1.261	1.507	0.894
11	88	128	1.455	1.551	0.850
12	71	83	1.169	1.591	0.810
13	95	120	1.263	1.538	0.863
14	103	116	1.126	1.524	0.877
15	113	127	1.124	1.510	0.891
16	85	92	1.082	1.557	0.844
17	101	140	1.386	1.528	0.873
18	42	60	1.429	1.508	0.693
19	97	121	1.247	1.534	0.867
20	92	108	1.174	1.543	0.858
21	100	131	1.310	1.530	0.872
22	115	119	1.035	1.507	0.894
23	99	93	0.939	1.531	0.870
24	57	88	1.544	1.636	0.765
25	89	107	1.202	1.549	0.852
26	101	105	1.040	1.528	0.873
27	122	143	1.172	1.498	0.903
28	105	132	1.257	1.521	0.880
29	98	100	1.020	1.533	0.868
30	48	60	1.250	1.675	0.726
Σ			36.300		

Calculations:

$$\bar{U} = \sum u/K = 36.33/30 = 1.21 = \text{Central line}$$

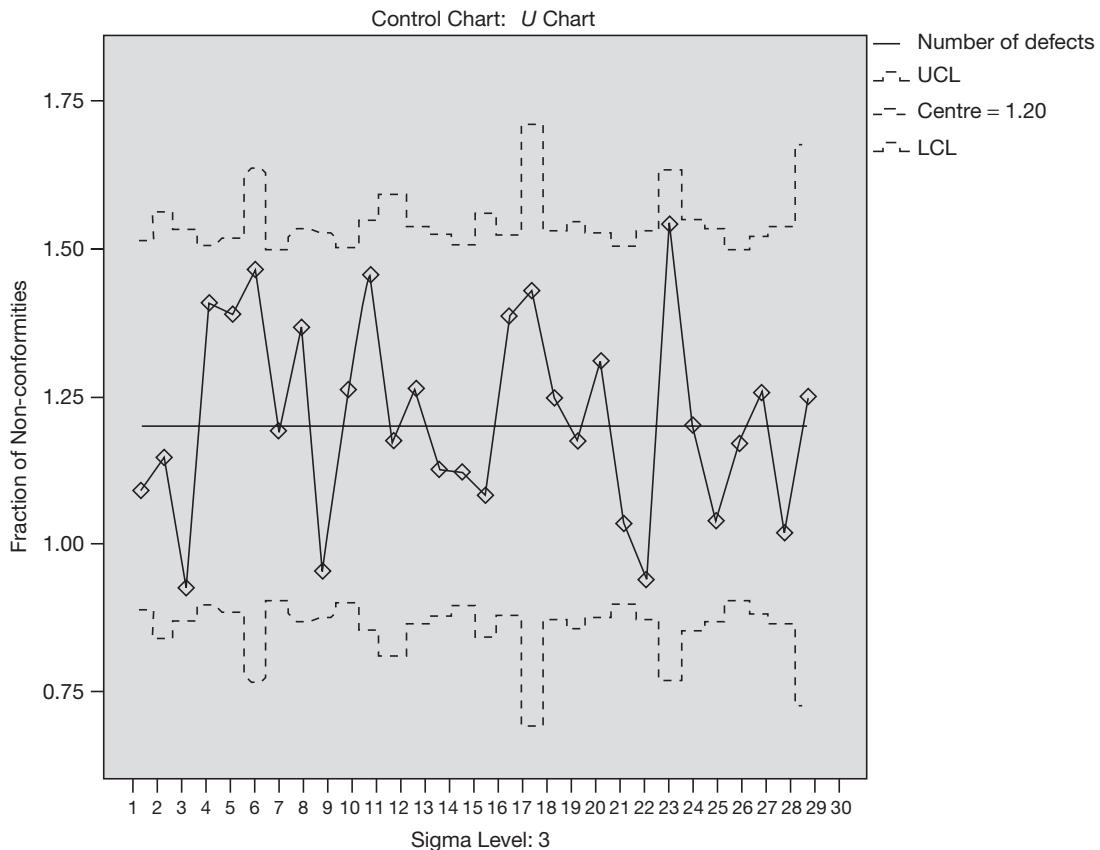
$$\text{UCL} = \bar{u} + 3 \times \sqrt{(\bar{u}/n(i))} = 1.21 + 3 \sqrt{(1.21/110)} = 1.52$$

$$\text{LCL} = \bar{u} - 3 \times \sqrt{(\bar{u}/n(i))} = 1.21 - 3 \sqrt{(1.21/110)} = 0.89$$

The u chart indicating non-conformities is shown in Figure 8.13.

Industrial application of c charts and u charts: C charts and u charts are used in industries to:

- For internal quality control and as a means of rating vendors
- To find the number of surface defects in a role of coated paper or a sheet of photographic film
- To find the number of surface defects observed in a galvanized sheet or a painted, plated enameled surface of a given area
- To find the number of breakdowns at weak spots in insulation in a given length of insulated wire subjected to specified test voltage
- To find the number of small air holes in glass bottles
- To find the number of imperfections observed in a cloth of unit area

Fig. 8.13 *u* Chart

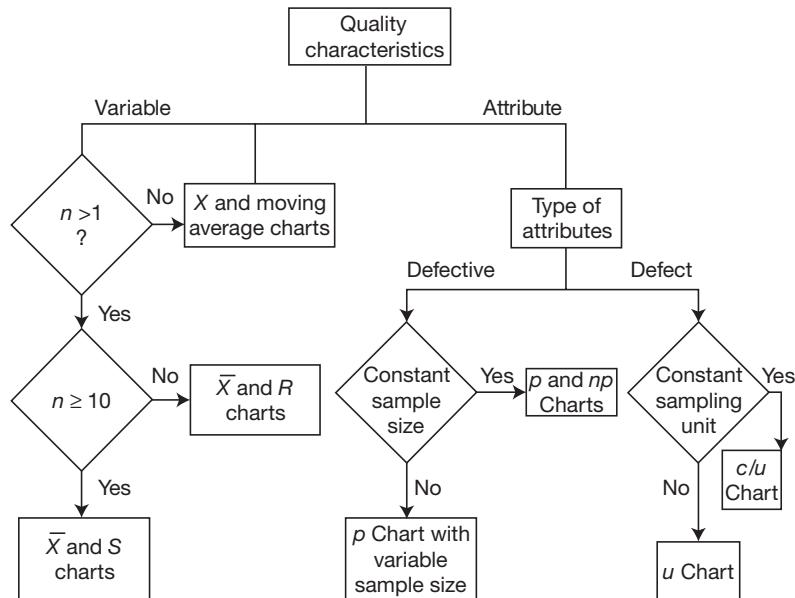
- To find the number of blowholes, cracks undercuts, etc. in a casting or welded piece
- To find the total number of defects of all types in complex assemblies such as tractors, sub-assemblies, radio receiving sets, sewing machines, etc.

A decision regarding the selection of a suitable control chart⁵ is depicted in Figure 8.14.

Uses of control charts: Control charts have the following basic applications:

- To establish a state of statistical control
- To monitor a process and signal when the process goes out of control
- To determine process capability
- When controlling ongoing processes by finding and correcting problems as they occur
- When predicting the expected range of outcomes from a process
- When determining whether a process is stable (in statistical control)
- When analysing patterns of process variation from special causes (non-routine events) or common causes (built into the process)
- When determining whether your quality improvement project should aim to prevent specific problems or to make fundamental changes to the process.

Box 8.1 discusses the applications of control charts in accounting.

Fig. 8.14 Control Charts Selection**Box 8.1** Applications of Control Charts in Accounting

Statistical techniques have been used in the manufacturing environment to improve quality and maintain control. Control charts are used to analyse, control and improve accounting processes. The repetitive nature of several accounting processes and procedures enable this type of statistical analysis. Control charts have immense potential for application within the accounting process. They can be used to measure efficiency, such as the number of days it takes to process an invoice from a shipping document or days it takes to complete a monthly close. Control charts also aid in detecting errors in data such as charting the weekly payroll. A week where the payroll is significantly higher than prior weeks should be investigated to make sure there is a valid explanation. The potential applications of control charts in accounting are given in Table 8.10.

Table 8.10 Applications of Control Charts in Accounting

Function or Area	Measurement Plotted on the Control Chart
Payroll function	Number of audit exceptions in samples of employee pay records
Accounts receivable billing	Average billing time
Tax preparation	Proportion of unusable returns due to error
Management travel and entertainment	Number of improperly authorized or documented expense vouchers
Accounts payable	Number of invoices processed
General accounting	Time required for monthly closing and statement preparation
Accounts receivable and cash management	Age of accounts receivable
Purchasing	Number of purchase discounts lost
Sales personnel	Sales returns per salesperson when commissions are based on gross sales

The process that needs to be measured should be clearly defined and the appropriate type of data chart that will properly measure the process should be selected. Selecting improper data can lead to “meaningless or misleading” results. The proper use of control charts can help improve performance and efficiency, which in turn can reduce cost, increase profits and improve both internal and external customer satisfaction.

Source: Adapted from www.statsoft.com, accessed June 2016.

Bird's-eye view:

Graphs are a convenient tool to represent data in an easier understandable way. Graph allows in communicating efficiently and easily without having to look at data tables and mentally depict the data meaning.

■ GRAPHS

Graphs are used depending on the shape desired and the purpose of analysis. Bar graphs compare values via parallel bars, while line graphs are used to illustrate variations over a period of time. Circle graphs indicate the categorical breakdown of values, and radar charts assist in the analysis of previously evaluated items.⁶

■ Radar Charts

A radar chart is a graphical tool that shows the relative strengths and weaknesses of activities.

Radar charts are used:

- When the aim is to involve people in evaluating key areas of business and in organizing spheres needing improvement.
- When rating performances and showing actual and ideal performances.
- When showing changes from period to period for items measured on a Likert scale.

Steps in the construction of a radar chart

1. Select 5 to 10 areas of performance.
2. Measure the performance on the Likert scale and take an average of the survey values.
3. Organize performance data in the descending order.
4. Construct a radar chart or a wheel.
5. Make equal segments for each performance area.
6. Make spokes as measurement scales with high performance on the outside edge. The slices range in values from “0,” to the outer most rim value of “7.”
7. Join the rating scores and fill in the performance areas. A pattern is formed representing the cumulative responses when the points are joined.
8. Identify the biggest gap in the most critical area.

Radar charts are helpful in displaying changes in intangible activities. They are eye-catching and an unusual method to display changes in small number of items.

Table 8.11 Data on Quality of Ice Cream

Surveys	Q ₁ Shape	Q ₂ Texture	Q ₃ Flavour	Q ₄ Colour	Q ₅ Mouth feel
Averages*	2.8	3	4	6	4

(*These are obtained from a survey carried out using the Likert scale)

Arranging the data in descending order

Surveys	Q_4 Colour Averages	6	Q_5 Mouth feel 4	Q_3 Flavour 4	Q_2 Texture 3	Q_1 Body 2.8
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Example: The data relating to the quality of ice cream produced by “Fantasia” on various parameters is given in Table 8.11. The corresponding radar chart is shown in Figure 8.15. Divide the circle into five sections subtending 72 degrees each. The radar chart shown in Figure 8.15 indicates that shape and texture need immediate improvements.

■ APPLICATIONS OF THE SEVEN QUALITY CONTROL TOOLS IN SIX SIGMA

Six Sigma created a renewed focus on process improvement. The seven QC tools are among the many tools that comprise the Six Sigma tool box. They have been used widely to support quality improvement problem-solving efforts. Table 8.12 shows the application of the seven QC tools in Six Sigma.

Fig. 8.15 Radar Chart

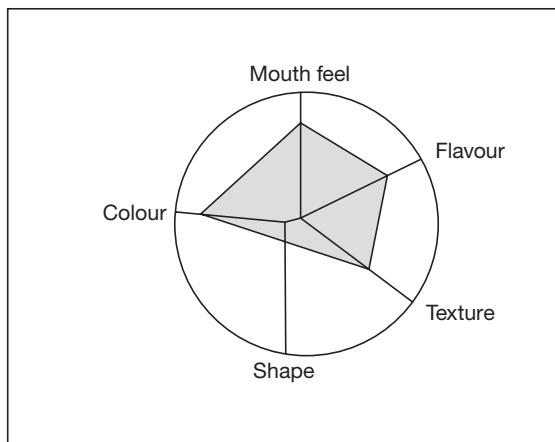


Table 8.12 Application of the Seven QC Tools in Six Sigma

Tool	DMAIC Application
Pareto chart	Analyse
Cause-and-effect diagram	Analyse
Stratification	Define
Check sheet	Measure, Analyse
Histogram	Measure, Analyse
Scatter diagram	Analyse, Improve
Control charts	Control

DISCUSSION FORUM

1. Name the seven QC tools.
2. Discuss the Pareto chart.
3. Explain the cause-and-effect diagram.
4. Prepare a note on check sheet.
5. Explain histogram.
6. Define scatter diagram.
7. Prepare a note on different types of control charts.
8. Describe a radar chart.

 **Bird's-eye view:**

In 1976, the Union of Japanese Scientists and Engineers (JUSE) saw the need for tools to promote innovation, communicate information and successfully plan major projects. A team researched and developed the seven new quality control tools, often called the **seven management and planning (MP) tools**, or simply the seven management tools. Not all the tools were new, but their collection and promotion were.

■ THE SEVEN NEW MANAGEMENT AND PLANNING TOOLS

In decision making, data needed for problem solving are not available always. Problem solving in the sphere of management calls for collaboration among people from different departments. Hard data are usually scarce and available data are likely to be highly subjective. In such cases, it is necessary to go beyond an analytical approach and to use a design approach for problem solving. The new seven tools used for this design approach have proved useful in areas such as product quality improvement, cost reduction, new product development and policy deployment. They are beneficial to the top-and-middle management in an organization for strategic planning, goal setting and problem solving.⁷ However, these are not replacements for the old seven tools.

In 1976, the Union of Japanese Scientists and Engineers (JUSE) realised the need for tools to promote innovation, communicate information and successfully plan major projects. A team researched and developed the seven new quality control tools, often called the seven management and planning (MP) tools, or simply the seven management tools. Though all the tools were not new, some novel methods were used to collect and promote them.

A committee for developing QC tools, affiliated with the Osaka Base QC course of JUSE, was set up in April 1972 with the aim of developing QC techniques for use by managerial level and staff. The committee headed by Yoshinobu Nayatani met regularly. In January 1977, the committee announced the results of its research in the form of a new set of methods called "the seven new QC tools." The seven new tools are:

- (i) Affinity diagram, otherwise known as the KJ method, was developed by Jiro Kawakita.
- (ii) Relations diagram is derived from the cause-and-effect diagram. It shows cause-and-effect relationships and helps to analyse the natural links between different aspects of a complex situation.
- (iii) Systematic or tree diagram is an adaptation of the functional analysis system technique (FAST) in value engineering.
- (iv) Matrix diagram is an adaptation of the "feasibility ranking method matrix" in value engineering.
- (v) Matrix data analysis is based on the multivariate analysis method.
- (vi) Arrow diagram is a derivative of the programme evaluation and review technique (PERT) and critical path methodology (CPM) techniques.
- (vii) Process decision program chart (PDPC) diagram is adapted from operations research methods.

Table 8.13 New Seven Tools

Tool Name	Utilization
Affinity diagram	Used to organize abstract thinking about a problem
Relations diagram	Used for determining causalities among parts of a problem
Systematic/Tree diagram	Planning tool
Matrix diagram (many types)	Used to organize knowledge in a matrix format; sometimes includes intercellular relationships
Matrix data analysis method	Principal components technique is performed on matrix data
Arrow diagram	Manage a complex project or task
Process Decision Program Chart (PDPC)	Determining which processes to use by evaluating events and prospective outcomes

Table 8.13 lists the new seven tools.⁸ These tools enable the complete analysis and understanding of a problem. While not essential, these tools can be used in the order shown from the top to bottom of the table to move from a more abstract analysis (affinity) to the explicit details provided by arrow diagrams. These tools can also be combined with the seven statistical tools.

Affinity Diagram

The affinity diagram, created in the 1960s by Japanese anthropologist Jiro Kawakita, is also known as the KJ method. The affinity diagram organizes a large number of language data (ideas, opinions, issues) into their natural relationships. This method taps a team's creativity and intuition.

Steps for creating an affinity diagram: The brainstormed list needs to be sorted to create an affinity diagram. Ideas acquired through brainstorming need to be moved into affinity sets and groups of related ideas need to be created. As you sort ideas:

1. Rapidly group ideas that seem to belong together.
2. It isn't important to define why they belong together.
3. Clarify ideas that are not clear.
4. Copy an idea into more than one affinity set, if appropriate.
5. Look for small sets. Should they belong in a larger group?
6. Do large sets need to be broken down more precisely?
7. When most of the ideas have been sorted, you can start to enter titles for each affinity set.

Bird's-eye view:

The seven MP tools, listed in an order that moves from abstract analysis to detailed planning, are: Affinity diagram; Relations diagram; Systematic or tree diagram; Matrix diagram; Matrix data analysis diagram; Arrow diagram and Process decision program chart.

Using the affinity diagram as a team: It is relatively simple to try out using affinity diagrams yourself using the steps mentioned above. Figure 8.16 is an affinity diagram that shows the reason for substandard customer service. Use the steps shown below to do this.

1. Gather a team; make sure the right people are on the team, i.e. ensure that the team has common goals and interests.
2. Discuss and select a specific problem area. For example, lack of productivity.

Fig. 8.16 Affinity Diagram

 **Bird's-eye view:**

Affinity Diagram

organizes a large number of ideas into their natural relationships. The affinity diagram is a tool for organizing a large number of ideas, opinions, and facts relating to a broad problem or subject area.

Human resource issues	Lack of standard processes and measurement	Workplace culture	Resources and tools
Too much turnover	No standard systems	Not enough management support	Not enough phone lines
Untrained staff	No measurement of what is and what isn't good service	Staff feel unappreciated	
Staff aren't compensated enough		Staff morale is low	

3. Have each member jot down as many contributing factors to the selected problem as possible on a post-it note.
4. Post the note on a board and begin as a team to logically group the notes.
5. Name the logically selected groups.
6. Have a period of quiet reflection and permit any team member to move any note to any other desired group.
7. Discuss the changes. Iterate these last two steps until a steady state is reached.
8. Next, analyse the different groupings and decide which things to focus on in the remaining tools.

Use of affinity diagram: Affinity diagrams can be used:

- When you are confronted with many facts or ideas in apparent chaos
- When issues seem too large and complex to grasp
- When group consensus is necessary

Relations Diagram

It is also termed as an inter-relationship diagram or a digraph or even a network diagram. The relations diagram depicts cause-and-effect relationships. The process of creating a relations diagram helps a group analyse the natural links between the different aspects of a complex situation.

Steps in constructing a relations diagram: The following steps can be used to construct a relations diagram:

1. State the issue or problem clearly. Write it on a card and stick it in the centre of a board.
2. Determine the factors related to the issue. Most frequently, these will be the headers from a previously completed affinity diagram. Place cards containing these factors in a circle around the issue card.
3. Determine if cause–effect relationships exist between any of the cards. If so, draw an arrow from the “cause” card to the “effect” card. Do this for all cause–effect relationships that you can find.

4. Analyse the relationships. Cards that have most arrows going from them tend to be root causes. Cards that have most arrows going to them are root effects.

Relations diagrams specify the relationships among things. More specifically, these diagrams are used to map and analyse problems where causes of the problem have complex interrelationships. In contrast to the Ishikawa diagram in which all causes of a problem are assumed to be hierarchically decomposable, the relations diagram promotes the discovery of a relationship among causes. This indicates that a single factor might influence two or more factors.

Example: Figure 8.17 represents the results of a team brainstorming session that identified 10 major issues involved in developing an organization's quality plan.

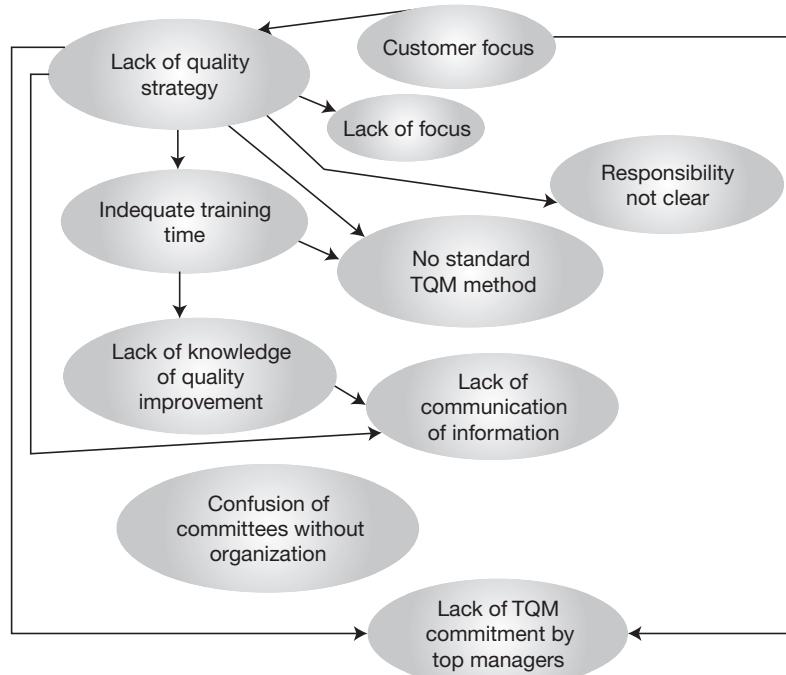
Uses of relations diagrams: The main uses of relations diagrams are:

1. Identifying key or driver issues from a list of important issues.
2. Identifying the most important problems for resolution when the number of problems exceeds the resources available to solve all of them.
3. Identifying the root cause of existing problems.
4. Identifying key factors needed to make a decision when there is insufficient information available to make a data-driven decision.

■ Systematic or Tree Diagram

The tree diagram, also known as systematic diagram, tree analysis and analytical tree, is a technique for mapping out a full range of paths and tasks that need to be formulated in order to achieve a primary goal and related subgoals. Such a diagram not only reveals the magnitude of the problem but also helps to arrive at methods that can be pursued to achieve the results. In other words, it serves the purpose of developing the essential means

Fig. 8.17 Relations Diagram



Eye Bird's-eye view:

Relations Diagram

shows cause-and-effect relationships and helps you analyze the natural links between different aspects of a complex situation. The digraph identifies and explores causal relationships among related concepts or ideas.

Eye Bird's-eye view:

Relationship diagrams shows that every idea can be logically linked with more than one other idea at a time, and allows for "lateral thinking" rather than "linear thinking." This technique is often used after the affinity diagram had clarified issues and problems.

 **Bird's-eye view:**

Tree Diagram breaks down broad categories into finer and finer levels of detail, helping you move your thinking step by step from generalities to specifics.

to achieve an objective or goal. The systematic diagram method searches for the most appropriate and effective means of accomplishing given objectives. Systematic diagrams can be divided into two types:

- The constituent–component–analysis diagram breaks down the main subject into its basic elements and depicts their relationships to the objectives and means of obtaining those objectives.
- The plan-development diagram systematically shows the means and procedures necessary to successfully implement a given plan.

The systematic diagram is the application of a method originally developed for function analysis in value engineering. The main advantages of tree diagrams are as follows:

- They allow a system of strategies for solving a problem or means of achieving an objective to be developed systematically and logically, making it less likely that any essential items are omitted.
- They facilitate agreement among group members. They are extremely convincing since they identify and clearly display the strategies for solving a problem.

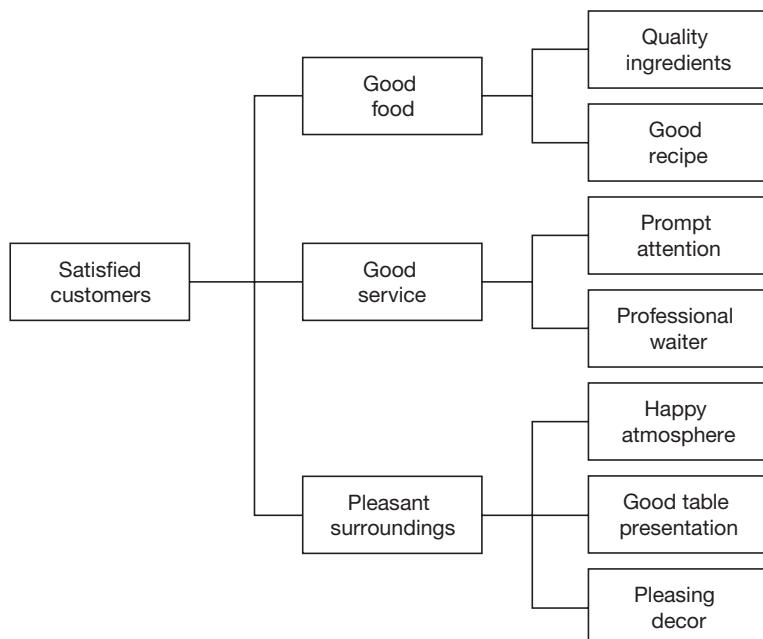
 **Bird's-eye view:**

A tree diagram maps out the paths and tasks necessary to complete a specific project or reach a specified goal.

Example: A hotel restaurant manager, concerned at low patronage figures and various vague complaints, wanted to identify the factors that affected the satisfaction of her customers so that areas for improvement might be identified. She decided to use a tree diagram to find a basic set of factors, which when taken together would cover all areas.

The tree generated is shown in Figure 8.18. A selection of customers were asked to review the diagram to test the result and it was revised accordingly. Measures were then derived from the leaves and a simple process of measurement was set in place. At the end of each month, a project was set up to improve the poorest score of the previous month. Over time, the average score gradually went up, and the restaurant became more popular.

Fig. 8.18 Tree Diagram



Uses of a systematic diagram: A systematic diagram can be used:

1. To develop a sequence of steps that form the solution to a problem.
2. When it is known that the implementation of some task will be a complex sequence.
3. When serious consequences can occur as the result of missing a key step in implementing the solution to a problem.

■ Matrix Diagram

The matrix diagram is also termed as a matrix or a matrix chart. It shows the relationship between two, three or four groups of information. It can also provide information about the relationship such as its strength and the roles played by various individuals or measurements.

A matrix diagram consists of a number of columns and rows whose intersections are checked to find out the nature and strength of the problem. This helps us to arrive at key ideas and analyse the relationship or its absence at the intersection, thereby assisting in finding an effective way of pursuing the problem-solving method. This enables the conception of ideas on two-dimensional relationship bases. The intersection points are also called “idea conception points.”

The matrix diagram method clarifies the problematic spots through multi-dimensional thinking. This method identifies corresponding elements involved in a problem situation or event. These elements are arranged in rows and columns on a chart that shows the presence or absence of relationships among collected pairs of elements. Effective problem solving is facilitated at the intersection points. Matrix diagrams are commonly used in quality function deployment (please refer the section on QFD in the book) and is a roof-shaped matrix.

Six differently shaped matrices are possible—L, T, Y, X, C and roof-shaped—depending on how many groups must be compared. Table 8.14 summarizes when to use each type of matrix. Figure 8.19 shows the frequently used matrix diagram symbols, and Figure 8.20 shows the different types of matrix diagrams.

- **An L-shaped matrix:** It relates two groups of items to each other (or one group to itself).
- **A T-shaped matrix:** It relates three groups of items. Groups B and C are each related to A. Groups B and C are not related to each other.
- **A Y-shaped matrix:** It relates three groups of items. Each group is related to the other two in a circular fashion.
- **A C-shaped matrix:** It relates three groups of items simultaneously in 3-D.
- **An X-shaped matrix:** It relates four groups of items. Each group is related to two others in a circular fashion.
- **A roof-shaped matrix:** It relates one group of items to itself. It is usually used along with an L or T-shaped matrix.

Bird's-eye view:

Matrix Diagram shows the relationship between two, three or four groups of information and can give information about the relationship, such as its strength, the roles played by various individuals, or measurements.

Bird's-eye view:

Matrix diagrams are “spreadsheets” that graphically display relationships between ideas, activities, or other dimensions in such a way as to provide logical connecting points between each item. A matrix diagram is one of the most versatile tools in quality planning.

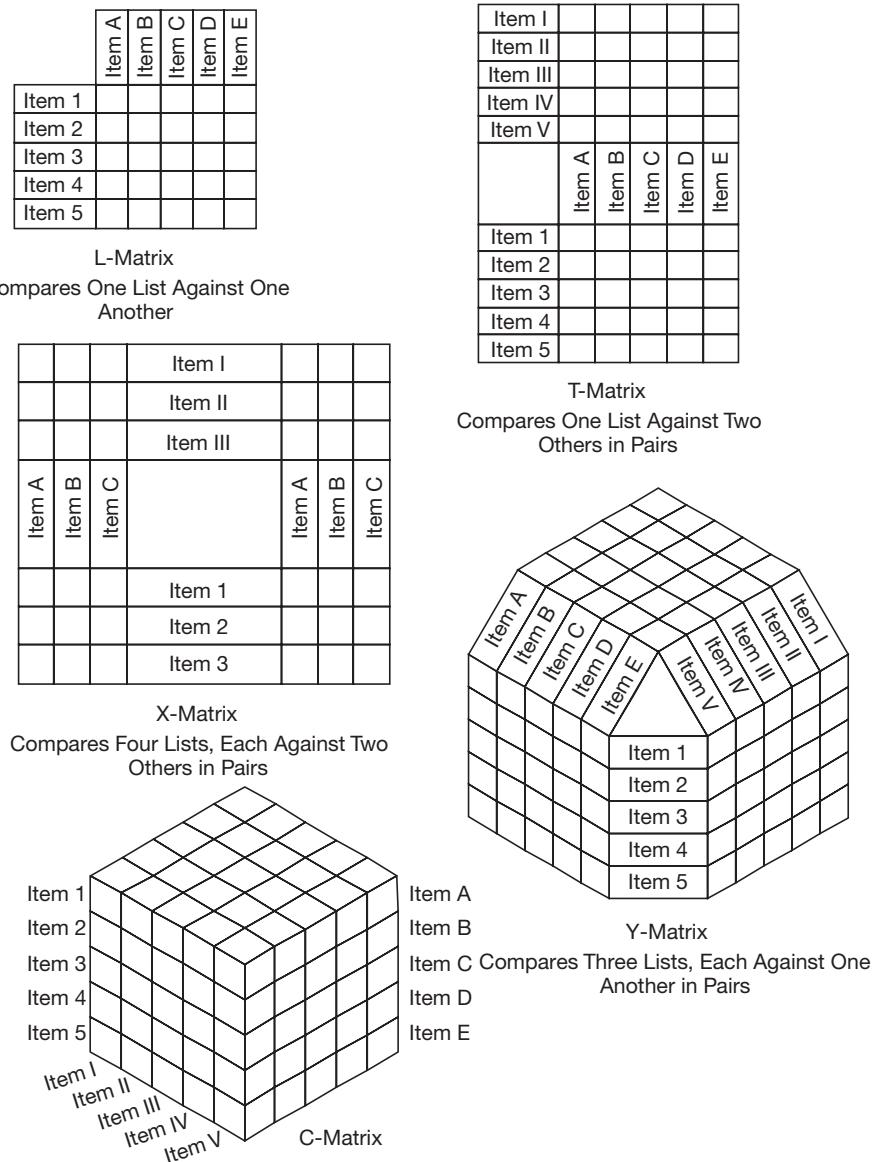
Table 8.14 When to Use Differently Shaped Matrices

L-shaped	2 groups	$A \leftrightarrow B$ (or $A \leftrightarrow A$)
T-shaped	3 groups	$B \leftrightarrow A \leftrightarrow C$ but not $B \leftrightarrow C$
Y-shaped	3 groups	$A \leftrightarrow B \leftrightarrow C \leftrightarrow A$
C-shaped	3 groups	All three simultaneously (3-D)
X-shaped	4 groups	$A \leftrightarrow B \leftrightarrow C \leftrightarrow D \leftrightarrow A$ but not $A \leftrightarrow C \leftrightarrow B \leftrightarrow D$
Roof-shaped	1 group	$A \leftrightarrow A$ when also $A \leftrightarrow B$ in L or T

Fig. 8.19 Frequently Used Matrix Diagram Symbols

<input checked="" type="radio"/> Strong relationship <input type="radio"/> Moderate relationship <input type="radio"/> Weak or potential relationship <input type="radio"/> No relationship	+ Positive relationship <input type="radio"/> Neutral relationship - Negative relationship
S Supplier C Customer D Doer O Owner	<p style="text-align: center;">↑ Item on left influences item at top ← Item on top influences item at left</p> <p>The arrows usually are placed next to another symbol indicating the strength of the relationship.</p>

Fig. 8.20 Matrix Diagram



Steps in constructing a matrix diagram: The following steps can be used to construct a matrix diagram:

1. Determine the factors that are important for making a correct selection or assignment.
2. Select the type of matrix to be used. L-shaped matrices are used for comparing two factors; T-shaped are used for comparing three factors with direct and indirect relationships; Y-shaped are used to compare three factors showing direct relationships only.
3. Select the relationship symbols to be used.
4. Complete the proper matrix using the appropriate factors and symbols.
5. Examine the matrix and draw the appropriate conclusion.

Industrial applications of a matrix diagram: Matrix diagrams can be used for the following:

- It is often used in deploying quality requirements into counterpart (engineering) characteristics and then into production requirements.
- To establish idea conception points for the development and improvement of system products.
- Achieve quality deployment in product materials.
- Establish and strengthen the quality assurance system by linking certified levels of quality with various control functions.
- Reinforce and improve the efficiency of the quality evaluation system.
- Pursue the causes of non-conformities in the manufacturing process.
- Establish strategies about the mix of products to send to the market by evaluating the relationships between the products and market situations.

■ Matrix Data Analysis

It is a complex mathematical technique for analysing matrices, often replaced in this list by the similar prioritization matrix. A prioritization matrix is an L-shaped matrix that uses pair wise comparisons of a list of options to a set of criteria in order to choose the best option(s). It is one of the most rigorous, careful and time consuming of decision-making tools.

Matrix data analysis is a multivariate analysis technique also known as “principal component analysis.” This technique quantifies and arranges data presented in a matrix diagram to find more general indicators that would differentiate and give clarity to large amounts of complexly intertwined information. This will help us to visualize and obtain an insight into the situation.

This diagram is used when the matrix chart does not provide sufficiently detailed information. This is the only method within the seven new tools that is based on data analysis and gives numerical results.

Characteristics of the matrix data analysis diagram:

- The matrix analysis method qualifies and arranges matrix diagram data so that the information is easy to visualize and comprehend.
- The relationships between the elements shown in a matrix diagram are quantified by obtaining numerical data for intersection cells.
- This is the only numerical analysis method among the seven new QC tools. The results of this technique, however, are presented in diagram form.
- One major technique that this method also utilizes is known as principal components analysis.

 **Bird's-eye view:**
Matrix Data Analysis a complex mathematical technique for analyzing matrices, often replaced in this list by the similar prioritization matrix.

 **Bird's-eye view:**
One of the most rigorous, careful and time-consuming of decision-making tools, a prioritization matrix is an L-shaped matrix that uses pairwise comparisons of a list of options to a set of criteria in order to choose the best option(s).

 **Bird's-eye view:**

Matrix data analysis takes data and arranges them to display quantitative relationships among variables to make them more easily understood and analyzed. In its original form used in Japan, the matrix data analysis is rigorous and statistically based “factor analysis” technique.

Uses of the matrix data analysis diagram:

- Analyse production processes where factors are complexly intertwined
- Analyse causes of non-conformities that involve a large volume of data
- Grasp the desired quality level indicated by the results of a market survey
- Classify sensory characteristics systematically
- Accomplish complex quality evaluations
- Analyse curvilinear data

Example: Figure 8.21 provides the results of an investigation into the effectiveness of different brands of medication used to cure an upset stomach. Brands 2 and 3 are effective and do not cause an upset stomach, whereas brand 1 is effective but causes an upset stomach. Brands 4, 5 and 6 are not effective.

 **Bird's-eye view:**

Arrow Diagram shows the required order of tasks in a project or process, the best schedule for the entire project, and potential scheduling and resource problems and their solutions.

■ Arrow Diagram

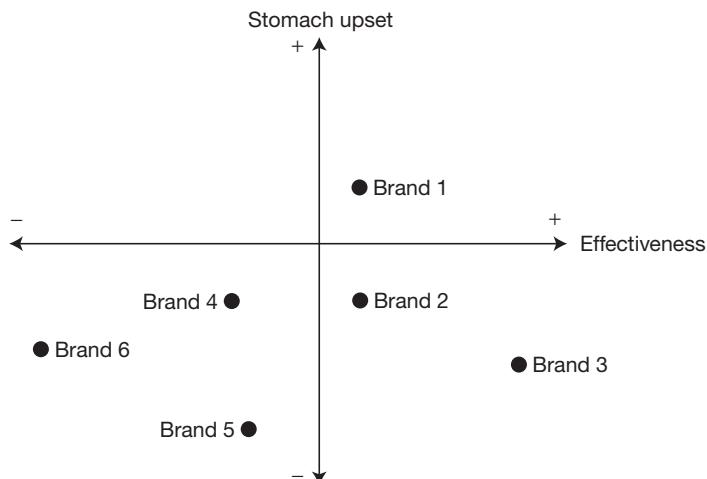
This is also termed as activity network diagram, network diagram, activity chart, node diagram, and critical path method (CPM) chart.

The arrow diagram shows the required order of tasks in a project or process, the best schedule for the entire project and potential scheduling and resource problems and their solutions. The arrow diagram lets you calculate the “critical path” of the project. This is the flow of critical steps where delays will affect the timing of the entire project and where the addition of resources can speed up the project.

Steps in constructing an arrow diagram: The following steps can be used to construct an arrow diagram.

1. Select a team that is knowledgeable about the project, its tasks and subtasks.
2. Record all the tasks and subtasks necessary for the completion of the project.
3. Sequence the tasks.
4. Assign the time duration for each task.

Fig. 8.21 Matrix Data Analysis Diagram



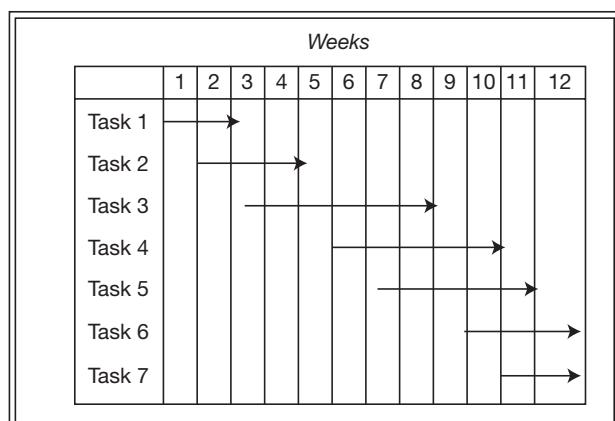
5. Calculate the shortest possible implementation time schedule using the critical path method.
6. Calculate the earliest start and finish time for each task.
7. Locate tasks with slack (extra) time and calculate total slack.
8. Update the schedule as the project is being completed.

Example: The Gantt chart shown in Figure 8.22 has been used for many years to permit visualization and scheduling of parallel activities. In Figure 8.22, tasks are listed on the right side of the diagram. The time during which the tasks are scheduled are shown by the extent of the arrows in the diagram. The abscissa in this example might be weeks or months. In contrast, the arrow diagram attaches the name of each task to a node and shows the times between the tasks. Parallelism is easily seen and, moreover, disconnects in time are easily observed so that delays can be identified and plans can be altered to achieve the minimum time from start to completion of the process.

Applications of arrow diagrams: Arrow diagrams can be used to:

- To understand and manage a complex project or task.
- To understand and manage a project that is of major importance to the organization, where the consequences of late completion are severe.
- To understand and manage a project in which multiple activities must take place and be managed simultaneously.
- To explain the project status to others.
- Implement plans for new product development and its follow up.
- Develop product improvement plans and follow up activities.
- Establish daily plans for experimental trials and follow up activities.
- Establish daily plans for increases in production and their follow up activities.
- Synchronize the preceding plans for QC activities.
- Develop plans for a facility move and for monitoring follow up.
- Implement a periodic facility maintenance plan and its follow up.

Fig. 8.22 Gantt Chart



- Analyse a manufacturing process and draw up plans for improved efficiency.
- Plan and follow up QC inspections and diagnostic tests.
- Plan and follow up QC conferences and QC circle conferences.

Box 8.2 discusses the role of network analysis in project management.

Bird's-eye view:

Process Decision Program Chart (PDPC) systematically identifies what might go wrong in a plan under development.

Bird's-eye view:

A process decision program chart (PDPC) is a method for mapping out every conceivable event and contingency that can occur when moving from a problem statement to possible solutions.

Bird's-eye view:

A PDPC takes each branch of a tree diagram, anticipates possible problems, and provides countermeasures that will (1) prevent the deviation from occurring, or (2) be in place if the deviation does occur.

■ Process Decision Program Chart (PDPC)

The process decision program chart (PDPC) is a very useful and powerful method to overcome a problem or achieve a goal that is not familiar⁹. All the conceivable events or contingencies that can occur in the implementation stage can be mapped out using the PDPC. Feasible counter measures to overcome these problems can also be arrived at.

Characteristics of a PDPC: The main characteristics are:

- The PDPC diagram is a simple graphical tool, which can be used to mitigate risk in virtually any undertaking.
- The PDPC method helps determine which processes to use to obtain desired results by evaluating the progress of events and the variety of conceivable outcomes.
- Implementation plans do not always progress as anticipated. When problems, technical or otherwise arise, solutions are frequently not apparent.
- The PDPC method, in response to these kinds of problems, anticipates possible outcomes and prepares countermeasures that will lead to the best possible solution.
- It establishes an implementation plan for management by objectives.

Box 8.2 Network Analysis

Network analysis plays a key role in project management. Planning, scheduling and control of a project becomes much easier by analysing a network. A network is a graphical depiction of activities and events. Program evaluation and review technique (PERT) and critical path method (CPM) represent the two well-known network analysis techniques used to assist managers in planning and controlling large and complex projects such as construction projects, research and development projects, etc.

PERT was first used to help coordinate the activities in the development of the Polaris missile system. CPM was developed by the DuPont and the Univac Division of Remington Rand Corporation as a device to control the maintenance of chemical plants.

CPM is a deterministic technique, frequently used in the construction industry to help organize and schedule those activities that together constitute a given construction project. The main difference between PERT and CPM is the method in which activity times are handled. In using CPM, one assumes the activity times are known with certainty (deterministic activity times).

PERT is probabilistic in nature and allows for uncertainty and statistical variation in activity times (stochastic activity times). This is used more in research and development projects. Nevertheless, PERT and CPM are closely related (CPM may be a special case of PERT). Some of the projects that are subject to analysis by either technique are (1) construction projects, (2) planning and launching a new product, (3) a turnaround in an oil refinery (or other maintenance projects), (4) installing and debugging a computer system, (5) scheduling ship construction and repairs, (6) manufacture and assembly of large job-lot operations, (7) missile countdown procedures, (8) end-of-the month closing of accounting records, (9) development of a new drug and (10) research and development projects.

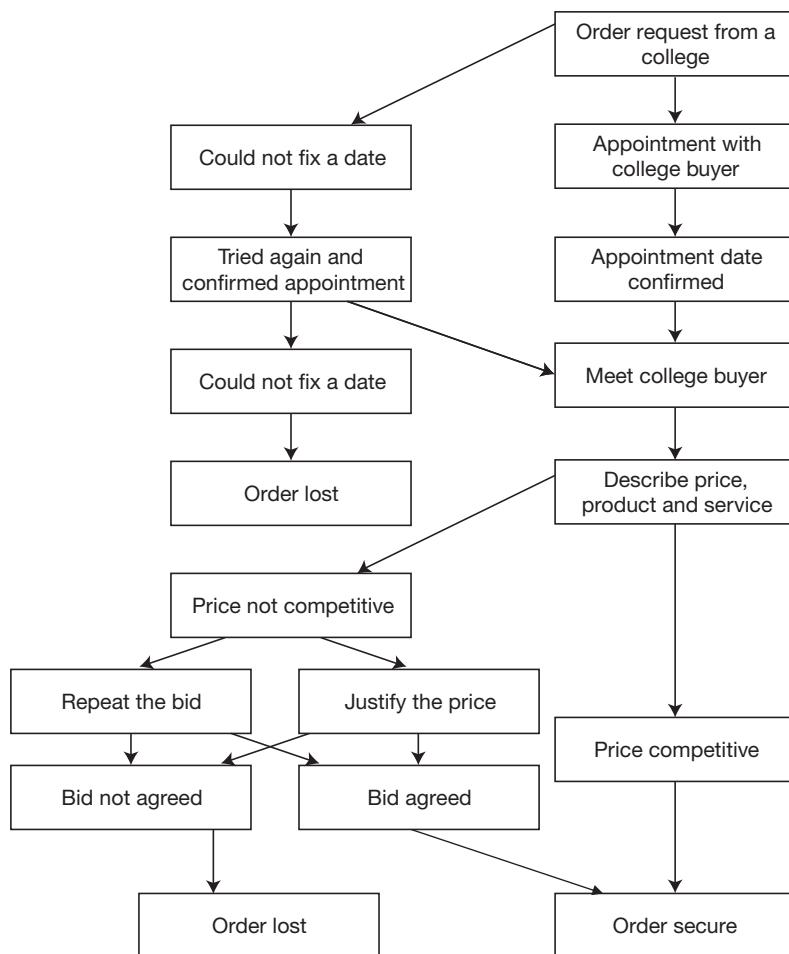
Source: Adapted from www.pertcpm.com, accessed June 2016.

- It establishes an implementation plan for technology-development themes.
- It establishes a policy of forecasting and responding in advance to major events predicted in the system.
- Implement countermeasures to minimize non-conformities in the manufacturing process to set up and select adjustment measures for the negotiating process.

Steps in constructing a PDPC chart¹⁰:

1. Select a team that is familiar with the process and possible contingencies. Typically, this will be a group that has been close to the effort or a similar effort.
2. Determine the flow of the activities of the plan and place them on a flow chart or sequence.
3. Construct a tree diagram, placing prerequisite activities in a time sequence. This can be done either using a horizontal or vertical format.
4. At each step, ask, “what could go wrong here?” and place that contingency on the chart.
5. Determine plausible explanations/solutions to each problem identified above and place the solution on the chart. An example of PDPC given in Figure 8.23 shows the process that can help secure a contract.

Fig. 8.23 Process Decision Program Chart



Uses of a PDPC chart

1. To explore all of the possible contingencies that could occur in the implementation of any new or untried plan that has risks involved.
2. To implement a plan that is complex and the consequences of failure are serious.
3. To implement a plan in which there is generally a time constraint for implementing a plan so that insufficient time is available to deal with contingent problems as they occur.

DISCUSSION FORUM

1. Describe the affinity diagram.
2. Explain the relations diagram.
3. Discuss the systematic or tree diagram.
4. Explain the matrix diagram.
5. Write a note on the matrix data analysis diagram.
6. Discuss the arrow diagram.
7. Explain PDPC.

SUMMARY

- Seven QC tools were identified by the Japanese Union of Scientists and Engineers (JUSE) as the seven most important tools for use in continuous improvement. They are primarily associated with the Study and Act steps in the PDSA cycle. The seven QC tools are Pareto chart, cause-and-effect diagram, check sheet, histogram, scatter diagram, control charts and graphs.
- The new seven QC tools are very useful to the top-and-middle management for strategic planning, goal setting and problem solving. However, these tools are not to be considered as replacements of the old seven tools. The knowledge of these basic seven tools is a must for every person from top management to grass root level employees.
- The new seven QC tools are affinity diagram, relations diagram, systematic or tree diagram, matrix diagram, matrix data analysis, arrow diagram and process decision program chart (PDPC).

Key Terms

Affinity Diagram	264	Check Sheet	241
Assignable Variations	246	Control Charts	246
Arrow Diagram	272	Histogram	242
c Chart	257	Matrix Data Analysis	271
Cause-and-effect Diagram	240	Matrix Diagram	269
Control Charts for Attributes	252	Mean chart	248
Control Charts for Variables	248	Natural Variations	246

New Seven QC Tools	276	Process Decision Program Chart (PDPC)	274
<i>np</i> Chart	254	R Chart	262
<i>p</i> Chart	253	Range Chart	248
Pareto Chart	238	Relations Diagram	266
Scatter Diagram	243	<i>u</i> Chart	248
Seven QC Tools	238	σ Charts for Standard Deviation	258
Systematic or Tree Diagram	267	\bar{X} Chart	248

Case Study

Using Pareto Analysis to Focus on Reliability Improvement at NTPC

National Thermal Power Corporation (NTPC) is India's largest power company. The company was set up in 1975 to accelerate power development in India. NTPC is a diversified power major with presence in the entire value chain of the power generation business. Apart from power generation, which is the mainstay of the company, NTPC has already ventured into consultancy, power trading, ash utilization and coal mining. NTPC was ranked 317th in the *Forbes Global 2000* ranking of the world's biggest companies in 2009.

The total installed capacity of the company is 30,644 MW (including JVs) with 15 coal-based and seven gas-based stations located across the country. In addition under JVs, three stations are coal based and another station uses naptha/LNG as fuel. By 2017, the power generation portfolio is expected to have a diversified fuel mix with coal-based capacity of around 53,000 MW, 10,000 MW through gas, 9,000 MW through hydro generation, about 2,000 MW from nuclear sources and around 1,000 MW from renewable energy sources (RES). NTPC has adopted a multi-pronged growth strategy, which includes capacity addition through greenfield projects, expansion of existing stations, joint ventures, subsidiaries and takeover of stations. NTPC has been operating its plants at high efficiency levels. Although the company has 18.79 per cent of the total national capacity it contributes 28.60 per cent of total power generation due to its focus on high efficiency.

NTPC is taking a proactive approach to identify and improve equipment performance. NTPC works with more than 100,000 components. Personnel perform thousands of maintenance activities annually. In organizations with high personnel turnover, many equipment reliability issues can go unnoticed or even become "expected" maintenance. It is not always easy to identify equipment that degrades prematurely when it occurs over many years with different people involved.

All plant components require some level of maintenance over time. Some contribute more than others to the maintenance workload. To minimize operation and maintenance costs, plant equipment needs to operate at a maximum maintenance interval. NTPC's Component Engineering group employs Pareto analysis, which when applied to maintenance work requests can identify the equipment that contributes the most to the plant maintenance work load.

Conducting Pareto Analysis

A Pareto analysis is conducted by adding the number of work requests for each component type over the time frame of interest. When ordered by the count of work requests for each component, the analysis identifies the "vital few" components that contribute the most to plant maintenance and distinguishes them from the "trivial many" that have a small contribution. The objective is to then take action to reduce the vital few into the trivial many.

Work requests from 2001–2003 were reviewed at NTPC and sorted by equipment type. The counts for equipment that comprised 40 per cent of all maintenance performed at the plant over the 3-year period are shown in Exhibit 8.1. There are several hundred equipment types in use at the plant. The benefit of this systematic breakdown is a focused review of a limited number of components. In this case, nine equipment types were involved—isolation valve, panel, pump, door, fan, motor, pneumatic operator, relief valve and breaker.

Breakdown by Manufacturer and Model

The work requests for a specific equipment type are reviewed then by manufacturer and model. The information for one equipment type, fans, is provided in Exhibit 8.2. Of the 58 fan models at NTPC, eight models required nearly 50 per cent of the fan maintenance work during 2001–2003. This systematic breakdown permits a focused review of a manageable number of fan applications. Of the 14 work requests on the model SZ-3024 fans (a centrifugal belt driven fan), 36 per cent were triggered by vibration and 64 per cent by loose belts. A study of corrective maintenance work orders revealed that bearings had failed.

The cam-lock style roller element bearings were failing on an average of every 2–3 years compared to their L10 design life of 12–15 years. A thorough review was conducted of the maintenance practices for belt and bearing replacements, the preventive maintenance strategy

Exhibit 8.1 Breakdown of Work Requests by Equipment Type

Equipment Category	Number of Work Requests	Percentage	Cumulative Percentage
Isolation valve	962	43.2	43.2
Panel	505	22.7	65.9
Pump	350	15.7	81.6
Door	127	5.7	87.3
Fan	97	4.4	91.7
Motor	83	3.7	95.4
Pneumatic operator	54	2.4	97.8
Relief valve	32	1.4	99.2
Breaker	15	0.8	100
Total	2,225		

Exhibit 8.2 Breakdown of Fan Work Requests by Model Number

Equipment Category	Number of Work Request	Percentage	Cumulative Percentage
772-BBC	14	22.95082	22.95082
SZ-3024	14	22.95082	45.90164
7182	7	11.47541	57.37705
SZ-2524	7	11.47541	68.85246
54-42-VU3	5	8.196721	77.04918
122-BBC	5	8.196721	85.2459
7222	5	8.196721	93.44262
7402	4	6.557377	100
Total	61		

employed on the fan and the design of the fan. Discussions with the bearing manufacturer identified a problem with the site maintenance practice, which did not require relocking the collar of the bearing after the run-in of fan belts. Additionally, a more reliable bearing was identified for the application, which is expected to improve the overall reliability of the fan. The result of these improvements will reduce fan maintenance by Rs 21,900,000.

Approach for Isolation Valves

The same systematic approach was used for isolation valves. Since initiating plant operations in 1987, NTPC has experienced repeated position indication (i.e. dual indication or loss of indication) with a particular manufacturer's solenoid valves. The solenoid valves use a reed switch assembly and a magnet mounted on the valve stem to actuate open or closed lights on the main control room panels.

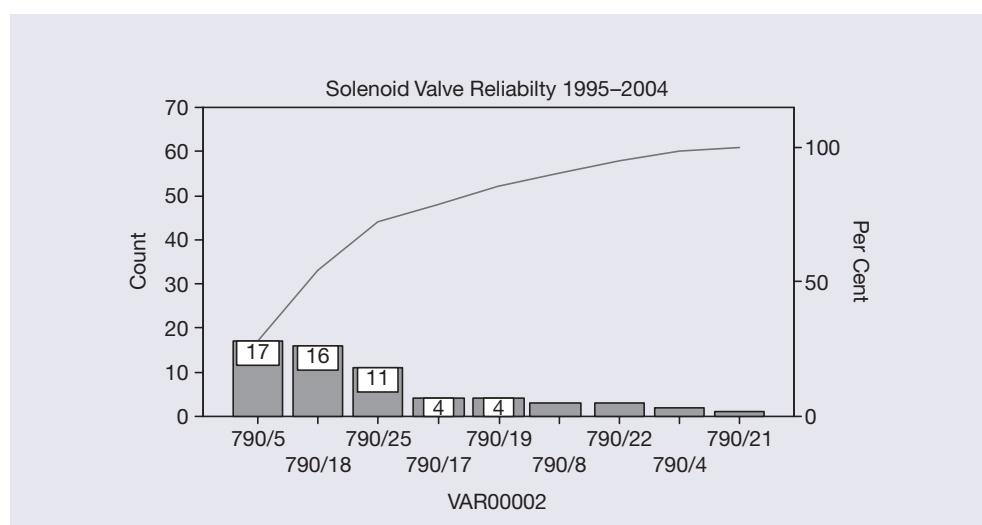
Over the years, various root-cause analyses focused on the switch assembly and maintenance practices for adjusting the reed switches. Modifications to the reed switch bracket and enhancements to the maintenance procedures did improve reliability. However, a significant number of these position indication problems were still occurring.

A Pareto analysis of position indication failures by valve model number was conducted over a 10-year period from 1995–2004 as shown in Exhibit 8.3. Three models were responsible for 75 per cent of the problems. Recognizing this permitted a focused comparison that identified the same three models had a relay in the position indication electrical circuit. The other models did not have the relay. Mock-up testing verified the relay was causing excessive voltage spikes across the reed switch contacts that resulted in electrical arcing. Over time, the condition would result in micro-welding the reed-switch contacts together, thus producing a malfunction of the position indication. The solution was to install a low cost varistor for voltage suppression that will eliminate the electrical arcing. The expected savings in maintenance is Rs 68,000,000.

Focus of the Investigation

In both the examples, Pareto analysis provided a systematic breakdown of work requests to focus on the vital few components that have the highest contribution to plant maintenance.

Exhibit 8.3 Pareto Analysis (Failure by Valve Model)



The further breakdown of this data by equipment model number and the cause of the equipment degradation focused available resources on a limited number of applications that required investigation. The investigation of the corrective maintenance procedures, preventive maintenance strategies and equipment design revealed equipment that was not operating at the optimum maintenance interval. This approach helps uncover reliability problems obscured by the volume of plant work requests. The Pareto analysis was effective in uncovering the equipment reliability problems. The systematic application of a Pareto analysis resulted in improved equipment reliability and reduced equipment maintenance.

Source: Adapted from www.ntpc.co.in, accessed March 2010.

For Discussion

1. Explain the issues faced by NTPC in its maintenance department.
2. What were the steps taken to improve the reliability of equipment?
3. Enumerate the benefits derived by NTPC by using Pareto analysis for reliability improvement.

Short-answer Questions

1. Name the seven QC tools.
2. Provide an application each for (a) Pareto chart, (b) cause-and-effect diagram, (c) check sheet, (d) histogram, (e) scatter diagram and (f) control charts.
3. Name the new seven QC tools.
4. Write one application of each: (a) affinity diagram, (b) relations diagram, (c) systematic or tree diagram, (d) matrix diagram, (f) matrix data analysis, (g) arrow diagram and (h) process decision program chart (PDPC).

Match the Following

a. Pareto analysis	Fundamental tool of SPC
b. Check sheets	Vital few and trivial many
c. Cause-and-effect diagram	Relationship between two variables
d. Histogram	Fishbone diagram
e. Scatter diagram	Presents information in graphical form
f. Control charts	A specialized type of bar chart

Discussion Questions

1. List the various tools that can be utilized for problem solving and situation analysis in the realm of TQM. Which of these tools are quantitative?
2. How do you interpret control charts? Explain the possible causes of different out-of-control indicators.
3. What is a histogram? What are the various types of histograms?

4. What are the areas of application of the stratification technique?
5. Discuss the typical applications of the “new seven tools” in quality improvement.

Projects

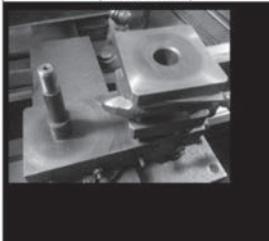
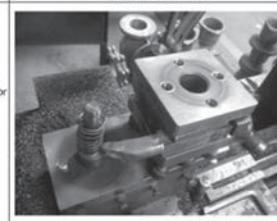
1. Research several companies to identify the type of problem-solving approach that they use in their improvement efforts. Compare and contrast their approaches.
2. In small teams, develop cause-and-effect diagrams for the following problems: (a) road accident, (b) late arrival at work and (c) poor exam grades.

End Notes

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9

Kaizen—Continuous Improvement

 KAIZEN	KAIZEN FORM NO: DEPARTMENT : M/C shop Unit -II SUGGESTION DATE : 05/10/2015 SUGGESTED BY : Gangat Desai		
KAIZEN IDEA: PLANNING FOR IMPROVEMENT IN: PRODUCTIVITY/ QUALITY/ COST REDUCTION/ DELIVERY / SAFETY / MORALE (PLEASE TICK MARK)			
PROBLEM /PRESENT STATUS BEFORE KAIZEN (PHOTO IF POSSIBLE) 	WHY WHY ANALYSIS & SUGGESTIONS FOR IMPROVEMENT <p>Why-1) Required more time for setting.</p> <p>Why-2) There was manual system for tool post locking.</p> <p>How- Indexing (90°) arrangement done.</p>	STATUS / AFTER KAIZEN (PHOTO IF POSSIBLE) 	
PROBLEMS / DIFFICULTIES/LOSSES 1) There was difficulty for exact position for tool post clamping. 2) Less productivity. 3) More time required.		TEAM LEADER : Gangat Desai TEAM MEMBERS : Gangat Desai, Pramod chouople, Vinod holkar, Kumar pujar START DATE : 07/10/2015 END DATE : 08/10/2015	BENEFITS (IN TERMS OF P.Q.C.O.S.M) 1) Exact Indexing (90°) can be done easily for clamping. 2) Improved productivity. 3) Within less time clamping can be done.
SIGN 	TEAM LEADER : Gangat Desai SCOPE FOR HORIZONTAL DEPLOYMENT : Can be implemented in other sections also		H.O.D : Anil stampure

Kaizen Participation Index

The Kaizen philosophy believes in involving everyone from the top to the bottom in an organization. Most organizations measure Kaizen in terms of the number of Kaizen per person per year. However, Kaizen principles believe in enhancing the participation of people in an organization. Therefore, it is essential to measure Kaizen by using, the **Kaizen Participation Index**.

$$\text{Kaizen Participation Index} = \frac{\text{Number of people participated in Kaizen}}{\text{Total number of employees}} * 100$$

Let us take the following example to understand more about Kaizen Participation Index.

Example 1: In Company A, there are 1,000 employees. The number of Kaizen during 2011 is 2,000. Therefore, the number of Kaizen per person is two. However, the number of people participated in Kaizen is 10. The Kaizen Participation Index in this case is:

$$\text{Kaizen Participation Index} = \frac{10}{1000} * 100 = 1\%$$

Example 2: In Company B, there are 1,000 employees. The number of Kaizen during 2011 is 2,000. Therefore, the number of Kaizen per person is two. However, the number of people participated in Kaizen is 100. The Kaizen Participation Index in this case is:

$$\text{Kaizen Participation Index} = \frac{100}{1000} * 100 = 10\%$$

From these examples, it is evident that by enhancing the participation of employees, we can enhance the Kaizen Participation Index. The critical factors that enable the success and the implementation of Kaizen are commitment of the management; education and training; communication process; customer focus; human resource integration; and documentation and evaluation of project results. The Kaizen Participation Index can be used as a measuring tool among various departments; inter-group and intra-group to measure the success of Kaizen implementation.

“Be the change you want to see in the world.”

Mahatma Gandhi

Upon completion of this chapter, you will be able to:

1. Understand Kaizen and *Gemba Kaizen*
2. Learn the approaches to continuous improvement
3. Discuss the 5 S
4. Explain company-wide quality control
5. Describe quality function deployment and the house of quality
6. Explain quality circles and the suggestion system
7. Understand *poka-yoke* and quality of work life (QWL)

■ INTRODUCTION

Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership. The concept of Kaizen was born in Japan following World War II. The word Kaizen means “continuous improvement.” It comes from the Japanese words 改 (kai), which means “change” or “to correct” and 善 (zen) which means “good.”

Kaizen is a company-wide philosophy oriented toward continuous improvement. The literal definition extends to one’s personal and social lives. In business, it applies to continuing improvement applicable to everyone, both managers and employees. The main idea is to maintain and improve work standards with the responsibility delegated to the worker.

The Kaizen strategy is one of the most important concepts in Japanese management and is credited with being the key to Japanese competitive success. One important aspect of Kaizen is its emphasis on process, complemented with management acknowledgement. This contrasts with results-oriented management, which is ingrained in western thinking. Kaizen, mostly, focuses on implementation.

Kaizen is a system that involves every employee from the upper management to the cleaning crew. Everyone in an organization is encouraged to come up with small improvement suggestions on a regular basis. This is not a random activity undertaken once a month or once

Bird's-eye view:

Kaizen is the practice of continuous improvement. Kaizen was originally introduced to the West by Masaaki Imai in his book *Kaizen: The Key to Japan's Competitive Success* in 1986.

Bird's-eye view:

Today Kaizen is recognized worldwide as an important pillar of an organization's long-term competitive strategy.

a year. It is continuous. In Japanese companies such as Toyota and Canon, a total of 60 to 70 suggestions per employee per year are written down, shared and implemented.

In most cases these are not ideas for major changes. Kaizen is based on making small changes on a regular basis. Kaizen focuses on improving productivity, safety and effectiveness while reducing waste. The suggestions are not limited to a specific domain such as production or marketing. Kaizen focuses on making changes in any area where there is a scope for improvement.

In business, Kaizen encompasses many components of Japanese businesses that have been seen as a part of their success. Quality circles, automation, suggestion systems, just-in-time delivery, Kanban and 5 S are all included within the Kaizen system of running a business.

Kaizen involves setting standards and then continually improving those standards. Kaizen also involves providing the training, materials and supervision that is needed for employees to achieve higher standards and maintain their ability to meet those standards on an on-going basis.

Bird's-eye view:

One of the most notable features of kaizen is that big results come from many small changes accumulated over time. However this has been misunderstood to mean that kaizen equals small changes.

Bird's-eye view:

Kaizen is based on certain guiding principles:

- Good processes bring good results
- Go see for yourself to grasp the current situation
- Speak with data, manage by facts
- Take action to contain and correct root causes of problems
- Work as a team
- Kaizen is everybody's business
- And much more!

■ CONCEPTS OF KAIZEN

The essence of most “uniquely Japanese” management practices—productivity improvement, TQC activities, QC (Quality Control) circles, or labour relations—can be reduced to one word, Kaizen. Using the term Kaizen in place of such words as productivity, TQC, ZD (zero defects) Kanban, and the suggestion system paints a far clearer picture of what has been happening in Japanese industry. Kaizen is regarded as a conceptual “umbrella” consisting of a collection of Japanese practices and includes customer orientation, total quality control, robotics, QC circles, suggestion systems, automation, discipline in the workplace, total productive maintenance, Kanban, just-in-time, zero defects, new product development, small group activities, productivity improvement, statistical quality control and cooperative labour/management relations.¹

■ Getting Started with Kaizen

Kaizen is about taking action to generate suggestions and then implementing these immediately. Some of the micro-level techniques for implementing Kaizen are mentioned below. Some of the techniques have been discussed in detail in the chapter.

- Involved and committed employees who use commonsense and creativity.
- Various types of check sheets or checklists.
- Active use of the seven quality control tools—Pareto chart, cause-and-effect diagram, histograms, control charts, scatter diagram, check sheets, graphs, etc.
- Systematic questioning techniques like 5W1H (What, When, Where, Whom, Why and How).
- Concept of the Deming Wheel (PDCA) and *poka-yoke* methods.
- Use of the Simply, Combine, Add and Automate, Re-arrange, Eliminate (SCARE) principle.
- Elimination of *muda*, *mura* and *muri* along with 5 S.
- Group dynamics.
- Principles of standardization and visual management.
- Some inputs on organizational behaviour topics such as team building, inter- and intra-group behaviour.

■ Gemba Kaizen

Masaaki Imai, the chairman of the Kaizen Institute, propounded the concept of *Gemba Kaizen*. *Gemba* in Japanese means “real place,” or the place where real action occurs. The problem with most managers is that they prefer their desk to be their workplace, and wish to distance themselves from the events taking place in the *gemba*. Most managers come in contact with reality only through their daily, weekly or even monthly reports or other meetings. The report from the *gemba* is merely secondary information. The manager’s first priority should be to go to the *gemba* and observe the situation. When managers go to the *gemba*, what they see is the real data.

The five *gemba* principles are shown below:

- 1. Go to the gemba:** Many managers learn about the problems that occurred in the *gemba* from a report that reaches them several days or weeks later. When there is a problem (abnormality), it is the manager’s responsibility to go to the *gemba* first. This helps the managers get first-hand information about the problems.
- 2. Check the gembutsu:** *Gembutsu*, another Japanese term, refers to tangible items that one can hold or feel. These may be machines, tools, rejects and customer complaints. If a machine is down (the machine itself is the *gembutsu*), go to the *gemba* and have a look at the machine. By looking at the machine and asking the question “why” several times, you can probably find out the reason for the breakdown on the spot.
- 3. Take temporary measures or countermeasures on the spot:** To begin with, take temporary countermeasures on the spot to solve the problem. For instance, if a customer is angry, you will need to apologize or even give some gifts to appease him. However, these are only temporary measures and do not address the real issue that lead us to the next point.
- 4. Find the root cause:** If any problem occurs, go to the root cause by repeating the question “why” several times. This will enable one to find out the root cause of the problem.
- 5. Standardize to prevent recurrence:** Once you identify the root cause and come up with appropriate measures, you should standardize such a measure so that the same problem will not recur.

■ Major Tools of Gemba Kaizen

One major tool of *gemba* Kaizen is waste elimination. There are three types of wastes—*muda*, *muri* and *mura*. *Gemba* Kaizen is the process of identifying, reducing and eliminating *muda*, *muri* and *mura* from the *gemba*.

Muda in Japanese means work without a product or effort wasted. *Muda* is any wasteful activity or any obstruction to the smooth flow of an activity.

$$\text{Activity} = \text{Work} + \text{Muda}$$

$$\text{Expenditure} = \text{Cost} + \text{Waste}$$

Each activity is associated with a cost. Any expenditure on the *muda* is a waste. Therefore, less *muda* equals happier clients (as it impacts quality, cost and delivery of products and services). The various types of *muda* are as follows:

- 1. Muda of overproduction:** This is regarded as the worst type of *muda*. If you produce more than your customer needs, you have extra pieces that need to be taken care of and expenses for handling and keeping in stock.

Bird's-eye view:

Gemba Kaizen is a Japanese concept of continuous improvement designed for enhancing processes and reducing waste. Within a lean context, **Gemba** simply refers to the location where value is created, while **Kaizen** relates to improvements.

Bird's-eye view:

One major tool of *gemba* Kaizen is waste elimination. There are three types of wastes—*muda*, *muri* and *mura*. *Gemba* Kaizen is the process of identifying, reducing and eliminating *muda*, *muri* and *mura* from the *gemba*.

2. **Muda of inventory:** This is the result of overproduction. If you process only those products that the next process needs, you can eliminate the muda of inventory altogether.
3. **Muda of waiting:** How often do you see operators just waiting for the materials to arrive or the machine to start? No value is added when there is a long waiting period.
4. **Muda of motion:** No value addition takes place when operators simply move around looking for tools or going to get the work pieces.
5. **Muda of transportation:** No value addition is made when materials are moving on the trucks, forklifts or on the conveyor.
6. **Muda of producing rejects:** Producing rejects leads to rework, or else rejects must be thrown away and this is indicative of a big muda.
7. **Muda of processing:** By rearranging the working sequence, you can often eliminate a particular process. The concept of muda elimination is central to Kaizen since elimination does not cost any money.

Muri in Japanese refers to an overburdened system. This leads to physical strain at the workplace such as bending to work, pushing hard, lifting weight, repeating tiring action and wasteful walk.

Mura in Japanese refers to the unevenness in the flow of work. Mura relates to the inconsistencies in the system.

■ LEAN

Lean is a business philosophy that was first developed by Taiichi Ohno in the 1990s with particular focus on manufacturing firms. It is applied in various organizations to improve their business and reduce waste. It is a concept applied to remove muda. There are seven types of waste—overproduction, wasting time, resources, transportation, processing, inventory and motion. The elimination of waste improves quality while reducing costs and the time required for producing goods.

■ Fundamental Lean Management Principles

The five fundamental lean management principles are:

1. Specify what creates value from the customer's perspective
2. Identify all the steps in the process chain
3. Make those processes flow
4. Make only what is pulled by the customer
5. Strive for perfection by continually removing wastes

According to many researchers and experts, waste can be eliminated by way of standardizing the work, the workplace, quality, etc. In order to apply the concept of lean in any organization, it should first be understood well by all the personnel in the organization. The lean concept in an organization should be implemented from the top (at the level of the management) and then go on to the employees at all levels. The organization should contribute to the awareness and training of employees as far as the lean concept is concerned.

Ford, Toyota and Boeing are some of the companies that have used lean techniques and are known as the best innovators in the industry. Lean was originally developed by Taiichi Ohno of the Toyota Motor Company in Japan based on the concepts pioneered by Henry Ford.² Ford started using lean manufacturing principles in all its operations in 1981. The re-engineering effort that was taken up by Ford, better known as the "Ford

Production System," has effectively involved the implementation of lean techniques to improve its business operations. Apart from using advanced technologies, Ford was successful in making its employees and other personnel in its organization work together in groups, and take swift decisions while avoiding wastage of time. Ford was able to effectively increase operations, eliminate waste and improve its financial position. It was able to transform itself from a mass production system to a lean manufacturing system. Improving operations and removing waste requires significant financial and human resources. Lean is the result of the involvement of all the departments of the organization.

There are many other techniques that have emerged with the same principle of eliminating waste—Kanban, Kaizen, JIT and Six Sigma are discussed in different sections of this book. TRIZ is also another innovative problem-solving tool used to resolve technical and technological problems, contradictions, thus providing companies ideal solutions and giving them the competitive advantage.

The lean concept is no longer exclusive to manufacturing firms. The same tools and concepts can also be applied to other businesses as well (non-manufacturing firms) and to industries such as health care, pharmaceuticals, banks, etc. It is used in improving patient care and reducing medical errors and in successful software development.

■ Building Blocks of Lean

5 S: A system for workplace organization and standardization. The five steps that go into this technique all start with the letter S in Japanese (*seiri, seiton, seiso, seiketsu* and *shitsuke*). These five terms are loosely translated as sort, set in order, shine, standardize and sustain.

Visual controls: The placement in plain view of all necessary information, tooling parts production activities and indicators so everyone involved can understand the status of the system at a glance.

Streamlined layout: A layout designed according to optimum operational sequence.

Standard work: Consistent performance of a task, according to prescribed methods without waste and focused on human movement (ergonomics).

Batch-size reduction: If one piece flow is not appropriate, reduce the batch to the smallest size possible.

Teams: In the lean environment, the emphasis is on working in teams, be they process improvement teams or daily work teams.

Quality at the source: This refers to inspection and process control by employees so that they are certain that the product or information is passed on to the next stage or the process is of acceptable quality.

Point of use storage: Raw materials, parts information, tooling work standards, supplies, procedures, etc. are stored where needed.

Quick changeover: The ability to change tooling and fixtures rapidly (usually in minutes) so multiple products in smaller batches can be run on the same equipment.

Pull/kanban: A system of cascading production and delivery instructions from downstream to upstream activities in which the upstream supplier does not produce until the downstream customer signals a need for the product using a Kanban system. Kanban is

Bird's-eye view:

The core idea is to maximize **customer value** while minimizing waste. Simply, lean means creating more value for customers with fewer resources.

a card designed to prevent overproduction by ensuring that each stage of a process produces only as much as the next stage needs.

Cellular/flow: Physically linking and arranging manual and machine process steps into the most efficient combination to maximize the value added while minimizing waste. The aim is to create a single piece flow.

Total productive maintenance (TPM): A lean equipment maintenance strategy for maximizing overall equipment effectiveness.

As lean has evolved, its potential impact has broadened. The philosophy that once was limited to the shop floor has found its way into all facets of an organization. Resources freed by lean can be reallocated to improve society at large and, in turn, the sustainability of an organization. Box 9.1 discusses the lean management principles practised by Toyota.

Bird's-eye view:

The term “lean” was coined to describe Toyota’s business during the late 1980s by a research team headed by Jim Womack, Ph.D., at MIT’s International Motor Vehicle Program.

■ Tools for Continuous Improvement

Measurements drive both behaviour and focus of projects. It can be confirmed whether the expected improvement has taken place or not only if the correct and appropriate tools of measurement are used.

Box 9.1 Seven Principles of Lean Manufacturing: Toyota Production System (TPS)

The famous seven principles of lean manufacturing as practiced by Toyota are as follows:

1. **Reduced setup times:** Toyota was able to slash setup times by organizing procedures, using carts and training workers to do their own setups. This was done because setup practices are generally wasteful and tie up labour and equipment.
2. **Small-lot production:** Producing things in large batches result in huge setup costs, high capital cost of high-speed dedicated machinery, larger inventories, extended lead times and larger defect costs. It became possible for Toyota to economically produce a variety of things in small quantities since it had found the way to make setups short and inexpensive.
3. **Employee involvement and empowerment:** Toyota organized its workers by forming teams and gave them the responsibility and training to do many specialized tasks. Teams are also given responsibility for housekeeping and minor equipment repair. Each team has a leader who also works as one of them on the line.
4. **Quality at the source:** Toyota focused on eliminating product defects by discovering and correcting them as soon as possible. A worker can stop the entire line by pulling a cord called *Jidoka* if the defect cannot be fixed.
5. **Equipment maintenance:** Toyota operators are assigned primary responsibility for basic maintenance since they are in the best position to detect signs of malfunctions. Maintenance specialists diagnose and fix only complex problems, improve the performance of equipment and train workers in maintenance.
6. **Pull production:** In order to reduce inventory holding costs and lead times, Toyota developed the pull production method wherein the quantity of work performed at each stage of the process is dictated solely by the demand for materials from the immediate next stage. The kanban scheme coordinates the flow of small containers of materials between stages. This is where the term just-in-time (JIT) originated.
7. **Supplier involvement:** Toyota treats its suppliers as partners and integral elements of the Toyota Production System (TPS). Suppliers are trained in methods to reduce setup times, inventories, defects, machine breakdowns, etc. and take responsibility to deliver best possible parts.

Source: Adapted from Taiichi Ohno, *Toyota Production System: Beyond Large Scale Production* (Portland, Oregon: Productivity Press, 1988).

1. The seven quality control tools: These are explained in Chapter 8 and are the tools used for continuous improvement. Use the appropriate tool(s) to measure the success of the improvement process.

2. 5-Why analysis: The why concept

Why → Why → Why → Why → Why

3. Approach to continuous improvement: The PDCA cycle (Plan–Do–Check–Act) is an approach particularly focused on continuous improvement of existing processes. This is explained in Chapter 2. When you follow the PDCA cycle, you need to do it continuously. After you have improved a process and set up a new procedure incorporating those improvements, only then is it time to move on to the next process.

■ Identifying Opportunities for Kaizen

Customer surveys: The suggestions for improvement of both internal and external customers must be recorded.

Employee suggestions: Be receptive to your employees' suggestions all the time, every time. Empower your employees by giving them the freedom of voice and expression.

Brainstorming: Conduct brainstorming sessions on a process you want to improve. Make sure that you involve all the employees regardless of their position in the organization.

Benchmarking: Identify the organization(s) you want to benchmark against. It can be other operating units within the company, competitors or unrelated companies. However, they should be a leader or “best in class” in the area being benchmarked.

Bird's-eye view:

Opportunities for Kaizen can be identified by: Customer surveys; Employee suggestions; Brainstorming and Benchmarking.

■ Guidelines for Preparing the Kaizen Proposal

The following guidelines need to be followed for a Kaizen proposal:

1. The Kaizen should be self-explanatory.
2. Sustenance of results must be clearly evident.
3. Ease of replication for other units/areas must be evident.
4. Clear impact on customer/quality/bottom line/intangible benefit must be presented.
5. Each team should have a maximum of five members including a coordinator.
6. The team must be a natural operating team.
7. The presentation must follow a systematic flow—methodology of theme/problem identification, root cause/analytical analysis, usage of different tools and techniques, problem faced if any, team working, actions taken, before/after condition through photograph/graphs/sketches/videos, etc., results achieved, replication and sustenance of results.

■ Kaizen Sheet

A Kaizen sheet is a useful way of depicting the information relating to the implementation of Kaizen suggested by an individual or group of workers.³ The typical format of a Kaizen sheet is shown in Figure 9.1.

■ Reward Success

The employees of an organization distinguish an average organization from a great one. The difference is not so much in the calibre of the personnel, as in the degree to which the

Fig. 9.1 Kaizen Sheet

Kaizen Sheet					Company	MM/YY	SI No.		
Productivity	Quality ✓	Safety	Material	Energy	Font: Arial type, size 8, black, bold				
Kaizen Theme: Font: Arial type, size 12, green, bold					Implemented Area:	Font: Arial type, size 12, black, bold			
Problem/Present Status: Font: Arial type, size 12, red, bold Define the problem (Graphical representation or text)			Before improvement: (Pictorial or flow diagram)			Result/Benefit: (Graphical representation or Text quantitative)			
Real root cause identification: Font: Arial type, size 12, black, bold Mention the tool used to arrive at real root cause			After improvement: (Pictorial or flow diagram)			Standardization: Font: Arial type, size 12, black, bold (Mention the standardization points)			
Root cause	Font: Arial type, size 12, red, bold			How many places this Kaizen can been deployed horizontally: Font: Arial type, size 12, black, bold					
Idea to eliminate root cause	Font: Arial type, size 12, green, bold								
Action taken	Font: Arial type, size 12, green, bold								

👁 Bird's-eye view:

A Kaizen sheet is in Report form that documents and summarizes continuous improvement activities. It is used to share and spread best practices across an organization, division or group.

personnel are used to their full potential. Each person's contribution should be valued. Employees should be motivated, inspired, rewarded and recognized for their contributions how ever small they may be. Rewards are not only in terms of monetary benefits. Rewards can also be in the form of displaying their special achievements on bulletin boards, giving letters of appreciation to encourage them, celebrating their success along with their teams by giving them a rolling trophy engraved with their names on it, etc.

■ Benefits of Kaizen

Kaizen involves every employee in the change process. In most cases, these changes may be small and incremental. It focuses on identifying problems at their source, solving them at their source, and changing standards to ensure that the problem does not recur. It's not unusual for Kaizen to result in 25 to 30 suggestions per employee, per year, and to have over 90 per cent of those implemented.

For example, Toyota is well known as one of the leaders in using Kaizen. In 1999 at one US plant, 7,000 Toyota employees submitted over 75,000 suggestions, of which 99 per cent were implemented. These continual small improvements add up to major benefits. They result in improved productivity, improved quality, better safety, faster delivery, lower costs and greater customer satisfaction. On top of these benefits to the company, employees working in Kaizen-based companies generally find work to be easier and more enjoyable, thus resulting in higher employee morale and job satisfaction and lower turnover. Kaizen reduces waste in areas such as inventory, waiting times, transportation, worker motion, employee skills, overproduction, excess quality and in processes. It improves space utilization, product quality, use of capital, communications, production capacity and employee retention. It provides immediate results. Kaizen focuses on creative investments that continually solve large numbers of small problems.

Box 9.2 Kaizen at Freudenberg-NOK

Freudenberg-NOK (FNOK), a firm formed by the amalgamation of a German, Japanese and an American company is a producer of sealing packages for transmissions, brakes, axles and steering. It succeeded in creating a culture of “Kaizen every day” as a means of continuous improvement. The company classified Kaizen events into major and minor categories. Through a series of Kaizen events, FNOK transformed its traditional batch manufacturing process from a “U-shaped cell” into a “best practice cell” and later into a “model cell.” FNOK firmly believes that involving the staff in all improvement activities is the key to success.

The Vice-President of FNOK’s GROWTTH (Get Rid of Waste through Team Harmony) and continuous improvement team conducted about 1,100 Kaizen events in 1999. This helped the company to improve activities continuously. Areas that were improved were also monitored continuously and further developed.

The major events conducted as part of Kaizen were undertaken by a cross-functional team consisting of six to eight people. The main objectives of these teams were to initiate improvement activities in specific areas. Major Kaizen events were separated by few weeks and during this time, few of the team members made changes in the process and collected data on these changes. By analysing the data, the team could decide whether the changes were justified or not.

Incorporating the culture of “Kaizen everyday” required a lot of strategic planning and training. The process improvement on its plant floor required reorganizing. Initially, FNOK had a traditional batch manufacturing process. The company had created U-shaped cells where small, inexpensive and dedicated equipment was placed in the order of the assembly process. This allowed a one-piece flow. The operations were standard and workers handled many processes. Retaining the U-shaped setup as it was, FNOK improved it by incorporating the 5 S practice that stressed on cleaning up, organization, neatness, standardization and discipline. In addition, it took steps for preventive maintenance. These “best practice cells” were then transformed into “model manufacturing cells” by adding internal support functions such as material management, technicians and quality engineering. This enabled operators in the cell to seek quick assistance in critical situations.

The company realised the importance of assigning trained operators permanently to specific processes and products. By doing so, the operators could improve their skills and knowledge especially in areas such as parts requirements, critical process characteristics and the mechanism of the process. Rather than defining people by their functions, FNOK aimed at identifying people with specific customers and specific products. This improved efficiency of customer services.

Source: Adapted from www.highbeam.com, accessed April 2010.

Kaizen will also improve the capital projects process, but the real power of Kaizen is in the ongoing process of continually making small improvements that improve processes and reduce waste. Box 9.2 discusses the Kaizen initiatives at Freudenberg-NOK.

DISCUSSION FORUM

1. Explain Kaizen with an example.
2. Discuss gemba Kaizen.
3. Describe the lean business philosophy.
4. What are the tools and techniques used for continuous improvement?
5. Explain the benefits of Kaizen with an example.

 **Bird's-eye view:**
Kaizen Reduces Waste in areas such as employee skills, waiting times, transportation, worker motion, over production, excess inventory, quality and in processes.

 **Bird's-eye view:**
Kaizen Improves - product quality, use of capital, production capacity, communications, Space utilization and employee retention.

■ WHAT IS THE 5 S?

Bird's-eye view:

5S is the name of a workplace organization method that uses a list of five Japanese words: *seiri*, *seiton*, *seiso*, *seiketsu*, and *shitsuke*.

The 5 S forms the foundation of Kaizen. A 5-S programme is usually a part of and the key component in establishing a visual workplace. It is both a part of Kaizen and a component of lean manufacturing. The 5-S programme focuses on implementing visual order, organization, cleanliness and standardization. The results that can be expected from a 5-S programme are improved profitability, efficiency, service and safety.

The principles underlying a 5-S programme at first appear to be simple and obvious common sense. However, many businesses ignored these basic principles until the advent of 5-S programmes. 5 S is the key to total quality environment. Japanese factories are well known for their cleanliness and orderliness. Therefore, the Japanese call their factories parlours. The 5-S practice is a technique used to establish and maintain quality environment in an organization. The name stands for five Japanese words—*seiri*, *seiton*, *seiso*, *seiketsu* and *shitsuke*. The Japanese 5-S practice is useful not just for improving the physical environment, but also for improving thinking processes. The English equivalent, their meanings and typical examples are shown in Table 9.1.⁴

■ The 5-S Movement

The 5-S movement takes its name from the first letter of the five Japanese words—*seiri*, *seiton*, *seiso*, *seiketsu* and *shitsuke*. As part of the visual management of an overall programme, signs that repeat the steps are often posted in the workshop.

Table 9.1 5-S Programme

	Japanese	English	Meaning	Typical Example
1 S	Seiri	Structurize/Sorting	<ul style="list-style-type: none"> • Organization • Distinguishes between necessary and unnecessary items • Putting things in order 	To discard unnecessary things and retain only necessary things
2 S	Seiton	Systemize/Systematic arrangement	<ul style="list-style-type: none"> • Keeping necessary things in designated places 	Reducing searching time
3 S	Seiso	Sanitize/Cleaning	<ul style="list-style-type: none"> • Making things clean • Keeping the workplace spic and span 	Getting rid of waste, grime and foreign matter. Make cleaning a form of inspection
4 S	Seiketsu	Standardization	<ul style="list-style-type: none"> • Standardization of 1 S, 2 S and 3 S • Emphasis on visual management 	Continually and repeatedly maintain neatness and cleaning standards in the organization
5 S	Shitsuke	Self-discipline	<ul style="list-style-type: none"> • To respect and cultivate standards • Instilling or having the ability to do things the way they are supposed to be done 	Emphasis on creating a congenial work place with good habits and discipline

Step 1 Seiri (straighten up): It is about separating the things that are necessary for the job from those that are not and keeping the number of the necessary items as low as possible and at a convenient location. Differentiate between the necessary and the unnecessary and discard the unnecessary in the areas such as work in process, unnecessary tools, unused machinery, defective products and documents. This can be achieved by:

- Stratification management: The key to good stratification management is the ability to make decisions about usage frequency and to ensure that the things are in their proper places. It involves deciding how important something is and then reducing the non-essential inventory.
- Differentiate between need and want.
- Applying the theory of one-is-best, for example, by using one set of tools/one day processing.

Step 2 Seiton (put things in order): Things must be kept in order so that they are ready for use when needed. An American mechanical engineer recalls that he used to spend hours searching for tools and parts in his previous job at Cincinnati. He realised the value of “seiton” only after he joined a Japanese organization and saw how easily the workers were able to find what they needed. Seiton is all about neatness. Neatness is a study of efficiency. It is a question of how quickly one can get the things needed and how quickly one can put them away. There are four steps in achieving neatness:

1. Analyse the status quo
2. Decide where things belong
3. Decide how things should be put away
4. Obey the put-away rules (putting things back where they belong)

Step 3 Seiko (clean up): Keep the workplace clean. Everyone in the organization should put cleaning into practice, right from the managing director to the cleaner.

Step 4 Seiketsu (standardization): It means continually and repeatedly maintaining neatness and cleanliness in the organization. As such, it embraces both personal cleanliness and the cleanliness of the environment. The emphasis is on visual management (put up appropriate labels) and standardization.

Step 5 Shitsuke (discipline): Discipline means instilling the ability of doing things the way they are supposed to be done. Discipline is a process of repetition and practice. The emphasis here is on creating a workplace with good habits. Everyone should follow the procedures in the workshop.

The logic behind 5-S practices is that organization, neatness, cleanliness, standardization and discipline at the workplace are basic requirements for producing high quality products and services with little or no waste and with high productivity. This is the reason why it is important to combine the Japanese 5-S practice in TQM.

■ Implementing the 5 S in an Organization

The five steps in implementing the 5 S in an organization are:

- Step 1: Get the top management's commitment and be prepared.
- Step 2: Draw up a promotional campaign.
- Step 3: Keep records.
- Step 4: Undertake 5-S training.
- Step 5: Evaluation.

Bird's-eye view:

The 5S philosophy applies in any work area. The elements of 5S are simple to learn and important to implement:
 Sort—Eliminate whatever is not needed
 Straighten—Organize whatever remains
 Shine—Clean the work area
 Standardize—Schedule regular cleaning and maintenance
 Sustain—Make 5S a way of life

 **Bird's-eye view:**

5-S Auditing helps evaluate the performance level of each “S” and identifies the gaps so that further improvement can be initiated to achieve the desired level of performance.

■ Conducting a 5-S Audit

Auditing helps evaluate the performance level of each “S” and identifies the gaps so that further improvement can be initiated to achieve the desired level of performance. Prepare a systematic audit sheet for each “S,” covering all elements like scoring criteria, for instance on a scale of 1 to 5, the area to be audited, the owner of the area, date of audit, auditor’s name and level and the opportunity for improvements (OFIs).

Level 1: Self-audit by the 5-S practitioners/area owners.

Level 2: Peer audit.

Level 3: Final audit by the unit head/facilitator/external expert.

Provide due weightage for awareness of the 5-S concepts and their physical deployment at the workplace.

- Be unbiased during the audit.
- Check all the area or sample area as applicable.
- Check for all the activities involved.
- Give attention to areas of negligence, safety and hygiene aspects.
- Focus on following the implementation strategy.

Approach: Interview all members for awareness on concepts and the benefits in terms of result indicators.

Deployment: Area covered all activities by all people.

Assessment and review: Self-audit system and continuous improvement.

Result: Tangible and intangible quantification.

- Scheduled audit to be carried out during implementation to know the gaps in terms of OFIs (opportunity for improvements) and upgrade level of house-keeping continuously.
- Surprise audits may be organized at frequent levels (six months) by an external agency to assess whether the performance is sustained or deteriorating so as to alert teams for sustenance.
- Conduct three level audits for each step, say, after joint operation of 1 S, 2 S, 3 S, 4 S and 5-S activities, respectively.
- Do not move on to the next step until the present step is satisfactory and certified.
- Certify only if the score is above 90 for level 1, above 85 for level 2 and above 80 for level 3.
- Ideal maximum score is 100.
- Scoring points to be given in whole numbers 1 to 100 or 1 to 5 as defined below.

One mark for almost zero implementation.

Two marks for implementation in exposed areas.

Three marks for partial implementation in hidden areas.

Four marks for full implementation in hidden areas.

Five marks for very effective implementation deriving desired result indicator values.

Make the audits more objective than subjective with enough specific remarks to guide the practitioner to improve.

■ 1-S Audit

The ideal status is to have zero unnecessary items at the workplace.

- Give five marks if not a single item is found as unnecessary in the area during audit.
- Give four marks if one item is found as unnecessary in the area during audit.
- Give three marks if two items are found as unnecessary in the area during audit.
- Give two marks if three items are found as unnecessary in the area during audit.
- Give one mark if four items are found as unnecessary in the area during audit.

■ 2-S Audit

The ideal status is to have a place for everything. The retrieval time should be less than 30 seconds.

- Give five marks if the locations of all items are marked and the items are in their respective positions.
- Give four marks if 80 per cent locations are marked and the items are in their respective positions.
- Give three marks if 60 per cent locations are marked and the items are in their respective positions.
- Give two marks if 40 per cent locations are marked and the items are in their respective positions.
- Give one mark if 20 per cent locations are marked and the items are in their respective positions.

■ 3-S Audit

The ideal status is a neat workplace and preserved items are perfectly neat and clean with no dust, dirt, grime and foreign matters.

- Give five marks if the area and the items are neat and clean.
- Give four marks if 80 per cent of the items and area are neat and clean.
- Give three marks if 60 per cent of the items and area are neat and clean.
- Give two marks if 40 per cent of the items and area are neat and clean.
- Give one mark if 20 per cent of the items and area are neat and clean.

■ 4-S Audit

The ideal status is that all the procedures, formats and practices are standardized.

- Give five marks if all the procedures, formats and practices are standardized.
- Give four marks if 80 per cent procedures, formats and practices are standardized.
- Give three marks if 60 per cent procedures, formats and practices are standardized.
- Give two marks if 40 per cent procedures, formats and practices are standardized.
- Give one mark if 20 per cent procedures, formats and practices are standardized.

■ 5-S Audit

The ideal status is “1 S, 2 S, 3 S and 4 S are practised by all in all areas with self-imposed discipline.”

- Give five marks if discipline is effective in all the areas.
- Give four marks if discipline is effective in 80 per cent of the areas.
- Give three marks if discipline is effective in 60 per cent of the areas.
- Give two marks if discipline is effective in 40 per cent of the areas.
- Give one mark if discipline is effective in 20 per cent of the areas.

■ Implementation Strategy

The following strategy can be used to implement a 5-S programme:

- Create awareness through workshops for all members
- Form the teams and assign ownership areas
- Equip the teams with tools and techniques
- Implement in a step-by-step manner
- Carry out three-level audits regularly
- Proceed to the next step only after completing the previous step satisfactorily
- Use a model area and implement all the 5 S practices, then replicate horizontally or start simultaneously at selected all areas by compressing the implementation time

■ Benefits of a 5-S Programme

All types of businesses benefit from having a 5-S programme in place. Manufacturing and industrial plants are the businesses that can realise the greatest benefits. However, any type of business whether a retail store, or a power plant, a hospital or a television station and all areas within it will realise the benefits incurring from implementing the 5-S programme. Some of the benefits of implementing a 5-S programme are:

- Builds a culture for creating a neat, safe, healthy and clean workplace with a conducive environment.
- Systematizes day-to-day working and improves the work efficiency.
- It inspires associates to maintain discipline in the workplace and also motivates them to carry home good practices by which their family members are also benefited.

DISCUSSION FORUM

1. What does the term 5 S stand for?
2. Explain the 5-S audit.
3. Discuss the benefits of a 5-S programme.

■ KAIZEN VERSUS INNOVATION

Innovation is seen as a major change in the wake of technological breakthroughs. Innovation is dramatic and a real attention-getter. Kaizen, on the other hand, is often undramatic and subtle, and its results are seldom immediately visible. While Kaizen is a continuous process that implies continuous improvement and involves every employee in every company function at all levels of the organization, innovation is generally a one-shot phenomenon. The comparison between Kaizen and innovation is shown in Tables 9.2 and 9.3.

Table 9.2 Features of Kaizen and Innovation

Criteria	Kaizen	Innovation
1. Effect	Long-term and long lasting but undramatic	Short-term but dramatic
2. Pace	Small steps	Big steps
3. Time frame	Continuous and incremental	Intermittent and non-incremental
4. Change	Gradual and constant	Abrupt and volatile
5. Involvement	Everybody	Select few “champions”
6. Approach	Collectivism, group efforts, systems approach	Rugged individualism, individual ideas and efforts
7. Mode	Maintenance and improvement	Scrap and rebuild
8. Spark	Conventional know-how and state of the art	Technological break-through, new inventions, new theories
9. Practical requirements	Requires little investment but great effort to maintain it	Requires large investment but little effort to maintain it
10. Effort orientation	People	Technology
11. Evaluation criteria	Process and efforts for better results	Results for profits
12. Advantage	Works well in slow-growth economy	Better suited to a fast-growth economy

Table 9.3 Comparison of Innovation and Kaizen

Innovation	Kaizen
Creativity	Adaptability
Individualism	Teamwork (systems approach)
Specialist-oriented	Generalist-oriented
Attention to great leaps	Attention to details
Technology-oriented	People-oriented
Information: closed, proprietary	Information: open, shared
Functional (specialist) orientation	Cross-functional orientation
Seek new technology	Build on existing technology
Line + staff	Cross-functional organization
Limited feedback	Comprehensive feedback

Bird's-eye view:

Kaizen, or continuous improvement, builds upon existing processes. It is by definition consistent and persistent small changes that can have a great impact through their cumulative application.

Bird's-eye view:

Innovation brings improvement through new products or processes that have a more dramatic initial impact than the slow accumulation of kaizens.

Analysing Table 9.3, we find that the West has been stronger in terms of innovation and Japan has been stronger on the Kaizen front. These differences are also reflected in the different social and cultural heritages such as the Western educational system's stress on individual initiative and creativity as against the Japanese educational system's emphasis on harmony and collectivism.

One big difference between Kaizen and innovation is that while Kaizen does not necessarily call for a large investment to implement it, it does call for a great deal of continuous effort and commitment. Innovation is a one-shot deal whose effects are gradually eroded by intense competition and deteriorating standards, Kaizen is an on-going effort with cumulative effects marking the steady rise as the years go by.

Continuous efforts towards improvement must exist within organizations to even maintain the status quo. If standards exist only in order to maintain the status quo, they will not be challenged so long as the level of performance is acceptable. When such effort is lacking, decline is inevitable. Therefore, even when an innovation makes a revolutionary standard of performance attainable, the new performance level will decline unless the standard is constantly challenged and upgraded. Thus, whenever an innovation is achieved, it must be followed by a series of Kaizen efforts to maintain and improve it. Kaizen is a constant effort not only to maintain but also to upgrade standards.

■ COMPANY-WIDE QUALITY CONTROL (CWQC)

Bird's-eye view:

Japanese-Style total quality control (TQC) is different from traditional U. S. TQC, and therefore Japanese managers have coined the phrase 'company-wide quality control' (CWQC) to distinguish this difference.

The avenues through which Kaizen may be pursued are almost endless. However, the "high road" to Kaizen has been the practice of company-wide quality control (CWQC). Hardware, software and human-ware are the three building blocks of business. CWQC starts with human-ware. The hardware and software aspects of business are considered only after the human-ware is in place. CWQC has become an elaborate system of corporate problem solving and improvement activities. The CWQC is expected to yield the following results:

- Provide products and services that satisfy customer requirements and earn customer trust.
- Steer the corporation towards higher profitability through such measures as improved work procedures, fewer defects, lower costs, lower debt service and more advantageous order filling.
- Help employees fulfill their potential for achieving corporate goals with particular emphasis on areas such as policy deployment and voluntary activities.
- Help the corporation cope with any severe environmental changes or other external problems, win customer confidence and secure and improve profitability.

CWQC signifies a statistical and systematic approach for Kaizen and problem solving. Its methodological foundation is the statistical application of quality control (QC) concepts, including the use and analysis of statistical data. This approach has fostered a process-oriented way of thinking. The following are the salient features of CWQC:

1. Company-wide total quality control (TQC) with the participation of all employees
2. Emphasis on education and training
3. Quality control circle activities
4. CWQC audits as exemplified by the Deming Prize audit
5. Application of statistical methods
6. Nationwide CWQC promotion

■ Characteristics of CWQC

The main characteristics of CWQC are:

1. Quality before profit
2. Consumer-oriented quality control, not producer-oriented quality control
3. The next process is the customer
4. Application of statistical methods
5. Cross-functional management
6. CWQC starts with training and ends with training

The introduction of CWQC invariably starts with all-out efforts for training managers and workers. This is a natural follow up to the concept of building quality into people. The major aim of various training programmes is to instill CWQC thinking in all employees. Companies should conduct separate courses for the different organizational levels and reach everyone horizontally (vendors on one end to customers on the other) and vertically (from the top management to workers).

■ KAIZEN—THE PRACTICE

A well planned Kaizen programme can be broken down into three segments—management-oriented Kaizen, group-oriented Kaizen and individual-oriented Kaizen—depending on the complexity and the level of Kaizen. Table 9.4 elaborates and explains this aspect.

■ Management-oriented Kaizen

Management-oriented Kaizen is considered the first pillar of Kaizen. It is a crucial pillar, since it concentrates on the most important logistic and strategic issues and provides the momentum to keep up progress and morale.

Since Kaizen is everybody's job, the manager must be engaged in improving his own job. Japanese management generally believes that a manager should spend at least 50 per cent of his time on improvement. The starting point of Kaizen is to identify "waste" in the worker's motion. Management-oriented Kaizen also takes the form of a group approach such as Kaizen teams, project teams and task forces. However, these groups are quite different from quality control circles in that they are composed of management and staff, and their activities are regarded as a routine part of the management's job.

The management should direct its effort to systems improvement as one of the most important tasks of management-oriented Kaizen. Systems improvement concerns such crucial areas of management as planning and control, decision-making processes, organization and information systems. Where the management has failed to establish such a system and has instead directed its efforts randomly and in bits and pieces, success has often been short lived. This is why top management commitment is indispensable when Kaizen is introduced. Many top executives believe that Kaizen comprises 50 per cent of the management's job.

Bird's-eye view:

A well planned Kaizen programme can be broken down into three segments—management oriented Kaizen, group-oriented Kaizen and individual-oriented Kaizen—depending on the complexity and the level of Kaizen.

■ Group-oriented Kaizen

Group-oriented Kaizen is represented by small group activities such as quality control circles that use various tools to solve problems. The permanent approach also calls for the full PDCA cycle and demands that team members identify problem areas and also identify the

Table 9.4 Three Segments of Kaizen

	Management-oriented Kaizen	Group-oriented Kaizen	Individual-oriented Kaizen
Tools	Seven statistical tools New seven tools Professional skills	Seven statistical tools New seven tools	Common sense Seven statistical tools
Involves	Managers and professionals	Quality control circle (group) members	Everyone
Target	Focus on systems and procedures	Within the same workshop	Within one's own work area
Cycle (period)	Lasts for the duration of the project	Requires four or five months to complete	Anytime
Achievements	As many as the management chooses	Two or three per year	Many
Supporting system	Line and staff project team	Small group activities QC circles Suggestion system	Suggestion system
Implementation cost	Sometimes requires small investment to implement the decision	Mostly inexpensive	Inexpensive
Result	New system and facility improvement	Improved work procedure Revision of standard	On-the-spot improvement
Booster	Improvement in managerial performance	Moral improvement Participation Learning experience	Morale improvement Kaizen awareness Self-development
Direction	Gradual visible improvement Marked upgrading of current status	Gradual and visible improvement	Gradual and visible improvement

causes, analyse them, implement and test new countermeasures and establish new standards and/or procedures.

Small group activities may be defined as informal voluntary small groups organized within the company to carry out specific tasks in the workshop. These small group activities take many forms, depending on their aims—big brother groups, big sister groups, QC circles, ZD movements, no-error movements, level-up movements, mini think tanks, suggestion groups, safety groups, workshop involvement movements, productivity committees, management-by-objectives groups and workshop talk groups. These small groups were often initially formed for the purpose of stimulating cross-development among its members. The advantages of small group activities are given below:

1. Setting group objectives and working for their attainment strengthens the sense of teamwork.
2. Group members share and coordinate their respective roles better.
3. Communication between labour and management, as well as between workers of different ages, is improved.

4. Morale is greatly improved.
5. Workers acquire new skills and knowledge and develop more cooperative attitudes.
6. The group is self-sustaining and solves problems that would otherwise be left to the management.
7. Labour-management relations are greatly improved.

Although small group activities begin as informal and voluntary for the most part, today they have come to occupy a respected and legitimate position in the eyes of management.

■ Individual-oriented Kaizen

The suggestion system is a vehicle for carrying out individual-oriented Kaizen. Individual-oriented improvement is often regarded as a morale booster. The management does not always ask for immediate economic payback on each suggestion. Management attention and responsiveness are essential if workers are to become “thinking workers,” always looking for better ways to do their work. The suggestion system is an integral part of individual-oriented Kaizen. Top management must implement a well designed plan to assure that the suggestion system is dynamic. The following are some examples for suggestions in most of the companies:

- Improvements in one’s own work
- Savings in energy, material and other resources
- Improvements in the working environment
- Improvements in machines and processes
- Improvements in jigs and tools
- Improvements in office work
- Improvements in product quality
- Ideas for new products
- Customer services and customer relations

DISCUSSION FORUM

1. Distinguish between Kaizen and innovation.
2. Differentiate between process-oriented management and result-oriented management.
3. Discuss company-wide quality control (CWQC).

■ QUALITY FUNCTION DEPLOYMENT (QFD)

Dr Mizuno, Professor Emeritus of the Tokyo Institute of Technology, is credited with initiating the quality function deployment (QFD) system. QFD can be applied practically to all industries in the manufacturing and service sector. QFD is a planning tool used to fulfill customer expectations.⁵ It focuses on customer requirements, often referred to as the voice of the customer and is a disciplined approach to product design, engineering and production and provides in-depth evaluation of a product. An organization that correctly implements QFD can improve engineering knowledge, productivity, quality and reduce costs, product

 **Bird's-eye view:**
Quality Function Deployment (QFD) is a structured approach to defining customer needs or requirements and translating them into specific plans to produce products to meet those needs.

development time and engineering changes. It is employed to translate customer expectations, in terms of specific requirements, into directions and actions and in terms of engineering characteristics that can be deployed through product planning, part development, process planning, production planning and service planning.

QFD is a team-based management tool in which customer expectations are used to drive the product development process. The QFD technique consists of a series of interlocking matrices that translate customer needs into product and process characteristics. QFD yields the following benefits:

- It facilitates identification of the causes of customer complaints and makes it easier to take prompt remedial action.
- It is a useful tool for improving product quality.
- It is a useful tool for competitive analysis of product quality.
- It stabilizes quality.
- It cuts down on rejects and rework at the production site.
- It decreases claims substantially.

Bird's-eye view:

The “**house of quality**,” the basic design tool of the management approach known as quality function deployment (QFD), originated in 1972 at Mitsubishi’s Kobe shipyard site. Toyota and its suppliers then developed it in numerous ways.

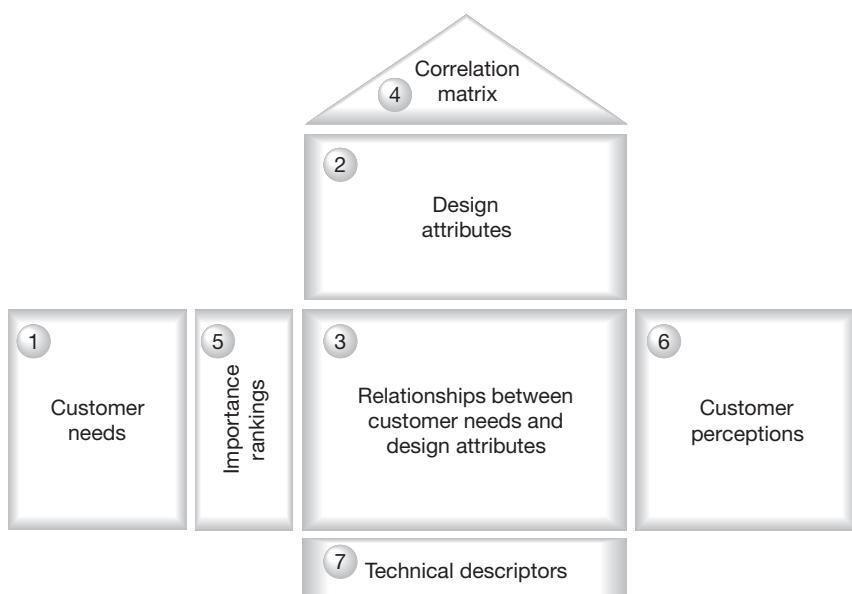
■ House of Quality

The house of quality is the primary planning tool used in QFD. The house of quality translates the voice of the customer into design requirements that meet specific values and matches those against the way in which an organization meets those requirements. Many managers and engineers consider the house of quality to be the primary chart in quality planning. The structure of QFD can be thought of as a framework of a house as shown in Figure 9.2. This is the basic structure for the house of quality.

Fig. 9.2 Quality Function Deployment’s House of Quality

Bird's-eye view:

The house of quality has been used successfully by Japanese manufacturers of consumer electronics, home appliances, clothing, integrated circuits, synthetic rubber, construction equipment, and agricultural engines. Japanese designers use it for services like swimming schools and retail outlets and even for planning apartment layouts.



■ Building the House of Quality

The following steps can be used to build the house of quality:

Step 1 List customer requirements: The left exterior wall of the house represents the customer requirements. It deals with the “Whats” that a customer needs or expects in a particular product. The list of customer requirements is divided into a hierarchy of primary, secondary and tertiary customer requirements.

Step 2 List technical descriptors: The ceiling or second floor of the house contains the technical descriptors. The goal of the house of quality is to design or change the design of a product in such a way that it meets or exceeds the customer expectations. Each engineering characteristic must directly affect a customer’s perception and be expressed in measurable terms. These characteristics are an expression of the voice of the customer in technical language. Brainstorming among the engineering staff is a suggested method for determining the technical descriptors.

Step 3 Compare the relationship between customer requirements and technical descriptors: The next step in building a house of quality is to compare the customer requirements and technical descriptors and determine their respective relationships. The interior walls of the house are the relationships between customer requirements and technical descriptors. Customer expectations (customer requirements) are translated into engineering characteristics (technical descriptors).

Step 4 Develop an interrelationship between each of the technical descriptors: The roof of the house is the interrelationship between technical descriptors. Trade-offs between similar and/or conflicting technical descriptors is identified.

Step 5 Implement competitive assessments: The competitive assessments are separated into two categories, customer competitive assessment and technical competitive assessment as shown in Figure 9.3. The customer competitive assessment is a good way to determine if the customer requirements have been met and to identify areas to concentrate on in the next design. The customer competitive assessment also contains an appraisal of where an organization stands relative to its major competitors in terms of customer requirements.

The technical competitive assessment is often useful in covering gaps in engineering judgement. When a technical descriptor directly relates to a customer requirement, a comparison is made between the customer’s competitive evaluation and the objective measure ranking. Customer requirements and technical descriptors that are strongly related should also exhibit a strong relationship in their competitive assessment. Both assessments are important, because they give the organization an understanding on where its product stands in relationship to the market.

Step 6 Develop prioritized customer requirements: The right side exterior wall of the house of quality represents the prioritized customer requirements corresponding to each customer’s competitive assessment in the house of quality.

Step 7 Develop prioritized technical descriptors: The foundation of the house represents the prioritized technical descriptors. The QFD team identifies technical descriptors that are most needed to fulfill customer requirements and needs improvement. These measures provide specific objectives that guide the subsequent design and provide a means of objectively assessing progress and minimizing subjective opinion.

Bird's-eye view:

The house of quality is a kind of conceptual map that provides the means for inter functional planning and communications. People with different problems and responsibilities can thrash out design priorities while referring to patterns of evidence on the house’s grid.

DISCUSSION FORUM

1. Describe QFD.
2. Explain the concept of the house of quality.
3. Discuss the seven steps used in building the house of quality.

Bird's-eye view:

A **quality circle** or **quality control circle** is a group of workers who do the same or similar work, whom meet regularly to identify, analyze and solve work-related problems.

Bird's-eye view:

Normally when quality circle small in size, the group is usually led by a supervisor or manager and presents its solutions to management; where possible, workers implement the solutions themselves in order to improve the performance of the organization and motivate employees.

Bird's-eye view:

Quality circles were at their most popular during the 1980s, but continue to exist in the form of Kaizen groups and similar worker participation schemes.

■ QUALITY CONTROL CIRCLES (QCC)

The concept of quality circles or quality control circles originated in Japan. In April 1962, Dr K. Ishikawa presented this idea in the inaugural issue of JUSE's journal *Gemba to QC*. In the last 36 years, this concept has been introduced in as many as 130 countries. However, the quality circle concept is well established only in ASEAN countries such as Japan, South Korea, the Peoples Republic of China, Taiwan, etc.

Quality control circle (QCC) or quality circle (QC) is a small team of people usually from the same work area who voluntarily meet on a regular basis to identify, investigate, analyse and solve their work-related problems. QCCs adopt a democratic process and introduce a participative management culture in the organization. In the QCC philosophy, the circle members share their ideas and expertise with the management. All people in the circle put their minds together to solve work-related problems. The circle presents the solutions to management and implements them after approval. Review and follow up after implementation are also responsibilities of the circle.

■ Concept of Quality Circle

The quality circle concept has three major attributes—(1) QC is a form of participative management, (2) QC is a human resource development technique and (3) QC is a problem-solving technique.

It is based on the concept that suggestions affecting the workplace should come from those who perform the work and who have the greatest knowledge about the job. The concept assumes that people closest to the problem better understand the nature of the problem and what is or is not a feasible solution. It assumes that a group of individuals working together will invariably come up with better solutions than one individual working alone. Quality circles are a specifically structured form and mode of participative management.

■ Philosophical Foundation of Quality Circles

- The belief that people will take pride and interest in their work if they have autonomy and control over the decisions that affect them.
- It helps to develop a sense of belonging in employees towards the organization. The concept of quality circles relies entirely upon intrinsic motivation, i.e. from increased satisfaction, involvement in decision making and the opportunity to satisfy higher order needs (such as high achievement orientation, individual dignity, etc.)
- A belief that each employee desires to participate in making the organization a better place to work.
- The recognition of the importance of the development of human resources. It implies the development of their skills, capabilities, confidence and creativity through the process of education, training, work experience and participation.

- A willingness to allow people to volunteer their time and effort for any improvement in the performance of the organization.
- The importance of each member's role in meeting organizational goals. Quality circles were thought of and created as an effective means of enabling every one involved in the organization to share responsibility, knowledge, experience a team effort for quality, productivity and perfection.
- An involved and respected employee is a productive employee whose work is of the highest quality.⁶ Table 9.5 indicates how a healthy group such as a quality circle is an important vehicle through which individual needs can be satisfied.

■ Characteristics of Quality Circles

The characteristics of quality circles as a management tool for improving quality are listed below:

1. Quality circles are small primary groups of employees/workers with a group size ranging between 2 and 3.
2. The membership in a quality circle is voluntary.
3. The area supervisor leads each circle. They are normally coordinated centrally in an organization by a person who has been trained as a facilitator.
4. The members meet regularly according to an agreed schedule.
5. The circle members are specially trained in the techniques of problem solving and analysis in order to play their roles effectively.
6. The basic role of quality circles is to identify and solve work-related problems for improving quality and productivity.
7. QC members enable their members to exercise their hidden talents, creative skills and competence for tackling challenging tasks and thus contribute to their self-development.
8. It also promotes the mutual development of members through cooperative participation.

Bird's-eye view:

Quality circles are typically more formal groups. They meet regularly on company time and are trained by competent persons (usually designated as facilitators) who may be personnel and industrial relations specialists.

Bird's-eye view:

Quality circles are generally free to select any topic they wish (other than those related to salary and terms and conditions of work, as there are other channels through which these issues are usually considered).

Table 9.5 The Role of Quality Circles in Meeting Individual Needs

Sl No.	Type of Need	Ways in which the Need can be Met through QC Activity
1.	Stimulation	QCs provide important ways to stimulate thought and reduce boredom at the workplace
2.	Security	Through QCs, employees can demonstrate their value to the organization and improve productivity by making important and necessary contributions to their jobs
3.	Social belonging	QCs provide an accepted social structure. Team building and acceptance are part of QC training
4.	Esteem	Successful QC projects receive recognition and generate respect for the talent and expertise of the individual members as well as the team
5.	Self-actualization	QCs combine opportunities to use knowledge, judgement and creativity with the freedom to decide how to contribute

9. The circle work is characterized by attributes such as high skill variety, task identity, task significance, autonomy, goal setting and feedback. These attributes contribute to job enrichment of the members.
10. It also contributes to job satisfaction of members by creating feelings of accomplishment from identifying and solving challenging problems.
11. It provides members with opportunities for receiving public recognition from the company's management in the form of company-wide presentation of their work.
12. The members also receive recognition in the form of mementos, certificates and privileges. In some cases they also share in productivity gains that might be the result of their work.
13. It also contributes to their self-esteem and self-confidence through the acceptance of their recommendations by the management.
14. The circle members participate in the organization's decision and policies by way of identification and solution of work-related problems and the acceptance and implementation of their recommendations by the management.

Bird's-eye view:

Quality circles were originally described by W. Edwards Deming in the 1950s, Deming praised Toyota as an example of the practice. The idea was later formalized across Japan in 1962 and expanded by others such as Kaoru Ishikawa.

Bird's-eye view:

The Japanese Union of Scientists and Engineers (JUSE) coordinated the quality circle movement in Japan. The first circles started at the Nippon Wireless and Telegraph Company; the idea then spread to more than 35 other companies in the first year. By 1978 it was claimed that there were more than one million quality circles involving some 10 million Japanese workers.

Bird's-eye view:

As of 2015 quality circles operate in most East Asian countries; it was recently claimed that there were more than 20 million quality circles in China.

■ Objectives of Quality Circles

The main objectives of quality circles are:

- To improve the quality and productivity and thus contribute to the improvements and development of the enterprise.
- To reduce the cost of products or services by waste reduction, safety, effective utilization of resources, avoiding unnecessary errors and defects.
- To identify and solve work-related problems that interfere with production.
- To tap the creative intelligence of the persons working in the organization and to make full use of its human resources.
- To motivate employees to apply their knowledge and skill to complete a range of challenging tasks.
- To improve communication within the organization.
- To increase employees' loyalty and commitment to the organization and its goals.
- To respect humanity and build a happy bright workplace environment.
- To enrich human capability, confidence, moral, attitude and relationship.
- To satisfy the human needs of recognition, achievement and self-development.

■ Basic Organizational Structure of Quality Circles

A quality circle should have an appropriate organizational structure for its effective and efficient performance. The organizational structure of quality circle may vary from industry to industry, but it is useful to have basic framework as a model. In a typical organization, the structure of a quality circle may consist of the following elements:

A steering committee: The steering committee is at the top of the structure of the quality circle. The General Manager or Works Manager or Senior Executive heads it. Its membership includes representatives from the top management personnel and human resource

development executives. It may also include the union representative. It establishes policy, plans and directs the programme as a whole including organizing training for the personnel. The steering committee meets usually once in a month.

Coordinators: The coordinators may be personnel or administrative officers. They coordinate and supervise the work of the facilitators and administer the programme. In small organizations (with less than 500 employees), one person acts as both the administrator and facilitator. Large organizations (usually with more than 5,000 employees) generally need corporate and unit level coordination and several facilitators. The coordinators help in case of difficulties and facilitate arrangements and interdepartmental communication. The administrator is a person from the middle management level.

Facilitator: A facilitator may be a senior supervisory officer or a foreman. He coordinates the work of several quality circles through the circles leaders. His role is to keep the circles on track and enthusiastic. A facilitator may manage up to ten circles. A facilitator is usually from one of the three departments—quality control, production or training.

Circle leader/deputy leader: Circle leaders may be from among the lowest level of supervisors. A circle leader organizes and conducts circle activities. Circle leaders interact among themselves, and with the facilitator besides their own group members. Initially, many organizations train supervisors to become circle leaders. However, when the organization develops a quality circle culture, even non-supervisory personnel can become effective circle leaders.

Circle members: Circle members may be line and/or staff workers. The programme cannot exist without circle members. They are the largest part of the quality circle structure. They are the lifeblood of quality circles. The circle members should attend all meetings as far as possible, offer suggestions and ideas, participate actively in group process and attend training programmes seriously with a receptive attitude.

■ Role of the Quality Circle Member

- Be focused on organizational problems/objectives related to the work at hand at all times.
- Not press for inclusion of personal problems.
- Demonstrate mutual respect.
- Offer views, opinions and ideas freely and voluntarily during the problem-solving process.
- Attend all meetings except when unavoidable.
- Contribute to finding solutions to problems.
- Contribute to implementing solutions.
- Attend training seriously with a receptive attitude.
- Acquire skills to contribute to the problem-solving activities of the circle.

■ Role of the Quality Circle Leader

- Conduct meetings and ensure participation by all members.
- Help in collecting data related to problems.
- Transmit QC suggestions to facilitator.
- Interact among themselves and facilitator beside their own group members.
- Present solutions/suggestions to management.

Bird's-eye view:

Quality circles have been implemented even in educational sectors in India, and QCFI (Quality Circle Forum of India) is promoting such activities. However this was not successful in the United States, as the idea was not properly understood and implementation turned into a fault-finding exercise although some circles do still exist.

- Maintain relevant records of meetings.
- Ensure implementation of solutions by the group.
- Keeping the circles informed about the status of previously submitted suggestions.
- Keeping meetings positive and on track.
- Train circle members in group processes and in the use of tools and techniques for generating ideas and problem solutions.

■ Role of the Facilitator

 **Bird's-eye view:**

Dr Ishikawa, the father of Quality Circle(QC), started the first Quality Control Circle in Japan in 1962. At Toyota QC started in 1969 and had 760 circles by 1976 involving 4000 employees. Almost all of them were blue collar. The company won **Deming** Prize in 1970.

- Coordinate the work of several QCs through leaders.
- Serve as a resource to the group/circle.
- Arrange for expertise from other groups/agencies.
- Keep the circles on track and enthusiastic.
- Acquire skills through training programmes.
- Transfer skills to members of QCs.
- Transmit proposals/solutions to management.
- Arrange for training of QC members.
- Provide feedback to members.
- Provide feedback to the management.
- Maintain budgets and keep cost records.
- Help circles to provide presentations to the management.

 **Bird's-eye view:**

Quality circles were originally associated with Japanese management and manufacturing techniques. The introduction of quality circles in Japan in the post-war years was inspired by the lectures of W. Edwards Deming (1900—1993), a statistician for the U.S. government.

The success of QCs depend mainly upon the proper selection of suitable personnel as facilitators. A facilitator has to serve as a coach for the circle leaders, a process consultant to the circles and a liaison man to the management.

■ Qualities Required for a Facilitator

- He should be able to train QC leaders and members in QC techniques.
- He should have leadership qualities and organizational abilities in participative management.
- He must have skills to motivate people and keep QCs on track.
- He must be able to express his ideas and the QC philosophy.
- He must be able to plan, organize and conduct meetings and make presentations to management.
- He must have the ability to contact and gain support from all levels of management.

■ Role of the Management (Steering Committee)

- Officially announce the initiation of the QC movement and stress the necessity to establish QCs and highlight its features and utility.
- Assist/contribute to the development of the QC models and structure.
- Provide opportunities to QCs to present their solutions and to implement accepted solutions after evaluation.
- Provide resources—space, time, training facilities and finance (if needed).

- Ensure adequate training opportunities to facilitators, QC leaders and members.
- Consider suggestions of QCs fairly and justly.
- Recognize the contributions of the facilitator and the quality circle members.
- Encourage the movement in general.
- Communicate the decisions to QCs generally in two weeks.
- Arrange for external specialist help when requested by circles.
- Develop guidelines for measurement of circle activities so that cost effectiveness can be monitored.
- Periodically review the progress.

■ Steps for Establishing QCCs

The following steps can be used to establish QCCs:

1. The management is made aware of the QCC process through management briefing.
2. The feasibility of the QCCs is analysed.
3. A steering committee is formed.
4. A coordinator and an in-house instructor are selected.
5. Potential areas for initial circles are selected.
6. QCC presentations are made first to line supervisors in identified areas, divisions or departments.
7. Coordinators and middle management receive extensive training on the process and their roles.
8. Supervisors who are interested volunteer and receive training.
9. Following training, QCC presentations are made to the employees who report to the newly trained supervisors.
10. Employees volunteer to be members of a circle and receive training.
11. A circle is formed and begins work.
12. A circle usually consisting of 6–8 members is formed.
13. Circle members should meet, ideally, once a week on a regular basis.
14. In the first meeting, the circle members select a name for their circle and elect a leader to conduct deliberations of their meetings.
15. The members of the circle fix a day, time and venue for their weekly meeting.
16. Circles work on a systematic basis in solving problems and not just discussing them.
17. Management must ensure that solutions are implemented quickly once they have been accepted.
18. Management recognizes appropriate and proper recognition for the solutions.

Box 9.3 discusses how Solar Semiconductor received a prestigious award for its quality circle activities.

■ QCC Operation Cycle

The basic purpose of quality circles is to identify and solve work-related problems. The circle members normally meet once a week for one hour. In the early meetings, time is devoted mainly to train the circle members. Once they have acquired the fundamental skills for



Bird's-eye view:

In India, by now several companies have implemented QC programmes. Companies where the QC programmes have been working successfully include BHEL, Kirloskar Oil Engines, Mahindra & Mahindra, Bajaj Auto, HMT, Maruti, Modi Xerox, SBI, Hindustan Aluminum, Modi Rubber, TELCO, LUCAS-TVS, etc.

Box 9.3 Solar Semiconductor Quality Circle Bags Quality Award

Solar Semiconductor produces innovative, high quality PV modules using mono- and multi-crystalline cells and offers its products and services to the worldwide solar PV module market. As a socially responsible, global energy producer, Solar Semiconductor offers an unwavering commitment to its customers. Solar Semiconductor bagged the Par Excellence Award at the 22nd National Convention of Quality Circles, organized by Quality Circles Forum of India (QCFI), at Vadodara, Gujarat in November 2008.

The three-day meet attracted 664 quality circles and 6000 delegates, from top notch companies which included the Tata Group, the Birla Group, the Reliance Group, the TVS Group, MNCs like Fag Bearings, Saint Gobain, giant public-sector undertakings such as BHEL, BEL, NMDC, Nalco, Balco, SAIL, Vizag Steel Plant, HAL, Mahindra & Mahindra, etc. All the 664 quality circles presented their case studies which were evaluated and awards were announced in the categories of "Par Excellence," "Excellence," "Distinguished" and "Meritorious."

Solar Semiconductor, a young company compared to all major competitors and the only one in the domain of manufacturing Solar Photovoltaics, participated for the first time in the National Convention and was awarded the "Par Excellence Award." Another Quality Circle team from Solar Semiconductor also bagged the "Excellence Award."

Vishnu Reddy, Vice President of the company said, "Even though we are a young company, we have formed as many as 21 quality circles in a very short time. Our quality circle teams have been working with the right attitude and enthusiasm to make Solar Semiconductor a world class organization in the field of Solar Photovoltaics."

Source: Adapted from www.solars semiconductor.com, accessed March 2010.

👁 Bird's-eye view:

A quality circle is a participatory management technique that enlists the help of employees in solving problems related to their own jobs.

👁 Bird's-eye view:

Circles are formed of employees working together in an operation who meet at intervals to discuss problems of quality and to devise solutions for improvements.

👁 Bird's-eye view:

Quality circles have an autonomous character, are usually small, and are led by a supervisor or a senior worker. Employees who participate in quality circles usually receive training in formal problem-solving methods.

problem solving and mastered the quality analysis techniques they start working on problems. During the quality control circle process, each problem passes through various stages of the operational cycle (shown in Figure 9.3).

■ QCC and Employee Empowerment

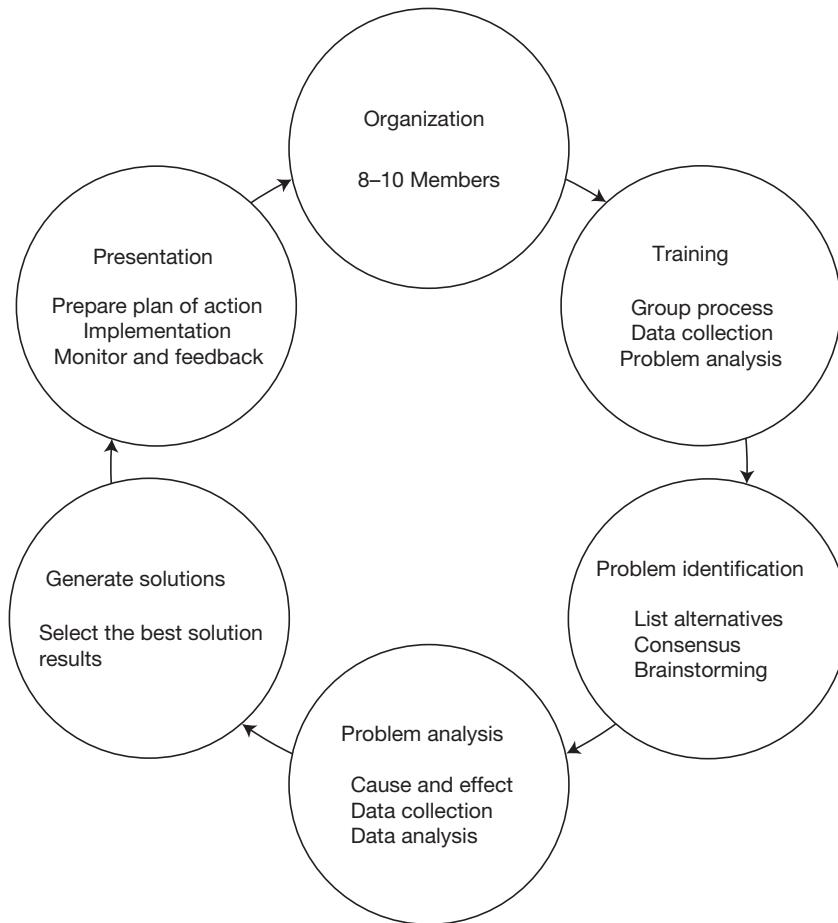
The management needs to address issues concerning the empowerment of its people. The fundamental philosophy of QCC is human resource-oriented. Therefore, QCC activities should reflect the following:

- Employees should clearly understand what is required of them.
- All the tools needed for the successful performance of the particular work should be available and accessible to the employee.
- People should know how the company defines success.
- Rewards must be based on clearly defined performance standards.
- People should have knowledge and skills to do the job.
- People should take part in problem solving at their workplace.

■ How to Empower Employees?

The ten tasks that management must identify and do in order for individual employees to be empowered are:

1. Understand that there is a need for change. Change is a process with a beginning and without an end. As a consequence, the organization must effectively communicate why it needs to change for continual growth.

Fig. 9.3 QCC Operational Cycle **Bird's-eye view:**

QC Circles are a basic method in Toyota used for developing employees in the basics of problem solving and eliminating some problems in the employee's realm of control.

2. Provide a clear role to play. The individual will lose interest unless specific roles of authority and responsibility are defined. The participant must know where he or she is going before the plan is made.
3. Provide for appropriate education and training. Education provides the whys, whereas training provides the hows. Both are important. However, make sure that the combination is not at the expense of one or the other.
4. Provide the resources to get the job done. No amount of delegated authority or responsibility can guarantee success, unless applicable resources are within the jurisdiction of the empowered team.
5. Allow the participants the freedom to be creative and innovative. In the process of exercising this freedom, mistakes may happen. Do not hold it against the team's career path or retaliate with a demotion or withholding a merit increase. Instead, look at the failures and mistakes as learning experiences and incorporate them in your experiences.
6. Allow and encourage the freedom to "rock the boat" without fear. The days of labeling someone as a troublemaker or a person with an attitude problem must be done away with. The person who challenges status quo fears of any kind is truly practising empowerment. It is through this challenge that different and/or improvement events

 Bird's-eye view:

The steps for QC Circles follow the logic of Plan-Do-Check-Act. QC Circle reports however are usually not summarized onto a single page in order to allow the members to present more detail.

will happen. Unless something changes, you will never change. Rocking the boat is one way to bring about change.

7. Give people the authority to exercise their best judgement. Again, members must be allowed to exercise their judgement without the fear of retaliation of any kind. To be sure, this judgement may not meet the organization expectations; however, always make it part of the learning process.
8. Give people the responsibility to improve continuously. If the delegated authority does not include the responsibility, nothing will happen. In order for the process to improve continuously, team members must be allowed to experiment and must be given the responsibility of owing that process.
9. Give people the recognition they deserve. As long as the task is completed, regardless of the level of success, recognition should be part of the closure. Recognition does not have to be monetary; rather, it can be the acknowledgment of a job well done, a token of appreciation, a thank-you note, a letter in the personnel file, etc.
10. Give people a sense of ownership. Be prepared to answer the question: What's in it for me? Once employees recognize that the process is their own, and there is a personal interest in the improvement, then they will be able to take reasonable risks for improvement. To give a sense of ownership, you must be willing to let go.

Bird's-eye view:

Suggestion systems are a form of employee-to-management communication that benefit employees as well as employers.

Bird's-eye view:

Suggestion system provide a two-way channel of communication between employees and management, with **management** accepting or rejecting employee suggestions and in some cases commenting on them.

Bird's-eye view:

Suggestion systems give employees a voice and a role in determining company policies and operating procedures.

Bird's-eye view:

Employee suggestions can help increase efficiency, eliminate waste, improve safety, and improve the quality of a company's products and services.

■ THE SUGGESTION SYSTEM

Employee suggestion systems are designed to encourage active cooperation of employees in the activities of business and industry through seeking ideas for cost reduction or cost prevention or increasing productivity or efficiency from the rank and file. The suggestion systems facilitate upward flow of communication—a type of communication that is very much needed in industry.

Suggestion systems are important features of quality control circles. QCCs that have completed their projects submit their suggestions to a committee, which reviews and grades them. Often, suggestions are posted individually on the notice boards at the workplace in order to encourage competition among workers and groups. Suggestions are usually rewarded with cash payments.

Another important aspect of the suggestion system is that each suggestion, once implemented, leads to revised standards. For instance, a special foolproof device that has been installed on a machine at a worker's suggestion may warrant the worker to work differently and, at times, more attentively.

Managers must listen to the voice of the employees in order to implement the suggestion system in the organization. By listening to this, the organization can receive feedback and help ensure a thriving TQM effort.

Before starting any suggestion system, the managers must assess the current state of employee relations, identify trends, measure the effectiveness of programme implementation, identify needs, improvements, and increase communication effectiveness. The best way to accomplish this activity is to conduct employee surveys.

■ Benefits of the Suggestion System

Some important benefits of using a suggestion system are:

- Improves employer–employee relationships
- Is an employee benefit scheme

- Tends to increase the morale of the workforce
- Acts as a good means of communication
- Commits the workforce to take active interest in their work and the company
- Provides management with an organized way of handling their ideas
- Constitutes an important tool of management “to feel the pulse” of the rank file

■ Standards for the Suggestion Scheme

1. The suggestion scheme should have the wholehearted support of the top management. The responsibility for the operation of the suggestion system must be assigned to a management official, usually in the personnel department, who has to find ways and means to stimulate employee ideas.
2. The rules and the processing operation of suggestions must be clearly explained to the employees. Sometimes the employees are informed about the kinds of problems faced by the company so that suggestions are given keeping these issues in mind.
3. All suggestions should be promptly acknowledged and evaluated. If a particular suggestion is rejected, an explanation must be given for the rejection.
4. Awards for acceptable suggestions should be monetary and on the liberal side, usually 15–30 per cent of the first year’s net savings.
5. The award winners must be given widespread publicity through in-house journals, newspapers, company reports, meetings, etc.



Bird's-eye view:

One of the first suggestion systems was started at General Electric in 1906. It consisted of a suggestion box in each department with a pad of blank paper on which employees were instructed to write practical suggestions for improving the company’s manufacturing and other operations.

■ Procedure for Introducing Suggestion Systems

1. **Introduction:** In introducing and operating an employee suggestion scheme, it is necessary for management to formulate the following principles:
 - The employees are intelligent enough to think constructively about their jobs.
 - There is always room for improvement in the company operations.
 - The management can gain from the ideas of employees.
 - The employees can contribute more than just a day’s work.
2. **Receiving suggestions:** The suggestions are received through:
 - **Suggestion box:** It is an invitation to employees to share their ideas to improve the functioning of the organization. Here, employees put forth their views and suggestions in a box. Once in a week or as per the company’s policies, suggestions are reviewed. If suggestions are rejected, it should be communicated with proper explanation.
 - **Attitude survey:** These surveys are extremely useful to understand the state-of-art and appreciation of the future direction of the organization. Since the participants do not have to reveal their identity, this is seen as a good opportunity to share views, feelings, likes, dislikes and opinions freely. These surveys are efficient as sufficient data can be generated at low cost and within a short duration. They can also be useful for establishing trends if they are done at frequent intervals.
 - **Exit interview:** Some organizations have a policy of having a discussion with employees who have left or are on the verge of leaving the organization since such



Bird's-eye view:

A successful suggestion system must be promoted to the company’s employees. Employees are typically given a handbook that explains the company’s suggestion system. Such handbooks usually contain a statement of management support that encourages workers to “speak up” and make practical suggestions for improving operations.

Bird's-eye view:

Suggestion systems typically provide some kind of reward to employees who have made suggestions that are adopted by the company. The rewards may be based on a percentage of cost savings realized as a result of the suggestion, or they may be a fixed amount with no relation to the savings involved.

Bird's-eye view:

Suggestion systems may be continuous or conducted for a limited period. Some companies conduct annual suggestion contests that may last for a month. During that time, employees are encouraged to come up with as many suggestions as possible.

Bird's-eye view:

In some cases employees may be divided into **teams** representing individual departments. Such teams compete against each other and try to produce the most suggestions.

employees can freely discuss impressions and opinions on a variety of organizational aspects. If conducted well, it can generate some very useful information that can be used to improve the functioning of the organization.

- **Quality circles:** Quality circles promotes team work and provide scope of interaction among employees for sharing their ideas, joint decision making, logical and systematic thinking and give them responsibility of implementation.
 - **Others:** Open-door policy, meetings, seminars, workshops, conferences and social get togethers.
3. **Processing suggestions:** The suggestions are processed either by the management alone or by a suggestion committee comprising representatives of both the management and employees. The relevant suggestions are selected for testing and then implementation.
 4. **Implementing suggestions:** The most important thing that the management looks for in a suggestion is whether it will improve the operations of the firm in any sphere. If the employee's suggestion is tested and found to have direct value for the firm, this value is the pay-off to the industry for operating the suggestion system. The suggestion award is the pay-off to the employee for his contribution. Through the scheme, the management comes to know about the fairly bright, intelligent and alert employees and the departments for which they are working.

DISCUSSION FORUM

1. Define quality circle.
2. Describe the characteristics of quality circles.
3. Discuss the steps for establishing the quality circle.
4. Explain QCC operation cycle.
5. Give tips for a successful suggestion system.
6. What is the procedure for introducing the suggestion system and what are the benefits?

■ POKA-YOKE

Bird's-eye view:

Prizes are then awarded to the teams making the most suggestions that can be used by the company. In the case of continuous suggestion systems, periodic contests can be used to stimulate employee interest in the existing program.

In the early 1960s, quality guru Shigeo Shingo combined the concepts of "successive," "independent" and "source" inspections with Toyota's in-house "fool proofing" techniques and devised the famous production philosophy "poka-yoke" (poka means mistake or inadvertent errors, while yoke means proofing. It is derived from the word "yokeru" meaning, to avoid).

The initial term was "baka-yoke," which means "fool-proofing." In 1963, a worker at Arakawa Body Company refused to use the "baka-yoke" mechanisms in her work area because of the term's dishonourable and offensive connotation. Hence, the term was changed to "poka-yoke", which means "mistake-proofing."

It was designed as a tool to achieve and sustain "zero defects." Poka-yoke refers to the absolute elimination of defects in the production process. Defect free supplies are not just a

desired goal, but in many instances essential for suppliers. In many cases, a single defect has been found to be the cause of outright rejection of the entire batch or 100 per cent manual reinspection of every component in the batch at the expense of the supplier.

It is simply a way to prevent the occurrence of defects, injuries or losses of any kind at the workplace. It makes use of sensors and instruments and devices that can identify disorders, abnormalities or mis-steps, without the workers having to be extra sensitive to the smallest details.

Poka-yoke helps people and processes work right the first time. It can be thought of as an extension of Failure Mode Effect Analysis. It can also be used to fine tune improvements and process designs from Six Sigma Define-Measure-Analyse-Improve-Control (DMAIC) projects. The use of simple poka-yoke ideas and methods in product and process design can eliminate both human and mechanical errors. Poka-yoke does not need to be costly. For instance, Toyota has an average of 12 mistake-proofing devices at each workstation and a goal of implementing each mistake-proofing device for under USD 150.

Poka-yoke works on five pillars as suggested by Shingo:

1. Use source inspection. The application of control functions at the stages where errors, mistakes may get converted into defects or accidents. That is, use control/warning function at the origin of the defect.
2. Always use 100 per cent source inspection at least for attributes. It is better than sampling inspection.
3. Minimize the time to carry out corrective actions when abnormalities appear or try to speed up the feedback corrective actions.
4. Set up mistake proofing devices (called poka-yokes), i.e. sensors, and transducers; limit switches, metal detectors according to products and process requirements.
5. Respect workers and operators. They are human beings and not robots or programmable machines.

■ Step-by-step Process in Applying Poka-yoke

1. Identify the operation or process based on a Pareto analysis.
2. Analyse the five whys and understand the ways a process can fail.
3. Decide on the right poka-yoke approach such as using a shut out type (preventing an error from being made) or an attention type (highlighting that an error has been made). Poka-yoke takes a more comprehensive approach and should not be deemed limit switches or automatic shutoffs. A poka-yoke can be electrical, mechanical, procedural, visual, human or any other form that prevents incorrect execution of a process step.
4. Use the method of creating a checklist to ensure that all process steps have been completed appropriately.
5. Try the method and see if it works.
6. Train the operator, review performance and measure success.

Bird's-eye view:

A **poka-yoke** is any mechanism in a lean manufacturing process that helps an equipment operator avoid (yokeru) mistakes (**poka**). Its purpose is to eliminate product defects by preventing, correcting, or drawing attention to human errors as they occur.

■ Poka-yoke Devices

Poka-yoke is a simple device or method to prevent mistakes at their source. These devices are used either to prevent the special causes that result in defects or to inexpensively inspect

each item that is produced to determine whether it is acceptable or defective. Some of the examples of poka-yoke devices⁸ are given below:

1. A large steel press is automatically monitored for wear. If the thickness becomes less than a specified amount, an alarm sounds and action has to be taken to rectify the error.
2. Packaging screws in groups of three to ensure that the assembler uses three screws. The package is a poka-yoke device.
3. A simple electrical check is made to verify that nuts are properly welded to a sheet metal panel at General Motors.
4. An airplane pilot may use a simple checklist to make sure everything is ready before flying his airplane.

■ **QUALITY OF WORK LIFE**

Bird's-eye view:

Quality of work life (QWL) refers to the favourableness or unfavourableness of a job environment for the people working in an organisation. The period of scientific management which focused solely on specialisation and efficiency, has undergone a revolutionary change. Employers are now redesigning jobs for better QWL.

Quality of work life (QWL) can be defined as “The quality of relationship between employees and the total working environment.” QWL is a process by which an organization responds to employee needs by developing mechanisms to allow them to share fully in making the decisions that design their lives at work. The QWL approach considers people as an “asset” to the organization rather than “costs.” It believes that people perform better when they are allowed to participate in managing their work and making decisions.

This approach motivates people by satisfying not only their economic needs but also their social and psychological ones. To satisfy the new generation workforce, organizations need to concentrate on job designs and organization of work. Further, today’s workforce is realising the importance of relationships and is trying to strike a balance between career and personal lives. Various programmes such as flexi time, alternative work schedules, compressed work weeks, telecommuting, etc. are being adopted by these organizations.

Technological advances further help organizations to implement these programmes successfully. Organizations are enjoying the fruits of implementing QWL programmes in the form of increased productivity and an efficient, satisfied and committed workforce that aims to achieve organizational objectives.

■ **Factors Influencing and Deciding the QWL**

The factors that influence and decide the quality of work life are attitude, environment, opportunities, nature of job, people, stress level, career prospects, challenges, growth and development, risk involved and reward.

Attitude: The person who is entrusted with a particular job needs to have sufficient knowledge, required skill and expertise, enough experience, enthusiasm, energy level, willingness to learn new things, dynamism, sense of belongingness in the organization, involvement in the job, inter-personal relations, adaptability to changes in the situation, openness for innovative ideas, competitiveness, zeal, ability to work under pressure, leadership qualities and team spirit.

Environment: The job may involve dealing with customers who have varied tolerance level, preferences, behavioural pattern, level of understanding; or it may involve working with dangerous machines like drilling pipes, cranes, lathe machines, welding and

soldering machines, or even with animals where maximum safety precautions have to be observed which needs lot of concentration, alertness, presence of mind, quick with involuntary actions, synchronization of eyes, hands and body, sometimes high level of patience, tactfulness, empathy and compassion and control over emotions.

Opportunities: Some jobs offer opportunities for learning, research, discovery, self development, enhancement of skills, room for innovation, public recognition, exploration, celebrity status and loads and loads of fame. Others are monotonous, repetitive, dull, routine, no room for improvement and in every sense boring. Naturally, the former is interesting and very much rewarding.

Nature of job: For example, a driller in an oil drilling unit, a driver , a fire fighter, traffic policeman, an engine driver, construction labourers, builders, miners, lathe mechanics have to do dangerous jobs and need to be more alert in order to avoid any loss of limb or loss of life. Whereas a pilot, doctor, judge or even a journalist have to be more prudent and tactful in handling the situation. A CEO, a professor, a teacher have more responsibilities and accountability but a safe working environment. A cashier or a security guard cannot afford to be careless in his job as it involves loss of money, property and wealth. A politician or a public figure cannot afford to be careless for his reputation and goodwill is at stake. Some jobs need soft skills, leadership qualities, intelligence, decision making abilities, abilities to train and extract work from others; other jobs need forethought, vision and yet other jobs require motor skills, perfection and extreme carefulness.

People: Almost everyone has to deal with three sets of people in the workplace. Those are, namely co-workers at the same level and subordinates. Apart from this, some professions need interaction with people like patients, media persons, the public, customers, thieves, robbers, physically disabled people, mentally challenged, children, foreign delegates, gangsters, politicians, public figures and celebrities. These situations demand a high level of prudence, a cool temper, tactfulness, humour, kindness, diplomacy and sensitivity.

Stress level: All these above mentioned factors are interrelated and interdependent. Stress levels need not be directly proportional to the compensation. Stress is of different types—mental stress/physical stress and psychological or emotional stress. A managing director of a company will have a lot of mental stress. A labourer will face physical stress. Psychiatric stress causes more damage than physical stress.

Career prospects: Every job should offer some career development. This is an important factor which decides the quality of work life. An improvement in status and recognition from the management are the motivating factors for anyone to take a keen interest in his job. The work atmosphere should be conducive to achieve organizational goals as well as individual development. It is a win-win situation for both the parties; an employee should be rewarded appropriately for his good work, extra efforts, sincerity. At the same time, a lethargic and careless employee should be penalized suitably. This will motivate the former to work with more zeal and deter the latter from being so and strive for better performance.

Challenges: The job should offer some challenges at least to make it interesting. This enables an employee to upgrade his knowledge, skills and capabilities. A monotonous job makes a person dull, unenthusiastic, dissatisfied, frustrated, complacent and uninteresting. Challenge is the fire that keeps the innovation and thrill alive. A well accomplished challenging job yields greater satisfaction than a monetary perk; it boosts one's self-confidence also.

Bird's-eye view:

QWL is a process of work organisations which enable its members at all levels to actively; participate in shaping the organizations environment, methods and outcomes. This value based process is aimed towards meeting the twin goals of enhanced effectiveness of organisations and improved quality of life at work for employees.

■ Evaluation of QWL Programmes

Bird's-eye view:

QWL is concerned with taking care of the higher-order needs of employees in addition to their basic needs. The overall climate of work place is adjusted in such a way that it produces more humanized jobs.

QWL programmes can be evaluated on the basis of following points:

- a. Fair compensation and job security:** The economic interests of people drive them to work at a job and employee satisfaction depends, at least partially, on the compensation offered. Pay should be fixed on the basis of the work done, responsibilities undertaken, individual skills, performance and accomplishments. Job security is another factor that is of concern to employees. Permanent employment provides security to the employees and improves their QWL.
- b. Health is wealth:** Organizations should realise that their true wealth lies in their employees and so providing a healthy work environment for employees should be their primary objective.
- c. Provide personal and career growth opportunities:** An organization should provide employees with opportunities for personal/professional development and growth and to prepare them to accept responsibilities at higher levels.
- d. Participative management style and recognition:** Flat organizational structures help organizations facilitate employee participation. A participative management style improves the quality of work life. Workers feel that they have control over their work processes and they also offer innovative ideas to improve them. Recognition also helps to motivate employees to perform better. Recognition can be in the form of rewarding employees for jobs done well.
- e. Work-life balance:** Organizations should provide leisure time for the employees and offer tips to balance their personal and professional lives. They should not strain an employee's personal and social life by forcing on them demanding working hours, overtime work, business travel, untimely transfers etc. Box 9.4 discusses an initiative of the NASSCOM Foundation to promote work-life balance among the members of the Indian IT industry.
- f. Fun at the workplace:** This is a growing trend adopted by today's organizations to make their offices a fun place to work.

The aim of QWL is to identify and implement alternative programmes to improve the quality of professional as well as the personal life of employees.

DISCUSSION FORUM

1. What is poka-yoke?
2. Explain the working of poka-yoke as suggested by Dr Shingo.
3. Give examples of five poka-yoke devices.
4. Discuss QWL.
5. What are the factors that influence and decide the quality of work-life balance?
6. Explain the basis for evaluating the QWL programme.

Box 9.4 Work-life Balance at NASSCOM Foundation

The NASSCOM Foundation (NF) and Ashvin Gidwani Productions (AGP) have collaborated to form iTheatre. Together, NF and AGP will initially present this unique opportunity to NASSCOM members only. NASSCOM Foundation's iTheatre was created to promote work-life balance and creative employee engagements among the Indian IT Industry. Through iTheatre, CEOs and HR heads can look forward to a lively, interactive and collaborative ambience that can increase interpersonal relations among management and employees as well as among peers themselves while at the same time having fun in watching the best of class theatre being staged by eminent artists and professionals from the theatre, television and Bollywood. The iTheatre can also be leveraged by members to involve the spouses and families of the employees who could be invited during these shows. The foundation wants to ensure that it creates the feel good factor and an ambience of fun and play where employees can bond, laugh a lot and be left with a 'happy feeling' while ensuring that the shows also have some social messages that employees and the organization can relate to.

iTheatre's plan is to stage shows on the campuses and integrate the objectives of members, NF and the sponsors who would be leveraging iTheatre as a vehicle to reach their target audience.

Source: Adapted from www.nasscomfoundation.org, accessed April 2010.

SUMMARY

- Kaizen is a system of continuous improvement in quality, technology, processes, company culture, productivity, safety and leadership. Kaizen provides immediate results. Instead of focusing on large capital intensive investments, Kaizen focuses on creative investments that continually solve large numbers of small problems.
- Masaaki Imai propounded the concept of gemba Kaizen. Gemba Kaizen is the process of identifying, reducing and eliminating three types of wastes—muda, muri and mura.
- Lean is a business philosophy that was developed by Taiichi Ohno in the 1990s and is a concept applied to remove waste. The building blocks of lean include 5 S, visual controls, streamlined layout, standard work, batch size production, teams, quality at the source, point of use storage, quick changeover, pull/kanban, cellular flow and TPM.
- Seven QC tools are used to measure continuous improvement. The PDCA cycle is an approach particularly focused on continuous improvement of existing processes.
- 5 S is the foundation of Kaizen. A 5-S programme is usually a part of and the key component of establishing a visual workplace and is both a part of Kaizen, a system of continual improvement and lean manufacturing.
- The 5-S movement takes its name from the initial letters of the five Japanese words seiri, seiton, seiso, seiketsu and shitsuke. Conducting the 5-S audit helps in evaluating the performance level of each "S" and identifying the gaps with which further improvements can be done to achieve the desired level of performance.
- The 5-S programme builds a culture for creating a neat, safe, healthy and clean workplace with a conducive environment. It improves work efficiency and is an effective system benefiting both associates as well as the organization.
- Kaizen is often undramatic and subtle. Its results are seldom immediately visible. Kaizen implies continuous improvement involving every employee in every company function at all levels of the organization. Innovation is defined as major changes in the wake of technological breakthrough, or the introduction of the latest management concepts or production techniques.

- One big difference between Kaizen and innovation is that while Kaizen does not necessarily call for a large investment to implement it, it does call for a great deal of continuous effort and commitment. Innovation is a one-shot deal whose effects are gradually eroded by intense competition and deteriorating standards.
- Kaizen is people-oriented and is directed at people's effort. It generates process-oriented thinking. The "high road" to Kaizen has been the practice of company-wide quality control.
- A well planned Kaizen can be broken down into three segments, depending on the complexity and the level of Kaizen. They are management-oriented Kaizen, group-oriented Kaizen and individual-oriented Kaizen.
- QFD is a planning tool often referred to as the voice of the customer and is used to fulfill customer expectations. It is a disciplined approach to product design, engineering and production and provides in-depth evaluation of a product. An organization that correctly implements QFD can improve engineering knowledge, productivity and quality and reduce costs, product development time and engineering changes.
- The primary planning tool used in QFD is the house of quality. The house of quality translates the voice of the customer into design requirements that meet specific values and matches those against how an organization will meet those requirements.
- There are seven steps used in building the house of quality. They are (1) list customer requirements, (2) list technical descriptors, (3) compare relationship between requirements and descriptors, (4) develop an interrelationship between each of the technical descriptors, (5) implement competitive assessment, (6) develop prioritized customer requirements and (7) develop prioritized technical descriptors.
- The quality circle or quality control circle concept originated in Japan. In April 1962, Dr K. Ishikawa presented this idea in the inaugural issue of JUSE's journal *Gembata QC*.
- Quality control circle (QCC) or quality circle (QC) has a formal organizational structure of a small team of people usually from the same work area who voluntarily meet on a regular basis to identify, investigate, analyse and solve their work-related problems. Quality control circles adopt a democratic process and introduce a participative management culture in the organization. In the QCC philosophy, the circle members share their ideas and expertise with the management.
- Suggestion systems are an important feature of a quality circle. Employee suggestion systems are designed to encourage active co-operation of the employee in the activities of business and industry through seeking ideas for cost reduction or cost prevention or increasing productivity or efficiency from the rank and file. Suggestion systems facilitate the upward flow of communication—a type of communication that is very much needed in industry.
- Poka means mistake or inadvertent errors. Yoke means proofing. It is derived from the word "yokeru" meaning, "to avoid." In other words, it means mistake proofing. Poka-yoke a way to prevent the occurrence of defects, injuries or losses of any kind at the work place.
- Poka-yoke works on five pillars as suggested by Dr Shingo. Poka-yoke helps people and processes work right the first time. It makes use of sensors and instruments and devices that can identify disorders, abnormalities or mis-steps, without the workers having to be extra sensitive to the smallest details.
- Quality of work life (QWL) can be defined as "the quality of relationship between employees and the total working environment." QWL is a process by which an organization

responds to employee needs for developing mechanisms to allow them to share fully in making the decisions that design their lives at work. The QWL approach considers people as an “asset” to the organization rather than as “costs.” It believes that people perform better when they are allowed to participate in managing their work and making decisions.

Key Terms

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Case Study

Kaizen Implementation at a National Bank

A major national bank uses a five-day Kaizen approach to attack process speed and efficiency problems. A cross-functional team is selected for the event and participants are pulled off their jobs for several days at a time. The project is well-defined in the beginning because there is no time to redefine the purpose or scope.

A Typical Kaizen Schedule

A sample agenda that the bank uses for the five days of Kaizen implementation is given below:

Day 1 is spent training participants on topics that cover basic concepts related to the goals of the project. This could include teaching relevant lean or Six Sigma concepts and reviewing relevant data.

Day 2 is spent looking at the process with new eyes. Participants do a “unit walk,” a tour of operations affected by the problem or situation being studied where they simulate being a work item flowing through the process. The group visits each portion of the process because there is cross-functional representation, they have the opportunity to hear insights from someone who works in that area. The group creates a value stream map (a picture of the “as-is” situation) that captures the basic process steps such as cycle times, number of steps, rework loops, queuing delays, work in progress (WIP) and transportation time.

Day 3 is designed around clarifying problems and brainstorming solutions. The team reorganizes the value stream. It creates a “should” map that depicts how the process would need to function to solve the identified problems. The outcome includes developing action plans for implementing solutions or trial simulations for the next day.

Day 4 is used to test the solutions. A simulation exercise is carried out if possible. The group quantifies the improvement if the proposed changes are implemented using estimates of reductions in travel time, queuing time, work in process, number of steps, number of forms, etc.

On day 5, the participants prepare and present their findings to the sponsor in a formal report-out session.

Making it Work

The bank makes this model work by having its internal consultants partner with the manager/sponsor to select problems that are extremely high priority, not only for that work area but also for the business as whole. This makes it much easier to justify taking people off their regular jobs. Also, the goal of the event is a little more modest than a traditional Kaizen. The teams are expected only to get through the simulation and piloting of solution ideas. The internal consultant will then assist the team with full-scale implementation.

The results achieved as a result of Kaizen implementation are:

1. Cycle-time improvements have ranged from 30 per cent faster to nearly 95 per cent faster. One administrative process went from 20 minutes to 12 minutes, and a complaint resolution process dropped from 30 days to eight days.
2. Fiscal indicators have all been positive. One high-level project has allowed the bank to start charging for a service that previously was offered free to customers. New revenues are expected to total between USD 6 million to USD 9 million per year. Other projects have led to cost reductions or loss avoidance in terms of hundreds of thousands of dollars.

Conclusion

Kaizen events are a powerful improvement tool because people are isolated from their day-to-day responsibilities and allowed to concentrate all their creativity and time on problem solving and improvement. Companies that use Kaizens have found that they generate energy among those who work in the area being improved and produce immediate gains in productivity and quality.

Source: Adapted from www.isixsigma.com, accessed April 2010.

For Discussion

1. What are the characteristics of the bank's Kaizen event?
2. Discuss the Kaizen model followed by the bank.
3. What are the results achieved by the bank by this Kaizen event?
4. Why do you consider the Kaizen event to be powerful?

Short-answer Questions

1. Define Kaizen.
2. What do you mean by gemba Kaizen?
3. Name the three types of wastes at the gemba.
4. Prepare a brief note on lean management principles.
5. Which are the ways to identify opportunities for Kaizen?
6. What are the various benefits of Kaizen?
7. What are the benefits of the 5-S programme?
8. What does 5 S stand for?
9. Compare Kaizen with innovation.
10. What is company-wide quality control (CWQC)?
11. Define the term quality function deployment.
12. Define the term house of quality.
13. What is the significance of employee suggestion system?
14. What do you mean by poka-yoke?
15. Prepare a brief note on quality of working life (QWL).

Match the Following

a. Seiri	Discipline
b. Seiton	Organization
c. Seiso	Standardization
d. Seiketsu	Cleaning
e. Shitsuke	Neatness

Discussion Questions

1. What is Kaizen? What are the five gemba principles in gemba management?
2. What are muda, muri and mura? Explain the various types of muda.
3. What is the 5 S in TQM? How does it help in improving the quality of products or services?
4. Build a house of quality for a university's academic department and comment on the results.

5. How can you install QCCs in your organization? What are the important considerations?
6. Design a suggestion system for your organization and explain the steps involved in the process.
7. How do you think the empowerment of your subordinates can enhance the performance of QCC in your company?
8. Explain the procedure for evaluating the QWL in a company.

Projects

1. Organize a quality circle by involving 6–8 people in the class. The objective of this quality circle would be to help each other in sorting out individual problems faced on the campus. Decide about the meeting frequency and time for this quality circle. After one month of starting this exercise, evaluate the effectiveness of quality circles.
2. Choose an organization of your choice and conduct a 5-S audit. Prepare a report giving feedback on how to improve housekeeping practice.

End Notes

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10

Breakthrough Improvement



BREAKTHROUGH IMPROVEMENTS AT APPLE INC.

Apple Inc. is based in Cupertino, California. The company designs, manufactures, and markets mobile communication and media devices, personal computers, and portable digital music players. Apple also sells a variety of related software, services, peripherals, networking solutions, and third-party digital content and applications. The company has always been a different company with a different view of the world. It is a special place where there are ample opportunities to create the best products. Apple is always ranked as one of the top innovative companies in the world. It stands at an exceedingly well-positioned position to take advantage of several major trends in the new digital economy.

The company is based on innovation. Steve Jobs, the founder of Apple, was the chief innovator of the company. Apple realized that an effective innovative strategy is the key to success in the global marketplace. Apple has crafted its own sustainable innovative strategy. Its innovation focuses on bringing together different parts of an eco-system and tightly integrating them together with meticulous attention to detail. Apple believes fostering employee diversity is critical to innovation. Smartphones, tablets, and Asian markets are the three ongoing trends that created the environment for Apple to continue its ascent.

Apple has built an innovation factory that harnesses creativity in its people, stimulating new ideas, and launching successful, profitable new innovations. Apple leverages its diverse culture, innovation processes, partners, and networks to seize new opportunities in the marketplace. Experts said that Apple was innovative because of its ability to iterate designs, devices, and functionality and create products that became a benchmark for customer experience.

“There is no doubt that creativity is the most important human resource of all.”

Edward de Bono

Upon completion of this chapter, you will be able to:

1. Explain creativity
2. Understand innovation and types of innovation
3. Discuss the S curve
4. Describe TRIZ and systematic inventive value augmentation
5. Explain value analysis and value engineering

Bird's-eye view:

Breakthrough improvements often occur suddenly and result in a dramatic improvement.

■ INTRODUCTION

Businesses today operate in a highly turbulent and hyper-competitive environment. In such an environment, companies cannot sustain or enhance their performance just by cost-cutting or by focusing on core business. Today's competitive advantage will not last for more than a few years. Companies have to recognize that transformation is a reality. In order to maintain a sustainable competitive advantage, companies should be good at exploiting certainties in the present. Simultaneously, they should also possess abilities to explore new opportunities. Effective management of creativity and innovation plays a critical role in developing this trait.

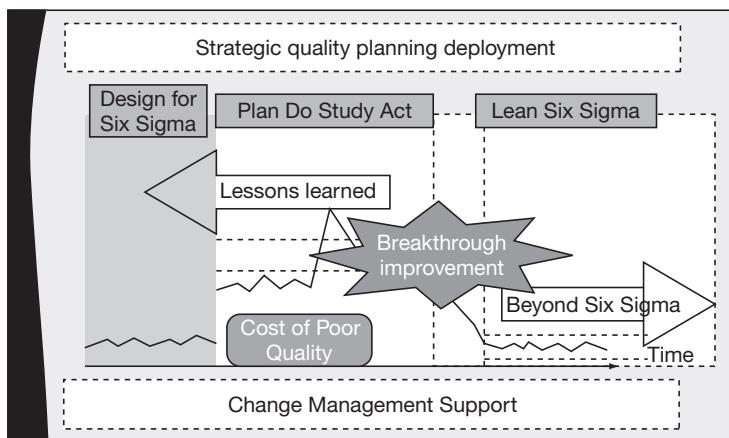
Breakthrough improvement refers to discontinuous change, as opposed to the gradual, continuous improvement philosophy of Kaizen. Breakthrough improvements result from innovative and creative thinking; often these are motivated by stretch goals or breakthrough objectives.

Breakthrough improvement is one component of the Juran trilogy. It refers to the meticulous uncovering and diagnosing of the root causes of chronic and costly problems within existing products or processes. It devises remedial changes that remove or manage the causes, and implement controls to prevent these from recurring.

Breakthrough improvement seeks to create unprecedented beneficial change by improving upon the current organizational standards. Once managers recognize the extent of the cost of poor quality (COPQ), usually through a COPQ study, their dissatisfaction with the results compels them to make a conscious deliberate decision to build lasting improvements. This can be accomplished by setting in motion breakthrough improvement¹ (Figure 10.1).

Bird's-eye view:

Typically, breakthrough improvements are made by one or a few individuals who develop a new theory, invention or technology to solve an old problem. While breakthrough improvements can produce huge gains, they are also unpredictable.

Fig.10.1 Breakthrough Improvement

Breakthrough improvement is carried out by adhering to a universal sequence of events:

- Identifying a business problem—something wrong with a product, service, or process that impacts the performance of the business.
- Establishing a project.
- Measuring and analysing the current process to establish a precise knowledge of baseline performance.
- Generating and testing theories as to the causes of the poor performance.
- Proving the root causes of the poor performance.
- Developing remedial improvements—changes to the process that remove or manage the causes of poor performance.
- Establishing new controls to prevent recurrence and to sustain the new standards.
- Dealing with resistance to change.
- Replicating the results and starting a new project.

■ INVENTION AND INNOVATION

Creativity is the ability to think and act in ways that are new and novel. There are two kinds of creativity—innovation and invention. Innovation refers to thinking creatively about something that already exists (for example, the tape recorder, walkman and CD player are all innovations on the phonograph). Invention is creating something that did not exist before (for example, the phonograph).

Invention is the first occurrence of an idea for a new product or process, while innovation is the first attempt to carry it out into practice. Invention, the creation of new forms, compositions of matter or processes, is often confused with innovation. An improvement on an existing form, composition or processes might be an invention, an innovation, both or neither if it is not substantial enough. It can be difficult to differentiate change from innovation. According to business literature, an idea, a change or an improvement is only an innovation when it is put to use and effectively causes social or commercial reorganization.

Bird's-eye view:

Breakthrough improvement involves major improvements in key business areas. They are often chronic problems solved permanently through focused, dedicated resources working for a limited period of time. Due to the investments in time and attention required, breakthrough improvement projects are selected by a management group that typically acts as a steering group.

Bird's-eye view:

The improvement goal is between 50 and 95 percent improvement in four to 12 months. Breakthrough improvement projects yield the highest economic return in the short- to medium-term.

Bird's-eye view:

In its purest sense, "**invention**" can be defined as the creation of a product or introduction of a process for the first time. "**Innovation**," on the other hand, occurs if someone improves on or makes a significant contribution to an existing product, process or service. Invention is about creating something new, while innovation introduces the concept of "use" of an idea or method.

Innovation occurs when someone uses an invention or an idea to change how the world works, how people organize themselves or how they conduct their lives. According this view, innovation occurs whether or not the act of innovating succeeds in generating value for its champions. Innovation is distinct from improvement in that it permeates society and has the potential to cause reorganization. It is distinct from problem solving and may cause problems. Thus, in this view, innovation occurs whether it has positive or negative results.

All inventions are innovations. However, not all innovations are inventions. All innovations begin as creative solutions, but not all creative solutions become innovations. Invention is an idea for a novel product or process. Innovation can be defined as the introduction of new products, processes or services in the marketplace.

Inventions become innovations when they are refined in a manner that brings them successfully to the market. Innovations create sustained competitive advantage when they are implemented in a manner that creates and sustains significant added value for customers above that created by competitors. Innovation is the initial commercialization of invention by producing and selling a new product, service or process.

Bird's-eye view:

Creativity is the act of turning new and imaginative ideas into reality. **Creativity** is characterized by the ability to perceive the world in new ways, to find hidden patterns, to make connections between seemingly unrelated phenomena, and to generate solutions.

Bird's-eye view:

Creativity is about coming up with the big idea. Innovation is about executing the idea — converting the idea into a successful business. The created item may be intangible (such as an idea, a scientific theory, a musical composition, or a joke) or a physical object (such as an invention, a literary work, or a painting).

■ CREATIVITY

The most basic definition of creativity is to bring something into being. Creativity is defined as the synthesis of existing ideas in a unique way that is appropriate to the context, issue or problem. Creativity is a prerequisite for innovation. Creativity is part of continuous improvement. The terms creativity and innovation are often used to mean the same thing. However, each has a unique connotation. Creativity is “the ability to bring something new into existence.” This definition emphasizes the “ability,” not the “activity,” of bringing something new into existence. A person may, therefore, conceive of something new and envision how it will be useful, but not necessarily take the necessary action to make it a reality. Creativity is a prerequisite to innovation. Creativity is important for the long-term survival of companies and organizations.

The similarity between creative problem solving and creativity depends on the meaning of creativity. Although most of us agree that Albert Einstein and Leonardo da Vinci had the kind of creativity we most appreciate, the word creativity is commonly used in ways that emphasizes the newness of an idea without also implying anything about the value of the new idea. Yet it’s the value of what Einstein and Da Vinci came up with, that makes them highly regarded as creative thinkers. Creative problem solving automatically involves value because a creative solution that fails to bring about improvement is not really a solution. The following considerations need to be kept in mind while using the term “creative problem solving”:

- The element of value is not forgotten when the word creativity is used.
- Improvement is kept in mind as an essential part of creative problem solving.
- The word problem is used in its broader meaning as an improvable situation.

■ Styles of Creativity

Many styles of creativity exist. They can be generally classified into the following four modes:

Structured creativity: Step-by-step, detailed, complex, tool-intensive, controlled, effective for individuals and groups and requiring little facilitation.

Non-linear creativity: Exciting, unpredictable, fast-paced, focused on quantity and not quality, promoting people involvement and usually used in groups.

Provoked creativity: Catalyst-focused, providing a springboard for forward movement, easy to build on, easy to start, requiring active facilitation and easily used by individuals or groups.

“Aha” creativity: Can be described as having no steps or patterns, focused on big issues, invariably having a defining moment, using simple methods and being individually intense.

■ The Creative Process

Lateral thinking is a term coined by Edward de Bono for the solution of problems through an indirect and creative approach. Lateral thinking is about using reasoning, which is not immediately obvious and about ideas that may not be obtainable by using only the traditional step-by-step logic. The term first appeared in the title of de Bono's book *New Think: The Use of Lateral Thinking* published in 1967.

Ideas usually evolve through a creative process whereby imaginative people bring them into existence, nurture them and develop them successfully. The creative process for an idea involves five stages—germination, preparation, incubation, illumination and verification.²

Germination: The germination stage is also termed as the seeding process. The exact manner in which an idea is germinated is a mystery. However, most creative ideas can be traced to an individual's interest in or curiosity about a specific problem or area of study.

Preparation: Once the seed of curiosity has taken the form of a focused idea, creative people embark on a conscious search for answers. If it is a problem they are trying to solve—such as Alexander Graham Bell's determination to help those with impaired hearing—then they begin an intellectual journey, seeking information about the problem and study how others have tried to resolve it. If it is an idea for a new product or service, then market research is the business equivalent. Inventors will set up laboratory experiments, designers will begin engineering new product ideas and marketers will study consumers' buying habits. Any individual with an idea will consequently think about it, concentrating his or her energies on rational extensions of the idea and how it might become a reality. In rare instances, the preparation stage will produce results.

Incubation: Individuals sometimes concentrate intensely on an idea. However, more often, they simply allow ideas time to grow without intentional effort. We have all heard about the brilliant “flashes” of genius, however, few great ideas come from thunderbolts of insight. Most evolve in the minds of creative people while they go about other activities. The idea, once seeded and given substance through preparation is put on a back burner and the subconscious mind is allowed time to assimilate information.

Incubation is a stage of “mulling it over” while the subconscious intellect assumes control of the creative process. This is a crucial aspect of creativity because when we consciously focus on a problem, we behave rationally to attempt to find systematic resolutions. When we rely on subconscious processes, our minds are untrammeled by the limitations of human logic. The subconscious mind is allowed to wander and to pursue fantasies. It is, therefore, open to unusual information and knowledge that we cannot assimilate in a conscious state.

Illumination: The fourth stage occurs when the idea resurfaces as a realistic creation. Illumination may be triggered by an opportune incident, as Bell discovered harmonic telegraphy in the accidental twang created by Watson. But there is little doubt that Bell would have had his moment of illumination, triggered perhaps by another incident or simply manifested through hard work. The point, of course, is that he was prepared and the idea was incubated. Bell was ready for an opportune incident and able to recognize its importance when it occurred.

Bird's-eye view:

Lateral thinking is solving problems through an indirect and creative approach, using reasoning that is not immediately obvious and involving ideas that may not be obtainable by using only traditional step-by-step logic.

Bird's-eye view:

Ideas usually evolve through a creative process whereby imaginative people bring them into existence, nurture them and develop them successfully. The creative process for an idea involves five stages—germination, preparation, incubation, illumination and verification.

Bird's-eye view:

Lateral thinking puzzles are strange situations in which you are given a little information and then have to find the explanation.

The important point is that most creative people go through many cycles of preparation and incubation, searching for that catalyst of an incident that can give their idea full meaning. When a cycle of creative behaviour does not result in a catalytic event, the cycle is repeated until the idea blossoms or dies. This stage is critical for individuals because ideas, by themselves, have little meaning. Reaching the illumination stage separates daydreamers from creative people who find a way to transmute value.

Verification: An idea once illuminated in the mind of an individual continues to have little meaning until verified as realistic and useful. Verification is a stage of development that refines knowledge into application. This is often tedious and requires perseverance by an individual committed to finding a way to “harvest” the practical results of his or her creation. During this stage, many ideas fall by the wayside as they prove to be impossible to execute or have little value. More often, a good idea has already been developed or the aspiring organization finds that competitors already exist. Inventors quite often come to this harsh conclusion when they seek to patent their products only to discover that similar inventions are registered.

■ Creative Problem-solving Tools

In business, creativity is used to solve problems. Therefore, the greater the amount of creativity that can be unleashed, the better the solution is likely to be. Several tools have been developed to enhance and extract the creative talents among individuals and groups. The effectiveness of these tools is a function of the people, the environment, the process need(s) and the problem being addressed. These tools help in developing creative focus, setting direction, exercising the mind, shattering paradigms and gaining new insights. These tools assist in creating a framework that over time has consistently yielded better results.

■ The Six Thinking Hats³

The Six Thinking Hats method is a creativity technique to solve problems and arrive at decisions. Dr Edward de Bono invented this method in the early 1980s. The method is a framework for thinking and can incorporate lateral thinking. Judgemental thinking has its place in the system. However, it is not allowed to dominate as in normal thinking.

Organizations such as Prudential Insurance, IBM, Federal Express, British Airways, Polaroid, Pepsico, DuPont, Nippon Telephone and Telegraph, possibly the world's largest companies, use this methodology to creatively solve problems.

The six hats represent six modes of thinking and are directions to think rather than labels. The method promotes fuller input from more people. According to de Bono, “it separates ego from performance.” Everyone is able to contribute to the exploration without denting egos as they are just using one of the coloured hats from among the six mentioned hats. People can contribute irrespective of a hat even though they may initially support the opposite view. Where six coloured, metaphorical hats represent the styles of thinking, the thinker can put on or take off one of these hats to indicate the type of thinking being used. This putting on and taking off of hats is essential. The hats must never be used to categorize individuals, even though their behaviour may seem to invite this. When done in a group, everybody wears the same hat at the same time.

The six hats are briefly explained below:

White hat: The white thinking hat covers data, information and facts and identifies the gaps and information needs. This is used to analyse past trends and to extrapolate from historical data.

Red hat: The red thinking hat originates in intuition, feelings and emotions brought on by the current discussions. Feelings need not be justified, allowing for valuable input. This input is valuable only when grounded in logic.

Black hat: The black hat indicates looking at things pessimistically, cautiously and defensively. One must try to see why ideas and approaches might not work. This is important because it highlights the weak points in a plan or course of action. It allows you to eliminate them, alter your approach, or prepare contingency plans to counter problems that arise.

Yellow hat: The yellow hat stands for sunshine thinking and helps to think positively. It is the optimistic viewpoint that helps to see all the benefits of the decision, the value in it and spot the opportunities that arise from it. Yellow hat thinking helps everyone to keep going when things look gloomy and difficult.

Green hat: The green hat represents creativity. This is where creative solutions to a problem can be developed. There is little criticism of ideas. However, a certain amount of pain or negative energy is associated with green hat thinking.

Blue hat: The blue hat stands for process control. This is the hat worn by people chairing meetings. Blue hat thinking is utilized when an overview and process control are needed. This thinking is not focused on the subject but rather on the thinking about the subject. Blue hat thinking identifies “other hat thinking” needed to facilitate and make progress. When running into difficulties because ideas are running dry, they may direct activity into green hat thinking. When contingency plans are needed, they will ask for black hat thinking, etc.

Suggested hat sequence: The following hat sequence is advised:

1. White hat: Presents information and data
2. Green hat: Provides creative thinking
3. Yellow hat: Gives rationale for why it may work
4. Red hat: Feedback feelings and intuition
5. Black hat: Gives rationale for why it may not work
6. Blue hat: Provide guidance to the direction taken by the thinking process

The Six Thinking Hats method is a good technique for looking at the effects of a decision from different points of view. It allows necessary emotion and skepticism to be brought into what would otherwise be purely rational decisions. It opens up the opportunity for creativity within decision making. It also helps, for example, persistently pessimistic people to be positive and creative.

Plans developed using the “Six Thinking Hats” method are considered to be sounder and more resilient. This technique helps to avoid public relations mistakes, and also enables to spot good reasons not to follow a course of action before you have committed to it. The key theoretical reasons to use the Six Thinking Hats are to:

- Encourage parallel thinking
- Encourage full-spectrum thinking
- Separate ego from performance

Example: The directors of a real estate company are looking at whether they should construct a new office building. The economy is doing well, and the amount of vacant office space is reducing sharply. As part of their decision, they decide to use the Six Thinking Hats technique during a planning meeting.

They first analyse the problem by looking at it with the white hat. They analyse the data and find a sharp reduction in vacant office spaces. They anticipate a severe shortage of office space by the time the office block is completed. Current government projections show steady economic growth for at least the construction period.

With the red hat line of thinking, some of the directors think the proposed building looks quite ugly. Though it will be highly cost-effective, they worry that people will not like to work in it.

When they think with the black hat, they worry that government projections may be wrong. The economy may be on the threshold of a “cyclical downturn,” in which case the office building may be empty for a long time. If the building is not attractive, then companies will choose to work in another better-looking building at the same rent.

With the yellow hat, however, if the economy holds up and their projections are correct, the company stands to make a great deal of money. If they are lucky, they could perhaps sell the building before the next downturn or rent to tenants on long-term leases that will last through any recession.

With green hat thinking, they consider whether they should change the design to make the building more pleasant looking. Building prestige offices that people may want to rent in any economic climate may make sense. Alternatively, maybe they should invest the money in the short-term to buy up property at a low cost when a recessionary phase begins again.

The blue hat has been used by the meeting’s Chair to move between the different thinking styles. He or she may have needed to keep other members of the team from switching styles or from criticizing other peoples’ points.

■ **CREATES⁴**

CREATES is a technique that can be used to spark creativity and help overcome challenges. In essence, CREATES is a general purpose checklist with idea-spurring questions, which are both easy to use and powerful. Each letter in the acronym represents a different way in which you can play with the characteristics of what is challenging you to trigger new ideas:

- C = Combine
- R = Rearrange/reverse
- E = Exaggerate (magnify)
- A = Adapt
- T = Transform
- E = Eliminate (or minify)
- S = Substitute

In order to use the CREATES technique, first state the problem you’d like to solve or the idea you’d like to develop. It can be anything—a challenge in your personal life or business. It may be a product, service or process that you want to improve on. After pinpointing the challenge, it’s a matter of asking questions about it using the CREATES checklist to guide you.

Combine: Creative thinking usually involves the combination of ideas. Think about combining two or more parts of your problem to create a different product or process or to enhance their synergy. A great deal of creative thinking involves combining previously unrelated ideas, goods or services to create something new.

Rearrange/reverse: Rearranging what is known in order to find out what is not known is often a part of creativity. Rearrangement usually offers countless alternatives for ideas, goods and services. Reversing one’s perspective on ideas, goods or services opens up

Box 10.1 Idea Clock

All innovations are triggered by ideas. In the absence of a systematic approach, there is always the dearth of innovative ideas as a result of which many organizations are left far behind. Many organizations still resort to the “trial and error” method under which innovation is merely a lucky accident. The idea clock developed by Pravin Rajpal, under the aegis of the Federation of Indian Chamber of Commerce and Industry (FICCI), is a simple but powerful tool, which can be used by any one in the organization to generate new ideas for creativity and innovation.

The idea clock is a systematic way of generating creative and innovative ideas for business. It integrates idea generation principles with time. It is a real-time clock on the computer, which shows 10 scientific principles of “creativity and innovation” along with two questions, “what else?” and “how else?” These principles and questions are written along with each number on the clock. As the clock needles show the actual time, they also point out the different principles. At different times of the day, the needles keep shifting from one principle to another to form hundreds of permutations and combinations to spark creative and innovative ideas.

Source: Adapted from www.ficci-etkf.com/ideaclock.htm, accessed March 2010.

Bird's-eye view:

Six Thinking Hats

is a system designed by Edward de Bono which describes a tool for group discussion and individual thinking involving six colored hats. “Six Thinking Hats” and the associated idea parallel thinking provide a means for groups to plan thinking processes in a detailed and cohesive way, and in doing so to think together more effectively.

thinking capability. Think of what you would do if part of your problem, product or process worked in reverse or were done in a different order.

Exaggerate: Think about ways to exaggerate or magnify your idea. Search for ways to exaggerate, magnify, add to, or multiply ideas, products or services. Magnifying your idea or parts of it may increase its perceived value or give new insights about what components are most important.

Adapt: Adaptation involves using others' ideas and changing them to satisfy needs. Think about adapting an existing idea to solve your problem. The solution of your problem is probably out there already. Bear in mind that all new ideas or inventions are borrowed to some degree.

The following questions may be asked while following the CREATES technique:

C (Combine): “How can I combine selling with other activities?”

R (Rearrange): “How can I change, reorder or reverse the way I sell?”

E (Exaggerate): “What can I magnify or put more emphasis on when selling?”

A (Adapt): “What can I adapt or copy from someone else's selling process?”

T (Transform): “How can I put my selling to other uses?”

E (Eliminate): “What can I eliminate or simplify in my selling process?”

S (Substitute): “What can I substitute in my selling process?”

Box 10.1 discusses an innovative tool developed by a management expert at the Federation of Indian Chamber of Commerce and Industries (FICCI) that organizations can use to generate ideas.

Bird's-eye view:

CREATES is a technique that can be used to spark creativity and help overcome challenges. In essence, CREATES is a general purpose checklist with idea-spurring questions, which are both easy to use and powerful.

Bird's-eye view:

Brainstorming is a group creativity technique by which efforts are made to find a conclusion for a specific problem by gathering a list of ideas spontaneously contributed by its members. The term was popularized by Alex Faickney Osborn in the 1953 book *Applied Imagination*.

BRAINSTORMING

Brainstorming is a method for developing creative solutions to problems. It works by focusing on a problem, and then deliberately coming up with as many unusual solutions as possible by pushing the ideas as far as possible.

Most problems are not solved automatically by the first idea that comes to mind. It is important to consider many possible solutions to get to the best solution. One of the best ways to do this is called brainstorming. Brainstorming is the act of defining a problem or

idea and coming up with anything related to the topic—no matter how remote the suggestion may sound. All these ideas are recorded and evaluated only after the brainstorming session is completed.

Bird's-eye view:

Brainstorming combines a relaxed, informal approach to problem solving with lateral thinking. It encourages people to come up with thoughts and ideas that can, at first, seem a bit crazy. Some of these ideas can be crafted into original, creative solutions to a problem, while others can spark even more ideas. This helps to get people unstuck by “jolting” them out of their normal ways of thinking.

■ Brainstorming Definitions

According to Alex F. Osborne, brainstorming is a tool for maximizing a group’s creativity in problem solving. It is “a conference technique by which a group attempts to find a solution for a specific problem by amassing all the ideas spontaneously by its members.”

Brainstorming can be a difficult process for many reasons. Sometimes, people are unwilling to suggest a solution for fear of criticism or the problem may just be a very difficult one, and one that no existing solutions exist for yet. Osborne’s solution is to think up as many ideas as possible regardless of how ridiculous they may seem at first. Since it is very unlikely to think up the perfect solution immediately, he recommends getting every idea out of your head and then going back to examine them afterwards. An idea that may have initially sounded off-the-wall may actually turn out to be a plausible idea with a little modification. Osborne’s technique of deferred judgement increases the individual’s synthesis capabilities by releasing the human mind from the analysis mode of thinking. Brainstorming is considered to be a group method of listing suggested ideas pertaining to a solution for a specific problem.

The technique of brainstorming takes place in a panel format. The brainstorming panel is composed of a leader, a recorder and panel members. The leader is responsible for maintaining a rapid flow of ideas while the recorder lists all the ideas as they are presented. The size of the panel may vary but a range of 10 to 12 is usually optimum. If the group were to get larger, there would be a greater chance of members remaining in the background or members would not have enough time to express their ideas in a reasonable amount of time.

Brainstorming helps answer specific questions such as:

- What opportunities face us this year?
- What factors is constraining performance in department X?
- What could be causing problem Y?
- What can we do to solve problem Z?

However, brainstorming cannot help you positively identify causes of problems, rank ideas in a meaningful order, select important ideas or check solutions.

Bird's-eye view:

During brainstorming sessions, people should avoid criticizing or rewarding ideas. You’re trying to open up possibilities and break down incorrect assumptions about the problem’s limits. Judgment and analysis at this stage stunts idea generation and limit creativity. Evaluate ideas at the end of the session – this is the time to explore solutions further, using conventional approaches.

■ How to Brainstorm?

The following rules are important to brainstorm successfully:

1. Make sure everyone understands and is satisfied with the central question before you open up for ideas.
2. You may want to give everyone a few seconds to jot down a few ideas before getting started.
3. Begin by going around the table or room, giving everyone a chance to voice their ideas or pass. Open the floor after a few rounds.
4. More ideas are better. Encourage radical ideas and piggybacking.
5. Suspend judgement of all ideas.
6. Record exactly what is said. Clarify only after everyone is out of ideas.
7. Don’t stop until ideas become sparse. Allow for ideas that come late.
8. Eliminate duplicates and ideas that are irrelevant to the topic.

■ Step-by-step Guide to Brainstorming

1. Define your problem. The word “problem” is not necessarily negative. The problem could be “We need a new product for the festive season” or “How can we effectively use our departmental budget surplus for this year?” Write out your problem concisely and make sure that everyone understands the problem and is in agreement with the way it is worded. There is no need to put a lot of restrictions on your problem at this time.
2. Give yourselves a time limit. Larger groups may need more time to get everyone’s ideas out.
3. Everyone must shout out solutions to the problem while one person records them. Ideas must not be criticized. If participants begin to fear criticism of their ideas, they will stop generating ideas. Ideas that may seem silly initially may prove to be very good or may lead to ideas that are very good.
4. Select the five ideas that you like best once the time is up. Make sure everyone involved in the brainstorming session is in agreement.
5. Write down five criteria for deciding on the ideas that best solve your problem. Each criterion should start with the word “should.” For example, “it should be cost effective,” “it should be legal,” etc.
6. Give each idea a score between 0 and 5 points depending on how well it meets each criterion. Add up the scores once all the ideas have been scored for each criterion.
7. The idea with the highest score will best solve the problem. However, a record must be maintained of all the best ideas in case the idea selected does not turn out to be workable.



Bird’s-eye view:

When managed well, brainstorming can help you generate radical solutions to problems. It can also encourage people to commit to solutions, because they have provided input and played a role in developing them.

■ Individual Versus Group Brainstorming

Individuals, groups or both can execute brainstorming. Individual brainstorming tends to produce a wider range of ideas than group brainstorming. However, it does not develop ideas as effectively, perhaps because individuals on their own run up against problems they cannot solve. Individuals are free to explore ideas in their own time without any fear of criticism and without being dominated by other group members.

Group brainstorming develops ideas more deeply and effectively. This is because when difficulties in the development of an idea by one person are reached, another person’s creativity and experience can be used to break them down. Group brainstorming tends to produce fewer ideas (as time is spent developing ideas in depth) and can lead to the suppression of creative but quiet people by loud and uncreative ones.

Individual and group brainstorming can be mixed, perhaps by defining a problem, and then letting team members initially come up with a wide range of possibly shallow solutions. These solutions could then be enhanced and developed by group brainstorming.

DISCUSSION FORUM

1. What do you mean by breakthrough improvement?
2. What is the difference between invention and innovation?
3. Discuss creativity.
4. Name the various stages of the creativity process.
5. Describe the six thinking hats with an example.
6. Describe the CREATES technique.
7. Explain the brainstorming procedure.

■ INNOVATION

The meaning of “innovation” is revealed by its Latin root, *nova*, or new. It is generally understood as the introduction of a new thing or method. Innovation is the embodiment, combination or synthesis of knowledge in original, relevant, valued new products, processes or services.

A convenient definition of innovation from an organizational perspective is given by Luecke and Katz⁴ who wrote, “Innovation is generally understood as the successful introduction of a new thing or method. Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services.”

Systematic innovation consists of purposeful and organized search for changes. Systematic innovation means monitoring the seven sources for innovative opportunities mentioned below:

- The unexpected—unexpected success, unexpected failure, unexpected outside event.
- The incongruity between reality as it actually is and reality as it is assumed to be or as it “ought to be.”
- Innovation based on process need.
- Changes in industry structure or market structure that catches everyone unawares.
- Demographics (population changes).
- Changes in perception, mood and meaning.
- New knowledge—scientific and non-scientific innovation is all about value addition through changed products, processes and concepts, markets, organization, etc.

Box 10.2 discusses the innovation strategies practised at Birla White Cement.

Box 10.2 Innovation Drivers at Birla White Cement

Although India is the fourth-largest consumer of white cement in the world, it has no place in terms of per capita consumption because of its high population base. White cement applications also lost out on consumer acceptance because of the high levels of skill, effort and time required to finish floor and wall surfaces. This trend is reflected in the compounded annual growth rate (CAGR) of the white cement industry.

The CAGR in the block period of 1991 to 1995 and 1996 to 2000 was 5.86 per cent and 6.19 per cent, respectively. In the subsequent block period of 2000 to 2005, the CAGR almost halved to 3.67 per cent. The projection for 2005 to 2010 is 3.52 per cent notwithstanding the construction boom in India. To make matters worse, cheap imports started eating into the domestic market and manufacturers' share during 2000 to 2001. Birla White, a division of Grasim Industries held a brainstorming session at its Kharia plant in 2001 in order to devise strategies to tackle the situation. A series of strategic decisions were made.

Innovation strategies: The business redefinition helped the team to innovate and develop new product concepts. Several concepts within the surface finishing definition were translated into tangible products in a couple of years, and trials were undertaken before formally launching these products into the market.

Birla White has been associated with architects for nearly two decades. It has succeeded in breaking the conventional cement barrier and developing numerous designs and architectural applications for walls and floors. Today, the company boasts a portfolio that ranges from the most basic wall finish to the most intricate of claddings. In addition to the wallcare putty, the company also

developed Textura, a ready-mix textured plaster, as well as Kool n Seal and GRC (glass fibre reinforced concrete). Some of the major structures that were built using a mix of white cement and GRC include the Leela Palace in Bangalore; the Digamber Jain temple near Ajmer; the airports in Bhuj (Gujarat), Ranchi and Gaya (UP); the Kalyanprasad temple in Baroda and the Hotel Sonar Bangla (ITC) in Kolkata.

Looking into the future: It launched the Birla Yuva Ratna Award, a design competition for budding architects as part of the latest step in its innovation strategy. The aim of this initiative is to encourage young architects to use white cement creatively. The entries have been both playful and eclectic, and creative use of digital technology has been at the forefront of many designs.

Source: Adapted from www.grasim.com, accessed April 2010.

■ Economic Concepts of Innovation

According to Joseph Schumpeter⁵, economic innovation can be defined as:

- The introduction of a new good or of a new quality of an existing good that consumers are not yet familiar with.
- The introduction of a new method of production that need not be founded upon a new scientific discovery and can also exist in a new way of handling a commodity commercially.
- The opening of a new market, i.e. a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before.
- The conquest of a new source of supply of raw materials or half-manufactured goods, irrespective of whether this source already exists or whether it has to be created first.
- The carrying out of the new organization of any industry such as the creation of a monopoly position or the breaking up of a monopoly position.

■ Types of Innovation

There are two major categories within which innovations fall:

- Incremental (developmental)
- Radical (breakthrough)

Incremental innovation exploits existing forms or technologies. It either improves something that already exists, making it “new and improved,” or reconfigures an existing form or technology to serve some other purpose.

A radical innovation is something new to the world. Radical innovations are based on a new paradigm and typically lead to the discovery of new markets and applications. Radical and incremental innovations often operate hand in hand. Thus, the introduction of a successful radical innovation is often followed by a period of incremental innovations, which improves its performance or extends its application. Many radical innovations have the potential to displace established technologies as the transistor did when introduced into the world of vacuum tubes or to create entirely new markets, or both.

A dominant design for cooling a room for many years was the ceiling fan. Changes to its blade design, enabling it to displace more air mass, possess a more quiet motor operation and new colours to match room décor, may represent examples of incremental innovation. In contrast, development of central air conditioning represents a radical innovation as it required new components, and different technologies were introduced along with new technical disciplines and relationships. This new radical innovation renders the core

Bird's-eye view:

Innovation is synonymous with risk-taking and organizations that create revolutionary products or technologies take on the greatest risk because they create new markets. Imitators take less risk because they will start with an innovator’s product and take a more effective approach. Examples are IBM with its PC against Apple Computer, Compaq with its cheaper PC’s against IBM, and Dell with its still-cheaper clones against Compaq.

Bird's-eye view:

There are two types of innovation- incremental and radical. Incremental innovation exploits existing forms or technologies. It either improves something that already exists, making it “new and improved”, or reconfigures an existing form or technology to serve some other purpose. A radical innovation typically leads to the discovery of new markets and applications.

competencies of the fan manufacturers obsolete and incapable of being leveraged for central air-conditioning systems. In the entire context stated above, the manufacturer or the service provider is seeking an increasingly higher value.

The first generation and the simplest definition of value is “to reliably provide the given function at the least cost,” to be represented as:

$$\text{Value} = \text{Function}/\text{Cost}$$

Over the years, many dimensions are added to these simple definitions, such as

$$\text{Value} = \frac{\text{Function, Quality, Service, ..., etc.}}{\text{Cost, Time, ..., etc.}}$$

The third generation, yet the simpler definition of value in the innovation context may be defined as:

$$\text{Value} = \text{Benefits} - (\text{Cost} + \text{Harmful Effects})$$

The underlying philosophy of innovation is to enhance the value of a product, process or a strategy to create wealth and more wealth. We need ideas in order to innovate. Ideas themselves are not enough. History has shown us many great ideas. However, these have not been implemented, nor have they created wealth nor have they helped innovate something. These ideas need to be creative, backed by a strong strategy for implementation. In order to systematically innovate the value of a product, process or a strategy, it is proposed that one follows the five-step methodology:

1. I (Identify the opportunity for innovation)
2. D (Develop creative alternatives)
3. E (Evaluate the alternatives and evolve the best alternative)
4. A (Action)
5. S (Satisfy the condition, customers and sell the idea)

These five steps are derived from PDCA (Plan, Do, Check, Act) cycle of innovation. Figure 10.2 is an innovation pentagon. This can be rotated to continuously enhance the value along the S curve. The concept of the S curve is discussed in detail in the following section.

Bird's-eye view:

The concept of the innovation S-Curve is used to determine performance in regard to time or effort. These are extremely important due to the fact that understanding where you are in regard to this system determines how you should proceed in regard to innovation strategy. It can also assist you in understanding your current risks and how to avoid certain pit-falls common to products or services in certain phases of maturity.

■ Diffusion of Innovation—The S Curve

The lifecycle of innovation can be described with the help of the S curve. The S curve is derived from half of a normal distribution curve. There is an assumption that new

Fig. 10.2 Innovation Pentagon

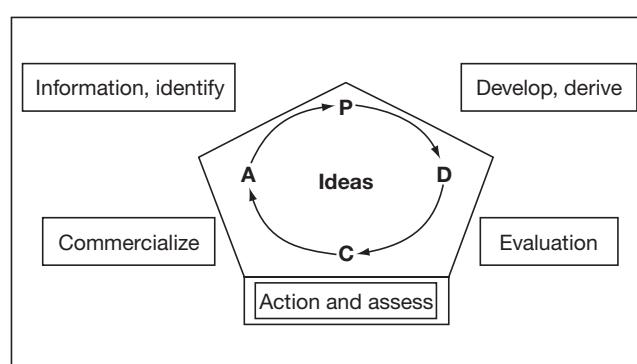
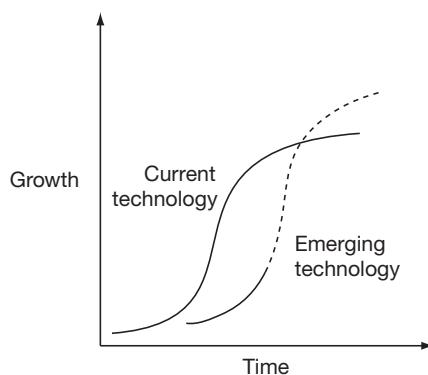


Fig. 10.3 S Curve **Bird's-eye view:**

S curves are a phenomenon showing the typical path of performance in relation to investment in research and development. S-curve describes how the performance or cost characteristics of a technology change with time and continued investments.

products are likely to follow a product lifecycle, i.e. a start-up phase, a rapid increase in revenue and eventual decline. In fact, a great majority of innovations never get off the bottom of the curve and never produce normal returns.

Every product, process, service or a strategy follows a typical S curve. The course of successful technological innovation is often described through an S-shaped curve like the one shown in Figure 10.3. Here, the horizontal axis reflects the unfolding history of technical innovations (time and investment), while the vertical axis indicates some particular dimension of product performance or cost competitiveness. At first, performance rises fast and from then on, once a decline in slope of the curve begins, the productivity is unlikely to increase much by heavy research and development expenses. More likely, a technological discontinuity will occur where an innovative technology is introduced and this rapidly creates massive gains in productivity. At the start of the curve, a significant effort is needed to get an achievement. However, once this basic learning is complete, productivity can advance significantly with little marginal effort. After a few years, further advances get more and more fractional. As technology generations change, few incumbents survive because they lack the features to adapt to new technologies.

S curves are a phenomenon showing the typical path of performance in relation to investment in research and development. The S curve method was introduced as a result of several studies on technologies and firms performance. An S curve describes how the performance or cost characteristics of a technology change with time and continued investments. In the generalized model, a newly introduced technology is crude and not particularly competitive with established rivals, except in specialized niche markets. Performance or cost characteristics or both enjoy a period of rapid and steady improvement as technical issues are solved. Eventually, the innovation's performance or costs may equal and perhaps exceed those of the established rival. Eventually, the new technology enters a period of maturity in which improvements are small, infrequent and increasingly costly. At this point, it becomes vulnerable to attack by still newer technologies. The S curve concept provides the following insights:

- Defenders face difficult choices with respect to how they should react to the appearance of a new technology.
- Leaders in one generation of technology are seldom leaders in the next.
- The attackers enjoy important advantages over established rivals—an undivided focus, an ability to attract talent, little bureaucracy and no need to protect investments in unrelated skills or assets.

Box 10.3 Voltas Scores for “Best Innovation” Breakthrough with Freezer-on-wheels

In a survey conducted in April 2008 by *BusinessWeek* and the Boston Consulting Group, the Tata Group was ranked as the sixth most innovative group in the world. An Innovation Day event held under the aegis of the Tata North Regional Forum in June 2008 adjudged an entry from Voltas’ Unitary Products as the “Best Innovation” within the group. This was in the face of formidable competition from group companies such as Tata Motors, Indian Hotels, TCS and Tata Teleservices.

The Voltas product innovation, developed at its Panthagar plant, is a breakthrough improvement in the familiar freezer-on-wheels, which keeps ice cream frozen while being pushed through the streets by vendors. The new freezer developed lasts longer than the existing product due to the elimination of corrosion, which is rampant in other brands available in the market. It is more economical, lighter in weight and easier to pedal, and keeps ice cream frozen longer when disconnected from the power source while in use on the streets.

Voltas has filed to patent the technology that has wide applications far beyond the freezer-on-wheels. Voltas’ Unitary Products business and Universal Comfort Products (Voltas’s manufacturing subsidiary) are developing a few more patentable products to build an asset base of intellectual property that will give Voltas a cutting edge in the marketplace.

Source: Adapted from www.voltas.com, accessed March 2010.

Bird's-eye view:

The S-Curve of Innovation is a robust framework that can be used to analyze various industries at their different stages and to explain their successes and failures.

- Managers should be able to track where their companies and their key technologies are on the S curve and do the same for their competitors. They should be able to determine which strategic option is most promising from this.

Innovative companies will typically be working on new innovations that will eventually replace older ones. Box 10.3 discusses an innovative product developed by Voltas. Successive S curves will come along to replace older ones and continue to drive growth upwards. In Figure 10.3, the first curve shows a current technology. The second shows an emerging technology where the current technology yields lower growth but the former will eventually overtake the latter and lead the company to even greater levels of growth. The length of life will depend on many factors. S curves can be applied in the following areas:

- Technology lifecycle assessment
- Industry maturity
- Assignment of the necessity of strategic refocusing

DISCUSSION FORUM

- Define innovation.
- What are the two types of innovation?
- Describe the five steps of innovation.
- Explain the innovation pentagon.
- Discuss the lifecycle of innovation using the S curve.

■ THE THEORY OF INVENTIVE PROBLEM SOLVING (TEORIJA REZBENIJA IZOBRETELASHIB ZADACH, TRIZ)

Design and development approaches such as the quality function deployment show us what to solve, but not always how to solve the technology bottlenecks that arise. Most techniques rely on the experience of designers that may be limited to certain areas of expertise. Thus, a solution that might be simpler and cheaper using another technique could be missed. The technique of Teorija Rezbenija Izobretelashib Zadach (TRIZ) can be used to explore design solutions in other fields.

Rockwell International's Automotive Division was losing a competitive battle with a Japanese company over the design of brakes for a golf cart. Both Rockwell and the Japanese competitor were competing on redesigns of an automobile brake system but with smaller components. Using TRIZ, the problem was solved by redesigning a bicycle brake system with larger components. The result was a reduction in parts from 12 to four and a cost savings of 50 per cent.

■ Genrich S. Altshuller, the Father of TRIZ

Genrich S. Altshuller was born in the former Soviet Union in 1926. Interested in scientific research from a young age, his invention for scuba diving was devised when he was only 14 years old. His job in the Soviet Navy as a patent expert in the 1940s was to help inventors apply for patents. He was also often asked to assist in solving problems as well. His curiosity about problem solving led him to search for standard methods. According to Altshuller, a theory of invention should satisfy the following conditions:

1. It should be a step-by-step procedure
2. It should be able to direct everyone to the ideal solution
3. It should be repeatable and reliable and not dependent on psychological tools
4. It should be able to access and add to the body of inventive knowledge
5. It should be familiar enough to inventors by following the general approach to problem solving

Bird's-eye view:

Genrich S. Altshuller, is the Father of Theory of Inventive Problem Solving (Teorija Rezbenija Izobretelashib Zadach – TRIZ). Altshuller more clearly defined an inventive problem as one in which the solution causes another problem to appear.

Bird's-eye view:

In the 1960s and 1970s, Altshuller categorized the solutions into five levels. He also noted that with each succeeding level, the source of the solution required broader knowledge and more solutions to consider before an ideal one could be found.

Altshuller screened over 200,000 patents looking for inventive problems and how they were solved. Altshuller defined an inventive problem as one in which the solution causes another problem to appear. For example, increasing the strength of a metal plate causing it to get heavier. Usually, inventors must resort to a trade-off and compromise between the features, thereby failing to achieve an ideal solution. In his study of patents, Altshuller found that many described a solution that eliminated or resolved the contradiction and required no trade-offs.

Altshuller categorized these patents in a novel way. Instead of classifying them by industry such as automotive, aerospace, etc. he removed the subject matter to uncover the problem-solving process. He found that often the same problems had been solved over and over again using one of only 40 fundamental inventive principles. Solutions could have been discovered more quickly and efficiently if later inventors had knowledge of the work of earlier ones. He categorized the solutions into five levels.⁵

Level one: Routine design problems solved by methods well known within the specialty. No invention needed. About 32 per cent of the solutions fell into this level.

Level two: Minor improvements to an existing system by methods known within the industry, usually with some compromise. About 45 per cent of the solutions fell into this level.

Table 10.1 Levels of Inventiveness

Level	Degree of Inventiveness	Percentage of Solutions	Source of Knowledge	Approximate Number of Solutions to Consider
1.	Apparent solution	32%	Personal knowledge	10
2.	Minor improvement	45%	Knowledge within the company	100
3.	Major improvement	18%	Knowledge within the industry	1,000
4.	New concept	4%	Knowledge outside the industry	100,000
5.	Discovery	1%	All that is knowable	1,000,000

Level three: Fundamental improvement to an existing system by methods known outside the industry. Contradictions were resolved in the process. About 18 per cent of the solutions fell into this category.

Level four: A new generation that uses a new principle to perform the primary functions of the system. More solutions found in science than in technology. About four per cent of the solutions fell into this category.

Level five: A rare scientific discovery or pioneering invention of essentially a new system. About one per cent of the solutions fell into this category.

He also noted that with each successive level, the source of the solution required broader knowledge and more solutions to consider before an ideal one could be found. His findings are summarized in Table 10.1.

As per Altshuller's tabulation, 90 per cent of the problems that engineers faced had been solved somewhere before. If engineers could follow a path to an ideal solution, starting with the lowest level, their personal knowledge and experience, and working their way to higher levels, most of the solutions could be derived from knowledge already present in the company, industry or in another industry. Altshuller distilled the problems, contradictions and solutions in these patents into a theory of inventive problem solving that he named TRIZ.

■ The TRIZ Process

Altshuller felt that an acceptable theory of invention should be familiar enough to inventors if they follow a step-by-step approach to problem solving:

Step 1 Identifying the problem: Boris Zlotin and Alla Zusman, Principal TRIZ scientists at the American company Ideation and students of Altshuller, developed an "Innovative Situation Questionnaire" to identify the engineering system being studied, its operating environment, resource requirements, primary useful function, harmful effects and ideal result.

Example: We can use the engineering system of a beverage can as an example to discuss the step-by-step TRIZ process. The function of a can is to contain beverages. Cans are stacked for storage purposes. The resources include weight of filled cans, internal pressure of cans and rigidity of can construction. The other parameters that come into play are the cost of materials for producing cans and the waste of storage space. The ideal result is a can that can support the weight of stacking to human height without damage to cans or the beverage in the cans.

◀ ● Bird's-eye view:

TRIZ literally: "theory of the resolution of invention-related tasks" is "a problem-solving, analysis and forecasting tool derived from the study of patterns of invention in the global patent literature"

◀ ● Bird's-eye view:

TRIZ was developed by the Soviet inventor and science-fiction author Genrich Altshuller (1926–1998) and his colleagues, beginning in 1946. In English the name is typically rendered as "the **theory of inventive problem solving**", and occasionally goes by the English acronym **TIPS**.

Step 2 Formulate the problem: The problem should be restated in terms of physical contradictions. All problems that could occur should be identified. Could improving one technical characteristic to solve a problem cause other technical characteristics to worsen, resulting in the arising of secondary problems?

Example: We cannot control the height to which the cans will be stacked. The price of raw materials may compel us to lower costs. The can walls must be made thinner in order to reduce costs. However, if we make the walls thinner, it cannot support a large stacking load. Thus, the can wall needs to be thinner to lower material cost and thicker to support stacking-load weight. If this physical contradiction can be solved, we will achieve an ideal engineering system.

Step 3 Search for previously well-solved problem: Altshuller extracted 39 standard technical characteristics that cause conflict from over 1,500,000 world-wide patents. These 39 engineering parameters have been presented in Table 10.2. The next step is to find the contradicting engineering principles. The standard technical conflict should be found by first finding the principle that needs to be changed and then the principle that is an undesirable secondary effect.

Example: The standard engineering parameter that has to be changed to make the can wall thinner is “No. 4, length of a non-moving object.” If we make the can wall thinner, the stacking-load weight will decrease. The standard engineering parameter that is in conflict is “No. 11, stress.”

The standard technical conflict is that the more we improve the standard engineering parameter “length of a non-moving object,” the more the standard engineering parameter “stress” becomes worse.

Bird's-eye view:

Altshuller extracted 39 standard technical characteristics from over 1,500,000 world-wide patents that cause conflict. These are called the 39 Engineering Parameters. Altshuller also extracted 40 inventive principles from the world wide patents. These are hints that will help an engineer find a highly inventive (and patentable) solution to the problem.

Table 10.2 The 39 Engineering Parameters

1. Weight of moving object	21. Power
2. Weight of non-moving object	22. Waste of energy
3. Length of moving object	23. Waste of substance
4. Length of non-moving object	24. Loss of information
5. Area of moving object	25. Waste of time
6. Area of non-moving object	26. Amount of substance
7. Volume of moving object	27. Reliability
8. Volume of non-moving object	28. Accuracy of measurement
9. Speed	29. Accuracy of manufacturing
10. Force	30. Harmful factors acting on object
11. Tension, pressure	31. Harmful side effects
12. Shape	32. Manufacturability
13. Stability of object	33. Convenience of use
14. Strength	34. Repairability
15. Durability of moving object	35. Adaptability
16. Durability of non-moving object	36. Complexity of device
17. Temperature	37. Complexity of control
18. Brightness	38. Level of automation
19. Energy spent by moving object	39. Productivity
20. Energy spent by non-moving object	

Step 4 Look for analogous solutions and adapt to the solution: Altshuller also extracted 40 inventive principles as shown in Table 10.3.⁶ These are hints that will help an engineer find a highly inventive (and patentable) solution to the problem. Altshuller also created a table of contradictions to find out which inventive principles to use. The table of contradictions lists the 39 engineering parameters on the X-axis (undesired secondary effect) and the Y-axis (features to improve). The appropriate inventive principles to use for a solution are listed in the intersecting cells.

Example: The engineering parameters in conflict for the beverage can are “No. 4, length of a non-moving object” and “No. 11, stress.” The feature to improve (Y-axis) is the can wall thickness or “No. 4, length of a non-moving object” and the undesirable secondary effect (X-axis) is the loss of load bearing capacity or “No. 11, stress.” Looking these up on the table of contradictions (Table 10.4), we find the numbers 1 (segmentation), 14 (spheroidality) and 35 (transformation of properties) in the intersecting cell.

Therefore, the solution for this problem can probably be arrived at by using inventive principles No. 1, No. 14 and No. 35 (Table 10.3). Applying inventive principle No. 1, segmentation can be carried out by—(a) dividing an object into independent parts, (b) making an object sectional and (c) increasing the degree of an object’s segmentation. By increasing the degree of an object’s segmentation, the wall of the can could be changed from a smooth continuous wall to a corrugated or wavy surface made up of many “little walls.” This would increase the edge strength of the wall, yet allow a thinner material to be used. Inventive principle No. 14 stands for spheroidality. This can be done by—(a) replacing linear parts or flat surfaces with curved ones; replacing cubical shapes with spherical shapes, (b) using rollers, balls spirals and (c) replacing linear motion with rotating movement by utilizing a centrifugal force.

Table 10.3 The 40 Inventive Principles

Sl No.	Inventive Principles	Sl No.	Inventive Principles
1.	Segmentation	21.	Rushing through
2.	Extraction	22.	Convert harm into benefit
3.	Local quality	23.	Feedback
4.	Asymmetry	24.	Mediator
5.	Consolidation	25.	Self-service
6.	Universality	26.	Copying
7.	Nesting	27.	Dispose
8.	Counter weight	28.	Replacement of mechanical system
9.	Prior counteraction	29.	Pneumatic or hydraulic construction
10.	Prior action	30.	Flexible membranes or thin films
11.	Cushion in advance	31.	Porous material
12.	Equipotentiality	32.	Changing the colour
13.	Inversion	33.	Homogeneity
14.	Spheroidality	34.	Rejecting or regenerating parts
15.	Dynamicity	35.	Transformation of properties
16.	Partial or overdone action	36.	Phase transformation
17.	Transition into new dimension	37.	Thermal expansion
18.	Mechanical vibration	38.	Accelerated oxidation
19.	Periodic action	39.	Inert environment
20.	Continuity of useful action	40.	Composite material

Table 10.4 Table of Contradictions

	1	2	3	4	5	6	7	8	9	10	11	12	13
Feature to Improve	Weight of Moving Object	Weight of Non-moving Object	Weight of Moving Object	Length of Non-moving Object	Area of Moving Object	Area of Non-moving Object	Volume of Moving Object	Volume of Non-moving Object	Object	Speed	Tension, Pressure	Shape	Stability of Object
Undesired Result (Conflict)	15, 8, 29, 34	10, 1, 29, 35	15, 17, 4	29, 17, 38, 34	35, 13, 13, 2	7, 17, 4, 35	29, 2, 40, 28	5, 35, 14, 2	2, 8, 15, 38	8, 10, 18, 37	10, 36, 37, 40	10, 14, 35, 40	1, 35, 19, 39
1 Weight of Moving Object	15, 8, 29, 34	10, 1, 29, 35	15, 17, 4	29, 17, 38, 34	35, 13, 13, 2	7, 17, 4, 35	29, 2, 40, 28	5, 35, 14, 2	2, 8, 15, 38	8, 10, 18, 37	10, 36, 37, 40	10, 14, 35, 40	1, 35, 19, 39
2 Weight of Non-moving Object	8, 15, 29, 34	8, 15, 29, 34	17, 7, 10, 40	10, 1, 29, 35	15, 13, 13, 2	17, 7, 10, 40	10, 1, 29, 35	13, 4, 8	17, 10, 4	13, 29, 10, 18	13, 10, 29, 14	26, 39, 1, 40	
3 Length of Moving Object	35, 28 40, 29	35, 28 40, 29	35, 8 2, 14	17, 7, 10, 40	7, 14, 17, 4	35, 8 2, 14	17, 7, 10, 40	13, 4, 8	17, 10, 4	1, 8, 35	1, 8, 10, 29	1, 8, 15, 34	
4 Length of Non-moving Object	2, 17, 29, 4	14, 15, 18, 4	7, 14, 17, 4	7, 14, 17, 4	7, 14, 17, 4	29, 30, 4, 34	29, 30, 4, 34	29, 30, 4, 34	28, 10	1, 14, 35	13, 14, 15, 7	39, 37, 35	
5 Area of Moving Object	14, 15, 18, 4	14, 15, 18, 4	7, 14, 17, 4	7, 14, 17, 4	7, 14, 17, 4	19, 30, 35, 2	19, 30, 35, 2	19, 30, 35, 2	19, 30, 35, 2	10, 15, 36, 28	5, 34, 29, 4	11, 2, 13, 39	

The perpendicular angle at which most can lids are welded to the can wall can be changed to a curve using inventive principle No. 14. Inventive principle No. 35 refers to the transformation of the physical and chemical states of an object—changing an object's aggregate state, density distribution, degree of flexibility, temperature. Thus, by using inventive principles No. 1, No. 14 and No. 35, the wall of the can can be designed to become thinner to lower material cost and thicker to support stacking-load weight.

DISCUSSION FORUM

1. What do you mean by TRIZ?
2. Explain the five levels on inventiveness.
3. What are the 39 engineering parameters?
4. What are the 40 inventive principles?

Bird's-eye view:

Value is a personal perspective of your willingness to pay for the performance delivered by a product, process or project.

Bird's-eye view:

VAVE is a generic name given to this technique of VALUE ANALYSIS and VALUE ENGINEERING.

■ VALUE ANALYSIS/VALUE ENGINEERING

Value is a personal perspective of one's willingness to pay for the performance delivered by a product, process or project. Good value is achieved when the required performance can be accurately defined and delivered at the lowest lifecycle cost.

■ What Is Value Engineering?

It is an undisputed fact that the gap between the price and the cost of production, i.e. the profit margin should be widened as far as possible for the sustained growth of an organization.

Value engineering (VE), also known as value analysis, is a systematic and function-based approach to improving the value of products, projects or processes. VE involves a team of people following a structured process. The process helps team members communicate across boundaries, understand different perspectives, innovate and analyse.

■ What Does Value Engineering Do?

VE improves value. On highway projects, improvements to value might include reducing the lifecycle cost of an interchange, enhancing safety in a design or reducing impacts to the public by shortening the duration of a construction project.

VE uses a combination of creative and analytical techniques to identify alternative ways to achieve objectives. The use of function analysis differentiates VE from other problem-solving approaches. VE focuses on delivering the product or service at the best price by incorporating those value characteristics deemed most important by the customer.

Value analysis can be used to understand the details of specific situations and to focus on key areas for innovation. It can be used in reverse (called value engineering) to identify specific solutions to detailed problems.

■ Identifying Priorities of VE

First, the main business goals have to be summarized broadly with regard to:

- The company's vision for business improvement

- An understanding of its products or services from the customer's perspective
- Analysis [identification] of its main customer and market segments
- An assessment of competition
- Objectives for growth, profitability, customer and employee satisfaction

A prioritized list of challenges facing the business is developed on the basis of these elements. These priorities are then evolved into projects suitable for the VE process. The VE "job plan" is then applied to the individual projects based on the order of their priorities. A "job plan" typically consists of the following phases:

Planning phase: During this phase, emphasis is on the objectives to be achieved, composition of the project study team, information on which to base the study and detailed planning.

Information phase: In this phase, the detailed information requirements for the project are identified and distributed among team members. This ensures that adequate data is available to the VE team.

Analysis phase: During the analysis phase, the VE team structures the information and applies techniques to analyse the problem.

Creative phase: During the creative phase, the teams undergo structured "brainstorming" to generate ideas, which are again combined or developed further.

Evaluation phase: Also termed team design, this phase comprises a series of processes to evaluate the best ideas generated during the creative phase. The ideas are prioritized in terms of cost, time and practicality. Those that meet most of the customer requirements at the lowest lifecycle cost are selected.

Reporting phase: Here, the new initiatives developed are formally presented to senior management as business cases along with alternatives and appropriate financial cases wherever investment is required.

Implementation phase: The selected proposals are implemented and new approaches brought into practice in this phase.

Follow-up phase: Systematic follow-up procedures must be put in place in order to ensure that all the benefits of the VE project are achieved.

Although VE practices vary from business to business, the above phases must be implemented to obtain full benefits.

■ Value Analysis and Value Engineering (VAVE)

VAVE is a generic name given to the techniques of value analysis and VE. Although it is believed that VAVE can be applied to all spheres of activities of an organization, the difficulties faced in the application phase have to be realised. Looking into the Aristotelian classification of the seven types of values, we realise that except in the case of economic value, all others are highly subjective and fully individual oriented rather than group or society oriented. Therefore, only economic value is explained in this section. The seven classes of values propounded by Aristotle are:

1. Economic value
2. Political value
3. Social value

Bird's-eye view:

The seven classes of values propounded by Aristotle are: Economic value, Political value, Social value, Aesthetic value, Ethical value, Religious value and judicial value. Long-term benefits of this approach include: Best of class performance, Enhanced quality, Greater employee involvement and better morale.

Bird's-eye view:

Although it is believed that VAVE can be applied to all spheres of activities of an organization, the difficulties faced in the application phase have to be realised. Looking into the Aristotelian classification of the seven types of values, we realise that except in the case of economic value, all others are highly subjective and fully individual oriented rather than group or society oriented.

4. Aesthetic value
5. Ethical value
6. Religious value
7. Judicial value

■ The Economic Value

Alternative products or services can be found so as to serve the required function at a much lower cost within a given framework and conditions. The economic value of a product or service can be broadly divided into six basic values:

(a) Usage value: A product has usage value to the extent that the money spent justifies the usefulness of the product or service. This can be related to the specific functional requirement. For example, a James Clip in place of a tie pin.

(b) Exchange value: A product has exchange value to the extent that the additional amount paid guarantees the resale or exchange at any point of time. Though the item is never exchanged in most cases, this factor helps by way of insurance against crises. An example of this is the purchase of a particular brand of scooter by paying three to four thousand rupees more than its face value. We also know that most people buying that particular brand never really sell it off. However, they are sure that if necessary they will be able to sell the brand more easily when compared to other brands. It is perhaps the feeling of safety that forces one to spend the extra amount.

(c) Esteem value: A product has esteem value to the extent that it meets ego needs. This is a very difficult item to assess. Hence, the main aim is to eliminate it as it does not contribute anything towards the satisfactory performance of the function. The concept of appearance engineering is picking up fast nowadays. For example, packaging a medicine in a nice package will not encourage the buyer to purchase it unless it has been prescribed by the doctor. In this case, packaging should aim at only preserving the medicine and nothing more. On the other hand, a consumer good can be packaged in an appealing manner as it would definitely add to the decision-making process of the buyer. Government sponsored and highly subsidized items such as bio-gas stoves, gasifiers, etc. need not be made more expensive by way of esteem features as they are supposed to be just functional products.

(d) Cost value: A product has cost value to the extent that the expense to produce the item or service has already been incurred.

(e) Place value: A product has place value when it has a specific value in a certain place and does not have the same value in another place. A glass of water in a desert is an ideal example for this.

(f) Time value: A product has time value when it loses its value after a certain period of time has elapsed. For example, transfusing blood to a patient during an operation.

■ How to Use VAVE?

- Identify and prioritize functions.
- Identify the item to be analysed and the customers for whom it is produced.
- List the basic functions (the things for which the customer is paying). Note that there are usually very few basic functions.

- Identify the secondary functions by asking, “How is this achieved?” or “What other functions support the basic functions?”
- Determine the relative importance of each function, preferably by asking a representative sample of customers (who will always surprise you with what they prefer).
- Analyse contributing functions.
- Find the components of the item being analysed that are used to provide the key functions. Again, the question, “How” can come in very useful here.
- Measure the cost of each component as accurately as possible, including all material and production costs.
- Seek improvements.
- Eliminate or reduce the cost of components that add little value, especially high-cost components.
- Enhance the value added by components that contribute significantly to functions that are particularly important to customers.

■ Understanding Value Engineering

Managers across various industries constantly face the challenge of survival and growth in today's dynamic and competitive business environments. The biggest challenge they face is, “How to improve performance on a continual basis to ensure survival and profitable development?”

For years, companies across the world have been looking for methods to improve and grow successfully. VE is a powerful technique that when applied on a systematic basis helps users achieve best performance and improve business by cutting costs and improving performances. Also known as value management or value analysis, VE is a function-oriented, systematic, team-approach to reduce costs and simultaneously add value to a product or service.

VE is a framework within which proven methods are systematically employed to identify better value for products and services. Although the key disciplines are not new, it is the way they are integrated and deployed that makes the approach effective. The VE methodology includes multi-disciplined teamwork, function analysis, implementation, financial reporting, communication techniques and lifecycle costs.

VE is recognized as an efficient way to achieve greater profits, enhanced customer satisfaction and improved quality. The concept has been successfully applied for many years to businesses across various government and service industries. The scope of its application is vast. VE has been applied for cost reduction in purchasing, overall reduction in cost of products and to minimize costs in the early stages of product development. It has also been applied to assembling and machining processes, packaging, transportation and distribution, construction, healthcare and environmental engineering.

Value analysis begins with functional analysis. A function is defined as the characteristics that products/services possess to make them work and sell. In VE, the various functions of a product are first listed accurately based on their priority.

Take the case of a washing machine. The functions to be performed in the order of priority can be listed as—remove dirt, extract water, rinse contents and drain the same. Similarly, in the case of an automobile, various parts perform various functions. The VE project can be broken into sub-projects for various sub-assemblies to facilitate better results. The VE methodology takes the cost of a product or service and allocates it to each function being performed to determine the cost of each function. In conducting value studies, functions are classified as either basic or secondary.

 **Bird's-eye view:**
Value engineering (VE) is a systematic method to improve the “value” of goods or products and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. It is a primary tenet of value engineering that basic functions be preserved and not be reduced as a consequence of pursuing value improvements.

 **Bird's-eye view:**
Value Engineering (VE) is concerned with **new products**. It is applied during product development. The focus is on reducing costs, improving function or both, by way of teamwork-based product evaluation and analysis. This takes place before any capital is invested in tooling, plant or equipment.

Basic functions: These are essential for the product to perform well and sell. In simple terms, they refer to the primary utilitarian characteristic of a product or service to fulfill a user requirement.

Secondary functions: These functions indicate quality, dependability, performance, convenience, attractiveness and other features required beyond those needed to satisfy the minimum requirements specified by the user (basic function).

Functional analysis helps to detect whether minor functions are responsible for a major part of the total cost or vice versa. Moreover, it enables detection of relatively expensive but unimportant parts of a product or aspects of a service.

Bird's-eye view:

Value Analysis (VA) is concerned with **existing products**. It involves a current product being analysed and evaluated by a team, to reduce costs, improve product function or both.

Bird's-eye view:

Value Analysis exercises use a plan which step-by-step, methodically evaluates the product in a range of areas. These include costs, function, alternative components and design aspects such as ease of manufacture and assembly.

Bird's-eye view:

A significant part of VA is a technique called **Functional Analysis**, where the product is broken down and reviewed as a number of assemblies. Here, the function is identified and defined for each product assembly. Costs are also assigned to each one. This is assisted by designing and viewing products as assemblies (or modules).

Benefits of VE

VE can integrate both value-for-money and quality initiatives under a common framework. The long-term benefits of this approach include:

- Best-of-class performance
- Enhanced quality
- Greater employee involvement and better morale

Best-of-class performance: VE not only brings about improvements in function, performance and quality, but also results in improved business processes and reduced project lead times. It facilitates growth of companies even in highly competitive markets. VE provides a framework with which businesses can either close the gap between them and the best in class or maintain the competitive edge where they are currently leading.

Enhanced quality: The quality of products, services, projects and business processes are a function of cost, time and performance. By systematically focusing on these aspects, VE provides a structured approach to enhance quality.

Greater employee involvement and better morale: VE stimulates an improved working culture by motivating employees to contribute to their business environment through team-based workshops. It encourages suggestions and feedback not only from employees, but also from customers and suppliers. Thus, it helps sustain competitiveness.

Box 10.4 discusses the benefits received by some famous corporations after applying VAVE techniques.

Box 10.4 Benefits of VAVE

Dupont Chemicals is a leading manufacturer of chemical products that have applications across various industrial sectors. It has successfully implemented value engineering on more than 300 projects to improve existing processes and to evolve better ones. VE has helped Dupont to save 10 to 12 per cent in project investments for all these projects. This has elevated the company to the best-in-class for project costs as per an analysis of industry benchmarking studies.

Similarly, Xerox Corporation has integrated VE process into their time-to-market product delivery processes. VE enabled Xerox to manufacture and deliver products that meet and even beat customer requirements at the lowest total lifecycle cost. Xerox could thus optimize productivity and efficiency both at the process and the organizational levels.

The US Office of Management and Budget Department applied VE methodology to wastewater treatment projects valuing more than USD10 million. The objective was to deliver safe and effective cost-effective solutions. This resulted in quick, creative and effective solutions such as optimized

environmental impact, maximum and economic utilization of resources, lower lifecycle costs, sustainable environmental solutions and the discovery of alternative technologies.

The best results are achieved when VE methodologies become part of the business culture and are automatically used for problem solving. Better quality and added value to products, projects, services and business processes implies delighted customers and increased profitability and competitiveness.

Source: Adapted from annual reports of NPC, Chennai.

DISCUSSION FORUM

1. Define value.
2. Name the seven classes of values propounded by Aristotle.
3. Name the different categories of economic value.
4. Define VAVE.
5. Explain the benefits of value management.

SUMMARY

- Breakthrough improvement refers to discontinuous change as opposed to the gradual, continuous improvement philosophy of Kaizen. Breakthrough improvements result from innovative and creative thinking. These are often motivated by stretch goals or breakthrough objectives.
- Creativity is the ability to think and act in ways that are new and novel. Creativity can be divided into two types—innovation and invention. Innovation is thinking creatively about something that already exists. Invention is creating something that did not exist before. The creative process for an idea involves five stages—germination, preparation, incubation, illumination and verification.
- The Six Thinking Hats method is a creativity technique to solve problems and arrive at decisions. Dr Edward de Bono developed the Six Thinking Hats method in the early 1980s. The method is a framework for thinking and can incorporate lateral thinking. The six hats represent six modes of thinking and are directions to think rather than labels. CREATIVES is a technique that can be used to spark creativity and overcome challenges.
- Brainstorming is a method for developing creative solutions to problems. It works by focusing on a problem, and then deliberately coming up with as many unusual solutions as possible and by pushing the ideas as far as possible. It is a tool for maximizing a group's creativity in problem solving.
- Innovation is the embodiment, combination or synthesis of knowledge in original, relevant, valued new products, processes or services. Systematic innovation consists of purposeful and organized search for changes. The lifecycle of innovation can be described with the help of S curve.
- There are two types of innovation—incremental and radical. Incremental innovation exploits existing forms or technologies. It either improves something that already exists, making it “new and improved,” or reconfigures an existing form or technology to serve

some other purpose. A radical innovation is something new to the world. Radical innovation typically leads to the discovery of new markets and applications.

- Genrich S. Altshuller is known as the father of the Theory of Inventive Problem Solving (Teoriya Rezbenija Izobretatelashib Zadach—TRIZ). Altshuller defined an inventive problem as one in which the solution causes another problem to appear. In the 1960s and 1970s, Altshuller categorized solutions into five levels. He also noted that with each successive level, the source of the solution required broader knowledge and more solutions to consider before an ideal one could be found.
- Altshuller extracted 39 standard technical characteristics that cause conflict from over 1,500,000 world-wide patents. These are called the 39 engineering parameters. Altshuller also extracted 40 inventive principles from world-wide patents. These are hints that will help an engineer find a highly inventive (and patentable) solution to the problem.
- Value is a personal perspective of your willingness to pay for the performance delivered by a product, process or project. VAVE is a generic name given to the technique of value analysis and value engineering.
- The seven classes of values propounded by Aristotle are economic value, political value, social value, aesthetic value, ethical value, religious value and judicial value. Value engineering can integrate both value-for-money and quality initiatives under a common framework. Long-term benefits of this approach include best-of-class performance, enhanced quality, greater employee involvement and better morale.

Key Terms

39 Engineering Principles	343	Judicial Value	348
40 Inventive Principles	341	Political Value	347
Aesthetic Value	347	Preparation	329
Breakthrough Improvement	326	Radical Innovation	337
CREATES	332	Religious Value	348
Creativity	328	S Curve	338
Economic Value	347	Six Thinking Hats	330
Ethical Value	347	Social Value	347
Germination	329	Systematic Innovation	336
Illumination	329	TRIZ	341
Incremental Innovation	337	Value Analysis	346
Incubation	330	Value Engineering	346
Innovation	327	VAVE	347
Invention	327	Verification	330

Case Study

Crescent Chemicals and Pharmaceuticals Limited

Crescent Chemical and Pharmaceuticals Ltd is one of the oldest and pioneering drug manufacturing companies in Calcutta. It has gained a high reputation because many of its patented

drugs and pharmaceutical products are distributed through a wide network of sales outlets across the country. It was obliged to make a serious effort to reduce total product cost due to the increase in competition, both from small and large-scale manufacturers. However, this seemed impossible immediately due to the steep and steady rise in the prices of heavy and basic chemicals and other raw materials. The company management then decided to analyse the requirements of the second-largest group of items in the purchase budget, i.e. packing materials. The group-wise annual purchase requirements of the company is given in Exhibit 10.1.

It was seen that out of the total annual requirements of stores of Rs 16 million, the packing material accounted for two-thirds of the money value of raw materials and laboratory chemicals. Therefore, even a slight reduction in the cost of these items was seen to be able to yield a large sum of savings, which would be available for deployment in other spheres of activities of the company. However, the preservative and protective characteristics of packing materials could not be sacrificed.

Several senior officials were grouped to form a value analysis team in order to explore the possibilities of cost reductions and make recommendations to control costs. The chief chemist, designer, chiefs of purchases, stores and packing departments as well as costs and works accountants, works manager and marketing manager were clubbed together to present their respective view points.

A broad analysis revealed that the packing costs had soared in recent years due to the heavy breakage of glass bottles, jars and other containers. This was attributed to a large extent to improper handling and the brittleness of glass. In an effort to substitute, the chief chemist isolated at least 15 items on the product line for which glass bottles and container neither enhanced any functional utility, nor acted as preservatives.

A detailed probe revealed that in many cases, container design and shape could be conveniently changed to standard sizes and shapes. A switchover scheme for these container items from glass to moulded plastics with caps (with polythene packs inside for pilfer proofing) was considered. It was worked out that about three per cent of net savings of the total packing costs could be affected as this would reduce breakages substantially.

A report from the packing department showed that it required extra hands for this item wise conversion for filling.

The marketing manager, however, objected to the plan on the ground that such a sudden switchover would create some marketing problems. This had to be heavily advertised and brought to the notice of the ultimate consumers, who had been accustomed to the company's product being available in traditional packs. Since the company name was etched on each

Exhibit 10.1 Total Annual Requirements

Sl No.	Particulars	Amount (in Million Rupees)
1.	Raw material and laboratory chemicals—heavy chemicals, basic drugs and fine chemicals	8
2.	Packing materials—printed and unprinted cardboard boxes, glass bottles, jars and other containers, ampoules, pilfer-proof caps, foil, etc.	6
3.	Miscellaneous items—general stationary, safety items, uniforms, etc.	1
4.	Main stores—electrical items, general lighting equipments, spares and stores for batch printing	0.6
5.	Printing items—for packing and general administrative purposes	0.4
Total		16

glass bottle, container, etc. he apprehended a shift of custom to other companies' products with unscrupulous traders taking advantage of these situations.

Mr Sarkar, the purchase manager, however, did not agree and argued that the company's name could be printed and moulded on plastic packs. The marketing manager was then approached with drawings of attractive designs and colours for various container shapes. After going through the drawings, he withdrew his initial objections satisfied that the proposal of substitution was both technically sound and economically feasible.

All that was done was a cost comparison of various cost components from functional utilities as well as the cost of acquisition, carrying and handling before and after substitution. The overall sales turnover at the end of financial year actually increased in spite of the gloomy projections of sales by the marketing manager. This increased sales turnover fully justified the additional expenditure on sales promotion activities.

For Discussion

1. Was the initial objection of the marketing manager valid? Do you agree with his views?
2. At the end of the year, the marketing manager contended that target sales were achieved through vigorous sales promotion activities and he had been requesting for an increase in the budget for sales promotion all along. Do you agree with the same?
3. Prepare a report on value analysis based on the data given in the case study.

Short-answer Questions

1. Define creativity.
2. Differentiate between the terms creativity, invention and innovation.
3. Mention the steps involved in the creative process.
4. Name the two main types of innovation.
5. Mention the six thinking hats.
6. What do you mean by CREATES?
7. Define brainstorming.
8. Define TRIZ.
9. Write a brief note on the S curve.
10. Name the 39 engineering parameters used in TRIZ.
11. Name the 40 inventive principles used in TRIZ.
12. Name the different types of values.
13. Define the term VAVE.

Match the Following

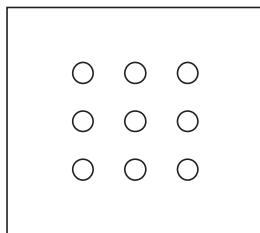
- | | |
|---------------|---|
| a. White hat | Supports why it may work |
| b. Green hat | Provides guidance to the thinking direction |
| c. Yellow hat | Gives the rationale for why it may not work |
| d. Red hat | Presents information and data |
| e. Black hat | Provides creative thinking |
| f. Blue hat | Feedbacks feelings and intuition |

Discussion Questions

1. Explain the creative process with an example.
2. Describe the uses of the six thinking hats with an example.
3. Comment on the statement, “It is easier to tone down a wild idea than to think up a new one.”
4. Explain the S curve.
5. Discuss the benefits of VAVE.
6. Prepare a comparative analysis on the applicability of different values.
7. Explain the different types of economic values.

Projects

1. Solve the three lateral thinking puzzles given below:
 - (a) The police raid a house to arrest a suspected murderer acting on an anonymous phone call. They don't know what he looks like, but they know his name is John. They find a carpenter, a taxi driver, a car mechanic and fireman playing cards inside. They immediately arrest the fireman without even asking his name. How do they know they've got their man?
 - (b) A murderer is condemned to death. He has to choose between three options in three rooms. The first is full of raging fires, the second is full of assassins with loaded guns and the third is full of lions that haven't eaten in 3 years. Which room is safest for him?
 - (c) Look at the picture below with the nine dots. Can you connect the nine dots using 4 straight lines without lifting your pencil from the paper and without retracing any lines?

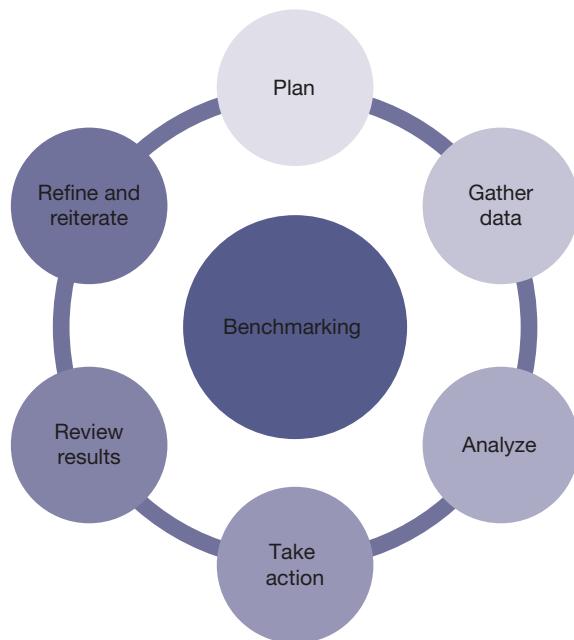


2. Select a problem of your choice and conduct a brainstorming session.

End Notes

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Benchmarking



BENCHMARKING AT XEROX CORPORATION

Xerox Corporation is an American global corporation that sells business services and document technology products. In the early 1980s, Xerox found itself increasingly vulnerable to intense competition from US and Japanese competitors. According to business analysts, Xerox's management failed to give strategic direction to the company. Xerox also suffered from its highly centralized decision-making processes. It ignored new entrants such as Canon, Ricoh, and Sevin who were consolidating their positions in niche market segments. The company's operating cost and prices of its products were high and quality was relatively poor in comparison to competitors. Between 1980 and 1984, Xerox's profits decreased from \$1.15 billion to \$290 million.

In 1982, David T. Kearns took over as the CEO. He discovered that the average manufacturing cost of copiers in Japanese companies was 40–50% of that of Xerox. Kearns emphasized on the reduction of manufacturing costs and as part of quality programme, introduced a benchmarking programme, 'Leadership Through Quality', to revitalize the company. Xerox collected data on key processes of the best practice companies and analysed them to

identify and improve opportunities. These initiatives played a major role in pulling Xerox out of trouble in a few years.

The company became one of the best examples of successful implementation of benchmarking. Similarly, Xerox also benchmarked other processes with various best practice companies. These included DuPont (for manufacturing safety); Fuji Xerox (for manufacturing operations); Toyota (for quality management); Hewlett-Packard (for research and product development); American Express (for billing and collection); Cummins Engines, and Ford (for factory layout); Florida Power and Light (for quality improvement); and Honda (for supplier development).

Bird's-eye view:

Benchmarking is the process of comparing one's business processes and performance metrics to industry bests and best practices from other companies. Dimensions typically measured are quality, time and cost.

“Benchmarking is a way to go backstage and watch another company’s performance from the wings, where all the stage tricks and hurried realignments are visible.”

The Wall Street Journal

Upon completion of this chapter, you will be able to:

1. Understand the essence of benchmarking
2. Identify the evolution of benchmarking
3. Explain the process of benchmarking
4. Identify the types of benchmarking
5. Understand the advantages and limitations of benchmarking

Bird's-eye view:

In the process of best practice benchmarking, management identifies the best firms in their industry, or in another industry where similar processes exist, and compares the results and processes of those studied (the “targets”) to one’s own results and processes.

■ INTRODUCTION

Benchmarking is a method of improving business performance by learning from others. The essence of benchmarking lies in the continuous process of comparing a company's strategies, products and processes with those of world leaders and the best-in-class organizations in order to learn how they achieved excellence, and then setting out to match and even surpass it. For many companies, benchmarking has become a key component of their TQM programmes.

■ BENCHMARKING: WHAT IS IT?

Benchmarking can be defined as a process for improving performance by constantly identifying, understanding and adapting best practices and processes followed inside and outside the company and implementing the results. The main emphasis of benchmarking is not on “best performance” but on improving a given business operation or a process by exploiting “best practices.”

“Benchmarking is the process of identifying, understanding and adapting outstanding practices and processes from organizations anywhere in the world to help your organization improve its performance.”

—American Productivity and Quality Centre

Bird's-eye view:

Benchmarking then allows organizations to develop plans on how to make improvements or adapt specific best practices, usually with the aim of increasing some aspect of performance. Benchmarking may be a one-off event, but is often treated as a continuous process in which organizations continually seek to improve their practices.

"Benchmarking is an on-going outreach activity; the goal of the outreach is identification of best operating practices that, when implemented, produce superior performance."

—Bogan and English, *Benchmarking for Best Practices*

Benchmark refers to a measure of best practice performance. Benchmarking is the search for the best practices that yield the benchmark performance with a focus on how you can apply the process to achieve superior results.

Benchmarking is the systematic search for best practices, innovative ideas and highly effective operating procedures. It considers the experiences of others and uses it. It measures performance against that of the best-in-the-class organizations. It determines how the best-in-the-class achieve those performance levels, and uses the information as the basis for adaptive creativity and breakthrough performance.¹

■ AN OVERVIEW OF BENCHMARKING

Benchmarking is the process of gathering, analysing and evaluating the world outside your organization and comparing it to your own. The result of this process becomes the cornerstone of the organization's improvement. It is dependent on the organization's determination to discover and continuously monitor industry leaders and the best practices they employ in business. Though the process is deceptively simple, it requires much time for planning, implementation and interpretation of data.

The secret underlying benchmarking is the notion of "best." The way we define and use "the best" will determine the yardstick used to define and measure performance. Once this characteristic has been defined and measured by the organization, this knowledge is used to evaluate and/or improve your own processes.

Bird's-eye view:

The company that invented photocopier in 1959 and maintained a virtual monopoly for many years thereafter, like "Coke" or "Kleenex," "Xerox" became a generic name for all photocopiers. By 1981, however, the company's market shrank to 35% as IBM, Kodak developed high-end machines and Canon, Richo, and Savin dominated the low-end segment of the market. The Xerox vice president of copier manufacturing remarked, "we were horrified to find that Japanese were selling their machines at what it cost us to make ours...we had been benchmarking against ourselves. We weren't looking outside."

■ THE EVOLUTION OF BENCHMARKING

Benchmarking has been around for a long time. In the 1800s, Francis Lowell, a New England colonist studied British textile mills and imported many ideas along with improvements he made for the burgeoning American textile mills.

Formally, benchmarking may have evolved in the 1950s when W. Edwards Deming taught the Japanese the idea of quality control. The method was rarely used in the United States until the early 1980s when IBM, Motorola and Xerox became the pioneers. Xerox is one of the best known examples of organizations that have implemented benchmarking.

Xerox invented the photocopier in 1959, and maintained a virtual monopoly for many years to the extent that its name became a generic name for all photocopiers. However, by 1981, the company's market shrank to 35 per cent as IBM and Kodak developed high-end machines and Canon, Richo, and Savin dominated the low-end segment of the market. The company was suffering from the "not invented here" syndrome as its managers did not want to admit that they were not the best. The company then instituted the benchmarking process. However, this was initially resisted. When faced with the facts, reaction went from denial to dismay to frustration and finally to action. Once the process began, the company benchmarked virtually every function and task for productivity, cost and quality. The results of benchmarking were dramatic:

- Quality problems were cut back by two-thirds.
- Suppliers were reduced from 5,000 to 300.
- Manufacturing costs went down by half.

- Development time was cut by two-thirds.
- “Concurrent engineering” was practised. Each product development group secured inputs from the design, manufacturing and services department from the initial stages of the project.
- Commonality of parts increased from about 20 per cent to 60–70 per cent.
- Direct labour was cut by 50 per cent and corporate staff went down by 35 per cent while increasing volume.
- The hierarchical organizational structure was pared, and use of cross-functional “Teams Xerox” was established.

Benchmarking created a climate of change and continuous improvement in the organization. Xerox became the only company worldwide to win all the three prestigious quality awards—the Deming Prize (Japan) in 1980, the Malcolm Baldridge National Quality Award in 1989 and the European Quality Award in 1992. The company’s document outsourcing division, Xerox Business Services, also won the Baldridge Award in the service category in 1997. Additionally, over the years, Xerox won quality awards in Argentina, Australia, Belgium, Brazil, Canada, China, Colombia, France, Germany, Hong Kong, India, Ireland, Mexico, the Netherlands, Norway, Portugal, the UK and Uruguay. This success is mainly attributed to the “leadership through quality” initiative, and to the positive intervention of benchmarking practices.

The success of benchmarking at Xerox motivated many companies to implement benchmarking practices. By the mid-1990s, many companies such as Ford, AT&T, IBM, GE, Motorola and Citicorp implemented benchmarking practices at their divisions across the world and derived many benefits. During the 1990s, Xerox, along with Ford, AT&T, Motorola and IBM, created the International Benchmarking Clearinghouse (IBC) to promote benchmarking and guide other companies across the world in benchmarking efforts. The institute offers information on various companies and best practices through its electronic bulletin board. More than 100 companies joined the IBC to gain access to its extensive database. By 2001, benchmarking had become a common phenomenon in many companies globally. Table 11.1 indicates the evolution of benchmarking.

Table 11.1 Evolution of Benchmarking

Time	Type	Description
First generation	Reverse engineering	Reverse engineering (RE) is the process of discovering the technological principles of a device, object or system through the analysis of its structure, function and operation
Second generation	Competitive benchmarking	Continuous process of comparing a firm’s practices and performance measures with that of its most successful competitor(s)
Third generation	Process benchmarking	The initiating firm focuses on its observation and investigation of business processes with a goal of identifying and observing the best practices from one or more benchmarked firms
Fourth generation	Strategic benchmarking	Involves observing how others compete
Fifth generation	Global benchmarking	Benchmarking with the partners across the globe



Bird’s-eye view:

The essence of benchmarking is the continuous process of comparing a company’s strategy, products, processes with those of the world leaders and best-in-class organizations. The purpose is to learn how the achieved excellence, and then setting out to match and even surpass it.



Bird’s-eye view:

Robert Bob Camp, one of the pioneers of organizational benchmarking, defined benchmarking as “the search for industry best practices that lead to superior performance.” This search is done in a study, generally over a specific period of time, with companies reporting on agreed upon data. The result of the study is often a case to make improvements in key business processes.

Bird's-eye view:

Benchmarking goes beyond competitive analysis to understanding the competitor's output and process of obtaining the output. The advantages of benchmarking include enabling organizations to outperform competitors, opening minds to new ideas, and placing organizations in a continuous improvement mode.

Bird's-eye view:

A primary advantage of benchmarking is that it sets the foundation of performance improvement aimed at enhancing competitiveness. By showing how to better competitors, benchmarking ensures the basic survival of the business.

■ ADVANTAGES OF BENCHMARKING

A benchmarking study results in valuable data that can stimulate thought-provoking discussions with key stakeholders. The results provide answers to the following key questions for the company:

- How well are we performing compared to other companies?
- What are best practices?
- What improvement opportunities should we focus on?

Establishing operating targets based on the best possible industry practices is critical to the success of any organization. Benchmarking can benefit organizations by:

- Helping to identify the current position of your business and determining priorities for improving environmental performance.
- Allowing comparisons with previous benchmarking profiles and against recognized best practices.
- Encouraging regular monitoring of progress and a programme of continuous improvement.
- Increasing the competitiveness of the organization by demonstrating environmental improvements to customers and shareholders.

Toyota is a brand name closely associated with the term "benchmark" when it pertains to the automotive industry. Toyota is benchmarked as the best-in-the-class by all of its peers and competitors throughout the world for high quality, high productivity, manufacturing speed and flexibility. Toyota automobiles have consistently been at the top of quality rankings in surveys conducted by J D Powers and Associates, consumer reports and others for many years. Much of Toyota's success comes from its astounding reputation for quality. Many organizations in India have also used the benchmarking technique to great success. Box 11.1 discusses how the NTR Trust, a social organization in Andhra Pradesh, India, set a global benchmark in maternal mortality.

DISCUSSION FORUM

Bird's-eye view:

Benchmarking quantifies the gap between the expected performance and the actual state; in the process it drives home uncomfortable facts and harsh realities about the business. This provides the organization with both the reason to improve and a definition of what constitutes improvement.

1. Define benchmarking.
2. Trace the evolution of benchmarking.
3. Explain the benefits of benchmarking.

Box 11.1 NTR Trust Sets Global Benchmark in Maternal Mortality

The NTR Trust was founded in 1997 in memory of N. T. Rama Rao, the late Chief Minister of Andhra Pradesh. The trust is committed to the economic empowerment of the people of Andhra Pradesh. The trust is known for its pioneering social work in the areas of health care, education and training. The key focus areas of the trust are primary health care, blood banks, women and child welfare, entrepreneurial skills and career development covering nearly 0.7 million beneficiaries.

The trustee decided to benchmark services given to its beneficiaries against United Nations stipulations. The millennium goals, set by the United Nations, stipulate that the ratio of maternal mortality should be reduced by three-quarters between 1990 and 2015. The maternal mortality

across the world is 400 per 100,000 as against India's 300 per 100,000. In Andhra Pradesh, the rate is 195 per 100,000.

The trust's healthcare programme *Thalli Bidda Samrakshana Padhakam*, run in association with four leading medical institutions set a benchmark in health care by minimizing maternal mortality in 257 villages in various parts of Andhra Pradesh. The trust's achievement in women and child welfare has surpassed Indian and global maternal mortality goals. The distinction has been achieved by minimizing the maternal deaths to two in 15,000 deliveries in 257 villages. This was achieved in the shortest possible time of 24 months between December 2006 and December 2008.

Source: Adapted from www.ntrtrust.org, accessed on 30 June, 2016.

Bird's-eye view:

A permanent benchmarking program forces organizations out of their comfort zones and provides specific and measurable short-term improvement plans based on current reality rather than historical performance.

■ TYPES OF BENCHMARKING

Benchmarking is a versatile tool that can be applied in a variety of ways to meet a range of requirements. Different terms are used to distinguish the various ways of applying benchmarking procedures to existing practices. The first word in each term relates to either the type of partner or the purpose of benchmarking. At the outset of benchmarking projects, it is vital to be clear on exactly what needs to be achieved through benchmarking and then apply an appropriate methodology.

Standard benchmarking terms include:

1. Strategic benchmarking
2. Performance benchmarking or competitive benchmarking
3. Process benchmarking
4. Functional benchmarking or generic benchmarking
5. Internal benchmarking
6. External benchmarking
7. International benchmarking

Bird's-eye view:

Very often, organizations set goals based on past trends and established internal patterns. Benchmarking helps remove such "paradigm blindness" and forces the organization to take a fresh approach to goal setting based on a broader perspective, including the external perspective, the most critical factor that drives customer expectations.

■ 1. Strategic Benchmarking

Strategic benchmarking is used where businesses need to improve overall performance by examining the long-term strategies and general approaches that have enabled high performers to succeed. It involves considering high-level aspects such as core competencies, developing new products and services and improving capabilities for dealing with changes in the external environment. Changes resulting from this type of benchmarking may be difficult to implement and may take a long time to materialize. This type of benchmarking is suitable when the company has to realign business strategies that have become inappropriate.

Bird's-eye view:

The various types of benchmarking are: Strategic Benchmarking, Performance Benchmarking or Competitive Benchmarking, Process Benchmarking, Functional Benchmarking or Generic Benchmarking, Internal Benchmarking, External Benchmarking, International Benchmarking.

■ 2. Performance Benchmarking

Performance benchmarking or competitive benchmarking is used when organizations consider their positions in relation to performance characteristics of key products and services. Benchmarking partners are usually drawn from the same sector. It is common practice for companies to undertake this type of benchmarking processes through trade associations or third parties to protect confidentiality.

Bird's-eye view:

Benchmarking is usually treated as a structured process. The structure is best provided by the development of a step-by-step model. It is important that the benchmarking process be customised to the needs, capabilities and culture of the individual organisation.

This type of benchmarking is suitable for assessing relative levels of performance in key areas or activities in comparison with others in the same sector to find ways of closing gaps in performance.

■ 3. Process Benchmarking

Process benchmarking is used by the organization when the focus is on improving specific critical processes and operations. Benchmarking partners are sought from best practice organizations and are drawn from the same sector. Process benchmarking invariably involves producing process maps to facilitate comparison and analysis. This type of benchmarking is suitable for achieving improvements in key processes to obtain quick and short-term benefits.

■ 4. Functional Benchmarking

Functional benchmarking or generic benchmarking can lead the organization to innovation and dramatic improvements. It is used when organizations look to benchmark with partners drawn from different business sectors or areas of activity to find ways of improving similar functions or work processes. This type of benchmarking is suitable for improving activities or services for which counterparts do not exist.

■ 5. Internal Benchmarking

Bird's-eye view:

Benchmarking has to be seen as integral to the business strategy - not just an add-on. What is benchmarked must be important to the whole organization.

Internal benchmarking involves seeking partners from within the same organization and from business units located in different regions. The main advantages of internal benchmarking are access to sensitive data and information, availability of standardized data and the whole process requiring less time and resources. There may be fewer barriers to implementation as practices may be relatively easy to transfer across the same organization. However, this process has certain limitations. Real innovation and best practices are more likely to be found through external benchmarking. This type of benchmarking is suitable when several business units within the same organization exemplify good practice and management and want to spread this expertise quickly throughout the organization.

■ 6. External Benchmarking

External Benchmarking involves analysing outside organizations that are known to be the best-in-the-class. External benchmarking provides opportunities of learning from those who are at the "leading edge." This type of benchmarking can take up significant time and resources to ensure the comparability of data and information and the credibility of the findings and development of sound recommendations. This type of benchmarking is suitable where examples of good practices can be found in other organizations and there is a lack of good practices within internal business units.

■ 7. International Benchmarking

This is used when the best practitioners are located in other countries. This is due to globalization and advances in information technology. There is a need for careful analysis and interpretation due to national differences.

This type of benchmarking is suitable where the aim is to achieve world-class status or simply because there are insufficient "national" businesses against which to benchmark. Box 11.2 illustrates the benchmarking of business schools in India for tracking and building quality.

Box 11.2 Benchmarking of B-Schools—Tracking and Building Quality

Business India was the first business magazine to report on the best business schools in India way back in 1982. The *Business India* group was also the first media house to team up with the All India Management Association (AIMA) to bring out the largest B-School Rating and Ranking exercise in the country. The surveys conducted by the group filled an important gap because there was hardly any information or benchmarks available about good quality business schools in the country.

The benchmarking survey was conducted using an online format, which was the first by any media house in tune with the emerging technologies. The easy to respond, user friendly online format allowed the business schools to keep visiting their completed questionnaires many number times to update and validate their information before submitting them finally. *Business India* had an overwhelming response to their online format with over 150 B-schools registering with them on the Web site. The survey questionnaire was also mailed to each individual B-school from their database of over 1,800 B-schools.

Once the benchmarking data was collected and analysed, it was distributed through a benchmarking report internally within the institutions and externally to benchmarking partners for the implementation of improved processes. The overall goal was the adoption of process enablers in the home institutions to achieve effective quality improvement. Benchmarking was more than just gathering data. It involved adapting a new approach of continually questioning how processes were performed, seeking out best practices and implementing new models of operation.

Source: Adapted from www.bibschooldsurvey.com, accessed on 30 June, 2016.

Bird's-eye view:

The Five major steps in benchmarking are: Planning, Analysis, Integration, Action and Maturity.

Bird's-eye view:

The Planning phase involves: What to benchmark and whom to benchmark.

Bird's-eye view:

The Analysis phase involves: Goal setting for improved performance and communicating findings and gain acceptance

DISCUSSION FORUM

1. What are the various types of benchmarking?
2. What are the requirements for a successful benchmarking model?
3. How does the organization decide on the type of benchmarking?

Bird's-eye view:

The integration phase involves: Establishing new functional goals and to develop action plan for implementation.

■ DESIGNING THE BENCHMARKING PROCESS

Benchmarking can be applied to virtually any business or production process. Improvements to the best-in-the-class levels in some areas will contribute greatly to market and financial success, whereas improvements in other areas will not have a significant impact. Organizations that benchmark adapt the process to best fit their own needs and culture. The logical process flow involved in benchmarking is given in Figure 11.1.

■ Phases in the Benchmarking Process²

Although the number of phases in the process may vary from organization to organization, the following five phases contain the core techniques:

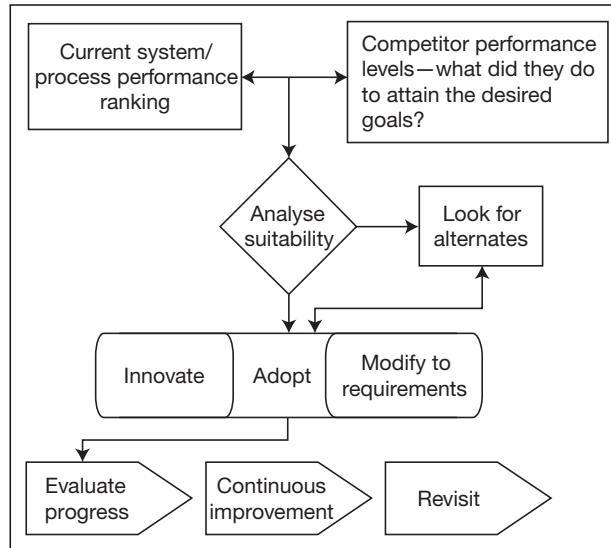
1. Planning
2. Analysis
3. Integration
4. Action
5. Maturity

Bird's-eye view:

The action phase involves: Implementing Specific Actions and Monitor Progress and to recalibrate benchmarks to keep the process continuous.

Bird's-eye view:

The Maturity phase involves: To attain leadership position and practices fully integrated into process and to keep the process continuous.

Fig. 11.1 Benchmarking—Logical Process Flow

Bird's-eye view:

Benchmarking is the process of researching and identifying industry best practices to enable organizational leaders to establish performance goals and quality improvement projects. Based on company-to-company comparisons of processes and practices, organizations can identify the “best of the best” in order to attain or maintain a competitive edge.

1. **Planning:** This phase involves answering the following questions:
 - What is to be benchmarked? Which processes cause the most trouble?
 - Which processes contribute most to customer satisfaction and which are not performing up to expectations?
 - What are the competitive pressures impacting the organization the most?
 - What processes or functions have the most potential for differentiating our organization from the competition?
 - To whom or what will we compare?
 - How will the data be collected?
2. **Analysis:** The analysis phase should involve a careful understanding of your current processes and practices as well as those of the organizations being benchmarked. What is desired is an understanding of internal performance on which to assess strengths and weaknesses. The following questions may then be asked:
 - Is there a gap between the organization’s performance and that of the best-in-the-class organizations?
 - What is the gap? How much is it?
 - Why is there a gap? What does the best-in-the-class do differently, that is better?
 - If best-in-the-class practices were adopted, what would be the resulting improvement?

Benchmarking studies can reveal three different outcomes. External processes may be significantly better than internal processes (a negative gap). Process performance may be approximately equal (parity) or the internal processes may be better than that found in external organizations (positive gap). Negative gaps call for a major improvement effort. Parity requires further investigation to determine if improvement opportunities exist. The finding of a positive gap should result in recognition for the

internal process. When best-in-the-class processes have been described and quantified, additional analysis is necessary to determine the root causes of the gaps. Gaps are a result of process practices themselves, general business practices and the organizational and operational structures.

3. **Integration:** Integration is the process of using benchmark findings to set operational targets for change. It involves careful planning to incorporate new practices and to ensure that benchmark findings are incorporated in all formal planning processes.

When benchmarking studies reveal a negative gap in performance, the objective is to change the process to close the gap. Benchmarking is a waste of time if change does not get implemented as a result. To effect change, the findings must be communicated to the people who can enable improvements within the organization. The findings must translate into goals and objectives. Action plans must be developed to implement new processes.

4. **Action:** Action plan for change also should contain milestones for updating the benchmark findings and an ongoing reporting mechanism. Progress toward benchmark findings must be reported to all employees. The generic steps for the development and execution of action plans are:

- (a) Specify tasks
- (b) Sequence tasks
- (c) Determine resource needs
- (d) Establish task schedules
- (e) Assign responsibility for each task
- (f) Describe expected results
- (g) Specify methods for monitoring results

5. **Maturity:** Maturity will be attained when best industry practices are incorporated in all business processes, thus ensuring superiority. Maturity is also achieved when benchmarking becomes an ongoing, essential and self-initiated facet of the management process. Benchmarking is a tool for continuous improvement. It is not to be undertaken to create one permanent improvement and thereby miss the opportunity for future improvements. In order to avoid complacency, benchmarking must be used continuously to pursue emerging new ideas. Figure 11.2 displays the phases in the benchmarking process. Table 11.2 illustrates how Xerox and AT&T have adapted benchmarking to their own needs. Box 11.3 illustrates the impact of benchmarking at AT&T and Box 11.4 illustrates how Ford gained its competitive edge by benchmarking against Japan's Mazda.

Bird's-eye view:

Almost any activity can be benchmarked. Even the most complex activities can be broken down into component steps or parts for comparison with those in organisations demonstrating good practice. Even processes that are not directly comparable with those in other organisations can be benchmarked using Functional Benchmarking.

Bird's-eye view:

Managers compare the performance of their products or processes externally with those of competitors and best-in-class companies and internally with other operations within their own firms that perform similar activities.

Bird's-eye view:

The objective of Benchmarking is to find examples of superior performance and to understand the processes and practices driving that performance. Companies then improve their performance by tailoring and incorporating these best practices into their own operations—not by imitating, but by innovating.

DISCUSSION FORUM

1. What are the various steps in benchmarking?
2. Name the critical factors for successful benchmarking.
3. Discuss how Xerox gained a competitive advantage by benchmarking.

Bird's-eye view:

Advantages of Benchmarking

- o It focuses the areas which should be given special attention.
- o Helps a company discovering various new ideas and way of working.
- o Helps in achieving improvement based on the past performance

Limitations of Benchmarking

- o Benchmarking does not contribute to solving the issues in hand.
- o Benchmarking simply compares the numbers. It does not take into account the micro and macro factors that led to your competitor or industry leader succeed or fail.

Fig. 11.2 Benchmarking Phases

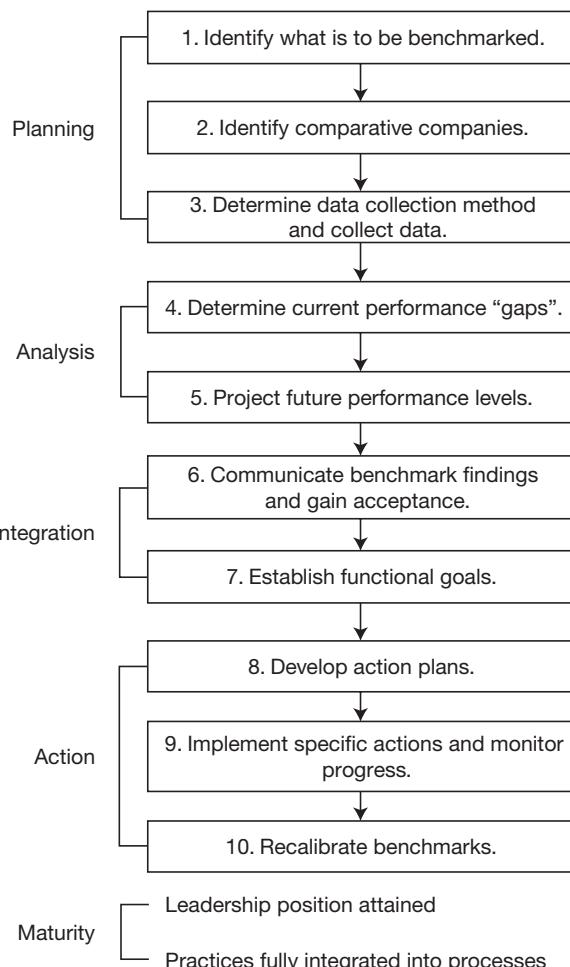


Table 11.2 Approaches to Benchmarking

Sl No.	Xerox's Ten-step Process	AT&T's Twelve-step Process
1.	Identify what is to be benchmarked	Determine clients who will use the information to improve their processes
2.	Identify comparative organizations	Advance the clients from the literacy stage to the champion stage
3.	Determine data collection method and collect data	Test the environment. Make sure the clients can and will follow benchmarking findings
4.	Determine current performance gap	Determine urgency. Panic or disinterest indicates little chance for success
5.	Project future performance levels	Determine the scope and type of benchmarking needed
6.	Communicate benchmark findings and gain acceptance	Select and prepare the team

(Continued)

Table 11.2 (Continued)

Sl No.	Xerox's Ten-step Process	AT&T's Twelve-step Process
7.	Establish functional goals	Overlay the benchmarking process onto the business planning process
8.	Develop action plans	Develop the benchmarking plans
9.	Implement specific actions and monitor progress	Analyse the data
10.	Recalibrate benchmarks	Integrate the recommended actions
11.		Take action
12.		Continue improvement

 **Bird's-eye view:**

The pre-requisite for benchmarking include: corporate culture of quality and the basic components of TQM such as information systems, process control, and human resource program.

Box 11.3 Impact of Benchmarking at AT&T

AT&T Inc. is one of the world's largest telecommunications holding companies and is the largest in the United States. Operating globally under the AT&T brand, AT&T companies are recognized as the leading world-wide providers of IP-based communications services to business and as the leading providers of high-speed DSL Internet, local and long distance voice, and directory publishing and advertising services in the United States.

While companies such as Motorola, Ford, DuPont and Xerox have routinely benchmarked their manufacturing operations, AT&T with the help of the accounting firm Coopers & Lybrand has benchmarked its cash management operations. Operations benchmarked include cash positioning, cash concentration, cash mobilization funds transfer and cash transactions accounting.

First, AT&T determined the areas to benchmark and the companies to benchmark against. Then, it determined the indicators that would be measured and collected data by interviewing other companies, conducting surveys, and reading technical journals and advertisements. It analysed the data and determined the best-in-the-class from each identified benchmark. AT&T then evaluated its progress against the benchmarks and decided on the best way to improve operations.

As a result of its extensive benchmarking effort, AT&T increased automated clearinghouse usage, increased electronic data interchange/electronic funds transfer focus, enhanced training and education, created a quality consultant position, reduced management and staffing, consolidated operations and systems, combined banking and cash management functions, simplified its banking network and reduced the number of its bank accounts.

Source: Adapted from www.benchmarkingbestminds.com, on 30 June, 2016.

 **Bird's-eye view:**

In launching a benchmarking project, the first step is to decide what standard of comparison to use — pools or surveys of competitors, companies in other industries, customers, or other divisions or facilities within one's own company.

 **Bird's-eye view:**

Once companies have identified best practices and assessed how their own practices compare to these gold standards, they must next plan how to bridge the gap and then execute the planned actions.

■ PREREQUISITES FOR BENCHMARKING

Benchmarking will not improve performance if the proper infrastructure for a total quality programme is not in place. Unless a corporate culture of quality and the basic components of TQM such as information systems, process control and human resource programmes are in place, trying to imitate the best-in-the-class may very well disrupt operations. The requirements are:

- Involve the employees who will ultimately use the information and improve the process. Participation can lead to enthusiasm.
- Relate process improvement to strategy and competitive positioning. Design factors that affect the customer's purchasing decision.

 **Bird's-eye view:**

Companies that eschew rigorous benchmarking exercises are destined to lose their way in the competitive fray and become second-rate performers.

 **Bird's-eye view:**

Companies must be prepared to change their organizations in light of the findings of their benchmarking studies. If the results of these studies are tucked away into vinyl binders without any follow-up actions, their paybacks will be zero.

Box 11.4 Benchmarking at Ford and Mazda

Ford recognized the need to benchmark in order to continuously improve its processes. In 1980, Ford decided to benchmark against Mazda in Japan, a company in which it had a 25 per cent stake. A Ford team visited Mazda in Japan. Their mission was to make an in-depth analysis of processes. It was found that Ford's accounts payable department had nearly 500 people in the United States while Mazda had only nine members in its accounts payable department. A gap like this was just too hard to ignore. The company recognized that massive improvements were needed to stay competitive and combat its diminishing market share.

Ford undertook further benchmark studies impacting accounts payable performance. This assisted them in identifying three important business differences: (1) Ford had more suppliers than Mazda, (2) Ford captured and matched more data elements on each payment transaction and (3) Ford's payments were triggered by invoices from its suppliers whereas Mazda's processes did not. Ford mapped out the basic business processes and found that Mazda was missing some steps. Ford decided on a programme of instituting a supplier review, re-engineering the requisitioning, receiving and payment process and automating the information flow between it and its suppliers.

Ford decided to implement a programme of redefining the terms of invoice, standardizing payment terms on a total supplier basis, communicating with suppliers to assure them sufficient controls existed, instituting disciplined receiving practices for inventory and payment control purposes and ensuring that all terms and conditions were on the purchase order. The change programme drastically improved efficiency in operations. The training provided to suppliers and changes in practices resulted in an 80 per cent reduction in accounts payable staffing requirements.

Source: Adapted from www.benchmarkingnetwork.com, accessed on 30 June, 2016.

- Define your own processes before gathering data or you will be overwhelmed and will not have the data to compare your own processes with.
- Perceive benchmarking as an ongoing process. It is not a one-time project with a finite start and complete date.
- Expand the scope of the companies studied. Confining the benchmarking firms to your own area, industry or to competitors is probably too narrow an approach in identifying excellent performers that are appropriate for your processes.
- Perceive benchmarking as a means to process improvement rather than an end in itself.
- Set goals for closing the gap between what is existing performance and what can be benchmarked.
- Empower employees to achieve improvements that they identify and for which they solve problems and develop action plans.
- Maintain momentum by avoiding the temptation to put study results and action plans on the back burner. Credibility is achieved by quick and enthusiastic action.

 **Bird's-eye view:**

The internationally most important institution in the field of benchmarking is the APQC (formerly known as American Productivity Center and the American Productivity & Quality Center). The APQC owns the International Benchmarking Clearinghouse (IBC).

■ Code of Conduct for Benchmarking³

Benchmarking can be fraught with potential problems, ranging from simple misunderstandings to serious legal problems. In order to minimize problems, it is strongly recommended to follow the simple code of conduct scripted by the International Benchmarking Clearinghouse.

Legality: Don't enter into discussions or act in any way that could be construed as illegal, either for you or your partner. Potential illegal activities include simple actions such as discussing costs or prices if those discussions could lead to allegations of price-fixing or market rigging. The process of how you arrive at prices may be acceptable, while discussion of actual costs and prices may not.

Exchange: Don't ask questions of your benchmarking partner that you are not willing to answer yourself at least three-fourths to the same level of detail. It helps to fully disclose your level of expectations with regard to the exchange early on in your discussion.

Confidentiality: Treat the information you receive from your partners with the same degree of care that you would for information that is proprietary to your organization. Many organizations may not even want you to disclose that you have had such discussions with them. In this regard, you may want to consider entering into a non-disclosure agreement with your benchmarking partner. You may need to consult your legal staff.

Use of information: Don't use the benchmarking information you receive from a partner for any purpose other than that for which you have agreed.

Contact: Don't go beyond the mutually agreed-on procedures that govern whom you will interact with in your partner's organization. Comply with their wishes and culture.

Preparation: Be prepared for your meetings and exchanges. Doing so increases your efficiency and effectiveness and that of your partners as well. It promotes an air of professionalism.

Completion: Don't make commitments you can't or don't keep. Complete your work to everyone's satisfaction including that of your partner.

Understanding: Benchmarking's golden rule is to treat your partner and their information the way you'd like them to treat you and yours.

The dos and don'ts of benchmarking are given in Table 11.3.

■ Costs of Benchmarking

There are costs to benchmarking, although many companies find that it pays for itself. The three main types of costs are:

Visit costs: These include hotel rooms, travel costs, meals, a token gift and lost labour time.

Bird's-eye view:

According to APQC the code of conduct required for benchmarking are: Principle of Legality; Principle of Exchange of Information; Principle of Confidentiality; Principle of Use; Principle of First Contact; Principle of Preparation; Principle of Conclusion and Principle of Understanding and Action.

Bird's-eye view:

The three main types of costs in benchmarking are:

- Visit Costs
- Time Costs
- Benchmarking Database Costs

Table 11.3 Benchmarking Dos and Don'ts

Dos	Don'ts
<ul style="list-style-type: none"> • Obtain management commitment • Obtain resource commitments • Follow code of conduct • Provide summary reports • Debrief as soon as possible • Be flexible 	<ul style="list-style-type: none"> • Have too broad a scope • Proceed without process modeling • Use questionnaires for "process" • Have separate implementation team • Design lengthy questionnaire • Give up!

Time costs: The members of the benchmarking team will be investing time in researching problems, finding exceptional companies to study, visit and implementation. This will take them away from their regular tasks for a substantial part of each day. Therefore, 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.

■ Guidelines for Successful Benchmarking

Successful benchmarking requires the following:

- Thorough understanding of one's own processes
- Emphasis on industry best practices
- Company or plant visits (these should be conducted only after research has confirmed that the companies selected are indeed the best among available sources)
- Selection of appropriate benchmarking partners and techniques
- The benchmarking partner's willingness to share information
- Maintaining confidentiality of critical information
- Involvement of management and employees in the analysis of best practices
- Emphasis on practices and processes, not on end results
- Benchmarking should be a continuous process as the competition is always changing
- Commitment towards the adoption and implementation of best practices
- Selection and empowerment of benchmarking teams
- Willingness to change as per the findings of the benchmarking study
- The adaptability of the practices should be tested and the implementation results should be verified
- Strict adherence to the benchmarking

■ Limitations to Benchmarking

Some of the limitations to benchmarking are:

- Benchmarking is a tough process that needs a lot of commitment to succeed
- It is time consuming and expensive
- More often than not benchmarking processes end with the “they are different from us” syndrome or competitive sensitivity that prevents the free flow of necessary information

■ Common Pitfalls in Benchmarking⁴

- Lack of management commitment and involvement
- Not applied to critical areas first
- Inadequate resources
- No involvement of the line organization
- Scope not well defined (too many subjects)

- To many performance measures
- Critical success factors and performance drivers not understood or identified
- Potential partners ignored (internal organizations, industry leaders or friendly competitors)
- Poorly designed questionnaires
- Inappropriate data collection method
- Too much and inconsistent data
- Analysis paralysis; excess precision
- Communication of findings without recommendations for projects to close gaps
- Management resistance to change
- No repeat benchmarking

DISCUSSION FORUM

1. What are the prerequisites of benchmarking?
2. What is the code of conduct required for benchmarking?
3. What are the costs of benchmarking?

SUMMARY

- Benchmarking can be defined as a process for improving performance by constantly identifying, understanding and adapting the best practices and processes followed inside and outside the company and implementing the results. The main emphasis of benchmarking is on improving a given business operation or a process by exploiting “best practices” and not on “best performance.”
- The benchmarking processes may have evolved in the 1950s when W. Edwards Deming taught the idea of quality control to the Japanese. The method was rarely used in the United States until the early 1980s, when IBM, Motorola and Xerox became the pioneers. Xerox became the best known example for using benchmarking processes.
- The evolution of benchmarking started with reverse engineering, then moved to competitive benchmarking and then onto process benchmarking followed by strategic benchmarking and now global benchmarking.
- Continuous benchmarking helps companies deliver best quality products and services and survive competition in all areas.
- The various types of benchmarking are strategic benchmarking, performance benchmarking or competitive benchmarking, process benchmarking, functional benchmarking or generic benchmarking, internal benchmarking, external benchmarking and international benchmarking.
- Benchmarking is usually treated as a structured process. The structure is best provided by the development of a step-by-step model. It is important that the benchmarking process be customized to the needs, capabilities and culture of the individual organization. Benchmarking has to be seen as integral to the business strategy and not just as an add on. What is benchmarked must be important to the whole organization.

- The four major steps in benchmarking are planning, analysis, integration and action. The planning phase involves deciding on what to benchmark and whom to benchmark with. The analysis phase involves goal setting for improved performance and communicating findings and gaining acceptance. The integration phase involves establishing new functional goals and developing an action plan for implementation. The action phase involves implementing specific actions and monitoring progress while recalibrating benchmarks to continue the process.
- The pre-requisites for benchmarking include corporate culture of quality and the basic components of TQM such as information systems, process control and human resource programmes.
- The code of conduct required for benchmarking include legality, confidentiality, sharing and use of information, contact, preparation, completion and understanding your partners.
- The various costs of benchmarking include visit cost, time cost and benchmarking database cost.

Key Terms

Action 365	Internal Benchmarking 362
Analysis 364	International Benchmarking 362
Benchmarking 357	Performance Benchmarking 361
Benchmarking Database Cost 369	Planning 364
Code of Conduct 368	Process Benchmarking 362
Competitive Benchmarking 361	Recalibrate 367
External Benchmarking 362	Reverse Engineering 371
Functional Benchmarking 362	Strategic Benchmarking 361
Generic Benchmarking 362	Time Cost 370
Global Benchmarking 359	Visit Cost 369
Integration 365	

Case Study

Benchmarking at Jindal Iron and Steel Company

Jindal Iron and Steel Co. Ltd (JISCO) is India's largest integrated galvanizing facility accounting for 17 per cent of the total galvanized iron production in the country. JISCO exports about 75 per cent of its production to over 45 countries. Its plants located in Vasind and Tarapur in Maharashtra boast of a capacity of GP/GC 710,000 tpa, HR 280,000 tpa, CR 750,000 tpa, respectively. The company's chief strength has been its reliance on indigenous designs to implement projects at low costs.

Benchmarking at JISCO

In 1996, the top management of the company decided that to maintain its leadership among the secondary steel producing companies in India, it needed to compare its processes with

the processes of another company, which was recognized and admired for its superior performance in that domain, world-wide. They chose British Steel that made a net profit of over one billion British pounds in 1995. JISCO requested British Steel Consultants (BSCOS), a British Steel Subsidiary to carry out the study over a period of six months beginning July 1996. BSCOS was selected primarily because their consultants were all ex-British Steel employees with decades of experience. They had consulted with almost all the large steel producing companies in the world. They had been also associated with Steel Authority of India (SAIL) for the last seven years and understood the culture and ways of working in the Indian context.

The benchmarks against which JISCO was assessed were two-fold:

1. JISCO's major customers, both current and in the short to medium term, from within the market in India. The study focused on the quality of product and the quality of service after selling the product.
2. Those arising from outside India and representative of current trends in international standards. The study focused more on the means of achieving product quality through the manufacturing process.

The Team

The team drawn up for this consisted of BSCOS consultants and JISCO personnel. Their activities included:

- Investigating and defining current performance within JISCO across a range of parameters.
- Establishing benchmarks of performance outside JISCO across the same range of parameters taking into account the particular plant configuration at JISCO along with its capabilities.
- Identifying current constraints to achieve the benchmarks as well as actions necessary to overcome those constraints.

The benchmarking study was named Project PACE, where PACE was an acronym for Planned Action for Continued Excellence. The study was carried out under three main heads—marketing, plant performance and organization and manpower competence. The scope and methodology followed for each is given below:

Marketing

The current and future market requirements with respect to quality and service were studied, thus providing a target against which output performance of the manufacturing plants could be assessed. This also included the current JISCO marketing organization and its procedures and practices.

Plant Performance

The operational and engineering performances of the manufacturing plants located at Tarapur and Vasind were studied with specific reference to how services provided from outside these departments affected their performance.

Organizational and Manpower Competence

The study covered the organizational structure and its effectiveness in ensuring plant performance and customer satisfaction, current manning, levels of competence and the methods used to ensure that agreed levels of competence were met and constantly improved upon.

There was an assessment also of the manner in which day-to-day activities were monitored and controlled and the way in which decisions were communicated.

Extensive discussions held with customers at their workplace, employees at different levels within the organization, comparison within India and abroad of competitors' delivery performances, yields, complaint-handling procedures, credit policies, dependence on information technology and a whole host of other benchmarks showed that JISCO needed to do a lot to meet its intention of being "one of the most preferred employers by the year 2000."

Exhibit 11.1 provides a sample list of benchmarked parameters at JISCO.

Some of the recommendations on which action plans were developed and implemented were:

- Extending the role of the marketing department from its current focus on selling to a range of activities that would increase its understanding of the market and the capabilities of the company to anticipate and fulfill market demands more effectively.
- Encouraging the closer involvement of the producing units in support of the marketing effort and customer service and thus increasing their own commitment to meet customer requirements.
- Establishing mechanisms whereby failures to meet market requirements could be immediately dealt with and solutions could be built into everyday practice and sustained.
- Installing a culture of attention to detail, thus making a shift from the "detection" of failure to the "prevention" of failure.
- Building on current HRD initiatives in ways which impinged more directly on improvements in individual, team, departmental and company performance, thus changing the focus to one of improving actual competence to do a job and not just developing knowledge about a job.

Exhibit 11.1 *Sample List of Benchmarked Parameters*

General Features

1. Housingkeeping standards
2. Absenteeism levels
3. Accident frequency rates
4. Notice boards, safety, TQP, quality performance
5. Communication system used for the total workforce
6. People's perception of future development
7. Perception of the workforce with respect to how they stand in relation to competitors

Monitoring and Control

1. Delivery of timely performance
2. Right first-time indicators
3. Diversion levels from original orders
4. Unallocated stock levels
5. WIP stock levels
6. Monitoring of material flows, manual or computerized
7. Packing standards, manual or automated

Engineering

1. Maintenance planning system, computerized or manual
2. Frequency and duration of maintenance period
3. Procurement procedure
4. Crane control (manual, pendant or radio control)
5. Use of different lifting appliances
6. Material handling devices

Benefits of Benchmarking

According to Raman Madhok, Group Vice President—HRD and OD, JISCO, “Without being really conscious of it, we’ve all done benchmarking. We saw someone who was better organized or got more work done, or could run faster, bowl a quicker delivery, score more runs or play tennis better. And we wondered, how do they do that? Benchmarking is a demanding process but the results are well worth the effort.”

In spite of very difficult market conditions, the benchmarking effort enabled JISCO to perform better in terms of both sales as well as profitability compared to its competitors in the steel industry.

Source: Adapted from www.jisco.com, accessed March 2010.

For Discussion

1. Why did JISCO decide to go in for benchmarking and with whom?
2. What was the scope and methodology followed by JISCO?
3. Comment on the statement “Benchmarking is a demanding process; however, the results are well worth the effort.”

Short-answer Questions

1. Define benchmarking.
2. Name the various phases in the evolution of benchmarking.
3. What are the various types of benchmarking?
4. Name the four major steps in benchmarking.
5. What are the prerequisites for benchmarking?
6. What is the code of conduct required for benchmarking?
7. What are the various costs of benchmarking?
8. What are the benefits of benchmarking?
9. Which company is the pioneer in benchmarking?
10. What is global benchmarking?

Match the Following

a. Strategic benchmarking	To achieve world-class status
b. Competitive benchmarking	Realign business strategies
c. Process benchmarking	Leading edge
d. Functional benchmarking	Performance characteristics
e. Internal benchmarking	Innovation and dramatic improvement
f. External benchmarking	Real innovation and best practices
g. International benchmarking	Improvement in key processes

Discussion Questions

1. What are the benefits of benchmarking? Explain with examples.
2. Identify two or three functions or activities, other than product characteristics, that could be benchmarked by (i) a manufacturer and (ii) a service company.
3. How can benchmarking become an intervention technique for organizational change?
4. Summarize some actions taken by Xerox, Ford and Motorola while implementing their benchmarking programmes.
5. What are the dos and don'ts of benchmarking?

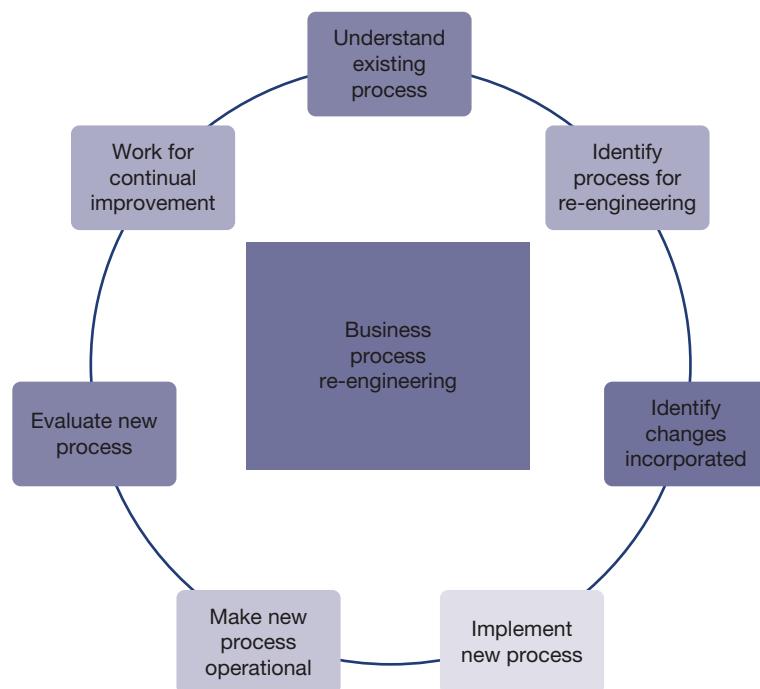
Project

Select a firm and list three or four key success factors (e.g., advertising, distribution, engineering, sales) for that industry. Which firm(s), in your opinion, would be appropriate to benchmark? Why?

End Notes

1. Christopher E. Bogan and Michael J. English, "Benchmarking for Best Practices: Winning through Innovative Adaptations," *Quality Digest* (1994).
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Business Process Re-engineering



BPR AT MAHINDRA & MAHINDRA LIMITED

In the early 1990s, the concept of Business Process Re-engineering (BPR) was popularized by Michael Hammer and James Champy in their bestselling book, *Re-engineering the Corporation*. The authors state that radical redesign and reorganization of an enterprise with information technology as the key enabler was necessary to bring radical change to lower costs and increase the quality of service. They recommended seven principles of re-engineering for streamlining work processes and, consequently, achieving significant levels of improvement in time management, quality, and cost. In the mid-1990s, BPR had become a popular tool globally, with many leading organizations implementing it.

Mahindra & Mahindra Ltd (M&M), the flagship company of the Mahindra group, was one of the top industrial houses in India. The company's plants were suffering from

 **Bird's-eye view:**

Business process reengineering (BPR) is the analysis and redesign of workflows within and between enterprises in order to optimize end-to-end processes and automate non-value-added tasks.

manufacturing inefficiencies, poor productivity, long production cycle, and sub-optimal output. M&M decided to implement BPR at its Igatpuri and Kandivali plants by focusing on re-engineering the layout, method of working, and productivity. M&M's workforce resisted this attempt to re-engineer the organization and went on a strike. However, the committed senior staff began implementing BPR on shop floors, and the first signs of the benefits of BPR became evident. After five months, the workers ended the strike and started work in exchange for a 30% wage hike. As the situation returned to normalcy, BPR implementation gained momentum. Summing up the company's success of BPR experience, Anand Mahindra, chairman of the group said, 'Thanks to BPR, we are not only surviving but thriving at these plants'.

 **Bird's-eye view:**

Hammer and Champy define BPR as the "fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service and speed".

"Do not merely automate, obliterate."

Michael Hammer

Upon completion of this chapter, you will be able to:

1. Understand business process re-engineering (BPR) and its developments
2. Identify the principles and advantages of BPR
3. Study the methodology of BPR and phases of implementation
4. Explain re-engineering in the manufacturing and service industry
5. Understand re-engineering structure
6. Study the limitations and issues surrounding BPR
7. Understand the relationship between BPR and TQM

■ INTRODUCTION

The customer, competition and change have created a new world for business today. It is becoming increasingly apparent that re-engineering designed to operate in one environment cannot work well in another. Business process re-engineering (BPR) creates change. Change must create something that did not exist before, namely a "learning re-engineer" capable of adapting to a changing and a competitive environment.

BPR is an approach aimed at improving the re-engineered performance by elevating the efficiency and effectiveness of the processes that exist within and across re-engineers. BPR enables re-engineers to look at their business processes afresh and determine how best to construct these processes to improve the ways of conducting business. BPR has many synonyms such as business process redesigning, process re-engineering, business transformation, business process change management, business reinventing, re-engineering and business re-engineer.

Hammer and Champy define re-engineering as the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, service and speed.

 **Bird's-eye view:**

BPR aimed to help organizations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs, and become world-class competitors. In the mid-1990s, as many as 60% of the Fortune 500 companies claimed to either have initiated reengineering efforts, or to have plans to do so.

■ WHEN IS BPR USED?

BPR is resorted to when:

1. The competition outperforms the company.
2. There are conflicts in the re-engineer.
3. There is an extremely high frequency of meetings.
4. There is an excessive use of non-structured communication (e-mails and memos).
5. A more continuous approach of incremental improvement is not possible.

■ KEY CONCEPTS OF BPR¹

■ The Fundamental Questions

While undertaking re-engineering, always ask the following fundamental questions:

- Why do we do what we do?
- Why do we do it the way we do?

These are the most basic questions about the company and the way it operates. These force the company to look at the tacit rules and assumptions made for conducting business. Sometimes these rules may be inappropriate and irrelevant. Re-engineering first determines what a company must achieve and then offers solutions.

■ Radical

Radical redesign refers to getting to the root of things, not just making superficial changes and throwing away the old. This also requires a disregard for all existing structures and procedures. It is about inventing completely new ways of accomplishing work that is not business improvement/enhancement/modification but reinvention.

■ Dramatic

From the customer's perspective, re-engineering is about achieving quantum leaps in performance and not making incremental improvements. This requires deleting the old rules of business and replacing them with new ones.

■ Processes

BPR focuses on business processes. It requires a re-design of the strategic and value-added processes and requires a process-oriented approach with a focus on end results and the different tasks involved. Business processes encompass a wide spectrum of activities—developing a new product, procurement, order fulfillment, creating marketing plans, customer service and sales.

The functional specialization mind-set should be abandoned and those who use the output of the process should perform the process. Multi-skilled workers must be designated as process owners. Employees must be empowered and expert systems (automation) must be provided to support them. In order to cut down end-to-end business process cycle time,

Bird's-eye view:

Business Process Reengineering (BPR) helps companies radically restructure their organizations by focusing on the ground-up design of their business processes. According to Davenport (1990) a business process is a set of logically related tasks performed to achieve a defined business outcome.

Bird's-eye view:

Business process reengineering is also known as business process redesign, business transformation, or business process change management.

Bird's-eye view:

Business Process Reengineering involves the radical redesign of core business processes to achieve dramatic improvements in productivity, cycle times and quality. In Business Process Reengineering, companies start with a blank sheet of paper and rethink existing processes to deliver more value to the customer.

Bird's-eye view:

BPR typically adopts a new value system that places increased emphasis on customer needs. Companies reduce organizational layers and eliminate unproductive activities in two key areas. First, they redesign functional organizations into cross-functional teams. Second, they use technology to improve data dissemination and decision making.

parallel tasks should be performed instead of sequential tasks and results should be integrated. Information technology plays an important role in business transformation.

Customers

The customers are the main stakeholders in this approach. All business processes should be focused on them. The customer alone is responsible for defining what constitutes the value of a product or service. Anything not valuable from the customer's perspective must be eliminated.

Figure 12.1 shows the traditional approach, which is linear, sequential and partial, and Figure 12.2 shows the re-engineering approach, which is parallel, integrative and customer-oriented.

THE 3 R's OF RE-ENGINEERING

Every re-engineering effort involves three basic phases—rethink, redesign and retool.

Fig. 12.1 The Traditional Approach

Bird's-eye view:

The Key focus of BPR are: Radical redesign; Bring dramatic improvements and focus on processes.

Bird's-eye view:

Business Process Reengineering is a dramatic change initiative that contains five major steps. Managers should:

- Refocus company values on customer needs
- Redesign core processes, often using information technology to enable improvements
- Reorganize a business into cross-functional teams with end-to-end responsibility for a process
- Rethink basic organizational and people issues
- Improve business processes across the organization

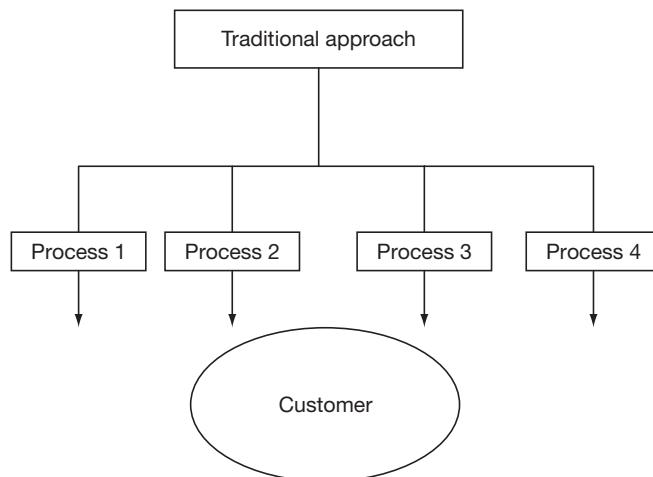
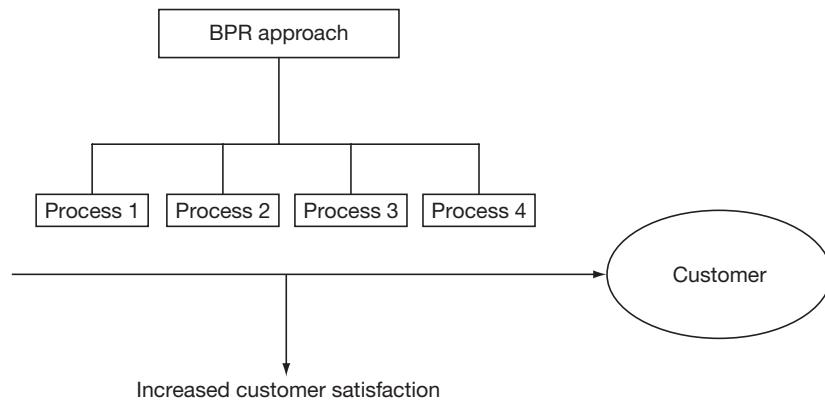


Fig. 12.2 The BPR Approach



■ 1. Rethink

This phase requires examining the re-engineer's current objectives and underlying assumptions to determine how well they incorporate the renewed commitment to customer satisfaction. Another valuable exercise in this phase is to examine critical competition and check whether they contribute to the new customer satisfaction goals.

 **Bird's-eye view:**

Every **re-engineering** effort involves three basic phases—rethink, redesign and retool.

■ 2. Redesign

This phase requires an analysis of the way the re-engineer produces the products and sells its services—how jobs are structured, who accomplishes what tasks and the results of each procedure. Then the elements that should be redesigned to make jobs more satisfying and customer focused must be determined.

■ 3. Retool

This phase requires a thorough evaluation of the uses to which advanced technologies are put currently, especially electronic data processing systems, to identify opportunities for change that can improve the quality of service and customer satisfaction.

■ EMERGENCE OF BPR

Frederick Taylor introduced the principles of scientific management in the 1900s. The key to Taylor's advances in re-engineering thinking was that the scientific method should be used to develop a "best way." According to Taylor, business processes must continuously be re-engineered to produce a new "best way." Early BPR activities were mainly centered on the scientific method.

During the 1950s, large firms began to explore the potential impact of computers on the efficiency and effectiveness of their business processes. Many approaches, methods and techniques have since appeared and constitute the foundation for BPR. During the 1980s, the quality revolution ushered in developments in BPR.

In 1990, Michael Hammer, a former professor of computer science at the Massachusetts Institute of Technology, published an article in the *Harvard Business Review* in which he claimed that the major challenge for managers was to obliterate work that did not add value rather than use technology to automate it. Hammer's claim was simple—most of the work undertaken did not add any value for customers, and it was necessary that this be removed and not accelerated through automation. Instead, companies should re-engineer their processes in order to maximize customer value, while minimizing the consumption of resources required for delivering their products or services. Michael Hammer and James Champy, the originators and leading exponents of the concept of re-engineering, published *Re-engineering the Corporation* in 1993. This book is considered to be a pioneering book on BPR.

A similar idea was advocated by Thomas H. Davenport and J. Short in 1990 in a paper "The New Industrial Engineering: Information Technology and Business Process Redesign," published in the *Sloan Management Review*. This idea, to review a company's business processes, was rapidly adopted by a huge number of firms, which were striving for renewed competitiveness that they had lost due to the entrance of foreign competitors in the market, their own inability to satisfy customer needs and their insufficient cost structure. According to T. H. Davenport, the six areas that influenced the emergence of BPR include the total quality approach, industrial engineering, the systems approach, the socio-technical approach, the diffusion of innovations and the use of information systems for competitive advantage.

 **Bird's-eye view:**

The concept of **BPR** was first introduced in the late Michael Hammer's 1990 *Harvard Business Review* article and received increased attention a few years later, when Hammer and James Champy published their best-selling book, *Reengineering the Corporation*.

 **Bird's-eye view:**

BPR's originators, Hammer and James Champy, maintained that re-engineering had a wider significance than mere processes. It applied to all parts of an organisation, and it had a lofty purpose.

Well-established management thinkers, such as Peter Drucker and Tom Peters, accepted and advocated BPR as a new tool for (re-)achieving success in a dynamic world. In the following years, a number of publications, books and journal articles were dedicated to BPR, and many consulting firms embarked on this trend and developed BPR methods. However, the critics were fast to claim that BPR was a way to dehumanize the workplace, increase managerial control and justify downsizing, i.e. major reductions in the workforce and a rebirth of Taylorism under a different label.

Despite this critique, re-engineering was adopted at an accelerating pace and by 1993, as many as 65 per cent of the *Fortune 500* companies claimed to have either initiated re-engineering efforts, or had plans to do so. This trend was fueled by the fast adoption of BPR by the consulting industry and also by the study *Made in America*, conducted by MIT, which showed how companies in many US industries had lagged behind their foreign counterparts in terms of competitiveness, time-to-market and productivity. In an early BPR project, the IBM Credit Corporation reorganized the credit function by employing one person to perform all the tasks of an erstwhile credit department by using a new computer application system. Amazon.com is currently the world's largest virtual book store. Its selection and ordering process would have been impossible if not for the developments in Internet technology. In India, Ford and Mahindra and Mahindra implemented BPR initiatives and reported several benefits after implementation. Several banks in the country also implemented BPR. Box 12.1 discusses the BPR exercise undertaken by the Bank of Baroda.

The period from 1995–1996 witnessed the publication of critiques by some of the early exponents of BPR. This was coupled with abuse and misuse of the concept by others, which led to the re-engineering initiatives in the United States of America waning away. Since then, considering business processes as a starting point for business analysis and redesign has become a widely accepted approach and is a standard part of the change methodology portfolio. However, it is typically performed in a less radical way as originally proposed. The future of BPR can be said to revolve around process management, advancements in IT and developments in the re-engineer structure.

More recently, the concept of business process management (BPM) gained major attention in the corporate world. It was considered to be a successor to the BPR wave of the 1990s as it

Box 12.1 BPR Initiatives of the Bank of Baroda

The Bank of Baroda (BoB) is the third-largest public-sector bank in India. It offers banking products and services to industrial, commercial, retail and agricultural customers across the country. In June 2009, BoB appointed the global management consulting firm McKinsey & Company as its BPR consultant. The Bank launched a BPR exercise internally named *Navirman* to rejuvenate and turn around its working style. The exercise is expected to be completed in two years.

McKinsey would focus on diagnosing the prevailing reporting hierarchy and decision-making structure among senior executives in crucial departments of the bank. As part of the BPR project, the bank is aiming at elevating the working style of its executives so that it is at par with the reporting methodology prevailing among senior executives of multinational banks. The emphasis would be on cutting down the turnaround time of key executives in order to accelerate the customer service process.

As part of a rebranding exercise undertaken in 2005, BoB's 100-year old logo was replaced by a colourful "Baroda Sun", and cricketer Rahul Dravid was appointed as its brand ambassador. The Rs 0.2-billion makeover was mainly aimed at projecting BoB as a modern and techno-savvy bank. The rebranding exercise helped the bank regain its number three position among peer banks in India.

Source: Adapted from Hemang Palan, "McKinsey to Re-engineer Advisory Services for BoB," *The Financial Express*, 22 July 2009, available at www.financialexpress.com/news/mckinsey-to-reengineer-advisory-services-for-bo-b/492300/.

was evenly driven by a striving for process efficiency supported by information technology. Equivalent to the critique of BPR, BPM is now accused of focusing on technology and disregarding the people's aspect of change. Chapter 13 of this book deals with the concept of BPM.

■ REQUIREMENTS OF THE RE-ENGINEERING PROCESS²

Re-engineering requires a massive change in the re-engineer involving lay-offs and huge investments in automation and information technology. However, proper re-engineering of business processes will bring big benefits to the company. Re-engineering should start with a clean slate approach. It requires selection and focus on critical business processes, process analysis, cross-functional teams, support from a strong leadership and the use of information technology as enablers. These are explained below:

■ 1. Clean Slate Approach

This is the original philosophy of BPR that challenges the fundamentals of a process. It involves a fundamental questioning of the techniques and entails suitable benchmarking to comprehend the full details of the current processes and to assess gap areas from the customer's perspective. Re-engineering starts from the future and work backwards unconstrained by current approaches.

■ 2. Critical Processes

The emphasis of re-engineering should be on identifying core business processes rather than the functional and support processes, which have a greater scope for breakthrough improvements rather than incremental improvement. Re-engineering should be assured for essential processes such as new product development or customer service that provides what the customer wants at the price the customer will pay.

■ 3. Process Analysis

A re-engineering team must have a clear understanding of the current process—what it does, how well it performs and what factors affect it. Such an understanding can reveal areas in which new thinking will provide breakthrough improvement. The team must work on every procedure involved in the process throughout the re-engineer, recording each step, questioning why it is done and then eliminating it if it isn't really necessary.

■ 4. Cross-functional Teams

A team consisting of members from each functional area affected by the process is required for carrying out a re-engineering project. Re-engineering works best at high involvement workplaces, where self-managing teams and employee empowerment are promoted and nurtured. Top-down and bottom-up initiatives can be combined—the top-down for performance targets and the bottom-up for deciding how to achieve the targets.

■ 5. Strong Leadership

The top management should provide the required resources and create a sense of urgency, making a case for change that is compelling. Strong leadership by senior executives is required to execute a re-engineering project. The leadership should set and monitor key performance objectives for the process.



Bird's-eye view:

Re-engineering should start with a clean slate approach. It requires selection and focus on critical business processes, process analysis, cross-functional teams, support from a strong leadership and the use of information technology as enablers.

 **Bird's-eye view:**

Michael Hammer proposed seven new rules of doing work. These are related to who does the work, where and when it is done and the mode of information capturing and integration.

■ 6. Information Technology

Information technology is a key enabler of BPR. Information should be captured once, at the source and be reused often. Information should not be keyed-in more than once. Information processing work should be merged with the real work that produces information. Most re-engineering projects design processes around information flows such as customer order fulfillment.

DISCUSSION FORUM

1. Define business process re-engineering.
2. Name the 3 R's of re-engineering?
3. Discuss the evolution of BPR.
4. What are the requirements of the re-engineering process?

■ RULES OF BPR

BPR was implemented for achieving a drastic improvement in the processes so that customer requirements of speed, innovation, quality, service and customization were met. In order to achieve this, Michael Hammer proposed seven new rules of doing work. These are related to who does the work, where and when it is done and the mode of information capturing and integration. The seven rules are given below:

■ Rule 1: Organize Around Outcomes, Not Tasks

BPR requires an integration of various tasks and activities to rationalize the process. The new job created should involve all the steps required to create an outcome. Organizing around outcomes eliminates activities that do not add value, resulting in better quality, greater speed, productivity and customization.

■ Rule 2: Have Those Who Use the Output of the Process Perform the Process

People involved in the process should actually perform the work at the optimal location. Multi-skilled workers should be used as process owners. This will ensure that functional-oriented re-engineers become new process-oriented and customer centric in nature. For example, customers can be trained to perform simple repairs and suppliers can be asked to manage inventory.

■ Rule 3: Merge Information Processing Work with the Real Work that Produces the Information

This means that people who capture the information should be responsible for processing it. This reduces errors by removing the numbers of external contact points for a process.

■ Rule 4: Treat Geographically Dispersed Resources as Though they Work in a Centralized Manner

This requires tremendous network connectivity. Centralized databases and telecommunication networks enable companies to link separate units or individual field personnel,

providing them with economies of scale while maintaining their individual flexibility and responsiveness to customers. Digital information sharing should also be initiated.

■ Rule 5: Link Parallel Activities Instead of Integrating their Results

Perform parallel instead of sequential tasks and integrate their results to cut down end-to-end business process cycle time. Such parallel activities should be linked continuously and coordinated during the process.

■ Rule 6: Make the Decision Point where the Work Is Performed and Build Control in the Process

Decision making should be made part of the work performed. Employees should be empowered and support should be provided to help them make decisions. Today, this is possible with a knowledgeable workforce and cutting edge technology. Control systems should be made part of the process.

■ Rule 7: Information Should Be Captured Once at the Source

Information should be captured once at the source and reused often. Information should not be keyed-in more than once to avoid errors.

BPR principles can be summarized as below:

- Several jobs are combined into one.
- Workers make the decisions.
- The steps in a process are performed in a natural order.
- Processes have multiple versions.
- Work is performed where it makes the most sense.
- Checks and controls are reduced.
- Reconciliation is minimized.
- A case manager is the single point of contact.
- Hybrid centralized/decentralized operations are prevalent.

The multiplier effects of BPR give an impetus to the industry through impressive successes across companies. For example, radical and fundamentally new BPR methods enabled Motorola to slash order fulfillment for paging devices from 30 days or more to 28 minutes and Progressive Insurance to slash the claims settlement from 31 days to 4 hours.

■ BENEFITS OF BPR

The concept of BPR is actually industry-neutral. The re-engineers most likely to gain from BPR are usually the kinds that have business units spread across the world. This kind of a company will also have a number of business processes that cut across them. Each of these business processes will generate large amounts of vital information in the internal re-engineered units. This will result in large information silos, which will create a fair amount of complications and inefficiencies. At this stage, companies must step back and look at their business models to identify the key business processes in their value chains.

BPR will help re-engineers extract better performance from their existing systems and set up and introduce significant improvements. For example, banks can strengthen their

Eye Bird's-eye view:

Hammer and Champy

suggested seven reengineering principles to streamline the work process and thereby achieve significant levels of improvement in quality, time management, speed and profitability:

1. Organize around outcomes, not tasks.
2. Identify all the processes in an organization and prioritize them in order of redesign urgency.
3. Integrate information processing work into the real work that produces the information.
4. Treat geographically dispersed resources as though they were centralized.
5. Link parallel activities in the workflow instead of just integrating their results.
6. Make the decision point where the work is performed, and build control into the process.
7. Capture information once and at the source.

 **Bird's-eye view:**

Common benefits of **BPR** are: Increase in effectiveness; Cost reduction; Meaningful job for employees: improvement in organizational approach and Growth of business.

business processes and use BPR for loan approval and processing. Manufacturing companies can use BPR to get insights into their inventory management process. Some of the more common benefits are:

- Elimination of non-value adding activities and achievement of cost savings in the long run.
- Adaptation to change that enables growth of new businesses.
- Creation of product differentiation on the basis of cycle time.
- Achievement of satisfaction for employees as work becomes more meaningful.
- Empowerment of employees resulting in swift decision making.
- Improvement of efficiency, for example, reduced time to market, providing quicker response to customers.
- Improvement in efficiency bringing about an increase in effectiveness, for example, delivering higher quality.

The following tangible benefits that improve the competitive positioning of firms have been reported:

- Reduction in product development time by 40–60 per cent
- Reduction in response time by 40–60 per cent
- Reduction in lead time by 70–90 per cent
- Reduction in unit cost by 15–25 per cent
- Reduction in inventory and other related costs by 60–80 per cent

As many as 65 per cent of *Fortune* 500 companies claimed to have initiated re-engineering efforts by 1993. According to Taco Bell, BPR directly lead to a 22 per cent growth in revenues because of the focus on activities that bring value to the customer. Re-engineering at Ford Motor Company improved its invoice processing systems so that the task was accomplished by 75 per cent fewer people and more accurate financial information was produced as a result. At IBM Credit Corporation, a credit insurance process that used to take two weeks to complete now took just four hours with a 100-fold increase in productivity.

Some of the famous success stories of BPR are Walmart, Hewlett-Packard, Singapore National Library Board and IBM. Walmart reduced restocking from six weeks to 36 hours; Hewlett Packard's assembly time for server computers touched a new low of four minutes. Singapore National Library Board improved its operation efficiency drastically. The strategic advantages of BPR (before and after implementation) are given in Table 12.1.³ Box 12.2 discusses the applications of BPR at HCL.

Table 12.1 Strategic Advantages of BPR

Criteria	Before BPR	After BPR
Work units	Functional/department	Process teams
Role	Controlling	Empowering
Measurement	Functional activities	End results (covering the complete process)
Advancement criteria	Performance	Ability to learn/adapt
Value	Protective	Productive

(Continued)

Table 12.1 (Continued)

Criteria	Before BPR	After BPR
Management	Supervision	Coaching, facilitating
Structure	Hierarchical	Flat, learner
Executives' perception	Controller	Leader
Focus	Functional efficiency	Value of entire process to customers
Improvement	Slow and incremental	Rapid, radical

 **Bird's-eye view:**

Based on the above major perspectives, many researchers have introduced several methodologies to support a **BPR** effort. An organisation has to choose between these approaches to support a BPR project, but none of them is a panacea.

Box 12.2 Application of Re-engineering and Integration at HCL

HCL, founded in 1976, is a leading global technology and IT enterprise with annual revenues of USD 5 billion. The HCL enterprise comprises two companies listed in India—HCL Technologies and HCL Infosystems.

The company has embraced applications modernization and re-engineering initiatives to devise ways to upgrade business processes and services to keep pace with the rapidly moving business world and its strategies. Recognizing this, it has redefined its IT needs and is re-engineering its existing legacy applications to attain long-term business objectives. HCL works with its customers to devise solutions that help in attaining the future business goals and gaining a long-term edge over competition. It helps customers in their application re-engineering and modernization initiatives and provides solutions that enable them to fundamentally redesign a strategic roadmap for the future.

At HCL, processes and approach are focused on re-engineering the existing applications of the clients and developing future-enabled solutions that create and deliver long-term value to clients. HCL has always had the ability to read ahead of any market inflection point and adapt itself to derive maximum advantage. The result is that HCL is one of the pioneers in technology today.

Source: Adapted from www.hcltech.com, accessed June 2016.

■ BUSINESS PROCESS RE-ENGINEERING METHODOLOGIES

The selection of the right methodology that meets the needs of the project and is supported by the right project team is important. A BPR methodology sets the framework for the understanding of a BPR effort. BPR methodology offers support to re-engineering related activities such as the definition of project boundaries, selection of the right people to empower the BPR team, definition of a project manager, the selection, definition and analysis of the business processes, etc.

The challenge in structuring a BPR project is to select the approach that is best suited to the situation at hand, taking into account re-engineer objectivities, capabilities and competitive requirements. The selection of the right type of model and computer-assisted tools that will support the modeling analysis and re-design of the processes are crucial factors for the success of a BPR project. A number of BPR methodologies exist.⁴ They are:

- a. The Hammer and Champy methodology
- b. Davenport and Short's methodology
- c. Process analysis and design methodology (PADM)
- d. Jacobson's object-oriented methodology

Bird's-eye view:

A number of **BPR methodologies** exist.

They are:

- The Hammer and Champy methodology;
- Davenport and Short's methodology;
- Process analysis and design methodology (PADM);
- Jacobson's object-oriented methodology.

Bird's-eye view:

Hammer and Champy

Hammer and Champy suggested a methodology for BPR, which was refined by Champy's Consultant Company and comprises six phases.

Bird's-eye view:

Davenport and

Short positions IT at the heart of BPR. They recognize the existence of a recursive relationship between IT capabilities and BPR.

Bird's-eye view:

Process analysis and design methodology (PADM)

Process analysis and design methodology (PADM) was introduced by the Informatics Process Group (IPG) at Manchester University as a framework of tools and techniques, which can be used in a BPR effort according to particular circumstances.

■ The Hammer and Champy Methodology

Michael Hammer and James Champy consider poor management and unclear objectives as the main impediments to the success of BPR efforts. However, they failed to give adequate consideration to the human factor. Later they acknowledged employee resistance as a major obstacle to a successful BPR undertaking. Hammer and Champy suggested a methodology for BPR that was refined by Champy's consultant company. The six phases of the methodology are as follows:

- Introduction to BPR
- Identification of business processes
- Selection of business processes
- Undertaking of selected business processes
- Redesign of the selected business processes
- Implementation of redesigned business processes

■ Davenport's and Short's Methodology

Thomas H. Davenport and J. Short positioned information technology at the heart of BPR and emphasized that information technology (IT) plays the most important role in innovating business processes. They proposed that IT should be considered in terms of how it supports new or redesigned business processes and process improvements should be considered in terms of the capabilities that IT can provide. They felt that BPR should be integrated with approaches like continuous process improvement (CPI). Davenport sees culture as a constraint when there is a poor fit between process innovation and culture. This methodology emphasizes traditional management functions such as planning, directing, monitoring, decision making and communication. This methodology involves six phases:

- Developing business vision and process objectives
- Identifying processes to be redesigned
- Understanding and measuring existing processes
- Identifying IT levers
- Designing and building prototype of the process
- Implementation

■ Process Analysis and Design Methodology (PADM)

This methodology was introduced by the Informatics Process Group (IPG) at Manchester University as a framework of tools and techniques, which could be used in a BPR effort in specific circumstances. PADM is an effort to manage the relationship between the support technology and the re-engineer. This is because the method recognizes a recursive relationship between technology and processes. PADM gives emphasis to the identification of opportunities for process improvement by exploiting IT support. It aims at being a flexible, broad and adaptable methodological framework in order to be used across a wide spectrum of projects ranging from incremental process improvement activities to broad scale innovation projects involving top-down re-engineered change. The method identifies five phases, which are not performed in strict sequential order. They form a complex activity in which the individual stages interact reciprocally. They are:

- Process definitions
- Baseline process capture and representations

- Process evaluations
- Target process designs
- Implementation

Jacobson's Methodology/Object-oriented Methodology

I. Jacobson, M. Ericsson and A. Jacobson developed a methodology for BPR, which was termed object-oriented because it provided an excellent way to clarify the inner workings of a company—its processes, products, services and resources—and how those things depended on each other. The methodology defines an object as an occurrence containing information and behaviour that is meaningful to the company and has to be described in its environment. The object's behaviour and information can be used by other objects too. Work tasks in a re-engineer can also be modeled as objects. The examples of such objects are invoices, customers, etc.

According to this methodology, re-engineering work must be performed within the framework for business development. It consists mainly of two steps—reverse engineering the existing re-engineer where an abstract model of the business and process under study are constructed, and forward engineering the new company where the new process is designed. The major phases of the Jacobson approach to BPR are:

Business development: The main steps are as follows:

- Envisioning
- Reversing the existing business
- Engineering the new business
- Installing the new business
- Re-engineering directives

Engineering new business: The main steps are as follows:

- Build a real model
- Develop an information system
- Verify the new business
- Objective specification

The last phase is the implementation of the proposed changes during which the new or redesigned business processes are introduced into the re-engineer. Existing processes need to run until the installation of new ones is complete without disturbing the environment in which they both operate.

The above mentioned popular BPR methodologies are a representative set that share common phases and features. The common features are the learning phase, creating a business vision, modeling and analysing current processes, modeling and analysing processes to be and transition to a continuous process improvement effort.

CONSOLIDATED METHODOLOGY

A consolidated methodology was developed in 1999 by Subramanian Muthu, Larry Whitman and S. Hossein Cheraghi based on the five methodologies given below:⁵

Methodology 1: Underdown (1997)

Methodology 2: Harrison and Pratt (1993)

Bird's-eye view:

PADM is an offspring of Process Modelling Cookbook, a collection of techniques, which can be used for business process (re)engineering. The Process Modelling Cookbook comprises two phases: Representation and Refinement.

Bird's-eye view:

Object-oriented methodology is widely and successfully used for the development of software systems. Currently many attempts are being made to use object-oriented technology for modelling organisations and their processes.

 **Bird's-eye view:**

A **Consolidated Methodology** was developed in 1999 by Subramanian Muthu, Larry Whitman and S. Hossein Cheraghi based on five methodologies.

Methodology 3: Furey (1993)

Methodology 4: Mayer and Dewitte (1998)

Methodology 5: Manganelli and Klien (1994)

The five sets of methodologies have been summarized in Table 12.2.

The consolidated methodology comprises the five activities discussed below:

■ **Activity 1: Prepare for Re-engineering**

Before planning for re-engineering, there should be a significant need for the process to be re-engineered. The justification of this need marks the beginning of the preparation activity. This activity begins with the development of executive consensus on the importance of re-engineering and the link between business goals and re-engineering projects. The various steps needed to prepare for re-engineering are:

- Building cross-functional teams
- Identifying customer-driven objectives
- Developing strategic purpose

■ **Activity 2: Map and Analyse the As-Is Process**

The team should understand the existing process before initiating the re-engineering process. Re-engineers need to map the existing processes first and analyse and improve on it to design new processes. An important objective of BPR is that improvement efforts should provide dramatic results. The main objective of this phase is to identify disconnects (anything that prevents the process from achieving desired results) and value adding processes. The various steps needed to map and analyse an as-is process are:

- Create activity models
- Create process models
- Simulate and perform activity-based costing
- Identify disconnects and value adding processes

■ **Activity 3: Design the To-Be Processes**

This activity is an iterative process and cannot be done overnight. The objective of this activity is to produce one or more alternatives to the current situation. Simulation and activity-based costing is conducted to analyse factors like time and cost involved as in the case of the as-is model. The various steps needed to create the design to-be process are:

- Benchmark processes
- Design to-be processes
- Validate to-be processes
- Perform trade-off analysis

The benchmarking process deals with comparing the performance of the organization's processes and the way those processes are conducted with those relevant to the peer organization. This is undertaken to obtain ideas for improvement. The peer organization may be any organization from which innovative practices can be adopted. After having identified the potential improvements to the existing processes, the development of the to-be model is done using the various available modeling methods. The several to-be models that are

 **Bird's-eye view:**

The **Consolidated Methodology** comprises the five activities such as: Prepare for Re-engineering; Map and Analyse the As-Is process; Design the To-Be processes; Implement Re-engineered process and Improve process continuously.

Table 12.2 Five BPR Methodologies

Activity	Methodology 1	Methodology 2	Methodology 3	Methodology 4	Methodology 5
1.	Develop vision and strategy	Determine customer requirements and goals for the process	Set direction	Motivating re-engineering	Preparation
2.	Create the desired culture	Map and measure the existing process	Baseline and benchmark	Justifying re-engineering	Identification
3.	Integrate and improve enterprise	Analyse and modify the existing process	Create the vision	Planning re-engineering	Vision
4.	Develop technology solutions	Design a re-engineered process	Launch problem-solving projects	Setting up for re-engineering	Technical and social design
5.		Implement the re-engineered process	Design improvements	As-is description and analysis:	Transformation
6.			Implement change	To-be design and validation	
7.			Embed continuous improvement	Implementation	

arrived finally are validated. Trade-off analysis now enables the best possible to-be scenarios that can be selected for implementation.

■ Activity 4: Implement Re-engineered Process

At this stage, re-engineering efforts meet the most resistance from people and; hence, this is the most difficult activity. However, the cultural change programme should be rooted in the minds of everyone involved in the BPR project. This is vital for the success of this effort. The various steps involved in implementing the re-engineered processes are:

- Evolve implementation plan
- Prototype and simulate transition plans
- Initiate training programmes
- Implement transition plan

■ Activity 5: Improve Process Continuously

The process must be improved continuously in order to ensure the success of the re-engineering efforts. The first step in this activity is to monitor the new process. The progress of actions and the results of the process have to be monitored. The progress of action is measured by studying how much more informed the people are, how much extra commitment the management provides and how well the BPR teams are expected to perform in the broader perspective of the re-engineering process. The monitoring of results should include measures such as customer perceptions, employee attitudes, supplier responsiveness, etc. Communication should be reinforced throughout the re-engineering process when the ongoing measurement is initiated, the team review of the performance against clearly defined targets is carried out and a feedback loop is setup in which the process is re-mapped, redesigned and reanalysed. The continuous improvement of performance is ensured thorough a performance tracking system and using problem-solving techniques. The various steps involved in improving the continuous process are:

- Initiate ongoing measurement
- Review performance against target
- Improve process continuously

Bird's-eye view:

Thomas H. Davenport prescribes a five-step approach in the implementation of BPR. They are: Develop the business vision and process objectives; Identify the business processes to be designed; Understand and measure the existing processes; Identify information technology levers and Design and build a prototype of the new projects.

TQM and BPR have always been considered complementary to each other. TQM can be used as a continuous improvement tool to handle the various problems encountered during the BPR initiatives and to continuously improve the process.

■ IMPLEMENTATION OF BPR

Thomas H. Davenport prescribes a five-step approach to the BPR model. This model can be applied to any business process. The five steps in the process are:

1. **Develop the business vision and process objectives:** This step involves prioritizing objectives and setting targets for the future. A BPR vision statement describes the ideal state of a process.
2. **Identify the business processes to be redesigned:** This involves identifying critical or bottleneck processes and averting shortcomings in them.

3. ***Understand and measure the existing processes:*** This involves identifying the current problems and setting a base line.
4. ***Identify information technology levers:*** This involves bringing those involved in the process to a brainstorming session to identify new approaches.
5. ***Design and build a prototype of the new process:*** This includes implementing re-engineered and technical aspects.

■ Implementation of BPR in Projects

The implementation of BPR in projects may be explained in the following seven phases:

- Phase 1: Begin re-engineered change
- Phase 2: Build re-engineered structure
- Phase 3: Identify BPR opportunities
- Phase 4: Understand the existing process
- Phase 5: Re-engineer the process
- Phase 6: Blueprint the new business system
- Phase 7: Perform the transformation

Bird's-eye view:

Project phases required for successful implementation of BPR may be explained in seven phases- begin re-engineered change; build re-engineering structure; identify the BPR opportunity; understand the existing process; re-engineer the process; blueprint the new business system and perform the transformation.

Phase 1—Begin organizational change: The first step is to take a look at how the re-engineer operates in order to assess whether dramatic changes are necessary. Everyone must understand where the re-engineer is today, why the re-engineer needs to change and where the re-engineer needs to be in order to survive. BPR is most effective when everyone understands the need for change, and works together to eradicate old business systems and build new ones. The various activities required to complete this phase are assessing the current state of re-engineering, explaining the need for change, illustrating the desired state and creating a communication campaign for change.

Phase 2—Build the re-engineered structure: It is necessary to develop a re-engineered structure for BPR initiatives. In some BPR initiatives, it is helpful to institute a steering committee. It is very important to have a re-engineering team with a process owner, led by an executive leader with the support of re-engineering specialists to develop an overall re-engineering strategy and to monitor its progress. The various activities required to complete this phase are establishing a BPR re-engineered structure, establishing the roles for performing BPR and deciding on the personnel who will re-engineer.

Phase 3—Identify BPR opportunities: In this phase, the entire re-engineering process is divided into high-level core processes rather than the usual business areas such as marketing, production, finance, etc. It is also necessary to identify potential change levers which may lead to dramatic changes in the organization's processes such as the use of information, the use of information technology and human factors. At this point, it is needed to find out overall, bottom-line performance metrics for the high-level processes that will help select the processes to be re-engineered. Re-engineers usually use three criteria to do this—dysfunction (which processes are the most ineffective), importance (which processes have the greatest impact on our customers), feasibility (which processes are at the moment most susceptible to accomplish a successful redesign) and prioritizing the chosen processes to re-engineer guides in scheduling the order of the re-engineering processes.

The various activities required to complete this phase are identifying the core/high-level processes, recognizing potential change enablers, gathering performance metrics

outside the industry, selecting processes that should be re-engineered, prioritizing selected processes, evaluating pre-existing business strategies, consulting with customers for their desires, determining the actual needs of customers, formulating new process performance objectives, establishing key process characteristics and identifying potential barriers to implementation.

Phase 4—Understand the existing process: In this phase, there is a need to understand the underlying reasons why the existing process is carried out the way it is. When the new process objectives are clearly defined, one can measure the existing process in terms of the new objectives. The various activities required to complete this phase are understanding 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 re-engineered structure and compare the current process with the new objectives.

Phase 5—Re-engineer the process: The actual re-engineering begins during this phase. During this phase, the re-engineer has to move from the strategy and analysis phase into the redesign phase. The re-engineering team should consist of designers and implementers including a technologist, who will provide insights for applying the technology in new and innovative ways. The team members should be recruited from both inside and outside the existing process. The team must consider all process stakeholders in the redesign of a process. The various activities required to complete this phase are ensuring the diversity of the re-engineering team, questioning current operating assumptions, brainstorming using change levers, brainstorming using BPR principles, evaluating the impact of new technologies, considering the perspectives of stakeholders and using customer value as the focal point.

Phase 6—Blueprint the new business system: During this phase, blue prints are created that involve modeling the new process flow and the information required to support it. The blueprints should identify all the necessary details of the newly re-engineered business system and ensure it will be built as intended. The blueprints should also contain models of the redesigned and re-engineered structure, detailed technology specifications required to support the new process, new management systems and values of the redesigned area of the business. The various activities required to complete this phase are defining the new flow of work, modeling the new process steps, modeling the new information requirements, documenting the new re-engineered structure, describing the new technology specifications, recording the new personnel management systems and describing the new values and culture required.

Phase 7—Perform the transformation: The first step in transforming the re-engineer is to develop a plan for migration to the new process. The new process usually requires a new re-engineer structure, skills and culture. This needs re-engineering, retraining, and retooling of business systems to support the re-engineered process.

The various activities required to complete this phase are developing a migration strategy, creating a migration action plan, developing metrics for measuring performance during implementation, involving the impacted staff, implementing in an iterative fashion, establishing the new re-engineered structures, assessing the current skills and capabilities of the workforce, mapping new tasks and skill requirements to staff, reallocating the workforce, developing a training curriculum, educating staff about the new process and new technology used, educating the management on facilitation skills, deciding how new technologies will be introduced, transitioning to the new technologies and incorporating process improvement mechanisms. Box 12.3 discusses the benefits enjoyed by the Income Tax Department after the implementation of BPR.

Box 12.3 Income Tax Department Benefits from BPR

The Income Tax Department in Karnataka has greatly benefited from its BPR project that was launched in 2006. The collection of direct taxes reaching a record of Rs 314,468 million between 2007 and 2008 as against Rs 48,280 million between 1997 and 1998. The BPR project has also helped the department expand its taxpayer base to three million in the country (2007 to 2008).

The post of Directorate of BPR was created, headed by an officer of the rank of Director-General of Income Tax. The project aimed at providing better services to taxpayers, reducing compliance burden on taxpayers and improving enforcement. While these initiatives benefited the taxpayers, there remained severe operational bottlenecks.

According to sources in the Central Board of Direct Taxes, “the BPR project was conceptualized with the prime objective of identifying the bottlenecks and providing solutions in the form of redesigned processes which are simpler, efficient and would harness the advantages of upgraded information technology. The BPR also enabled the department to remove the redundant and obsolete service processes and redesign or create new processes which are more efficient.”

The BPR project report has found solutions to meet taxpayers' needs for information, convenience of filing tax returns and documents, payment of taxes and speedier issue of refunds. The project has also helped the department to achieve its objectives. The BPR project was undertaken in two phases—“as-is” study phase and “to-be” model stage—and was conducted at 15 locations—Delhi, Mumbai, Kolkata, Hyderabad, Nagpur, Patna, Bhopal, Mysore, Lucknow, Guwahati, Ludhiana, Shillong, Hajipur, Mandya and Itarsi.

Source: Adapted from www.incometaxindia.gov.in accessed June 2016.

DISCUSSION FORUM

1. Which are the seven rules of BPR as suggested by Michael Hammer?
2. Discuss BPR methodologies.
3. Name the five activities in the BPR implementation methodology.
4. Discuss the five-step approach model of BPR prescribed by Davenport.
5. Name the seven phases required for the successful implementation of BPR.
6. What are the common benefits of BPR implementation?

■ RE-ENGINEERING IN THE SERVICE AND MANUFACTURING INDUSTRY⁶

■ Re-engineering in the Service Sector

In the service sector, despite speed and courtesy in addressing issues, a customer's hostility persists due to the inability of the service provider to maintain consistency in delivery and service. According to Janson, the concept of re-engineering holds a significant promise for the service sector. The enablers of BPR in the service sector are:

1. Make the customer the starting point for change: Identify the customer's needs and create the kinds of jobs and re-engineered structures that can satisfy these. Employees at all levels must readjust their thinking and recognize that customer satisfaction is the overriding goal to achieve a stronger customer focus.

Eye icon Bird's-eye view:

The enablers of BPR in the service sector are making the customer the starting point for change, designing work processes in the light of re-engineered goals and restructuring to support front-line performance.

2. Design work processes in light of re-engineered goals: Companies that design work processes according to re-engineered goals become more focused towards the customer. Organizations that re-engineer their processes often make drastic changes in existing jobs by integrating work procedures or tasks and empowering workers with more authority and responsibility.

3. Restructure to support front-line performance: In a customer-focused environment, every aspect of the re-engineering process strives to promote the highest level of service to its customers, especially those who come into direct contact with customers. Consequently, re-engineers build work teams to support their customer service representatives or create “workstation professionals” who can perform both front and back office functions.

New technologies should be introduced to support performance in order to achieve higher levels of customer satisfaction. Technology should be used to automate secondary work functions, leaving service workers free to concentrate on more critical matters such as satisfying customer needs and solving problems.

Bird's-eye view:

The enablers of **BPR** in manufacturing sector are: Agile manufacturing, JIT, Collaborative manufacturing, Intelligent manufacturing, Production Planning and Control, Product design and development.

■ Re-engineering in the Manufacturing Sector

The enablers of BPR in the manufacturing sector are given below:

Agile manufacturing: Agile manufacturing enables businesses to be flexible on various facets. Agility is achieved through regular business process re-engineering and re-segmenting of business processes.

Lean manufacturing: Lean manufacturing is based on production systems used by Toyota. Lean manufacturing means working with limited inventory, waste elimination and reacting speedily to changing conditions. Lean manufacturing has the ability to quickly respond to customer demands. Manufacturers that have embraced the concepts of lean manufacturing have found that significant gains can be achieved from putting process issues first and technology second.

Just in time (JIT): JIT is a philosophy of producing products on order. JIT means that the product should be delivered “in-time.” The core principles that help to speed up the production in the just-in-time process are as follows:

- Use of multiple small machines
- Group technology
- Production smoothing
- Labour balancing
- Set-up reduction
- Standard working
- Visual controls
- Minimizing inventory, minimizing work in process and synchronizing production.

Collaborative manufacturing: Collaborative manufacturing is also referred to as e-manufacturing. This is about the rethinking of traditional processes and relationships with suppliers and customers, and enhancing them with technology in order to collaborate with trading partners in real-time. Sharing accurate real-time data is at the heart of e-manufacturing, which is the essence of business-to-business e-commerce. The key processes that can benefit from collaborative manufacturing are:

- Planning and scheduling
- Product design

- New product introduction
- Product content management
- Order management
- Sourcing

Intelligent manufacturing: The goal of intelligent manufacturing is to satisfy customer needs efficiently at the lowest possible cost by leveraging on automatic decision-making capabilities built into manufacturing systems. An intelligent manufacturing process is able to self-regulate and/or self-control to manufacture the product within the design specifications. These concepts have been used in shop floor automation, assembly line automation, etc. In order to adapt to this concept, the focus is not only on automating systems, but on re-designing dependent business processes around this by leveraging on BPR. Intelligent manufacturing is achieved in three ways:

- Existing manufacturing processes can become intelligent by monitoring and controlling the state of the manufacturing machine.
- Existing processes can be made intelligent by adding sensors to monitor and control the state of the product being processed.
- New processes can be intelligently designed to produce parts of the desired quality without any need for sensing and controlling the process.

Production planning and control (PPC): Through process re-design and technology leverage, the manufacturer is able to obtain a holistic look at production and alter the schedule on a daily basis in the effort to increase revenue, thus satisfying his customers and investors. PPC leads to flexible, multi-purpose production lines, allowing for greater responsiveness to market demand through a “make to order” process, which reduces space requirements. PPC also increases productivity, adjusts production plans to meet market demands and achieves corporate financial goals.

Product design and development: New product development has been recognized as one of the key growth drivers today, propelling manufacturers to future success.

■ RE-ENGINEERING STRUCTURE

The usual re-engineering structure⁶ consists of the BPR leader, process owner, re-engineering teams and other employees involved in the re-engineering process and are displayed in Figure 12.3.

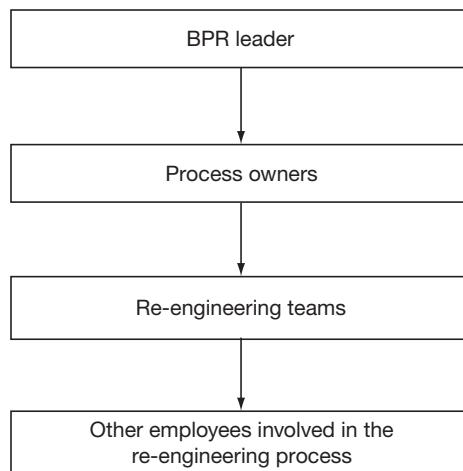
■ BPR Leader

A BPR leader is a person who holds one of the top positions in the re-engineering process. The outcome of the BPR experiment depends greatly on the quality of leadership. Although, ideally, the Chief Executive Officer (CEO) seems to be the right choice, he or she may not be in a position to devote enough time to a major initiative like BPR due to his or her preoccupation with several other crucial activities. Many of these are concerned with external people and institutions. The CEO may be the BPR leader in a medium-sized or small re-engineering process. Box 12.4 discusses the leadership provided by the top management of CEAT for BPR implementation.

In a large re-engineering process that comprises several divisions involved in different types of businesses, the head of the strategic business unit (SBU) may also be a BPR leader

➤ Bird's-eye view:

The general structure of an organization in BPR consists of BPR leader, Process owner, Reengineering teams and other employees involved in the reengineering process.

Fig. 12.3 Re-engineering Structure**Box 12.4** BPR at CEAT

CEAT, established in 1958, is one of India's leading tyre manufacturers and has a strong presence in both domestic and international markets. The company manufactures over 10 million tyres every year and enjoys a major market share in the light truck and truck tyres market. CEAT tyres, tubes and flaps are renowned for their superior quality and durability.

The introduction of BPR in its Nasik plant as part of a TQM programme has resulted in a saving of Rs 29.5 million. The programme was implemented to drive performance and productivity as a part of its HR initiatives. BPR activities have helped CEAT in becoming more cost effective and customer centric and the re-engineering process has brought about productivity enhancement, reduction of wastage, enhanced machine efficiencies, reduction of process variations, inventory control, while building a culture of continuous improvement and decision making based on data at all levels.

As part of BPR, the company took decisions based on facts and data that have helped in streamlining the process to achieve the long-term goals. It wants to spread the total quality management culture through the involvement of all employees as a part of the BPR activity across all sections of the re-engineer at the Nasik plant.

The CEAT Nasik leadership reviews projects every 15 days, and in this process seeks the participation of all HODs, the BPR champion and the HR partner. A weekly BPR flash report is sent to the CEAT leadership and also to the top management, which reviews the progress every month at the Nasik plant.

Source: Adapted from www.ceatyres.com, accessed June 2016.

because of his full control over different departments of the division. However, he can re-engineer only those processes that are confined to his SBU. The success of one SBU may generate interest among other SBU heads who then take the initiative to introduce BPR in their own divisions. Eventually, the re-engineering process, as a whole, may succeed in developing a process-oriented culture.

BPR is essentially teamwork. The leader alone cannot carry it out. The leader appoints process owners and each is given the charge of re-engineering a process.

■ Process Owners

The objectives to be achieved by the re-engineering processes should be fixed by the leader in consultation with the process owners. In addition to technical aspects, the process owners need to display behavioural aspects such as leadership, communication, teamwork, attitude, resistance to change, re-engineered culture, etc. and they should also feature in the training programmes. The process owners should; however, be prepared for setbacks, which may be both technical and behavioural and may occur due to several reasons. Just as the BPR leader is expected to support and encourage the process owners when things are not working so well, it is the responsibility of the process owners as team leaders to work with the members and resolve the problems faced by them during implementation.

The first job of the process owners while conducting meetings with the team members is to explain the objective of the meeting and ensure the involvement of all. In consultation with the members, the process owner should explore the viability of the ideas thrown up in the meeting through brainstorming or otherwise and, as far as possible, quantify the benefits derived from them. Each process owner works with a re-engineering team for process implementation.

■ Re-engineering Teams

The re-engineering team members represent a cross-functional group with expertise in different parts of the process. The objective of the team is to integrate the fragmented tasks or sub-processes into a complete process that brings about radical improvements.

The concerned departments should be prepared to spare their best performing employees to join the team. Any attempt to re-engineer a process with process owners and team members of mediocre calibre will result in a mediocre outcome. Their efforts may improve the process, but the improvement is most likely to be marginal.

Before the initiation of BPR, it is possible that many of these high performers may have brilliant ideas that could not be implemented due to task-oriented and functional constraints. Once BPR succeeds in removing these barriers by creating a process-oriented culture, they can avail of the opportunity to communicate their ideas. As high performers, they are already seen to be performing their tasks well. However, BPR broadens their horizons and offers greater challenges that they are prepared to face.

■ Other Employees Involved in the Re-engineering Process

Process owners and team members need the assistance of other employees for the successful implementation of a re-engineering process. Adequate training should be given to the employees for the successful implementation of a re-engineering process. In order to successfully implement the re-engineering process, there is a need for co-operation and active involvement of other employees to perform the tasks assigned to them.

The other employees involved in the re-engineered process support the process owners. They are not members of the BPR teams. Apart from them, some middle management level or junior level managers may also act as "catalysts" and initiate re-engineering projects.

In some re-engineering processes, the need for BPR is first felt not by the top management but by a person who plays the role of a "catalyst" and tries to initiate the endeavor. A catalyst is normally a manager who holds a relatively junior position and is close to the place of action. The catalyst, however, undertakes a detailed study of the process to convince the top management about its shortcomings and the benefits of re-engineering it. Unless his diagnosis is supported by hard facts and figures and detailed analysis, the top management may not attach due importance to it.

However, a catalyst due to his or her relatively junior position will not be chosen as the BPR leader. He or she will not have control over tasks performed in other departments. The leadership is always at the level of the top management. If the top management decides to re-engineer a process analysed by the catalyst, then the catalyst is also quite likely to be involved in it and eventually in other processes.

Bird's-eye view:

A typical **BPR** team in project management comprises of Executive sponsor, Business analyst, Project manager, Developer, Quality assurance analyst, Trainer, Application architect, Database analyst, Infrastructure analyst, Information architect, Solution owner, End-user, Subject matter expert, Stakeholders.

■ BPR Teams in Project Management

BPR team roles should be identified early in project management to help ensure timely delivery. Some individuals may be called on to play a variety of roles in different projects and occasionally even on the same project. Many re-engineering processes may have standards applicable to defining team roles. Typical team roles may include, but not be limited to the following:

Executive sponsor: The executive sponsor has the overall responsibility for the project at the management level including funding, go/no go decision making and providing resource support. Often the executive sponsor also will function as the project “champion” within the organization.

Business analyst: The business analyst elicits, analyses, documents and reviews the requirements for accuracy and presents them to project stakeholders for review and approval.

Project manager: The project manager manages the day-to-day activities of the project ensuring that tasks are delivered on time and within the budget and scope. The project manager must ensure that proper stakeholder approval of the requirements is obtained before progressing forward with project delivery.

Developer: Developers are the technical resources assigned to a project and may include many technical roles within a project team, e.g. the technical lead oversees the design, code, and test activities for the technical members of the project team. Developers also plan the application’s transition to the user community, often working directly with the business analyst and trainers.

Quality assurance analyst: The quality assurance analyst is responsible for ensuring that quality standards are adhered to by the project team.

Trainer: The trainer is responsible for developing user training curriculum materials and delivering training to end-user personnel. These materials are based on the functional requirements.

Application architect: The application architect defines the architectural approach and high-level design for a project solution. The application architect is responsible for determining the technical direction of the project and the overall structure of the solution.

Database analyst (DBA): The database analyst is responsible for all technical aspects related to designing, creating and maintaining project databases.

Infrastructure analyst: The infrastructure analyst designs the overall hardware and software infrastructure and environment needed to meet the application development and operational requirements.

Information architect: The information architect is responsible for assessing the overall data requirements of an information system project. Information architects identify reusable data assets and resolve enterprise data modeling issues.

Solution owner: The solution owner is responsible for defining and approving the project scope and ensuring that it aligns with the business strategy. Approving project scope changes and defining the project success criteria and measurement are also part of the responsibility of the solution owner.

End user: The end user represents the group of people in the organization (and is often external to it) who will actually interact directly with the software application.

Subject matter expert (SME): The subject matter expert (SME) provides expertise in a particular business's functional area. SME responsibilities are closely related to defining, approving and using the functional requirements for the project. SMEs, typically, work very closely with business analysts in identifying and managing the requirements.

Stakeholders: Stakeholders are people or entities materially affected by the outcome of the project. Stakeholders are often a prime source of information when planning and managing requirements.

DISCUSSION FORUM

1. What are the key enablers of BPR in the service and manufacturing sectors?
2. Discuss the re-engineering structure of BPR.
3. Explain the BPR team in project management.

■ LIMITATIONS AND ISSUES IN BPR⁷

Resistance to BPR usually occurs at the levels of the junior and middle management. Personnel in these levels have an unfounded fear that process-oriented thinking will result in the loss of power, control and authority. There are a number of common pitfalls that companies fall into while re-engineering key business processes such as:

- **Re-engineering too many processes at the initial stages:** The top management may be so impressed with the achievements of BPR in other re-engineering processes that it makes the mistake of initiating this for too many processes simultaneously.
- **Ignoring everything except process redesign:** Sometimes, re-engineering teams fail to address the much needed changes in job designs, management systems and re-engineered structures that are required for a successful outcome.
- **Placing prior constraints on the definition of the problem and the scope of the re-engineering effort:** An example for this might be defining the problem in the context of the way the company is doing business today, not the way it will need to do business in the future. Re-engineering is not simply about making a process faster or more efficient, though ROI (return on investment), ROA (profit/assets) and ROM (management) are important measures of success.
- **Inadequate training of process owners and team members:** Training plays an important role in BPR. If a company does not give proper attention to training, it is unlikely to succeed in re-engineering its business processes. The management cannot expect the desired results from the process owners and team members if they are inadequately trained.

Bird's-eye view:

The successful implementation of **BPR** becomes difficult due to the complex nature of BPR and the radical changes that have to be brought about in organizational structure, processes, procedures, behaviour and attitude of employees etc. To overcome this problem, it is necessary to understand the pitfalls and avoid the same while implementing BPR.

Training in re-engineering cannot be undertaken in the form of a standard training package. The trainers should have a fairly clear idea about the way the company works and the attitude of its employees towards change.

- **Delay in showing results:** Undue delay in showing significant improvements in quantitative terms has an adverse impact on re-engineering initiatives. Such delay is likely to create an impression in the minds of people that re-engineering is a just a fad. Even the top management may lose interest if a process takes long to show results.
- **Non-availability of adequate resources:** A re-engineering team may come up with a brilliant idea to re-engineer a process. The design and evaluation of the process prototype may be carried out successfully. At the implementation stage, the team members may; however, find that adequate resources are lacking. A problem of this type dampens their enthusiasm and results in the company's inability to re-engineer the process.
- **Limited awareness among employees:** In order to institutionalize process-oriented thinking, the message to re-engineer business processes should reach all the employees. They should be aware that the management has decided to conduct businesses on the basis of processes, not tasks. They need to be given a clear understanding of the meaning of a process.

■ THE RELATIONSHIP BETWEEN BPR AND TQM

Bird's-eye view:

BPR is closely related to TQM because it can be one of the best tools to achieve total quality and to improve a company's performance significantly.

Bird's-eye view:

Both TQM and BPR primarily focus on customers, both are process-oriented and both involve cross-functional activities. While TQM aims at process improvement, BPR aims at drastic changes to improve a process, if possible discarding the existing process and developing an entirely new, improved process.

BPR is closely related to TQM because it is one of the best tools to achieve total quality and to improve a company's performance significantly. Both TQM and BPR primarily focus on customers, both are process-oriented and both involve cross-functional activities. While TQM aims at process improvement, BPR aims at drastic changes to improve a process, if possible, by discarding the existing process and developing an entirely new, improved process.

Both TQM and BPR are customer-oriented. They both aim at improving customer satisfaction and suggest that it is important to analyse the situation from the customer's viewpoint. Also, both TQM and BPR are process-oriented. They both target altering the processes, but not just the product. Moreover, they both take the team approach.

Nearly all BPR projects are initiated by the top-down approach. Since BPR results in great changes, staff resistance is obvious. Therefore, the top management's support and commitment are very important. For TQM, both top-down approach and the bottom-up approach are possible.

The basic assumptions of TQM and BPR are different. TQM aims for smooth and incremental improvements whereas BPR aims at dramatic results. The objective of TQM is to improve on the basis of the existing system. However, BPR assumes that the existing system is useless and suggests starting it over. TQM emphasizes the total involvement of all the stakeholders including suppliers and customers. TQM also recommends involving all the processes in the company, including human resources management, order fulfilling, manufacturing, marketing and customer management and others. However, for BPR, the project can be limited to a specified area only.

Standardization is one of the critical points of TQM. TQM aims to standardize the practices, thus achieving a consistent performance. It also ensures that there is a certain degree of documentation. However, BPR emphasizes flexibility and believes that standardization would increase the complexity of the process. Therefore, standardization is rare in BPR and the level of documentation is much lower.

TQM emphasizes the use of statistical process control. However, there is no similar concern for BPR. On the other hand, BPR emphasizes on information technology as an enabler.

TQM is a cultural issue. Once the culture is built, TQM is absorbed in the daily operation. However, BPR is a project. It has a clear target that needs to be achieved as soon as possible.

DISCUSSION FORUM

1. Discuss the limitations of BPR.
2. Explain the relationship between TQM and BPR.

SUMMARY

- Re-engineering is the fundamental rethinking and radical re-design of business processes to achieve dramatic improvements in critical contemporary measures of performance such as cost, quality, service and speed.
- The three R's of re-engineering are rethink, redesign and retool. Re-engineering requires focusing on critical processes, often using cross-functional teams, information technology, leadership and process analysis.
- Business process re-engineering originated in the 1950s as large firms began to explore the potential impact of computers on the efficiency and efficacy of their business processes. Some of the main benefits of BPR are improvement in efficiency and effectiveness of the process, cost saving, change management and business growth.
- Davenport notes six areas that influenced the emergence of BPR—the total quality approach, industrial engineering, the systems approach, the socio-technical approach, the diffusion of innovations and the use of information systems for competitive advantage. Michael Hammer and James Champy, the originators and leading exponents of the concept of re-engineering, published a book *Re-engineering the Corporation*, which was a pioneering work on BPR.
- Re-engineering is about achieving a significant improvement in a process so that contemporary customer requirements of quality, speed, innovations, customization and service are met. This entails seven new rules of doing work proposed by Michael Hammer, relating to who does the work, where and when it is done and information gathering and integration.
- The seven rules of doing work proposed by Michael Hammer are (1) organize around outcomes, not tasks, (2) have those who use the output of the process perform the process, (3) merge information processing work with the real work that produces the information, (4) treat geographically dispersed resources as though they work centralized, (5) link parallel activities instead of integrating their results, (6) put the decision point where the work is performed and build control into the process and (7) capture information only once at the source.
- BPR implementation methodology has five activities—prepare for BPR, map and analyse the as-is process, design the to-be processes, implement the re-engineered processes and improve continuously.
- Davenport prescribes a five-step approach to the BPR model. They are develop business vision and process objectives, identify the business processes to be re-designed, understand and measure the existing processes, identify IT levers, design and build a prototype of new process.

- Project phases required for successful implementation of BPR may be explained in seven phases—begin re-engineered change, build re-engineering structure, identify the BPR opportunity, understand the existing process, re-engineer the process, blueprint the new business system and perform the transformation.
- The enablers of BPR in the service sector are making the customer the starting point for change, designing work processes in the light of re-engineered goals and restructuring to support front-line performance.
- The enablers of BPR in the manufacturing sector are agile manufacturing, lean manufacturing, JIT, collaborative manufacturing, intelligent manufacturing, production planning and control, product design and development.
- The general structure of a re-engineer in BPR consists of BPR leaders, process owners, re-engineering teams and other employees involved in the re-engineering process.
- A typical BPR team in project management comprises executive sponsors, business analysts, project managers, developers, quality assurance analysts, trainers, application architects, database analysts, infrastructure analysts, information architects, solution owners, end-users, subject matter experts and stakeholders.
- The successful implementation of BPR becomes difficult due to the complex nature of BPR and the radical changes that have to be brought about in the re-engineered structure, processes, procedures, behaviour and attitudes of employees. To overcome this problem, it is necessary to understand the pitfalls and avoid the same while implementing BPR.
- BPR is closely related to TQM because it is one of the best tools to achieve total quality and to improve a company's performance significantly. Both TQM and BPR primarily focus on customers, both are process-oriented and both involve cross-functional activities. While TQM aims at process improvement, BPR aims at drastic changes to improve a process, if possible discarding the existing process and developing an entirely new, improved process.

Key Terms

Agile Manufacturing	396	Dramatic	378
Application Architect	400	End User	401
As-is Process	390	Executive Sponsor	400
BPR Leader	397	Fundamental	378
BPR Methodologies	387	Information Architect	400
Business Analyst	400	Information Technology	384
Catalyst	399	Infrastructure Analyst	400
Clean Slate Philosophy	383	Intelligent Manufacturing	404
Collaborative Manufacturing	396	Just in Time	396
Consolidated Methodology	389	Lean Manufacturing	396
Critical Process	383	PPC	397
Cross-functional Teams	383	Process Analysis	383
Database Analyst	400	Process Owner	399
Developer	400	Processes	378

Product Design and Development	397	Retool	380
Project Manager	400	Solution Owner	401
Quality Assurance Analyst	400	Stakeholder	401
Radical	379	Strong Leadership	383
Redesign	381	Subject Matter Expert	401
Re-engineering Structure	397	To-be Process	390
Re-engineering Teams	399	Trainer	400
Rethink	380		

Case Study

ERP Implementation at Escorts

Escorts Limited's Agri Machinery Group (EL-AMG) manufactures agricultural machinery and was set up in 1960. It accounts for almost two-thirds of the company's revenues. It has four manufacturing plants in Faridabad and manufactures three lines of tractors and imports and sells different farm equipment. The use of ERP plays a crucial role in the business operations of this manufacturing company.

EL-AMG had already implemented ERP systems from Avalon. However, the implementation was not successful. The company was unable to draw a future roadmap and upgrade its technology. Avalon also closed down its operations in India. EL-AMG was forced to look for an alternative enterprise applications vendor for its business. It zeroed in on Oracle 11i suite of products. The ERP solutions offered by Oracle enabled EL-AMG to make better and more informed decisions and enjoy bug-free software performance.

Challenges

In spite of using ERP solutions offered by Avalon, the company could not offer e-commerce and other Web initiatives because the ERP offered by Avalon could not be Web-enabled. This was obstructing the future growth of the company. Since Avalon had stopped operations in India, there was no possibility of further upgrades. It was also very difficult to incorporate frequent changes in the application because the product had inadequate documentation. The Avalon software was plagued with software bugs, which could not be resolved due to the lack of proper documentation. The central systems department that took charge of applications maintenance spent most of its time tackling these bugs. A huge backlog of work also was created because users were not able to run queries on their own. The central systems department was responsible for running queries and generating reports. This created a huge backlog of work.

The group wanted an end-user-driven system that would empower the users and allow them to run their own queries, thus reducing the burden on the systems department. They decided to implement a new ERP system, which could take care of the future growth strategies of the company and provide the much needed functionalities.

Selecting and Implementing the ERP System

In early 2001, EL-AMG chose Oracle as the vendor keeping in mind the re-engineer's functional and technical requirements. The ERP project was named *Pragati*. The project was completed in an elaborate and phased manner to ensure efficiency. A lot of time was

invested in planning and deciding upon the right software. Three ground rules were laid down for all the vendors involved in the programme. The vendor had to conduct a three-month business BPR exercise at EL-AMG. The ERP vendor would be the technology implementation partner and handle the sole responsibility of the project. The ERP systems had to integrate seamlessly with the company's legacy software systems. End users were also involved in the vendor selection process. A team of around 70 members with almost 80 per cent belonging to functional areas was organized. The rest were from the IT department. Each member of the team gave ratings to the vendor. Functionality, the ability to integrate third party software, the type of feedback from the existing user base (through visits to other companies ERP sites), presence in India, localization of modules, cost and the time taken to implement were some of the criteria used in the vendor selection process.

In March 2002, Oracle was chosen for the applications and Accenture was chosen to conduct the BPR exercise. The rollout of Oracle's products began in March 2002. The company decided upon the big bang approach for implementation in its five locations. It went live on Oracle 11i in March 2003. The modules implemented were Oracle Financials, Oracle Discrete Manufacturing, Oracle Purchasing, Oracle Order Management, Oracle Workflow and Alerts, Financial Analyzer (OFA), Purchasing and Manufacturing Intelligence, Teleservice, iReceivables and Oracle Treasury.

The Company Network

The company network consists of 40 servers at its second plant in Faridabad. The servers range from NT, Windows 98, and Windows 2000 to Linux and Solaris.

A set of four HP servers (HP-Ux 11i) run the core Oracle application modules. These are connected to a SAN box. The other three plants and the R&D locations connect to these servers through 2 Mbps leased lines. The area offices are able to connect to the servers located in Plant 2 through a VPN provided by HCL Infinet using a PSTN dial-up.

BPR

"If one goes for an ERP without BPR, there is a chance the company will miss out on a lot of benefits of BPR," said Mehta. The BPR exercise was closely aligned with the ERP implementation, ensuring that "best practices" were incorporated. Accenture was involved in defining the re-engineered processes and convincing the end users of the future benefits. Oracle's role was to map the processes into their products. The processes involved in re-engineering included finance, procurement, materials, plant maintenance and quality assurance.

After BPR implementation, the company was able to create better workflow processes, easily generate MIS reports, enable bug-free performance of systems and ensure timely closing of accounting cycles. The new ERP system also brought down the value of inventory by around 30 per cent. There have been substantial savings in terms of inventory and manpower resources.

Source: Adapted from "New Tools at Escorts AMG," available at www.networkmagazineindia.com/200308/case1.shtml, accessed May 2010.

Discussion Questions

1. What were the challenges faced by the company despite using ERP?
2. What was the solution?

3. Comment on the statement “If one goes for an ERP without BPR, there is a chance that the company will miss out on a lot of benefits of BPR.”
4. What were the benefits of implementing ERP?

Short-answer Questions

1. Define BPR.
2. Name the three R's of re-engineering.
3. What are the requirements of the re-engineering process?
4. Trace the evolution of BPR.
5. Name the seven rules of doing work in BPR.
6. Name the five activities in BPR implementation strategy.
7. Name the five steps in the BPR model prescribed by Davenport?
8. Name the BPR methodologies.
9. Name the seven phases required for successful implementation of BPR.
10. What are the common benefits of re-engineering the business process?
11. Which are the key enablers of BPR in the service sector?
12. Which are the key enablers of BPR in the manufacturing sector?
13. What is the re-engineered structure of BPR?
14. Name the BPR teams in project management.
15. What are the pitfalls of BPR?
16. Compare TQM and BPR.

Match the Following

a. Methodology 1	Manganelli and Klien (1994)
b. Methodology 2	Furey (1993)
c. Methodology 3	Harrison and Pratt (1993)
d. Methodology 4	Mayer and Dewitte (1998)
e. Methodology 5	Underdown (1997)

Discussion Questions

1. Discuss the formal definition of BPR in detail.
2. Explain the benefits of BPR with examples.
3. Discuss the success factors of BPR in detail.
4. Discuss the structure of the re-engineers implementing BPR.
5. Describe the methodology used in BPR approaches.

Projects

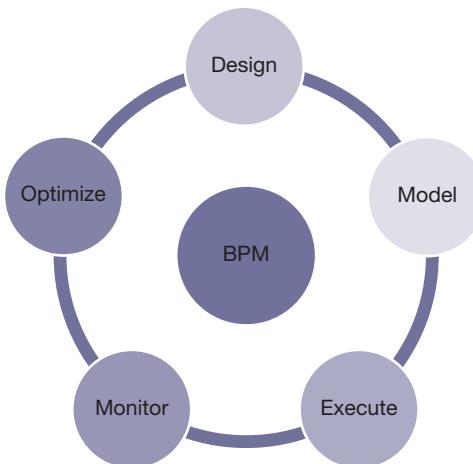
Visit the Web sites of the following re-engineers and prepare a report on BPR implementation and benefits derived due to BPR.

- a. IBM Credit Corporation
- b. Ford Motor
- c. Kodak
- d. Mahindra and Mahindra
- e. Singapore National Library Board

End Notes

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Business Process Management



BPM AT GENERAL ELECTRIC

Business Process Management (BPM) typically examines continuous improvement in business processes and results in increased efficiency at reduced costs. Enterprise BPM, advanced BPM, and iBPM are some of the new definitions coined in the BPM space. BPM is a holistic and systematic approach to achieve optimized business outcomes. It enables organizations to align business functions with customer needs, and helps executives determine ways to deploy, monitor, and measure the company's resources. When properly executed, BPM has the ability to enhance the efficiency and productivity, reduce costs, and minimize errors and risks, thereby optimizing results.

BPM has been put to use by companies like General Electric (GE) to deliver double-digit improvements in measures such as margin, capacity, resource utilization, and capital utilization. In 1997, Genpact—an acronym for generating business impact—began as a business unit within GE. In January 2005, Genpact became an independent company to bring process expertise and unique DNA in lean management to clients beyond GE. In August 2007, it became a publicly traded company. Genpact is a pioneer in BPM and process transformation. Based on the company's experience, the four practices responsible for turning BPM into a strategic capability are articulation of BPM strategy in terms of business outcomes and not efficiency in terms of information technology; execution of BPM through consistent end-to-end governance and management practices; support given to BPM's execution through a simple, effective structure; and development of a culture of performance supported by HR best practices.

“Almost all quality improvement comes via simplification of design, manufacturing, layout, process and procedures.”

Tom Peters

Upon completion of this chapter, you will be able to:

1. Understand the relevance and importance of business process management
2. Describe the evolution and scope of business process management
3. Explain how business process management can be designed
4. Discuss process mapping
5. Implement process management

Bird's-eye view:

Business process management (BPM) is a systematic approach to making an organization's workflow more effective, more efficient and more capable of adapting to an ever-changing environment.

■ INTRODUCTION

An organization is a collection of processes. These processes are the natural business activities performed by organizations and produce value, serve customers and generate income. Managing these processes is the key to the success of the organization.

In the new era of business transformation, an increasing number of enterprises are looking at re-orienting themselves into process-centric, customer-focused organizations. This paradigm shift has led to the evolution of business process management (BPM) as a principal management discipline to enable strategic planning of business goals. BPM drives process improvements and innovative applications of technology for greater agility.

Many companies have business processes that are unique to their business models. Since these processes tend to evolve over time as the business reacts to market conditions, the BPM solution chosen must be easily adaptable to the new conditions and requirements and continue to be a perfect fit for the company.

BPM refers to the designing, executing and optimizing of business activities that incorporate people, systems and partners. Business process management suites (BPMS) are integrated tools designed to support BPM efforts. In order to use BPM effectively, organizations must stop focusing exclusively on data and data management, and adopt a process-oriented approach that makes no distinction between the work done by a human and a computer.

Process management involves planning and administering the activities necessary to achieve a high level of performance in key business processes, identifying opportunities for improving quality and operational performance and ultimately customer satisfaction.

■ Evolution of BPM

There was a considerable focus on TQM in the 1980s. Six Sigma was invented in 1986 and created awareness about “processes.” This was followed by business process re-engineering (BPR). BPM has been around for some time and created significant interest and discussion when Smith and Fingar¹ published *BPM: The Third Wave* in 2002. Smith and Fingar describe how the third “wave” is where automation, business process and quality management come together. The third wave of BPM is a synthesis of process representation and collaboration technologies that removes the obstacles blocking the execution of management intentions. BPM can be termed as the convergence of management theory, total quality management, Six Sigma, business engineering and general systems thinking with modern technologies.

Bird's-eye view:

A **business process** is an activity or set of activities that will accomplish a specific organizational goal.

The current view of BPM focuses on the merger of three main streams: business process thinking, automation and quality thinking, which have independently evolved over many years. It can now be argued that BPM is the most important topic on the management agenda.

■ Scope of Process Management

BPM is a management discipline and requires an end-to-end organizational view. Management at the operational level is predominantly about the improvement and control of the processes essential to business to achieve the objectives of the organization. Setting the direction and goals for the business process improvement is a critical step, and one that needs to be addressed by the top management. There are two aspects to the operational management of a business process:

1. Management of the business process as an integral part of “management.”
2. Management of business process improvements.

The introduction of technology can be a useful contributor in this. It is far more important to get the processes right before the implementation of technology.

The critical success factors in a BPM project are leadership, BPM-experienced business project manager, linkage to organization strategy, process architecture, people change management, people and empowerment, project initiation and completion, sustainable performance and realising value.

A business process is any goods or non-goods related cross-functional process of critical importance. Typically, managing such processes requires a process owner and a permanent team. Leading companies identify important business processes throughout the value chain that affect customer satisfaction. These processes typically fall into two categories:

1. Value creation processes
2. Support processes

Value creation processes are sometimes called core processes because they are the most important processes “running the business” and maintaining or achieving a sustainable competitive advantage. They drive the creation of products and services, are critical to customer satisfaction and have a major impact on the strategic goals of an organization. Value creation processes typically include design, production/delivery and other critical business processes.

Value creation processes involve the majority of the organization’s employees and produce value for the customers, stockholders and other key stakeholders. They include the processes through which the organization adds greatest value to its products and services. Value creation processes include the business processes most critical to adding value to business itself, resulting in success and growth. Box 13.1 discusses the sourcing strategy followed by Tata Steel for value creation.

Box 13.1 Value Creation through Strategic Sourcing at TATA Steel

Tata Steel, with an experience of 100 years in steel making, is among the top 10 steel producers in the world. It has an annual crude steel production capacity of 30 million tonnes per annum. The company has a global presence in over 50 developed European and fast growing Asian markets, and has manufacturing units in 26 countries.

The company has successfully created value through strategic sourcing. Strategic sourcing attempts to lower the cost of goods manufactured through reduction in the prices of purchased products and services and reduction in their specific consumption. The supplier value management (SVM)

Bird's-eye view:

The evolution of **Business Process Management (BPM)** as a customer-centric and process centric approach to improving business results has entered its third wave over the last forty five years in the form of Business Process Management (BPM)

Bird's-eye view:

Processes typically fall into two categories: Value creation processes and Support processes.

 **Bird's-eye view:**

Business Process Management (BPM), as the name suggests is managing business processes. Each and every business has some processes that are to be followed if the desired goal is to be achieved in the most efficient and optimum manner. So in generalized view, BPM allows you to create those processes as models/diagrams that can then be implemented.

approach followed addresses the internal value chain of Tata Steel and in some cases goes up to the distribution channels of suppliers. According to the SVM philosophy, the value chain of the suppliers and that of Tata Steel is considered as a single entity. There is a strong belief that enhancements/improvements at the suppliers' end will directly enhance the value delivered to the end customer. The supply chain used by suppliers is also studied in detail to identify revenue leakages.

Tata Steel follows the criteria mentioned below for conducting SVM with suppliers:

- The supplier should be a manufacturer and Tata Steel must be the key customer for the supplier.
- The commodity should have a direct impact on Tata Steel's throughput.
- The supplier should fit culturally with Tata Steel and should be willing to be a long-term partner.

The strategic sourcing strategy followed by the company has delivered savings of more than USD 80 million over the last five years, and played a key role in making Tata Steel the lowest cost producer of steel.

Source: Adapted from www.tatasteel.com, accessed on 30 June, 2016.

Key value creation processes differ greatly among organizations depending on many factors. These factors include the nature of products and services, how they are produced and delivered, technology requirements, customer and supplier relationships and involvement, outsourcing, importance of research and development, role of technology acquisition, information and knowledge management, supply chain management, mergers and acquisitions, global expansion and sales and marketing.

In many companies, value creation processes take the form of projects—temporary work structures that start up, produce products or services and then shut down. In order to achieve better process performance and reduce variability, organization's might implement approaches such as the lean enterprise system, Six Sigma methodology, make use of ISO 9000:2000 standards or other process improvement tools.

Support processes are those that are most important to an organization's value creation processes, employees and daily operations. They provide infrastructure for value creation processes, but generally do not add value directly to the product or service. In general, value creation processes are driven by external customer needs while support processes are driven by internal customer needs. Because value creation processes do add value to products and services, they require a higher level of attention than support processes. These might include facilities management, finance and accounting, public relations, legal services, human resource services, project management and administration processes.

■ DESIGNING PROCESSES FOR QUALITY²

 **Bird's-eye view:**

The design of processes that produce and deliver goods and services can have a significant impact on cost, flexibility and the quality of the output. Standardized processes establish consistency of output. However, standardized processes may not be able to meet the needs of different customer segments. Today, many companies use a strategy of mass customization—providing personalized, custom-designed products to meet individual customer preferences at prices comparable to mass produced items. Mass customization requires significant changes to mass produced standardized products. These products include flexible manufacturing technologies, just-in-time systems, information technology and an emphasis on cycle time reduction. The goal of process design is to develop an efficient procedure to satisfy both internal and external customer requirements. The methodology of business process quality management

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builds on the customer–supplier relationship and makes use of the processes of quality planning, quality control and quality improvement. Process management consists of the important concept mentioned below:

- Emphasis is placed on the overall effectiveness of a cross-functional process, rather than the output of the individual functional departments.
- The process is analysed in an integrated manner not only for correcting defects, errors or other problems but also for identifying and meeting customer needs.
- Detailed tasks in the process are evaluated to ensure that there is value added for each task.
- The responsibility for the process is defined in terms of a process owner and a process team. The owner and the team are permanent. The process team may set up quality teams that function temporarily to address specific problems within the total process.

■ The Process Owner

The design of a process begins with the process owner. The concept of a “process owner” deserves elaboration. A process owner might be an individual, a team, a department or some cross-functional group responsible for the overall performance of a process. These responsibilities include effectiveness, efficiency, control and adaptability. A basic approach to process design is suggested below and the model is provided in Table 13.1.

1. Identify the product or service: What work do I do?
2. Identify the customer: Who is the work for?
3. Identify the supplier: What do I need and from whom do I get it?
4. Identify the process: What steps or tasks are performed? What are the inputs and outputs for each step?
5. Mistake-proof the process: How can I eliminate or simplify tasks? What *poka-yoke* (i.e. mistake-proofing) devices can I use?
6. Develop measurements, controls and improvement goals: How do I evaluate the process? How can I improve further?

Bird's-eye view:

A **process owner** might be an individual, a team, a department or some cross-functional group responsible for the overall performance of a process. These responsibilities include effectiveness, efficiency, control and adaptability.

■ Design Processes

Design processes involve all activities that are performed to incorporate customer requirements, new technology and past learning into the functional specifications of a product, and define its fitness for use. Most companies have some type of structured product

Bird's-eye view:

Design processes involve all activities that are performed to incorporate customer requirements, new technology and past learning into the functional specifications of a product, and define its fitness for use.

Table 13.1 Methodology of Business Process Quality Management

Elements of the Cycle	Stages	Steps
Management	Ownership Assessment	1. Establish process management responsibilities 2. Define process and identify customer requirements 3. Define and establish measures
	Opportunity Selection	4. Assess conformance to customer requirements 5. Investigate the process to identify improvement opportunities 6. Rank improvement opportunities and set objectives
Improvement	Improvement	7. Improve process quality

 **Bird's-eye view:**

A typical product development process consists of six phases: Idea generation; Preliminary concept development; Product/process development; Full-scale production; Market introduction and Market evaluation.

 **Bird's-eye view:**

Design for manufacturing (also sometimes known as **Design for Manufacturability** or DFM) is the general engineering art of designing products in such a way that they are easy to manufacture.

 **Bird's-eye view:**

DFM allows to improve efficiency by minimizing the number of parts through part standardization and/or modular architecture so that the assembly is cost effective and efficient.

 **Bird's-eye view:**

Production/delivery processes create or deliver the actual product. Some examples are manufacturing, assembly, dispensing medications, teaching a class, etc. These processes must be designed to ensure that the product will conform to specifications and also be produced economically and efficiently.

development process. It is important to realise that design processes apply to products and services as well. The typical product development process consists of six phases.

1. **Idea generation:** Product ideas should incorporate customer needs and expectations. However, true innovations often transcend customers' expressed desires, simply because customers may not know what they like until they have it.
2. **Preliminary concept development:** In this phase, new ideas are studied for feasibility while addressing such questions as:
 - Will the product meet customers' requirements?
 - Can it be manufactured economically with high quality?
3. **Product/process development:** If an idea survives the concept stage, the actual design process begins by evaluating design alternatives and determining engineering specifications for all materials, components and parts. This phase usually includes prototype testing in which a model is constructed to test the product's physical properties or use under actual operating conditions as well as consumer reactions to the prototypes.
4. **Full-scale production:** If no serious problems are found, the company releases the product to manufacturing or service delivery teams.
5. **Market introduction:** The product is distributed among the customers.
6. **Market evaluation:** Future product development and improvement processes depend on market evaluation and customer feedback to initiate continuous improvements. Many companies view customers as significant partners in product development, thus integrating market evaluation throughout the process.

Design for manufacturing: Design for manufacturability is the process of designing a product for efficient production at the highest level of quality. Design approaches often differ depending on the nature of products or services. For example, approaches to designing entirely new products will be unlike those that address minor changes and improvements. Design approaches might consider factors such as functional performance, cost, manufacturability, safety and environmental impacts. Product design can significantly affect the cost of manufacturing (direct and indirect labour, materials and overheads), redesign, warranty and field repair, the efficiency by which the product can be manufactured and the quality of the output.

Production processes: Production/delivery processes create or deliver the actual product. Some examples are manufacturing, assembly, dispensing medications, teaching a class, etc. These processes must be designed to ensure that the product will conform to specifications and also be produced economically and efficiently. Product design greatly influences the efficiency of manufacture as well as the flexibility of service strategies, and; therefore, must be coordinated with the production/delivery processes. The ultimate value of the product and; hence, the perceived quality to the consumer depend on both these types of processes. The process-centric approach followed at Patni Computers is discussed in Box 13.2.

Box 13.2 Process Framework—Applying Innovation for Enterprise Agility at Patni Computers

Organizations need to continuously improve their products and services to deal with increased competition and the pressure to enhance shareholder value. Enterprises also need to comply with changing regulations and adopt good governance practices. They need to be highly efficient,

effective, agile and flexible. Many companies have adopted a process-centric approach to deal with the challenges posed by dynamic markets. Organizations that have adopted a process-centric approach have benefited from an increase in operational efficiencies, customer satisfaction and corporate profits. This approach focuses on optimizing value chain business processes by driving out inefficiencies.

Patni Computer Systems focuses on business process management through its dedicated BPM Center of Excellence. The company has been able to bring together the right mix of functional expertise, best practices, frameworks, methodologies and product expertise to provide end-to-end BPM services and solutions to its customers. It has also developed a BPM strategy and roadmap in alignment with its core business objectives. Patni also offers BPM solutions such as process consulting services, process implementation services and specialized services like composite application framework and template based rapid ROI development.

Source: Adapted from www.patni.com, accessed on 30 June, 2016.

DISCUSSION FORUM

1. Define business process management.
2. Explain the value creation and support processes with an example.
3. Discuss product development process.
4. Who is a process owner?

■ PROCESS MAPPING³

Process mapping establishes the overall status of a business enterprise and defines what it does, along with what the people responsible for running the business and the standard are required to do to ensure the success of its operations. Clear-cut knowledge of these matters will enable managers to get a clearer picture of what the company does, where it stands and what it requires to become successful. These factors are better seen and evaluated in a unified illustration referred to as the process map.

The majority of companies eyeing ISO 9001 status, resort to hiring the services of a business process improvement consultant, to assist in coming up with business processing maps. Such a consultant may also be requested to help implement the new business processes efficiently and correctly.

Process mapping (some companies make use of flow charts) is an illustration of the different actions that a company has to perform to accomplish a certain goal. Companies that want to maximize their productivity or those that are experiencing production and output-related problems can use process mapping to improve their processes.

The growth of the process mapping method is shown through the following timeline:

- Frank Gilbreth introduced the flow process chart in 1921. Industrial engineering schools started to use this tool in their curriculum.
- Businessmen got their first taste of the use of flow charts at a conference (geared towards work simplification) spearheaded by Allan H. Mogensen.
- The process mapping tool was introduced to Proctor & Gamble by Art Spinanger, who himself learned from Mogensen.

 **Bird's-eye view:**
Business Process Mapping refers to activities involved in defining what a business entity does, who is responsible, to what standard a business process should be completed, and how the success of a business process can be determined.

 **Bird's-eye view:**
The main purpose behind business process mapping is to assist organizations in becoming more efficient. A clear and detailed business process map or diagram allows outside firms to come in and look at whether or not improvements can be made to the current process.

- Process mapping was also adapted by Ben Graham who was then working at Standard Register Corporation as Formcraft Engineering Director.

Through the use of a map or a flowchart, decision makers and other employees are able to visualize and understand the organization's processes and what is required to improve these processes. Some of the process mapping tools commonly used by companies that want to move up the productivity ladder are:

- ISO criteria
- Baldrige criteria for excellence
- Balanced scorecard
- Deming's total quality management model

Process mapping requires a company to identify its processes as well as its strengths and weaknesses. This enables the company to identify the practices and the necessary changes that should be implemented to improve the overall performance of the employees and the company in general. Box 13.3 discusses how process mapping has added value to human resource management at Godrej Industries.

Through a diagram or a process map, the company is able to identify what is delaying the operations, and which are the processes that require overhauling to improve the company's processes. It is an important tool to ensure quality control and improve performance.

Therefore, it is best that the process map be designed (under the supervision of a process mapping consultant) by the employees themselves since they are the front-liners and have personal experiences that can help the improvement process. They are the ones who can really tell whether a certain process is working for them or not and they can also suggest ways to improve on the processes being used.

■ Process Mapping Essentials

To get the most out of process mapping, it is important to take into consideration the following:

- Use the appropriate type of process map.
- Get experienced facilitation for best results.

Box 13.3 Process Mapping at Godrej Industries

Godrej Industries Ltd has benefited from using process mapping to streamline its training and development programmes. Before a training calendar was charted out, the managerial professionals come up with a requisition on a host of training sessions and programmes that they would like to attend.

The requests for attending training programmes arose due to the interest of managers to acquire new learning experiences. They were not necessarily aligned to the goals, job profiles or the business strategy of the organization.

A database was created on the training needs of the organization and process mapping was deployed. The strong need for identifying the development needs of managers was felt. The functional heads along with the human resources department have periodic discussions to identify the training needs. Quarterly reviews and feedback on all the training initiatives are also conducted.

Source: Adapted from "Adding Value to Human Resource Management," *The Financial Express*, 7 September 2002, available at www.financialexpress.com.

Bird's-eye view:

Process Mapping is a workflow diagram to bring forth a clearer understanding of a process or series of parallel processes. Business process mapping takes a specific objective and helps to measure and compare that objective alongside the entire organization's objectives to make sure that all processes are aligned with the company's values and capabilities.

- Identify the product or service clearly to determine the related sequence of events that produce the product or service.
- Set clear boundaries or start/end points for the process.
- Mapping should be conducted together with the people involved in the process.

■ Process Mapping Tools

There are many different approaches to process mapping, and choosing the right one can seem daunting. Some of the more commonly used types of process maps and their benefits are given below:

■ 1. Basic Flowchart

A basic flowchart is the simplest to create. It shows the flow from one step to the next and often includes basic information such as who performs a particular step or how long a step takes. Basic process maps are useful for sketching out an “As-Is” or “To-Be” process and serve as the basis for more complex types of maps.

Flowcharts are easy-to-understand diagrams showing how the steps in a process fit together. This makes them useful tools for communicating how processes work, and for clearly documenting how a particular job is done.

A flowchart can be used to:

- Define and analyse processes.
- Build a step-by-step picture of the process for analysis, discussion or communication.
- Define, standardize or find areas for improvement in a process.

Also, by conveying the information or processes in a step-by-step flow, you can then concentrate more intently on each individual step without feeling overwhelmed by the bigger picture.

Main symbols used in flowcharts: Most flowcharts are made up of three main types of symbols:

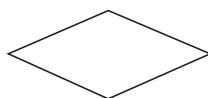
- Elongated circles that signify the start or end of a process.



- Rectangles that show instructions or actions.



- Diamonds that show the decisions that must be made.



Steps in flowchart preparation: The following steps can be used to prepare a flowchart:

- Write down what the symbol represents within each symbol. This could be the start or finish of the process, the action to be taken or the decision to be made. Symbols are connected to one another by arrows that indicate the flow of the process.

Bird's-eye view:

Commonly used Process Mapping Tools are: Basic Flowchart; Swim Lane Diagram; Value Stream Map; SIPOC Diagram; Spaghetti Diagram

Bird's-eye view:

A **Flowchart** is a type of diagram that represents an algorithm, workflow or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic representation illustrates a solution model to a given problem.

- To draw the flowchart, brainstorm process tasks and list them in the order they occur.
- Start the flowchart by drawing the elongated circle shape and labeling it “Start.” Then move to the first action or question, and draw a rectangle or diamond appropriately. Write the action or question down, and draw an arrow from the start symbol to this shape.
- Work through the whole process, showing actions and decisions appropriately in the order they occur, and link these together using arrows to show the flow of the process. Where a decision needs to be made, draw arrows leaving the decision diamond for each possible outcome, and label them with the outcome. At the end of the process use an elongated circle labeled “Finish.”
- Finally, challenge your flowchart. Work from step-to-step asking yourself if you have correctly represented the sequence of actions and decisions involved in the process.

Bird's-eye view:

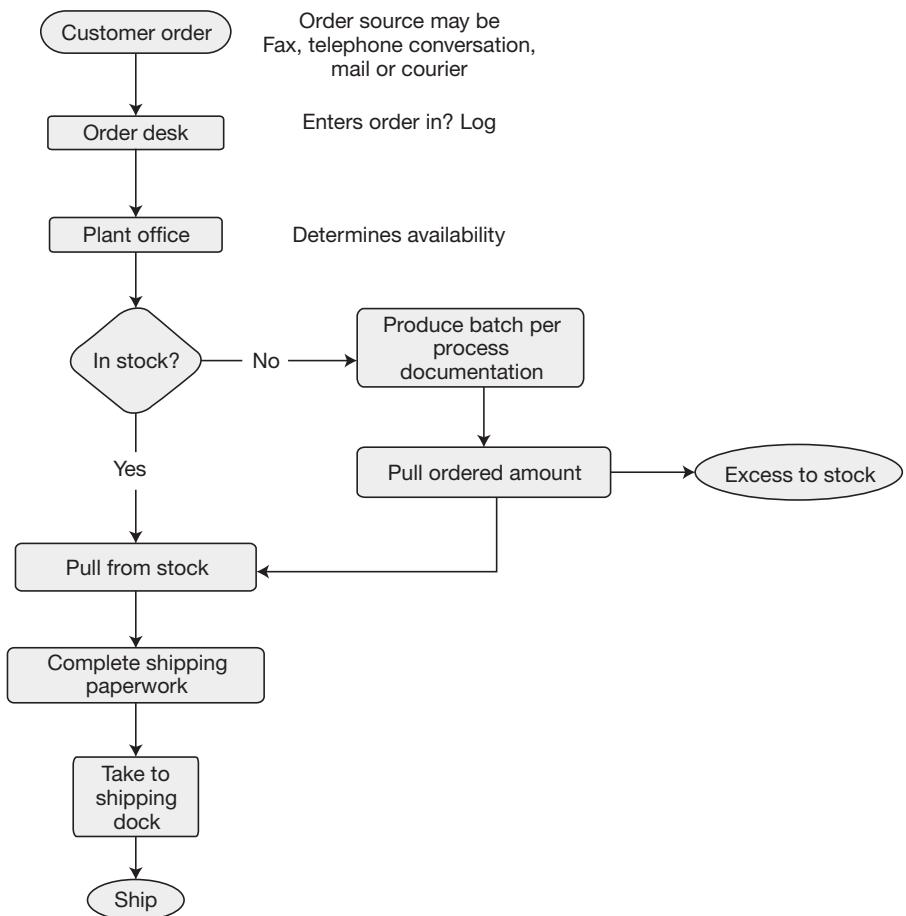
A **Swim lane** (or **Swimlane diagram**) resembles a swimming pool with lanes. It is a visual element used in process flow diagrams, or flowcharts that visually distinguishes job sharing and responsibilities for sub-processes of a business process. Swim lanes may be arranged either horizontally or vertically.

Figure 13.1 shows a flowchart prepared for customer order processing.

■ 2. Swim Lane Diagram

They are also termed deployment maps or cross-functional flowcharts. The swim lane diagram resembles a swimming pool with lanes. The blocks that denote compound parts of

Fig. 13.1 Flowchart for Customer Order Processing



processes are located on definite lanes according to the responsibility of the workers. The lanes may be located either horizontally or vertically depending on the existing process flow diagram. These lanes are denoted according to the resource name, which is charged with the execution of the given part of the process. Figure 13.2 shows a swim lane diagram for invoice processing.

Swim lanes could be a useful way of mapping processes and indicating which person or organizational unit is responsible for certain tasks. Here, each person or organizational unit has a column, and all the processes that they execute will be specified in the column. Swim line diagrams are one of the tools for documenting business processes. They provide an instant overview of who is doing what activities and also facilitate a visual representation of the handover between activities and processes.

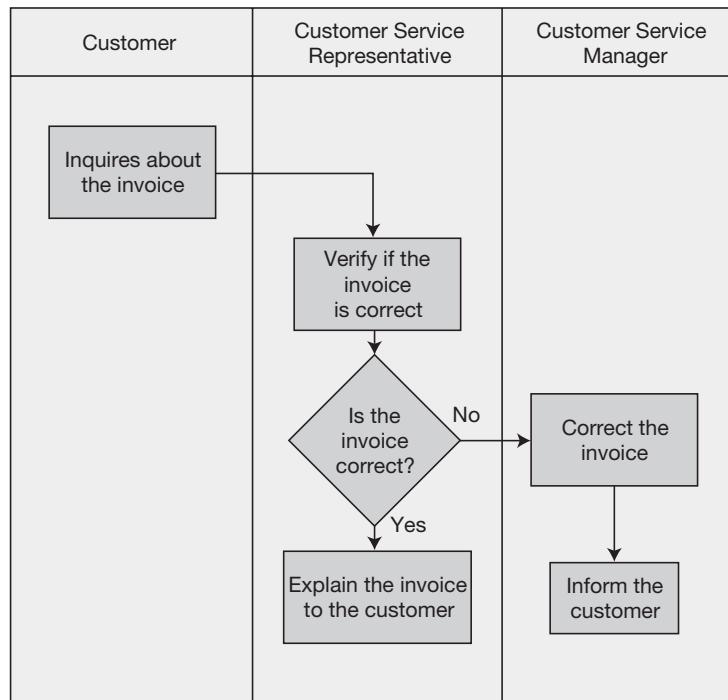
■ 3. Value Stream Map (VSM)

Value stream mapping⁴ creates a graphical representation of how a process works, showing the links between the flow of materials and information. It provides a common language for people to use to communicate what's happening, and why things need to change. This enables an organization to create an action plan for eliminating waste. This, ultimately, results in the increase in profits of the organization. It is a key method of implementing "lean manufacturing" to reduce waste and streamline both material and information flow.

VSM looks at the full, end-to-end process. By looking at the process from start to finish, one can clearly identify steps where no real value is added or where there's a bottleneck. Thus, the organization can eliminate different types of wastes. The value stream

 **Bird's-eye view:**
Value stream mapping is a lean-management method for analyzing the current state and designing a future state for the series of events that take a product or service from its beginning through to the customer. At Toyota, it is known as "material and information flow mapping".

Fig. 13.2 Swim Lane Diagram for Invoice Processing



map becomes the baseline for improvement initiatives that eliminate non-value added and wasteful activities. The objective of value stream mapping is to create a picture of how items such as materials, designs or customer needs flow through the value stream from raw materials and inputs through to the customer's end product.

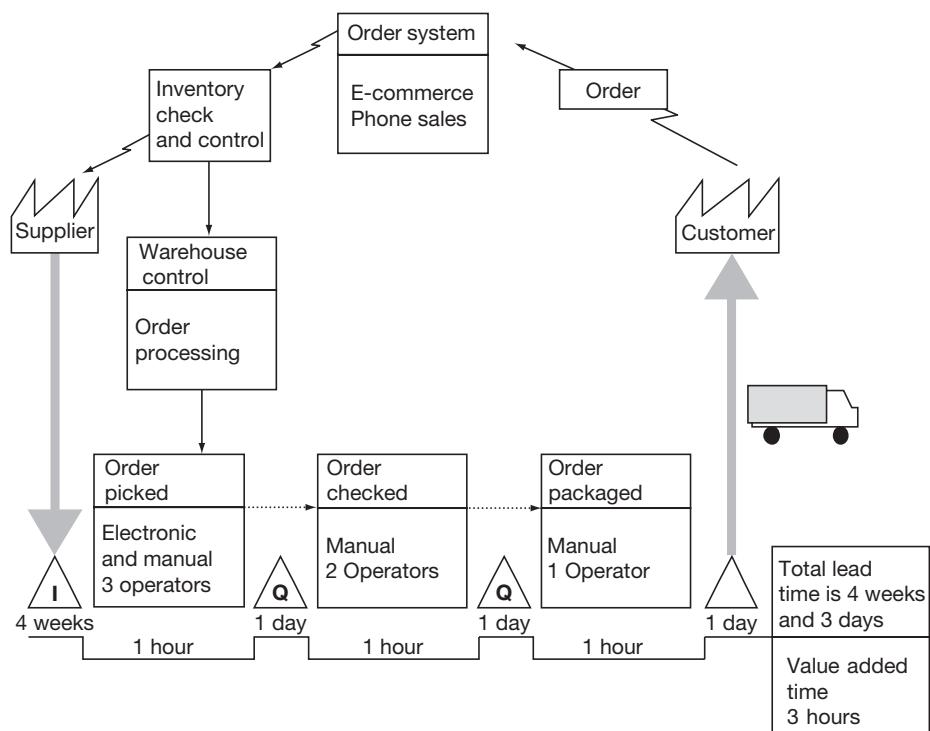
VSM is best applied to processes that are reasonably routine and standardized. The three steps for using VSM tools are:

Step 1: Draw a detailed picture of each part of the operation to produce a “current-state-map” that indicates the situation as it exists today. The entire manufacturing process is mapped out, including cycle times, down times, in process inventory, material moves and information flow paths.

Step 2: Identify ways to improve the process flow that will eliminate waste and utilize time, talent and equipment more efficiently. This invariably results in a better understanding of the entire manufacturing process. These improvements define the “future-state-map”—where we want to be in a speculated time from now.

Step 3: The final step is implementing the process improvements that lead to reduction of work-in-progress and production lead times, fewer defects and faster responses to demand changes. The results of VSM implementation can be immediate and dramatic. It should be noted that VSM is an ongoing process. Figure 13.3 shows a simplified VSM.

Fig. 13.3 Value Stream Map



Benefits of VSM: The key benefits of VSM are:

- It helps to visualize more than just the single-process level.
- It helps to see more than waste. Mapping helps to see the sources of waste.
- It makes decisions about the flow apparent.
- It ties together lean concepts and techniques.
- It shows the linkage between the flow of information and that of materials.

■ 4. SIPOC Diagram

A SIPOC diagram is a high-level process map that provides an overview of the entire process, from the supplier to the customer. It is commonly used in Six Sigma projects during the Define phase to provide an understanding of a process at the macro level. The SIPOC diagram consists of five columns—suppliers, inputs, process, outputs and customers. SIPOC diagrams are best used to capture the big picture. The SIPOC tool is particularly useful when it is not clear:

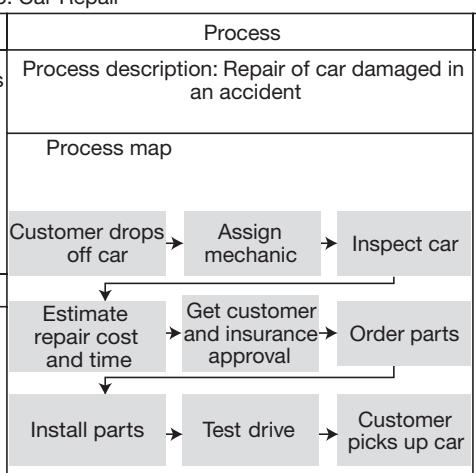
- Who supplies inputs to the process?
- What specifications are placed on the inputs?
- Who are the true customers of the process?
- What are the requirements of the customers?

A SIPOC diagram⁵ is a tool used by a team to identify all relevant elements of a process improvement project before work begins. It helps define a complex project that may not be well scoped, and is typically employed during the Measure phase of the Six Sigma DMAIC methodology.

Steps to complete the SIPOC diagram: SIPOC diagrams (Figure 13.4) are very easy to complete. Here are the steps you should follow:

Fig. 13.4 SIPOC Diagram for Car Repair

SIPOC Analysis and Map: Car Repair

Suppliers	Inputs	Process	Outputs	Customers
Auto parts distribution Car owner	Auto parts Car	Process description: Repair of car damaged in an accident 	Repaired car	Car owner Insurance company
Enablers	Insurance company			

 **Bird's-eye view:**

SIPOC (sometimes **COPIS**) is a tool that summarizes the inputs and outputs of one or more processes in table form. The acronym SIPOC stands for suppliers, inputs, process, outputs, and customers which form the columns of the table. It was in use at least as early as the total quality management programs of the late 1980s and continues to be used today in Six Sigma, lean manufacturing, and business process management.

 **Bird's-eye view:**

SIPOC diagram defines the scope of work for a team and identifies at a high level the potential gaps between what a process expects from its suppliers and what customers expect from the process.

 **Bird's-eye view:**

A SIPOC diagram maps a process at a high level and identifies potential gaps between suppliers and inputs specifications and between outputs specifications and customers' expectations, thus defining the scope for process improvement activities.

1. Create an area that will allow the team to post additions to the SIPOC diagram. This could be a transparency (to be projected by an overhead) made of the provided template, flip charts with headings (S-I-P-O-C) written on each or headings written on post-it notes posted to a wall.
2. Begin with the process. Map it in four to five high-level steps.
3. Identify the outputs of this process.
4. Identify the customers who will receive the outputs of this process.
5. Identify the inputs required for the process to function properly.
6. Identify the suppliers of the inputs that are required by the process.
7. Identify the preliminary requirements of the customers. This will be verified during a later step of the Six Sigma measurement phase.
8. Discuss this with the project sponsor, champion and other involved stakeholders for verification.

■ 5. Spaghetti Diagram

Bird's-eye view:

A **Spaghetti Diagram** is a visual representation using a continuous flow line tracing the path of an item or activity through a process. The continuous flow line enables process teams to identify redundancies in the work flow and opportunities to expedite process flow.

Spaghetti diagrams, also referred to as spaghetti maps, indicate the flow of materials through various areas, departments or physical spaces. Maps of airline flight routes are a common example of a spaghetti diagram. Spaghetti diagrams are most useful for finding inefficiencies in the layout of a shop floor or office, but can also be used to show unnecessary handoffs in digital environments.

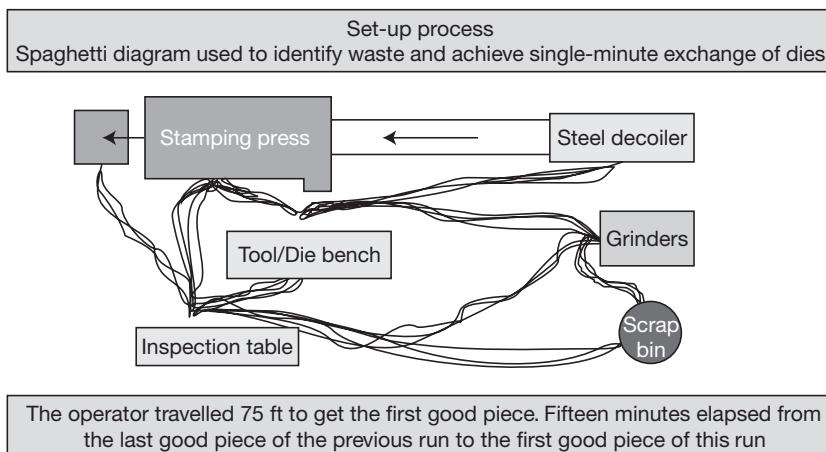
Spaghetti diagrams are named so because the line movements drawn on this diagram resemble a pile of tangled noodles. The spaghetti diagram is a great waste observation tool even for people taking their very first steps at Kaizen and lean management, and also one that serves even the most seasoned lean practitioners faithfully. It is a method that uses a continuous line to trace the path and distance travelled of a particular object or person throughout a process.

Steps to create a spaghetti diagram: The following steps can be used to create a spaghetti diagram:

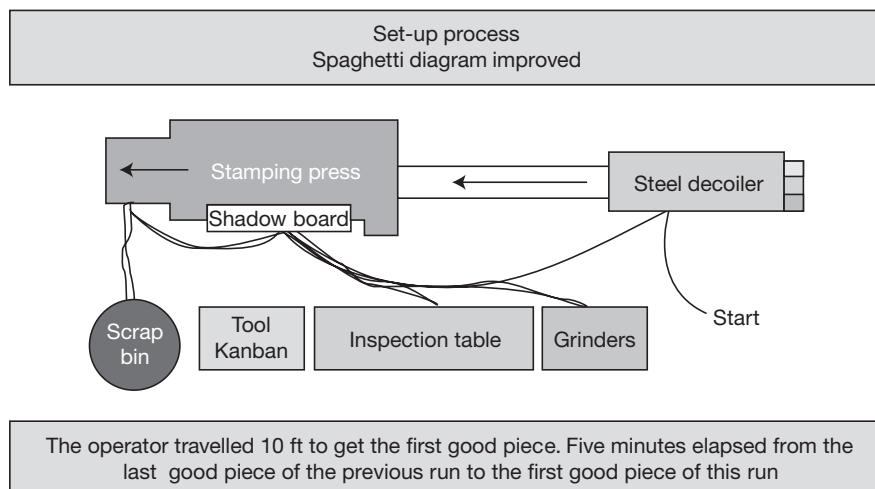
1. Create a diagram of the workspace.
2. Mark the location from the first step of the process and draw an arrow from there to the second step.
3. Continue until all the process steps are mapped.
4. Discuss the final diagram with the aim of improving the workflow.

A complicated diagram with many lines indicates opportunities to simplify the process. If the lines cross each other, explore the possibility of rearranging the workspace to create a cleaner flow. If lines repeatedly come back to one location, see if the work performed can be combined and performed at the same time.

An example of a spaghetti diagram is shown in Figure 13.5 (before improvement) and Figure 13.6 (after improvement).

Fig. 13.5 Spaghetti Diagram (Before Improvement) **Bird's-eye view:**

A **Spaghetti Diagram** is a method of viewing data to visualize possible flows through systems. Flows depicted in this manner appear like noodles, hence the coining of this term. This method of statistics was first used to track routing through factories. Visualizing flow in this manner can reduce inefficiency within the flow of a system.

Fig. 13.6 Spaghetti Diagram (After Improvement)**DISCUSSION FORUM**

1. Define process mapping.
2. Name the various tools used for process mapping.

Bird's-eye view:

There are ten phases in the **BPM** implementation framework: Organisation strategy, Process architecture, Launch pad, Understand, Innovate, Develop, People, Implement, Realise value, sustainable Performance.

■ THE BPM IMPLEMENTATION FRAMEWORK⁶

The creation of a BPM project or programme and project implementation framework that is appropriate to all organizations and will suit all circumstances is challenging, especially when organizations are not the same. Even if the organizations were the same, the approach to implement BPM would vary enormously from organization to organization and within an organization. There are ten phases in the framework and the phases are:

1. Organizational strategy
2. Process architecture
3. Launch pad
4. Understand
5. Innovate
6. Develop
7. People
8. Implement
9. Realise value
10. Sustainable performance

■ 1. Organizational Strategy

This phase requires that the project team members should clearly understand the organizational strategy, vision, mission, strategic goals and business drivers. The organizational strategy should be understood by the project team to ensure that the project scope and direction add value to it. The strategy must be communicated and sold to all relevant stakeholders until it becomes entrenched in the culture of the organization. The steps involved in aligning the organizational strategy and the BPM project are an analysis of the internal and external aspects of the organization, making strategic choices, determining impact on processes, establishing strategic measurements, completing the plan, sign-off and communication.

Bird's-eye view:

Process Management consists of three key activities: design, control, and improvement. Companies that are recognized world leaders in quality and customer satisfaction share some common practices.

■ 2. Process Architecture

This phase is the means by which the organization establishes a set of rules, principles, guidelines and models for the implementation of BPM across the organization. During this phase, the process and IT and business architectures are brought into alignment with the organizational strategy. This phase provides the basis for the design and realisation of BPM process initiatives. The steps in the creation of process architecture are obtaining strategy and business information, obtaining process guidelines and models, obtaining relevant information and technology principles and models, consolidating and validating, communications and applying architecture.

■ 3. Launch Pad

The launch pad phase is the platform from which the BPM projects are scoped, established and launched. This phase not only provides a way of initiating the process, it also completes the steps necessary to establish the project for success. These steps include project scope, project team selection and structure, stakeholder expectations, establishment and engagement, the establishment of the initial process goals, the use of the process start architecture to provide a fast start to the project from an architectural perspective.

This phase has three major outcomes—the selection of where to start the initial or next BPM project within the organization, agreement of the process goals once the process has been selected and the establishment of the selected project.

■ 4. Understand

This phase is for the project team members and the business process to gain sufficient understanding of the current business processes to enable the Innovate phase to commence. During this phase, it is essential to include the collection of appropriate metrics to gain further understanding, establishing prioritization for innovation and baselining the current status. This phase will also validate the current process reality within the organization and define improvement priorities within the project scope. The various steps to be completed within this phase are communication, revalidate scope, understand workshops, complete metric analysis, root cause analysis, complete people capability matrix, identify available information, identify the priorities of the Innovate phase, identify quick wins and understand phase reports. The Understand phase will provide valuable inputs on other phases of the framework.

The results expected from this phase are process model of the current process, appropriate metrics sufficient to establish a baseline for future process improvement measurement, prioritization and selection in the innovate phase, measurement and documentation of the current or actual performance levels, documentation of what works well and what would work better, identification of any “quick wins” that could be implemented within a three to six month period and a report on the phase.

Bird's-eye view:

A framework for business process management facilitates the implementation, management and improvement of process-based organisations. In order to do so, organisations require new capabilities such as change roadmaps, knowledge management and balanced performance measures.

■ 5. Innovate

This is the creative phase of the BPM project and provides an opportunity for innovation to occur. The purpose of this phase is to make the process within the scope of the project as efficient and effective as possible to meet stakeholders' current and future expectations. This phase also provides a unique opportunity to quantify further, in a more rigorous manner, the benefits outlined in the original business case.

■ 6. Develop

This phase requires the building of all the components for the implementation of the new process. It involves the building of all infrastructure to support the people change management programme and the changes in the support of the people who execute the processes. It also involves testing of hardware and software.

It includes the steps necessary to take the newly re-designed or improved processes from the Innovate phase to the Implement phase and deployment. The steps required to complete this phase are communication, determining BPM components, deciding on re-use, buy, make or outsource, update functional and technical specifications, software development, hardware deployment and testing. The deliverables for this phase are a high-level overview of the solution, detailed business requirements, finalizing software selection documentation, software specification/design, software development/configuration, software test scripts and results.

■ 7. People

This is a critical phase of the framework because at the end of the day, it is the people that will make processes function effectively and efficiently, no matter how much automation

is involved. This phase will usually be conducted at the same time as the Develop phase of the project. The purpose of this phase is to ensure that the activities, roles and performance measurement match the organization strategy and process goals.

The steps required to complete this phase are communications, designing the people strategy, activity definition, role re-design, performance management and measurement, people core capabilities gap analysis, designing the organization's structure, updating the HR policies and developing training programmes.

■ 8. Implement

Bird's-eye view:

BPM is about the management of process improvement sustainability within the organization. It is about the establishment of a business architecture, process governance, organizational change management capability, sustainable process performance and increasing BPM maturity, among others.

In this phase, all the designed and developed process improvements will actually be "brought to life." It is also the phase where many of the people change management activities come together. The steps required to complete this phase are communication, updating implementation strategy, preparation for user acceptance testing, training staff, completing business tests and pilots, updating deliverables, involving management, developing roll-out, back-out and contingency plans, developing and running marketing programmes, mentoring staff, rolling out changes, monitoring and providing feedback to users and shareholders.

After completing this phase successfully, the organization can expect to have trained and motivated staff, improved or new processes that work satisfactorily according to the identified stakeholders' requirements and needs and as outlined in the project business case.

■ 9. Realise Value

The purpose of this phase is to ensure that the benefit outcomes outlined in the project business case are realised. This phase comprises the delivery of the benefits of the realisation management process and benefits realisation reporting. The steps required to complete this phase are establishing benefits management framework, identifying potential benefits and plans, establishing baseline and comparative measurement, refining and optimizing benefits mix, defining benefit details, benefits delivery and tracking and value monitoring and maximization. There will be a number of results and outputs that the business can expect from the steps in this phase, including a benefits summary plan, a benefits milestone network matrix, a benefits delivery matrix and a benefits realisation register.

■ 10. Sustainable Performance

This phase is about the conversion from a "project" to a "business operational" activity. The steps involved in completing this phase are evaluating project results, developing sustainability strategy, embedding performance measures in management, introducing feedback loops, embedding sustainability, rewarding sustainability, institutionalizing process governance, monitoring sustainability, communicating and maintaining the process model.

Sustainable performance is about the continual management of processes aimed at achieving the specified objectives. It is absolutely essential that the project team works with the business to establish a process structure to ensure that continued process agility and improvements are sustainable. The organization should realise that processes have a life-cycle and will need continuous improvement after the project's targeted improvements have been realised.

■ Process Management Practices⁷

Process management consists of three key activities—design, control and improvement. Process management requires a disciplined effort involving all the managers and the workers

in an organization. Companies that are recognized world leaders in quality and customer satisfaction share the following common practices:

- They define and document important value creation and support processes and manage them carefully.
- They translate customer requirements into product and service design requirements early in the design process, taking into account linkages between product design requirements and manufacturing or service process requirements, supplier capabilities and legal and environmental issues.
- They ensure that quality is built into products and services and use appropriate engineering and quantitative tools and approaches during the development process.
- They manage the product development process to enhance cross-functional communication, reduce product development time, and ensure trouble free introduction of products and services.
- They define performance requirements for suppliers, ensure that requirements are met, and develop partnering relationships with key suppliers and other organizations.
- They control the quality and operational performance of key processes and use systematic methods to identify significant variations in operational performance and output quality, determine root causes, make corrections and verify results.
- They continuously improve processes to achieve better quality, cycle time and overall operational performance.
- They innovate to achieve breakthrough performance using approaches such as benchmarking and re-engineering.

Box 13.4 illustrates the benefits obtained by Tech Mahindra after implementing BPM.

Box 13.4 Business Process Management at Tech Mahindra

Tech Mahindra, a leading solutions provider for the telecom industry in India, has benefited enormously from implementing business process management in its operations. The BPM practice at Tech Mahindra offers end-to-end solutions across the business framework pyramid, supporting strategy and implementation.

The company creates value by combining business, strategy, processes and technologies. It has been able to provide an improved and uniform customer experience because of its focus on building robust, efficient KPI-based customer-centric processes. Tech Mahindra's BPM solutions are based on the strong foundations of Six Sigma and balanced scorecard practices.

Some of the key business benefits that Tech Mahindra has obtained after implementing BPM are (1) improvement in service levels, (2) reduced operational cost, (3) improved operational flexibility and efficiency, (4) improvements in customer satisfaction and higher customer retention, (5) reduction in the cost of development and maintenance and (6) low revenue leakage.

Source: Adapted from www.techmahindra.com, accessed on 30 June, 2016.

Bird's-eye view:

Process Management consists of three key activities – design, control and improvement. Process management requires a disciplines effort involving all the managers and workers in an organization.

DISCUSSION FORUM

1. Describe the ten phases in the BPM implementation framework.
2. Explain the common process management practices of companies that are recognized as world leaders in quality and customer satisfaction.

SUMMARY

- Business process management refers to the designing, executing, and optimizing of business activities that incorporate people, systems, and partners. Leading companies identify important business processes throughout the value chain that affect customer satisfaction. These processes typically fall into two categories—value creation processes and support processes.
- A business process is any goods or non-goods related cross-functional process of critical importance. Typically, managing such processes requires a process owner and a permanent team. A process owner might be an individual, a team, a department or some cross-functional group responsible for the overall performance of a process. These responsibilities include effectiveness, efficiency, control and adaptability.
- Value creation processes are important to “running the business” and maintaining or achieving a sustainable competitive advantage. Support processes are those that are most important to an organization’s value creation processes, employees and daily operations.
- Design processes involve all activities that are performed to incorporate customer requirements, new technology, and past learning into the functional specifications of a product and thus define its fitness for use. The typical product development process consists of six phases—idea generation, preliminary concept development, product/process development, full-scale production, market introduction and market evaluation.
- Process mapping is a process that establishes the overall status of a business enterprise and defines what it does, the people responsible for running the business and the standard required to ensure the success of its operations. The tools used for process mapping are basic flowchart, swim lane diagram, value stream map, SIPOC diagram and the spaghetti diagram.
- There are ten phases in the BPM implementation framework—organization strategies, process architecture, launch pad, understand, innovate, develop, people, implement, realise value and sustainable performance. Process management consists of three key activities—design, control and improvement. Companies that are recognized world leaders in quality and customer satisfaction share some common practices.
- BPM is about the management of process improvement sustainability within the organization. It is about the establishment of a business architecture, process governance, organizational change management capability, sustainable process performance and increasing BPM maturity, among others.

Key Terms

Basic Flowchart 417	Full-scale Production 414
BPM Implementation Framework 424	Idea Generation 414
BPM Maturity 428	Implement 426
Business Architecture 424	Innovate 425
Business Process 429	Launch Pad 424
Business Process Management 429	Market Introduction 414
Design Process 413	Market Evaluation 414
Develop 425	Organization Strategy 411

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Case Study

Business Process Management at Otis

About the Company

Otis Elevator Company (India) Ltd is a part of Otis Elevator Co., US, which is a wholly-owned subsidiary of United Technologies Corporation. Otis Elevator Co. is the world's largest manufacturer, installer and maintainer of elevators, escalators, moving walkways and other people-moving systems.

The Need

The existing system consisted of a structure that did not have a standardized procedure for the initialization of a contract for prospective clients. A single contract involved physical transfer of about 30 documents in the organizational hierarchy comprising approximately 13 departments in the Regional Offices and the Head Office. There was no automation involved till the order reached the order finalization stage. Also, the automation was limited to the department level whereby documents were processed for department-specific purposes. As a result, there was a definite redundancy of data and delay in document transfer and information retrieval.

Solution

Otis CIO V. Subramanium entrusted the work of creating a Net Framework based workflow solution for managing the sales lifecycle for the clients to Maestros Mediline Systems Ltd. Maestros developed a .Net Framework based workflow solution for capturing the contract details for the clients right from enquiry to handover. The application was developed using the SQL server as the backend. The database designed clearly defined the organizational hierarchy with the aim of achieving centralization of information with the scope for a complete gradual integration and automation. Exhibit 13.1 shows the solution architecture used for implementing BPM at Otis. The application included the modules mentioned below:

Enquiry Module

The process is initiated whenever there is an enquiry for elevator/elevators. The Secretary (Secy.) or Sales Executive (S.E.) initiates the enquiry. On logging into the system the S.E. is

initially displayed a listing of all the enquiries assigned to him, and the option to select and view the source or the person who has assigned the enquiry. On selecting the appropriate option from the dropdown, a listing of all the active enquiries assigned to the S.E. is displayed along with the role of that person who had assigned the enquiry. The process is started with the filling of the client details in the client form. This form contains a brief detail of the customer. After the client form is filled in, the details are then mapped to the enquiry register. The enquiry register contains the client name and a brief specification of the requirement. If the enquiry fails to mature into a proposal, a loss report is generated.

Proposal

A proposal is the enquiry document that has been approved by the client, and starts the order booking process. A proposal is differentiated on the basis of the type of elevator and further on the basis of speed. In case of the elevator type being traditional, specific requirements are captured in the Sales Negotiation Datasheet (SND) for pre-sales estimation. The documents involved in this process are proposal document, which are legal documents, SND sheet, 2824 form, price page, loss provision form and NS 1 form.

Order Finalization

This process is invoked by the approval of the proposal by the client. It involves capturing of client specific information by the SE. and its dispatch to the SM./GM. and Mktg HO. as the case may be, for approval.

Order Booking and Data Release

Upon receipt of order documents at Marketing, they are validated and the order is booked. Order Booking involves allocation of a unique contract number, which is used for reference in all future communications pertaining to that order.

Building Progress Report

The building progress report is initiated after the contract is booked (a contract number is generated) and the RO construction receives the AOS/COD from the Marketing HO. The building data is fed into a local system, the CMS, which will be used throughout till the handover stage.

Scheduling

This process is initiated when NS-10 (Request for Shipment Schedule) form from the S.E. reaches the CCD-KW. A manufacturing/shipment schedule is generated by CCD-KW using the predetermined slots for each region.

Manufacturing of Materials

This process is used for the manufacturing of materials by KW and BW. The specified data is sent to the PCD department, which prepares the BOM (Bill of Material). The planning manager publishes a list of backlog contracts. CCD conveys the unavailability of materials through ITF (Items to Follow).

Dispatch

This process takes care of the movement of the material from the factories KW and BW to the site. The CCD department coordinates the activities between the various departments.

Once the material is shipped, the CCD prepares DSR, which is sent to RO/AO. The RO/AO makes the necessary arrangements for it. A copy of the DSR is also sent to the Finance Department.

Receipt of Material at Site

In this process, the material that is shipped from the KW and BW, along with Packing List, Lorry Receipt and ITF form, is received at the site.

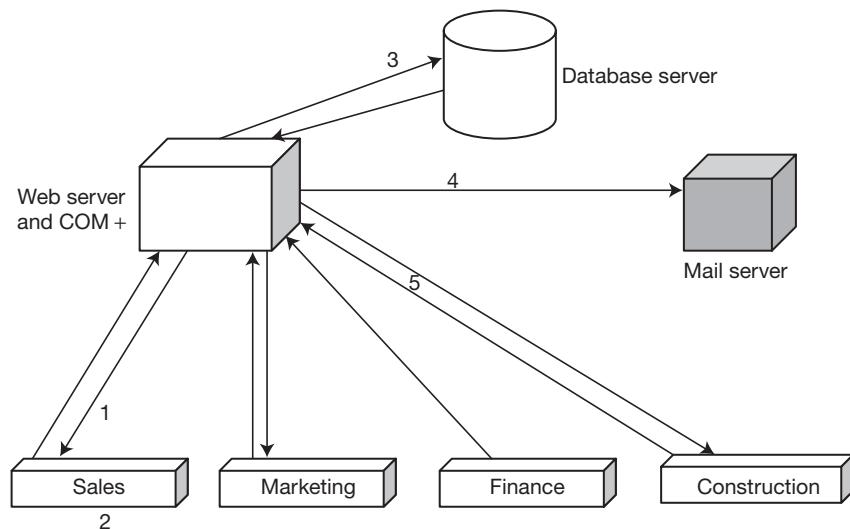
Erection

This process is responsible for the erection of the lift at the site. The Finance RO issues a "C" note (Commencement Note) to the Construction department for the commencement of the erection work if payment of material is received or an exception raised is authorized by the RGM. The construction supervisor maintains the status of the site and tracks the construction activity by filling up the FLSP (Field Line Schedule Progress) report. An "A" form with permission to erect the elevator is issued by the PWD.

Handover

After the erection is over, the construction department needs to hand over the unit. The construction department prepares the "B" form and forwards to Finance RO, who in turn checks the material payment status. If received, it returns the "B" form to Construction for forwarding to Client/PWD. The Finance HO raises the final bill on receipt of their copy of the acceptance forecast. After this the customer is followed up with for final payment. After collection of the final payments from the customer and authorization from the RGM, an "H" note is generated leading to the processing of Y3930 form by the construction department after inspection by PWD. Physical handover can be complete only after the receipt of Y3930 form indicating completeness of erection and handover note from finance indicating completeness of payment and PWD inspection.

Exhibit 13.1 Solution Architecture



The phases of implementation are:

1. Upload the required documents to the Web server.
2. Access the information from Web server.
3. Update information stored into database.
4. Fetch information from the data server requested by user and generate alerts and notification.
5. Send information such as alerts, notifications and escalation as e-mail.

Benefits of BPM at Otis

- Complete centralization and automation of the relational data pertaining to a contract.
- Decrease in physical transfer of documents and hard copies.
- Implementation of alerts and escalations resulting in enhancing the productivity of employees and also facilitating the automatic delegation of tasks.
- All the forms that were processed at department level were replaced by web forms, which captured the data for storage at a central database with the provision for exporting the captured data in specific formats supported by local departmental packages where it can be re-used for processing thereby eliminating with existing redundancy.
- The centralization facilitated information retrieval in terms of various reports, which were not easy to acquire in the earlier scenario.
- Privileged users in the marketing and other important departments could have access to the MIS-based reports.
- The system can be upgraded in the future to include other processes also apart from E2H.
- This system provided an ideal platform for transmission of extensive data in the form of publications. For example, daily shipment report was published and viewable by all relevant people based on the designed security model.
- The online tracking of the status of all contracts was possible through a centralized system.

Source: Adapted from www.otisworldwide.com, accessed April 2010.

For Discussion

1. What was the problem in the existing sales system at Otis Elevator Company (India) Ltd.?
2. Explain the solution evolved by their CIO, Mr V. Subramanium.
3. What were the benefits derived on introducing Business Process Management at Otis?

Short-answer Questions

1. Define business process management.
2. Briefly explain the importance of business process management.
3. Write a brief note on the value creation process.
4. Write a brief note on the support process.
5. What are the various phases in the product development process.
6. Who is a process owner?

7. Define process mapping.
8. Name the various tools used in process mapping.
9. Name the ten phases in the BPM implementation framework.
10. Which are the three key activities in process management?
11. Write a brief note on: (a) basic flowchart, (b) swim lane diagram, (c) value stream map, (d) SIPOC diagram and (e) spaghetti diagram.

Match the Following

a. Flowchart	Lean process improvement tool
b. Swim lane diagram	Basic tool for process mapping
c. Value stream mapping	Shows links between flow of materials and information
d. SIPOC process map	Functional flowcharts
e. Spaghetti diagram	Supplier, input, process, output, customer

Discussion Questions

1. Explain the relevance and importance of business process management with examples.
2. Describe the scope of business process management.
3. Explain the methodology of business process quality management.
4. Explain product development process phases with an example.
5. Evaluate the various tools used in process mapping.
6. Describe the BPM implementation framework.

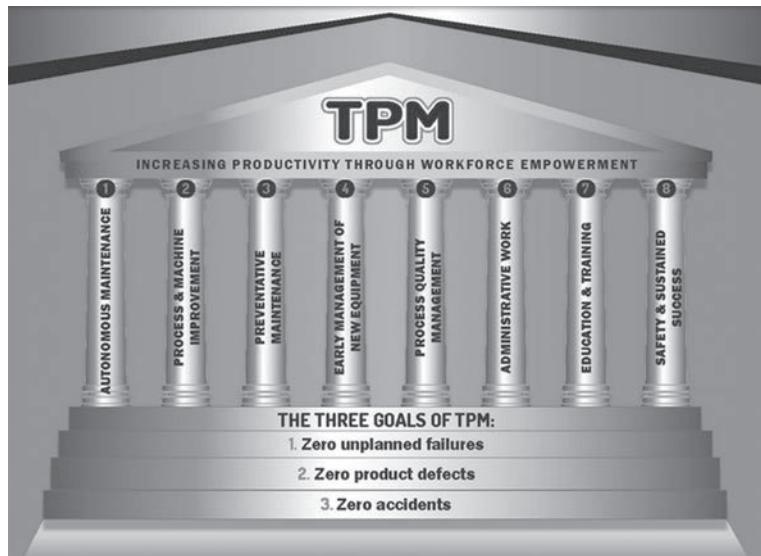
Project

Select an administrative or support department in an organization and list all the major activities and prepare a flow diagram for one activity.

End Notes

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Total Productive Maintenance



TPM AT TOYOTA KIRLOSKAR AUTO PARTS PRIVATE LIMITED

Total Productive Maintenance (TPM) is a unique Japanese philosophy, which was developed based on productive maintenance concepts and methodologies. This concept was first introduced by M/s Nippon Denso Company Ltd., of Japan, a supplier of M/s Toyota Motor Company, Japan in 1971. TPM is an innovative approach to maintenance that optimizes equipment effectiveness, eliminates breakdowns, and promotes autonomous maintenance by operators through day-to-day activities involving total workforce.

The TPM awards were established in 1969 by the Japan Institute of Plant Maintenance (JIPM) in Japan to strengthen the improvement of enterprise constitutions and contribute to the development of industry, by promoting the modernization of plant maintenance and the development of plant maintenance technologies. The main purpose of the TPM award is to encourage development of the manufacturing industries and factories that displayed remarkable achievement in plant maintenance. TPM awards are given to companies inside and outside Japan.

Toyota Kirloskar Auto Parts Private Limited (TKAP), established in 2001, is an auto parts manufacturing company based at Bidadi near Bangalore, India. It is a joint venture amongst

Toyota Motor Corporation, Japan; Toyota Industries Corporation, Japan, and Kirloskar Systems Limited, India. TKAP manufactures axles and shafts, and transmissions and engines and supplies them to Toyota companies globally and locally. TKAP received the TPM excellence category award from JIPM for maintaining quality, safety, secure, and reliable production, and for maintenance activities.

“Intrinsic is the belief that quality does not happen by accident, it must be planned.”

Peter F. Drucker

Upon completion of this chapter, you will be able to:

1. Explain reliability
2. Understand failure mode and effect analysis
3. Understand total productive maintenance (TPM)
4. Identify the pillars of TPM
5. Find out the overall equipment effectiveness
6. Explain the various steps in the introduction of TPM

■ RELIABILITY

The quality and reliability of a product reflects the image of an organization and its market potential. In a competitive world, each organization has to strive hard to boost the quality and reliability of its products. Therefore, there is a strong need to develop a workforce that is proficient in the principles and practices of reliability engineering.

The ability of a product to perform as expected over time is one of the principal dimensions of quality. Reliability is an essential aspect of both product and process design. Sophisticated equipment used today in areas such as transportation, communication and medicine require high reliability. High reliability can also provide a competitive advantage for many consumer goods. Japanese automobiles gained large market shares in the 1970s primarily because of their high reliability.

■ Defining Reliability

Reliability is defined as the probability that a device will perform its required function under stated conditions for a specific period of time without requiring repairs and adjustments. Predicting reliability with some degree of confidence is dependant on correctly defining a number of parameters. For instance, choosing the distribution that matches the data is of primary importance. If a correct distribution is not chosen, the results will not be reliable. The failure rates of individual components must be based on a large enough population to truly reflect normal usages in the present day. There are empirical considerations such as determining the slope of the failure rate and calculating the activation energy, as well as environmental factors such as temperature, humidity and vibration. Lastly, there are electrical stressors such as voltage and current.

Bird's-eye view:

Reliability is the overall consistency of a measure. A measure is said to have a high reliability if it produces similar results under consistent conditions.

Bird's-eye view:

Reliability engineering is that which emphasizes dependability in the lifecycle management of a product. Dependability, or reliability, describes the ability of a system or component to function under stated conditions for a specified period of time.

Reliability engineering can be somewhat abstract in that it involves much statistics; yet it is engineering in its most practical form. Will the design perform its intended mission? Product reliability is seen as a testament to the robustness of the design and the integrity of the quality and manufacturing commitments of an organization.

Reliability is defined as the probability that a product will perform well under specified environmental conditions for a stipulated time period.

This definition has four important elements—probability, time, performance and operating conditions.

- First, reliability is a probability. This means that failure is regarded as a random phenomenon and the likelihood for failures to occur varies over time according to the given probability function. Reliability engineering is concerned with meeting the specified probability of success at a specified statistical confidence level.
- Second, reliability is predicated on performance or “intended function.” Generally, this is taken to mean operation without failure. However, even if individual parts of the system do not fail, but the system as a whole does not do what was intended, then it is still charged against system reliability.
- Third, reliability applies to a specified period of time. In practical terms, this means that a system has a specified chance that it will operate without failure before time. Reliability engineering ensures that components and materials will meet the requirements during the specified time. Units other than time may sometimes be used. For example, the automotive industry might specify reliability in terms of miles; the military might specify reliability of a gun for a certain number of rounds fired. A piece of mechanical equipment may have a reliability rating value in terms of cycles of use.
- Fourth, reliability is restricted to operation under stated operating conditions. This constraint is necessary because it is impossible to design a system for operation under unlimited conditions.

By defining a product’s intended environment, performance characteristics and lifetime, a manufacturer can design and conduct tests to measure the probability of the product’s survival or failure. The analysis of such tests enables better predictions of reliability and improved product and process designs.

Reliability may be inherent reliability, which is the predicted reliability determined by the design of the product or process, and achieved reliability, which is the actual reliability observed during use. Actual reliability can be less than the inherent reliability due to the effects of the manufacturing process and the conditions of use.

Bird's-eye view:

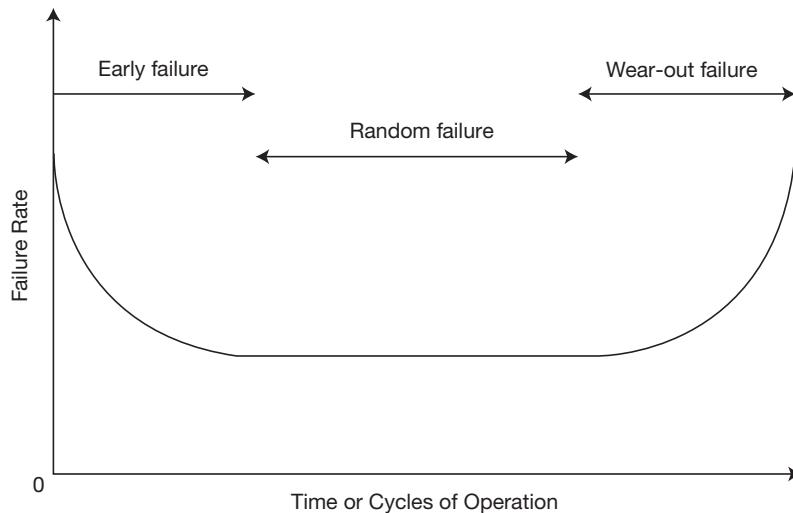
In practice, **reliability** is determined by the number of failures per unit of time during the period under consideration called the failure rate (λ). The reciprocal of the failure rate is used as an alternative measure. Some products must be scrapped and replaced upon failure, others can be repaired. For items that must be replaced when a failure occurs, the reciprocal of the failure rate (having dimensions of time units per failure) is termed as the mean time to failure (MTTF). For repairable items, the term mean time between failures (MTBF) is used.

$$\text{MTTF} = 1/\lambda$$

The lifecycle of the product in terms of failure rate (λ) can be categorized into the early failure phase, the random failure phase and the wear-out phase. The three phases of the product lifecycle are shown in a bathtub curve (Figure 14.1). The bathtub curve, widely used

■ Reliability Measurement

In practice, reliability is determined by the number of failures per unit of time during the period under consideration called the failure rate (λ). The reciprocal of the failure rate is used as an alternative measure. Some products must be scrapped and replaced upon failure, others can be repaired. For items that must be replaced when a failure occurs, the reciprocal of the failure rate (having dimensions of time units per failure) is termed as the mean time to failure (MTTF). For repairable items, the term mean time between failures (MTBF) is used.

Fig. 14.1 Bathtub Curve

in reliability engineering, describes a particular form of the hazard function, which comprises three parts:

- The first part is a decreasing failure rate known as early failures/infant mortality.
- The second part is a constant failure rate known as random failures/normal life/useful life.
- The third part is an increasing failure rate known as end of life/wear-out failures.

The bathtub curve displayed in Figure 14.1 does not depict the failure rate of a single item, but describes the relative failure rate of an entire population of products over time. Some individual units will fail relatively early (infant mortality failures), others will last until wear-out, and some will fail during the relatively long period typically called normal life. Failures during the infant mortality phase are highly undesirable and are always caused by defects and blunders such as material defects, design blunders and errors in assembly. Normal life failures are normally considered to be random cases of "stress exceeding strength." However, many failures often considered normal life failures are in fact infant mortality failures. Wear-out is a fact of life due to fatigue or depletion of materials (such as lubrication depletion in bearings). A product's useful life is limited by its component with the shortest lifespan. A product manufacturer must ensure that all specified materials are adequate to function through the intended product life.

The bathtub curve is typically used as a visual model to illustrate the three key periods of product failure and not calibrated to depict a graph of the expected behaviour for a particular product family. It is rare to have enough short-term and long-term failure information to actually model a population of products with a calibrated bathtub curve.

Gathering enough data about failures to generate as smooth a curve as shown in Figure 14.1 is not always possible. If limited data are available, the failure rate is computed using the following formula:

$$\text{Failure Rate} = \lambda = \frac{\text{Number of Failures}}{\text{Total Unit Operating Hours}}$$

Or alternatively,

$$\lambda = \frac{\text{Number of Failures}}{\text{Units Tested} \times \text{Number of Hours Tested}}$$

Bird's-eye view:
The **Bathtub curve** is typically used as a visual model to illustrate the three key periods of product failure and not calibrated to depict a graph of the expected behaviour for a particular product family.

 **Bird's-eye view:**

Mean time to failure (MTTF) is a basic measure of reliability for non-repairable systems. It is the mean time expected until the first failure of a piece of equipment. MTTF is a statistical value and is meant to be the mean over a long period of time and for a large number of units.

■ MTTF and MTBF

Mean time to failure (MTTF) is a basic measure of reliability for non-repairable systems. It is the mean time expected until the first failure of a piece of equipment. MTTF is a statistical value and is meant to be the mean over a long period of time and for a large number of units. For constant failure-rate systems, MTTF is the inverse of the failure rate. If failure rate is computed in terms of failures/million hours,

$$\text{MTTF} = 1000,000 / \text{Failure Rate for Components with Exponential Distributions}$$

$$\text{MTTF} = 1/\lambda$$

Mean time between failures (MTBF) is a basic measure of reliability for repairable items. It can be described as the number of hours that pass before a component, assembly or system fails. It is a commonly used variable in reliability and maintainability analysis. MTBF can be calculated as the inverse of the failure rate for constant failure-rate systems. For example, if a component has a failure rate of two failures per million hours, the MTBF would be the inverse of that failure rate.

$$\text{MTBF} = (1000,000 \text{ hours}) / (2 \text{ Failures}) = 500,000 \text{ hours}$$

Technically, MTBF should be used only in reference to repairable items, while MTTF should be used for non-repairable items. However, MTBF is commonly used for both repairable and non-repairable items.

MTBF is a vastly misunderstood (and often misused) term. MTBF historically stands for “mean time between failures,” and as such applies only when the underlying distribution has a constant failure rate (e.g. an exponential distribution). However, the use of the term MTBF is confused by the fact that a few reliability practitioners have used it to indicate “mean time before failure,” a case where the underlying distribution may be a wear-out mode. Mean time before failure (often termed mean time to failure or MTTF) describes the average time for the failure of a product, even when the failure rate is increasing over time (wear-out mode). Some units will fail before the mean life, and some will last longer. Thus, a product specified as having an MTTF of 50,000 hours implies that some units will actually operate longer than 50,000 hours without failure.

How does MTBF describe the failure rate? It is quite simple—when the exponential distribution is applied (constant failure rate modeled by the flat bottom of the bathtub curve), the MTBF is equal to the inverse of the failure rate. For example, a product with an MTBF of 3.5 million hours used 24 hours per day:

- $\text{MTBF} = 1/\text{Failure rate}$
- $\text{Failure rate} = 1/\text{MTBF} = 1/3,500,000 \text{ hours}$
- $\text{Failure rate} = 0.000000286 \text{ failures/hour}$
- $\text{Failure rate} = 0.000286 \text{ failures}/1,000 \text{ hours}$
- $\text{Failure rate} = 0.0286 \text{ per cent}/1,000 \text{ hours}$ and since there are 8,760 hours in a year
- $\text{Failure rate} = 0.25 \text{ per cent/year}$

Note that 3.5 million hours is 400 years. Do we expect that any of these products will actually operate for 400 years? No! Long before 400 years of use, a wear-out mode will become dominant and the population of products will leave the normal life period of the bathtub and start up the wear-out curve. But during the normal life period, the “constant” failure rate will be 0.25 per cent per year, which can also be expressed as an MTBF of 3.5 million hours.

A power supply with an MTBF of 40,000 hours does not mean that the power supply should last for an average of 40,000 hours. According to the theory behind the

 **Bird's-eye view:**

Mean time between failures (MTBF) is a basic measure of reliability for repairable items. It can be described as the number of hours that pass before a component, assembly or system fails. It is a commonly used variable in reliability and maintainability analysis. MTBF can be calculated as the inverse of the failure rate for constant failure-rate systems.

statistics of confidence intervals, the statistical average becomes the true average as the number of samples increase. An MTBF of 40,000 hours, or 1 year for 1 module, becomes 40,000/2 for two modules and 40,000/4 for four modules. Sometimes failure rates are measured in per cent failed per million hours of operation instead of MTBF. The FIT is equivalent to one failure per billion device hours, which is equivalent to a MTBF of 1,000,000,000 hours. The formula for calculating the MTBF is:

$$\text{MTBF} = T/R$$

T = Total time

R = Number of failures

To distinguish between MTTF and MTBF, the concept of suspensions must first be understood. In reliability calculations, a suspension occurs when a destructive test or observation has been completed without observing a failure. MTBF calculations do not consider suspensions whereas MTTF does. MTTF is the number of total hours of service of all devices divided by the number of devices. It is only when all the parts fail with the same failure mode that MTBF converges to MTTF.

$$\text{MTTF} = T/N = 1/\lambda$$

T = Total time

N = Number of units under test.

Example: Suppose 10 devices are tested for 500 hours. During the test, 2 failures occur. The estimate of the MTBF is:

$$\text{MTBF} = 10 \times 500/2 = 2,500 \text{ hours/failure}$$

$$\text{Whereas MTTF} = 10 \times 500/10 = 500 \text{ hours/failure}$$

The cumulative probability $P(t)$ that the product will fail before time instant (t) is given by the area under the probability density function $P(t)$ curve up to the time instant (t).

$$P(t) = 1 - e^{-\lambda t}$$

Thus, the cumulative probability that the product will not fail before time instant t , which is reliability $R(t)$ is given by

$$R(t) = e^{-t/\text{MTBF}} = e^{-\lambda t}$$

However, when $t = \text{MTBF}$

$$R(t) = e^{-1} = 0.3677$$

This tells us that the probability that any one particular product will survive to its calculated MTBF is only 36.8 per cent.

Example: A toy manufacturing company has found that the average life of its most popular "robot toy" is 200 hours. Assume that it follows the exponential distribution.

- What is the failure rate?
- What is the chance that the toy would last for at least 300 hours?
- What is the chance that the toy would fail within 100 hours?

Solution: This problem may be solved using spread sheet (MS Excel)

Average life = 200 hours

- Failure rate = $\lambda = 1/200 = 0.005$
- The chance that it would last for at least 300 hours



Bird's-eye view:

Mean time between failures (MTBF) is the predicted elapsed time between inherent failures of a system during operation. MTBF can be calculated as the arithmetic mean (average) time between failures of a system. The term is used in both plant and equipment maintenance contexts.



Bird's-eye view:

The MTBF is typically part of a model that assumes the failed system is immediately repaired (mean time to repair, or MTTR), as a part of a renewal process. This is in contrast to the **mean time to failure (MTTF)**, which measures average time to failures with the modeling assumption that the failed system is not repaired (infinite repair time).

There is an in-built function in MS Excel called the exponential distribution function to find the value of $P(t)$.

Here, $t = 300$ hours

$$P(300) = 1 - e^{-\lambda t} = 0.7769$$

$$R(300) = e^{-\lambda t} = 0.2231$$

c. $t = 100$ hours

$$P(100) = 1 - e^{-\lambda t} = 0.3935$$

Example: Twenty air-conditioners designed for use in a space shuttle were operated for 1,000 hours in a test facility. Two of the air-conditioners failed during the test—one after 200 hours and the other after 600 hours. Compute the failure rate and mean time between failures.

Solution:

Failure rate = λ = Number of failures/Total unit operating hours

Total time of operation = 1000 hours \times 20 units = 20,000 unit hours

Non-operating time = 800 hours for the first unit + 400 hours for the second unit
 $= 1,200$ unit hours

Operating time = Total time – Non-operating time
 $= 20,000 - 1200 = 18,800$ unit hours

Failure rate = $\lambda = 2/18,800 = 0.000106$ failures per unit hour

MTBF = $1/0.000106 = 9,434$ hours

Example: An electronic component has a failure rate of 0.0001 per hour. Calculate the MTTF and the probability that the component will not fail in 15,000 hours.

Solution:

MTTF = $1/\lambda = 1/0.0001 = 10,000$ hours

The probability that the component will not fail in 15,000 hours is

$$\begin{aligned} R(15,000) &= e^{-15,000/10,000} \\ &= e^{-1.5} \\ &= 0.223 \end{aligned}$$

Example: A machine is operated for 10,000 hours and experiences four failures that are immediately repaired. Calculate the MTBF and the failure rate.

MTBF = $10,000/4 = 2,500$ hours

Failure rate = $\lambda = 1/2,500 = 0.0004$ failures per hour

Bird's-eye view:

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.

Bird's-eye view:

“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.

DISCUSSION FORUM

1. Define reliability engineering.
2. How do you measure reliability?
3. Distinguish between MTBF and MTTF.
4. What is a bathtub curve?

■ FAILURE MODE AND EFFECT ANALYSIS (FMEA)

Customers are placing increasing demands on companies for high quality reliable products. The increasing capabilities and functionality of many products are making it more difficult for

manufacturers to maintain quality and reliability. Traditionally, reliability has been achieved through extensive testing and the use of techniques such as probabilistic reliability modeling. These are techniques done in the late stages of development. The challenge is to design in quality and reliability early in the development cycle.

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. 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. Begun in the 1940s by the US military, FMEA was further developed by the aerospace and automotive industries. Several industries maintain formal FMEA.

FMEA is a methodology for analysing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effects on the operation of the product and identify actions to mitigate the failures. A crucial step is anticipating what might go wrong with a product. While anticipating every failure mode is not possible, the development team should formulate as extensive a list of potential failure modes as possible.

The early and consistent use of FMEAs in the design process allows the engineer to design out failures and produce reliable, safe and customer pleasing products. FMEAs also capture historical information for use in future product improvement.

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 action to eliminate or reduce failures, starting with the highest-priority ones.

FMEA also documents current knowledge and actions about the risks of failures for use in continuous improvement. FMEA is used during design to prevent failures. It is also subsequently used for control, both before and during the 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.

When to Use FMEA?

FMEA can be used:

- When a process, product or service is being designed or re-designed after quality function deployment.
- When an existing process, product or service is being applied in a new way.
- Before developing control plans for a new or modified process.
- When improvement goals are planned for an existing process, product or service.
- When analysing failures of an existing process, product or service.
- Periodically throughout the life of the process, product or service.

Types of FMEAs

There are several types of FMEAs. Some are used more often than others. FMEA should always be done whenever failures mean potential harm or injury to the user of the end item being designed. The different types of FMEA are:

- System—focuses on global system functions
- Design—focuses on components and subsystems
- Process—focuses on manufacturing and assembly processes

Bird's-eye view:

Begun in the 1940s by the U.S. military, FMEA was further developed by the aerospace and automotive industries. Several industries maintain formal FMEA standards.

Bird's-eye view:

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.

- Service—focuses on service functions
- Software—focuses on software functions

Bird's-eye view:

Failure Mode and Effects Analysis, or FMEA, is a methodology aimed at allowing organizations to anticipate failure during the design stage by identifying all of the possible failures in a design or manufacturing process.

■ FMEA—Procedure

The process for conducting an FMEA is straightforward. The basic steps are outlined below:

1. **Describe the product/process and its function:** An understanding of the product or process under consideration has to be clearly articulated. This understanding simplifies the process of analysis by helping the engineer identify those product/process uses that fall within the intended function and the ones that fall outside. It is important to consider both intentional and unintentional uses since product failure often ends in litigation, which can be costly and time consuming.
2. **Create a block diagram of the product or process:** A block diagram of the product/process should be developed. This diagram shows major components or process steps as blocks connected by lines that indicate how the components or steps are related.
3. **Complete the header on the FMEA form worksheet:** FMEA table headers vary since they are supposed to be customized according to the requirements of the companies using them. Generally, the header requires information such as product/process/system name, component/step name, product designer or process engineer, name of the person who prepared the FMEA form, FMEA date, revision level (letter or number) and revision date. These headings must be modified as needed.
4. **Enumerate the items (components, functions, steps, etc.) that make up the product or process:** Table 14.1 shows a simplified FMEA sheet. The items that make up the product or process must be listed.
5. **Identify all potential failure modes associated with the product or process:** A failure mode is defined as the manner in which a component, subsystem, system, process, etc. could potentially fail to meet the design intent. Examples of potential failure modes include corrosion, hydrogen embitterment, electrical short or open, torque fatigue, deformation and cracking.
6. **List down each failure mode using its technical term:** A failure mode in one component can serve as the cause of a failure mode in another component. Each failure should be listed in technical terms. Failure modes should be listed for functions of each component or process step. At this point the failure mode should be identified whether or not the failure is likely to occur.
7. **Describe the effects of each of the failure modes listed and assess the severity of each:** For each failure mode identified in Column 2, a corresponding effect (or effects) must be identified and listed in Column 3 of the FMEA table. A failure effect is defined as the result of a failure mode in the function of the product/process as perceived by the customer. Examples of failure effects include injury to the user, inoperability of the product or process, improper appearance of the product or process, degraded performance and noise. A numerical ranking must be established for the severity of the effect. A common industry standard scale (1 to 10) uses 1 to represent “no effects” and 10 to indicate “very severe” with failures affecting system operation and safety without warning. Column 4 of the FMEA table is used for the severity rating (SEV) of the failure mode.
8. **Identify the possible cause(s) for each failure mode:** A failure cause is defined as a design weakness that may result in a failure. The potential causes for each failure mode should be

Table 14.1 A Simplified FMEA Table

Potential Failure Modes and Effects Analysis									
				FMEA Revision _____					
				FMEA Prepared by _____			FMEA Date _____		
				FMEA Revision Date _____					
Item / Function	Potential Failure	S Potential	P Current	D	R	Actions	Owner	Actions	S P D R
1	Failure Modes	Mode Effects	E Failure Causes	F Control S	E T	P N	Required	Taken	E F E P
			V				Target Date	V	2 T N
				6	7	8	10	12	2 2 2
2	3	4	5			9	11		13 14 15 16

 **Bird's-eye view:**

FMEA is not a substitute for good engineering. Rather, it enhances good engineering by applying the knowledge and experience of a **Cross Functional Team (CFT)** to review the design progress of a product or process by assessing its risk of failure. There are two broad categories of FMEA, Design FMEA (DFMEA) and Process FMEA (PFMEA)..

identified and documented. The causes should be listed in technical terms and not in terms of symptoms. Potential causes are listed in Column 5 and examples include improper torque applied, improper operating conditions, contamination, erroneous algorithms, improper alignment, excessive loading and excessive voltage.

9. Quantify the probability of occurrence (probability factor or PF) of each of the failure mode causes: Every failure cause must be quantified and will be assigned a number (PF), which indicates how likely that cause has the probability of occurring. A common industry standard scale uses 1 to represent “not likely” and 10 to indicate “inevitable.” PF values for each of the failure causes are indicated in Column 6 of the FMEA table.

10. Identify all existing controls (current controls) that contribute to the prevention of the occurrence of each of these failure mode causes: Current controls (design or process) are the mechanisms that prevent the cause of the failure mode from occurring or which detect the failure before it reaches the customer. The engineer should now identify testing, analysis, monitoring and other techniques that can or have been used on the same or similar products/processes to detect failures. Each of these controls should be assessed to determine how well it is expected to identify or detect failure modes. Each of the controls must be listed in Column 7 of the FMEA table. After a new product or process has been in use, previously undetected or unidentified failure modes may appear. The FMEA should then be updated and plans must be made to address those failures to eliminate them from the product/process.

11. Determine the ability of each control in preventing or detecting the failure mode or its cause: Detection is an assessment of the likelihood that the current controls (design and process) will detect the cause of the failure mode or the failure mode itself, thus preventing it from reaching the customer. As usual, a number must be assigned to indicate the detection effectiveness (DET) of each control. DET numbers are shown in Column 8 of the FMEA table.

12. Calculate risk priority numbers (RPN): The risk priority number is a mathematical product of the numerical severity, probability and detection ratings:

$$\text{RPN} = (\text{Severity}) \times (\text{Probability}) \times (\text{Detection}) = \text{SEV} \times \text{PF} \times \text{DET}$$

The RPN that is listed in Column 8 of the FMEA table is used to prioritize items required for additional quality planning or action.

13. Determine recommended action(s) to address potential failures that have a high RPN: A high RPN needs immediate attention since it indicates that the failure mode can result in an enormous negative effect, its failure cause has a high likelihood of occurring and there are insufficient controls to catch it. Action items must be defined to address failure modes that have high RPNs. These actions could include specific inspection, testing or quality procedures, selection of different components or materials, de-rating, limiting environmental stresses or operating range, redesign of the item to avoid the failure mode, monitoring mechanisms, performing preventative maintenance and inclusion of back-up systems or redundancy. Column 10 of the FMEA table is used to list applicable action items.

14. Implement the defined actions: Assign responsibility and a target completion date for these actions. This makes responsibility clear-cut and facilitates tracking. The responsible owner and target completion dates must be indicated in column 11 of the FMEA table.

15. Review the results of the actions taken and reassess the RPNs: After the defined actions have been taken, re-assess the severity, probability and detection and review the revised RPNs. The new RPN should help the engineer decide if more actions are needed or if the

Bird's-eye view:

The **Risk Priority Number**, or **RPN**, is a numeric assessment of **risk** assigned to a process, or steps in a process, as part of Failure Modes and Effects Analysis (FMEA), in which a team assigns each failure mode numeric values that quantify likelihood of occurrence, likelihood of detection, and severity of impact.

actions are sufficient. Columns 13, 14, 15 and 16 of the FMEA table are used to indicate the new SEV, PF, DET and RPN, respectively.

16. Keep the FMEA table updated: Update the FMEA as the design or process changes, the assessment changes or new information cause the SEV, PF or DET to change.

■ Benefits of FMEA

FMEA is designed to assist the engineer improve the quality and reliability of design. FMEA provides the engineer several benefits when used properly. These benefits include:

- 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/organization knowledge
- Emphasizes problem prevention
- Documents risk and actions taken to reduce risk
- Provides focus for improved testing and development
- Minimizes late changes and associated cost
- Catalyst for teamwork and idea exchange between functions

DISCUSSION FORUM

1. Define the term FMEA.
2. Name the types of FMEA.
3. Mention the various steps involved in the process of conducting FMEA?
4. Explain the benefits of FMEA.

■ TOTAL PRODUCTIVE MAINTENANCE (TPM)

Total productive maintenance (TPM) is a concept developed by the Japan Institute of Plant Maintenance (JIPM) Tokyo in the late 1960s. TPM is the key for the operational excellence of many Japanese companies. TPM is a maintenance programme that involves a newly-defined concept for maintaining plants and equipment. The goal of the TPM programme is to markedly increase production, while at the same time increasing employee morale and job satisfaction. The TPM programme closely resembles the popular TQM programme. Many of the same tools such as employee empowerment, benchmarking, documentation, etc. are used to implement and optimize TPM.

All manufacturing organizations possess industrial equipment for various processes in the production of goods. Similarly services organizations also use various gadgets such as computers, printers, facsimiles, photocopies, etc. to aid their daily operations. Maintenance of facilities and equipment is done to ensure that these are in good working condition at any point of time. If breakdowns occur, necessary repairs should be conducted in order to bring them back into running condition as early as possible. Maintenance management involves

Bird's-eye view:

Process FMEA:

Used to analyze transactional processes. Focus is on failure to produce intended requirement, a defect. Failure modes may stem from causes identified.

Bird's-eye view:

System FMEA:

A specific category of design FMEA used to analyze systems and subsystems in the early concept and design stages. Focuses on potential failure modes associated with the functionality of a system caused by design.

Bird's-eye view:

Design FMEA:

Used to analyze component designs. Focuses on potential failure modes associated with the functionality of a component caused by design. Failure modes may be derived from causes identified in the system FMEA.

 **Bird's-eye view:**

Total Productive Maintenance (TPM) is a system of maintaining and improving the integrity of production and quality systems through the machines, equipment, processes, and employees that add business value to an organization.

 **Bird's-eye view:**

TPM focuses on keeping all equipment in top working condition to avoid breakdowns and delays in manufacturing processes.

planning, organizing and controlling maintenance activities such that the overall maintenance cost is minimized.

TPM is an approach with the core objective of organizing a workplace to prevent all losses and achieve zero defects, zero breakdowns, zero accidents and zero pollution in the entire production system lifecycle. This is done by involving all the employees and covering the entire organization in the form of small competing teams to establish a culture for maximizing production efficiency. It strives to maintain optimum equipment conditions in order to prevent unexpected breakdowns, speed losses and quality defects arising from process activities. Box 14.1 discusses TPM implementation at HUL.

■ History of TPM

TPM evolved from TQM and is an innovative Japanese concept. The origin of TPM can be traced back to 1951 when the Japanese companies introduced preventive maintenance. However, the concept of preventive maintenance was taken from the work of Dr W. Edwards Deming. In 1960, Nippon Denso was the first company to introduce plant-wide preventive maintenance. Preventive maintenance is the concept wherein, operators produced goods using machines and the maintenance group was completely dedicated to the work of maintaining those machines. With the automation of Nippon Denso, maintenance became a problem as more maintenance personnel were required. So the management decided that the routine maintenance of equipment would be carried out by the operators. This is referred to as autonomous maintenance, one of the main features of TPM. Only the essential maintenance work was carried out by the maintenance group.

Thus, Nippon Denso that already followed preventive maintenance also added autonomous maintenance to activities undertaken by the production operators. The maintenance crew went into equipment modification for improving reliability. The modifications were made or incorporated in all new equipment. This led to maintenance prevention. Thus, preventive maintenance along with maintenance prevention and maintainability improvement gave birth to productive maintenance. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum lifecycle cost of production equipment. By then Nippon Denso had also formed quality circles. Based on these developments, Nippon Denso was awarded the Distinguished Plant Prize for Developing and Implementing TPM by the Japanese Institute of Plant Engineers (JIPE). Thus, Nippon Denso of the Toyota group became the first company to obtain TPM certification.

Box 14.1 JIPM Awards TPM Certification to HUL

Hindustan Unilever Limited (HUL) has been in India since 1931 and has played a key role in the industrial development of India. It is India's fastest growing and the largest consumer goods company with leadership in home and personal care products, beverages and ice creams.

HUL's regional office in Mumbai has bagged the TPM Level-One certification from the Japan Institute of Plant Maintenance (JIPM), which accords TPM certifications worldwide.

HUL implemented TPM in its sales operations in order to re-orient its office processes. The objective was to become the best-in-class service provider. HUL has rolled out TPM in sales operations at its three regional offices—Chennai, Delhi and Kolkata. These offices will be audited by JIPM. HUL introduced TPM in its sales operations after deriving benefits from it in its manufacturing operations.

Some of the benefits obtained after implementing TPM are improved delivery time to redistribution stockists, drastic reduction in damaged stocks, significant improvements in claims settlement and in-transit stock display.

 **Bird's-eye view:**

TPM (Total Productive Maintenance) is a holistic approach to equipment maintenance that strives to achieve: No break downs; no small stops no defects and no accidents.

■ Objectives of TPM

The main objectives of TPM are:

- TPM aims to maximize overall equipment effectiveness (OEE).
- TPM establishes a thorough system of planned maintenance (PM) for the equipment's entire lifespan.
- TPM should be implemented by cross-functional teams from various departments.
- TPM involves every single employee from the top management to workers on the shop floor.
- TPM is based on the promotion of planned maintenance through autonomous small group activities.

■ Overall Equipment Effectiveness (OEE)¹

TPM strives to achieve OEE by maximizing output while minimizing input. The input consists of labour, machine and materials while the output consists of production (P), quality (Q), cost (c), delivery (D), safety, health and environment (S) and morale (M). TPM strives to maximize output (PQCDSM) by maintaining ideal operating conditions and running equipment effectively. To achieve OEE, TPM concentrates on eliminating "six big losses." Figure 14.2 shows the OEE model.

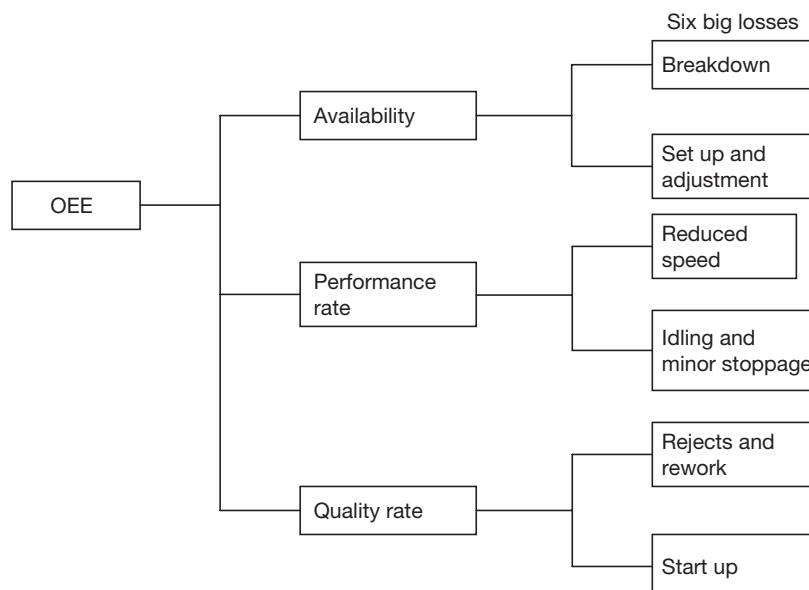
■ Six Big Losses

The six big losses can be grouped under three main heads—availability (downtime), performance rate (speed losses) and quality rate (defects).

Availability (downtime): Downtime results because of

1. Equipment failure from breakdowns.
2. Setup and adjustment from exchange of die, tool changes.

Fig. 14.2 Overall Equipment Effectiveness Model



Bird's-eye view:

Overall equipment effectiveness (OEE) is a term coined by Seiichi Nakajima in the 1960s to evaluate how effectively a manufacturing operation is utilized. It is based on the Harrington Emerson way of thinking regarding labor efficiency. The results are stated in a generic form which allows comparison between manufacturing units in differing industries. It is not however an absolute measure and is best used to identify scope for process performance improvement, and how to get the improvement.

Performance rate (speed losses): Speed losses result on account of:

1. Idling and minor stoppages due to abnormal operation of sensors, blockage of work on chutes, etc.
2. Reduced speed due to discrepancies between the designed and the actual speed of equipment.

Quality rate (defects): Defects arise due to:

1. Process defects due to scraps and quality defects to be repaired.
2. Reduced yield from machine startup to stable production.

Overall Equipment Effectiveness = Availability × Performance Efficiency × Quality Rate

$$\text{OEE} = A \times PE \times QR$$

These terms are explained below:

Availability (A) is the duration of the time for which the equipment is actually available to do useful work, out of the time it should be available. It is calculated as below:

$$\text{Availability (A)} = \frac{\text{Actual Time}}{\text{Standard Time}}$$

Where MTBF = Mean time between failures (a measure of equipment reliability)

MTTR = Mean time to repair (a measure of equipment maintainability)

Reliability is the consistency of performance. It is measured by the length of time a product can be used before it fails.

Durability is the ability of a product to continue to function even when subjected to rough and frequent use.

Maintainability is the ability of a product to return to operating conditions after it has failed.

Alternatively, availability can also be defined as:

$$\text{Availability (A)} = \frac{\text{Actual Time}}{\text{Standard Time}} = \frac{\text{Actual Time}}{\text{MTBF} + \text{MTTR}}$$

Performance efficiency (PE) is a measure of how well a machine performs, while it is running.

$$\text{Performance Efficiency (PE)} = \text{Rate Efficiency (RE)} \times \text{Speed Efficiency (SE)}$$

Alternatively, performance efficiency can be defined as:

$$\text{Performance Efficiency (PE)} = \frac{\text{Theoretical Cycle Time} \times \text{Units Produced}}{\text{Loading Time} - \text{Downtime}}$$

Quality rate (QR) is a measure that indicates the equipment's ability to produce non-defective products. It is defined as:

$$\text{Quality Rate (QR)} = \frac{\text{Actual Production Volume} - \text{Defective Outputs}}{\text{Actual Production Volume}}$$

Example:

Working hours per day = 60 minutes × 8 hours = 480 minutes

Loading time per day = 460 minutes

Downtime per day = 60 minutes

Operating time per day = 400 minutes

Output per day = 400 pieces

👁 Bird's-eye view:

How to calculate OEE?

$$\text{Availability} = \frac{\text{Standard time} - \text{downtime}}{\text{Standard time}}$$

$$\text{Performance} = \frac{\text{Components produced}}{\text{Components supposed to be produced}}$$

$$\text{Quality} = \frac{\text{Total Acceptable Components}}{\text{Total Components produced}}$$

Types of downtime:

Setup: 20 minutes

Breakdown: 20 minutes

Adjustments: 20 minutes

Defects: 3 per cent

Availability (operating rate) = $(400/460) \times 100 = 87$ per cent

Ideal cycle time = 0.5 minutes per product

Actual cycle time = 0.8 minutes per product

Operating speed rate = $(0.5/0.8) \times 100 = 62.5$ per cent

Net operating rate = 400 pieces $\times 0.8/400$ minutes $\times 100 = 80$ per cent

(100 – Net operating rate) reflects losses caused by minor stoppages

Performance rate = $0.625 \times 0.800 \times 100 = 50$ per cent

Quality rate = 98 per cent

Overall equipment effectiveness = $0.87 \times 0.5 \times 0.98 \times 100 = 42$ per cent



Bird's-eye view:

Total productive maintenance has eight pillars that are aimed at proactively establishing reliability of machines.

DISCUSSION FORUM

1. Define TPM.
2. Trace the development of TPM.
3. Discuss the objectives of TPM.
4. Explain the term OEE.

■ EIGHT PILLARS OF TPM²

The eight pillars of TPM (Figure 14.3) are:

1. *Jishu Hozen*
2. *Kobetsu Kaizen*
3. Planned maintenance
4. *Hinshitsu Hozen*
5. Education and training
6. Development management
7. Safety, health and environment
8. Pillar 8—Office TPM

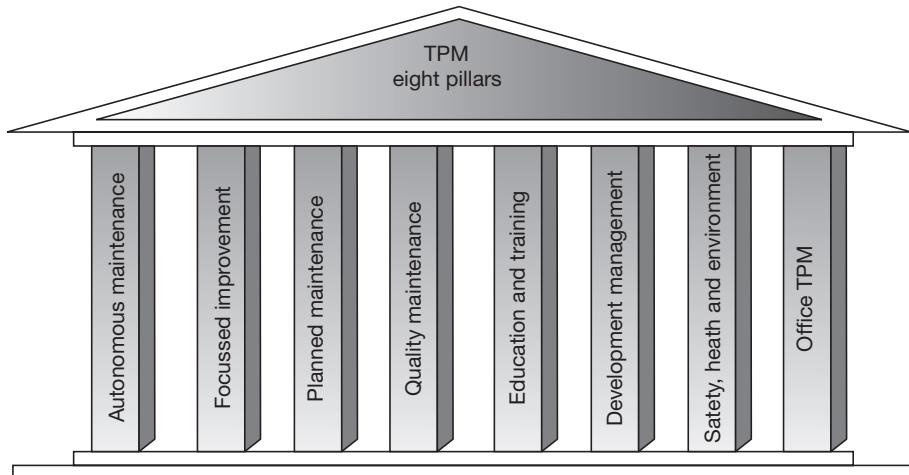
■ Pillar 1—*Jishu Hozen* (Autonomous Maintenance)

The first pillar of TPM is *Jishu Hozen* (JH), which in Japanese means autonomous maintenance. This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value-added activities and technical repairs. The operators are responsible for the upkeep of their equipment to prevent it from deteriorating. The policy followed is the uninterrupted operation of equipments, flexible operators to operate and maintain other equipments, eliminating the defects at source through active employee participation and stepwise implementation of JH activities.

 **Bird's-eye view:**

Availability- which is a measure of the percentage of time that a piece of equipment or a process is available for productive work. The goal of this metric to ensure that there are no break-downs and downtime beyond the already planned downtime.

Fig. 14.3 Eight Pillars of TPM



Source: Adapted from www.tpmclubindia.org/tpmbook.htm, accessed May 2010, reproduced with the permission of TPM Club India.

 **Bird's-eye view:**

Performance measures how well a process performed against the set targets and exposes any speed losses that may arise during the running of a production process

Steps in Jishu Hozen: The main steps in Jishu Hozen are discussed below.

1. Preparation of employees: Employees should be educated about TPM, its advantages and the advantages and steps of Jishu Hozen.
2. Initial clean-up of machines: The supervisor and the technician should discuss the initial clean-up of machines. All the items should be arranged for cleaning and on the arranged date, employees should clean the equipment completely with the help of the maintenance department. After the clean-up, problems should be categorized and suitably tagged. White tags are placed where problems can be solved by operators and pink tags are placed where the aid of maintenance department is needed. The details about the tags placed should also be transferred to a register.
3. Take countermeasures: Necessary action must be taken to prevent the workout of machine parts. Machine parts should be modified to prevent accumulation of dirt and dust.
4. Fix tentative Jishu Hozen standards: The Jishu Hozen schedule must be followed strictly. Schedules should be made regarding cleaning, inspection and lubrication. It also should include details like when, what and how.
5. General inspection: Employees are trained in disciplines like pneumatics, electrical, hydraulics, lubricant and coolant, drives, bolts, nuts and safety. This is necessary to improve the technical skills of employees and to use inspection manuals correctly.
6. Autonomous inspection: Each employee prepares his own autonomous chart/schedule in consultation with the supervisor. New methods of cleaning and lubricating are used. Parts that have never given any problem or parts that don't need any inspection are removed from the list permanently based on experience. The frequency of clean-up and inspection is reduced based on experience.
7. Standardization: Upto the previous step, only the machinery/equipment were the focal points of concentration. However, in this step, the surroundings of machinery

 **Bird's-eye view:**

Quality is a measure of the percentage of good parts that come out of a process against all the parts produced. It is concerned with the defect rate and the ability of a process to produce good quality the first time without the need for rework.

are organized. Necessary items should be organized such that searching time is reduced. The work environment is modified such that there is no difficulty in getting any item.

- Autonomous management: OEE and OPE and other TPM targets must be achieved by continuous improvement through Kaizen. PDCA (Plan, Do, Check and Act) cycle must be implemented for Kaizen.

Pillar 2—Kobetsu Kaizen (Focused Improvement)

Kobetsu Kaizen or focused improvement is a move towards zero losses of all kinds. The concept of zero losses is practised in every sphere of activity. There is a relentless pursuit to achieve cost reduction targets in all resources and improvement of plant equipment effectiveness. The Kobetsu Kaizen target is to achieve and sustain zero-losses with respect to minor stops, measurement and adjustments defects and unavoidable downtimes. It also aims to achieve a 30 per cent reduction in manufacturing costs. The tools used in Kobetsu Kaizen are PM analysis, why-why analysis, summary of losses, Kaizen register and Kaizen summary sheet.

The objective of TPM is the maximization of equipment effectiveness.³ TPM aims at the maximization of machine utilization and not merely machine availability maximization. As one of the pillars of TPM activities, Kaizen pursues efficient equipment, operator and material and energy utilization and aims at achieving substantial effects. Kobetsu Kaizen activities try to thoroughly eliminate 16 major losses in an organization. These are given in Table 14.2. A classification of these losses is given in Table 14.3.

Table 14.2 Sixteen Major Losses in an Organization

A. Seven major losses that impede overall equipment efficiency	
1	Failure losses (breakdown)
2	Set-up and adjustment losses
3	Cutting blade change losses, stoppage losses
4	Start-up losses
5	Minor stoppage and idling losses
6	Speed losses
7	Defect and rework losses
B. Losses that impede equipment loading time	
8	Shutdown (SD) losses

Bird's-eye view:

One distinct advantage of **Total productive maintenance (TPM)** is that it empowers the shop floor to work in a concerted manner to ensure that machines are functioning at their optimal performance.

(Continued)

 **Bird's-eye view:**

TPM strives to achieve OEE by maximizing output while minimizing input. The input consists of labour, Machine and Materials. While the output consists of PQCDSM.

Table 14.2 (Continued)

C. Five major losses that impede worker's efficiency		
9	Management losses	Waiting losses that are caused by management such as waiting for materials, waiting for a dolly, waiting for tools, waiting for instructions, etc.
10	Motion losses	Man-hour losses arising from differences in skills, etc.
11	Line organization losses	Idle time losses when waiting for multiple processes or multiple platforms
12	Distribution losses	Distribution man-hour losses due to transport of materials, products (processed products) and dollies
13	Measurement and adjustment losses	Work losses from frequent measurement and adjustment in order to prevent the occurrence and outflow of quality defects

D. Three major losses that impede the efficient use of production subsidiary resources		
14	Energy losses	Losses due to ineffective utilization of input energy (electric, gas, fuel oil, etc.) in processing
15	Die, jig and tool losses	Financial losses (expenses incurred in production, regarding reiterating, etc.) that occur due to production or repairs of dies, jigs and tolls due to aging beyond service life or breakage
16	Yield losses	Material losses due to differences in the weight of the input materials and the weight of the quality product

Source: Adapted from www.tpmclubindia.org, accessed April 2010, reproduced with the permission of TPM Club India.

Table 14.3 Classification of Losses

Aspect	Sporadic Loss	Chronic Loss
Causation	Causes for this failure can be easily traced. Cause–effect relationship is simple to trace	This loss cannot be easily identified and solved even if various counter measures are applied
Remedy	Easy to establish a remedial measure	This type of losses is caused because of hidden defects in machine, equipment and methods
Impact/loss	A single loss can be costly	A single cause is rare, a combination of causes tends to be a rule
Frequency of occurrence	The frequency of occurrence is low and occasional	The frequency of loss is more
Corrective action	Usually the line personnel in the production can attend to this problem	Specialists in process engineering, quality assurance and maintenance people are required

■ Pillar 3—Planned Maintenance (PM)

PM supports the Jishu Hozen pillar of TPM by encouraging the operators to identify abnormalities and prepare tentative standards for cleaning, lubrication and inspection by way of on-the-job training of operators. It is aimed at having trouble-free machines and equipments producing defect-free products for total customer satisfaction. It comprises the following types of maintenance.⁴

1. **Preventive maintenance:** A type of maintenance practice whose sole objective is to reduce the probability of failure or performance degradation by replacing or reconditioning worn components or by servicing the facilities at pre-planned intervals.
2. **Daily maintenance:** The first step in machine care and in extending the productive life of any machine is the establishment of a daily maintainance programme and checklist.
3. **Periodic maintenance** (time-based maintenance): Significant activities carried out regularly (according to a predetermined schedule) to maintain the condition or operational status of a building, equipment, machine, plant or system.
4. **Predictive maintenance** (condition-based maintenance): This type of maintenance practice is initiated on the basis of the knowledge about the condition of a part/component that comes from routine or continuous monitoring. The basic idea of predictive maintenance is to track some kind of warning signals indicating the necessity of replacement or overhauling.
5. **Breakdown maintenance:** A type of maintenance practice that involves caring of the equipment only after a failure or breakdown has occurred.
6. **Corrective maintenance:** A type of maintenance practice that involves making improvements, modifications and changes in the existing equipment, besides its regular upkeep through other combinations of maintenance.

The policy followed is to achieve and sustain availability of machines, optimum maintenance cost, reduce spares inventory, improve reliability and maintainability of machines. The targets are zero-equipment failures and breakdowns, improved reliability and maintainability by 50 per cent, reduced maintenance cost by 20 per cent and continuous availability of spares.

The six steps in planned maintenance are:

1. Equipment evaluation and recoding present status.
2. Restore deterioration and improve weakness.
3. Building up information management system.
4. Prepare time-based information system, select equipment, parts and members and map out plan.
5. Prepare predictive maintenance system by introducing equipment diagnostic techniques.
6. Evaluation of planned maintenance.

■ Pillar 4—Hinshitsu Hozen (Quality Maintenance)

It is aimed towards customer delight through defect-free manufacturing. The focus is on eliminating non-conformances in a systematic manner. Quality maintenance (QM) activities focus on setting equipment conditions that preclude quality defects based on the concept of maintaining perfect equipment to maintain perfect quality. The condition is checked and measured in time series to verify that measured values are within standard values to prevent defects. The transition of measured values is monitored to predict possibilities of defects



Bird's-eye view:

Maintenance and reliability as a core business strategy is a key to a successful TPM implementation. Without the support of top management, TPM will be just another “flavor of the month.” There are twelve steps in the implementation of TPM.

occurring and to take countermeasures before hand. The policy focuses on the prevention of defects at source, defect-free conditions and control of equipments, QM activities to support quality assurance, focus on *poka-yoke*, in-line detection and segregation of defects and effective implementation of operator quality assurance. The targets are to achieve and sustain customer complaints at zero, reduce in-process defects by 50 per cent and reduce cost of quality by 50 per cent.

Bird's-eye view:

There are various myths in the implementation of **TPM**. The most important among them are: TPM cannot be practiced in public sector companies, TPM is only for auto and auto ancillary companies, and TPM is only for manufacturing companies.

■ **Pillar 5—Education and Training**

The aim is to have multi-skilled revitalized employees whose morale is high and who are eager to come to work and perform all the required functions effectively and independently. Operators are trained to upgrade their skills. It is not sufficient to know only the “know-how” but they should also learn the “know-why.” The employees should be trained to achieve the following four phases of skills so that the goal of creating a factory full of experts is achieved. The different phases of skills are:

- Phase 1: Do not know.
- Phase 2: Know the theory but cannot do.
- Phase 3: Can do but cannot teach.
- Phase 4: Can do and also teach.

The policy focuses on the improvement of knowledge, skills and techniques, creating a training environment for self-learning based on felt needs and training to remove employee fatigue and make work enjoyable. The target is to achieve and sustain downtime due to want of men at zero on critical machines, achieve and sustain zero losses due to lack of knowledge/skills/techniques and aim for 100 per cent participation in suggestion schemes.

The six steps in educating and training activities are:

1. Setting policies and priorities and checking present status of education and training.
2. Establishment of a training system for operation and maintenance skill upgradation.
3. Training the employees for upgrading the operation and maintenance skills.
4. Preparation of training calendar.
5. Kick-off of the system for training.
6. Evaluation of activities and study of future approach.

■ **Pillar 6—Development Management (Early Management)**

Development management or early management helps in drastically reducing the time taken to receive, install and set-up newly purchased equipment (known as vertical start-up). Development management can also be used for reducing the time to manufacture a new product in the factory.

■ **Pillar 7—Safety, Health and Environment**

The safety, health and environment (SHE) pillar of TPM strives to achieve the objective of zero-accidents and defects and reducing the level of human effort required for attaining a given level of production. The targets are zero-accidents, zero-health damage and zero-fires.

■ **Pillar 8—Office TPM**

Office TPM should be started after activating the four other pillars of TPM (JH, KK, QM, PM). It focuses upon improving the productivity and infusing efficiency in the administrative support functions of the organization by identifying and eliminating losses.

Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. The efficiency losses are further broken down into decision-making losses, communication losses, data and document processing losses, etc. This includes analysing processes and procedures towards increased office automation. Office TPM addresses twelve major losses. They are processing loss, cost loss in areas such as procurement, accounts, marketing, sales leading to high inventories, communication losses, idle losses, set-up loss, accuracy loss, office equipment breakdown, communication channel breakdown, telephone and fax lines, time spent on retrieval of information, non-availability of correct online stock status, customer complaints due to logistics and expenses on emergency dispatches/purchases.

How to start office TPM? A senior person from one of the support functions, e.g. Head of Finance, MIS, Purchase, etc. should be heading the sub-committee. Members representing all support functions and people from Production and Quality should be included in the sub-committee. TPM must co-ordinate plans and guide the sub-committee.

Benefits of office TPM: The main benefits of office TPM are:

1. Involvement of all people in support functions for focusing on better plant performance.
2. Better utilized work area.
3. Reduced repetitive work.
4. Reduced inventory levels in all parts of the supply chain.
5. Reduced administrative costs.
6. Reduced inventory carrying cost.
7. Reduction in number of files.
8. Reduction of overhead costs (to include cost of non-production/non-capital equipment).
9. Productivity of people in support functions.
10. Reduction in breakdown of office equipment.
11. Reduction of customer complaints due to logistics.
12. Reduction in expenses due to emergency dispatches/purchases.
13. Reduced manpower.
14. Clean and pleasant work environment.

■ PQCDSM in Office TPM

P—Production output lost due to want of material, manpower productivity and production output loss due to want of tools.

Q—Mistakes in preparation of cheques, bills, invoices, payroll, customer returns/warranty attributable to BOPs, rejection/rework in BOP's/job work and office area rework.

C—Buying cost/unit produced, cost of logistics—inbound/outbound, cost of carrying inventory, cost of communication and demurrage costs.

D—Logistics losses (delay in loading/unloading):

- Delay in delivery due to any of the support functions
- Delay in payments to suppliers
- Delay in information



Bird's-eye view:

Office TPM is the seventh pillar and concentrates on all areas that provide administrative and support functions in the organisation. The pillar applies the key TPM principles in eliminating waste and losses from these departments. The pillar ensures that all processes support the optimisation of manufacturing processes and that they are completed at optimal cost.

S—Safety in material handling/stores/logistics and safety of soft and hard data.
 M—Number of Kaizen in office areas.

■ How Office TPM Supports Plant TPM

Office TPM supports the plant in undertaking a Jishu Hozen of the machines (after being trained in Jishu Hozen) during the:

1. Initial stages when machines are more and manpower is less. The help of commercial departments can be taken for this.
2. Office TPM can eliminate the loads online for logistics.

DISCUSSION FORUM

1. Name the eight pillars of TPM.
2. Name the 16 major losses identified in an organization.
3. How are the losses in the organization classified?
4. How does office TPM support plant TPM?

Bird's-eye view:

TPM is not a quick fix, it can often take between 2 and 5 years to implement fully depending on the size and complexity of your organisation. Taking short cuts or only cherry picking parts of the system will not give you the full benefits and you will end up creating problems that then take longer to address.

■ Extension of Office TPM to Suppliers and Distributors

This is essential, but only after as much as possible is done internally. With suppliers, it will lead to on-time delivery, improved “in-coming” quality and cost reduction. With distributors, it will lead to accurate demand generation, improved secondary distribution and reduction in damages during storage and handling.

■ Implementing TPM

The biggest challenge in the successful implementation of TPM is to motivate the employees from the top management level to the shop floor level. Total productive maintenance is based on teamwork and provides a method for the achievement of world-class levels of overall equipment effectiveness through people and not through technology or systems alone.

Maintenance and reliability as a core business strategy is a key to successful TPM implementation. Without the support of the top management, TPM will be just another “flavor of the month.” Implementing TPM using the following 12 steps will start the journey towards “zero-breakdowns” and “zero-defects.”

Step 1: Announcement of TPM The 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 programme This programme will inform and educate everyone in the organization about TPM activities, benefits and the importance of contributions 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 the management to the shop floor. This structure will promote communication and will guarantee that everyone is working toward the same goals.

Step 4: Establish basic TPM policies and quantifiable goals Analyse 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 analyse each piece of equipment and make the necessary improvements.

Step 8: Develop an autonomous maintenance programme for operators Operators undertaking a routine cleaning and inspection schedule will help stabilize conditions and stop accelerated deterioration.

Step 9: Develop a planned or preventive maintenance programme Create a schedule for preventive maintenance on each piece of equipment.

Step 10: Conduct training to improve operation and maintenance skills The 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 programme 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.

■ TPM—Various Myths⁵

Myth 1: TPM cannot be practised in public-sector companies. There is a belief that TPM cannot be practised in public-sector companies. However, some of the Indian public-sector companies have taken this as a challenge and have been successful in their journey of achieving and implementing TPM.

Myth 2: TPM is only for auto and auto ancillary manufacturing companies. With the cut-throat competition that exists even in the food industry, it becomes imperative that they evolve themselves for continuing to survive in the present market scenario.

Myth 3: TPM is only for manufacturing companies. TPM has been considered as a methodology only for manufacturing companies for all. However, some of the service sector companies have seriously taken up the methodology of TPM to improve their operations and were successful in challenging the TPM Excellence Award.

■ TPM Awards⁶

The CII-TPM Club India has been providing consulting and training services to Indian industry for the last 10 years. The training is imparted to develop TPM experts and TPM masters. Box 14.2 discusses the activities of the TPM Club of India.

TPM expert: A person who applies TPM and reliability methodologies and tools to assist or lead teams in optimizing asset capacity and productivity at minimum lifecycle cost. A TPM expert is responsible for determining critical equipment and measuring its overall effectiveness, thus enabling growth and productivity through optimum asset utilization.

TPM master: A highly skilled individual experienced in the use of TPM and reliability tools and methodologies. A TPM master's responsibilities include assisting the leadership in identifying high-leverage asset improvement opportunities; leading critical, high leverage

Bird's-eye view:

TPM award is given to companies who have implemented the concepts of "Total Productive Maintenance" as developed by the Japan Institute of Plant Maintenance, Japan (JIPM), and achieved excellent results. This award is challenged by companies inside and outside Japan, which enables good benchmarking amongst manufacturing companies.

Bird's-eye view:

The CII-TPM Club of India has been providing consulting and training services to Indian industry for the last 10 years. The training is given to develop TPM expert and TPM master. Over a period of time, Indian companies have started successfully challenging the TPM Awards.

Box 14.2 TPM Club of India

The Confederation of Indian Industries (CII) in association with the Japan Institute of Plant Maintenance (JIPM) established the TPM club in 1998 with the purpose of being a national point of reference for TPM activities and promotion, consultancy and research to benefit Indian industry. The main objectives of the CII-TPM division are to promote TPM in the Indian industry, assist industry to implement TPM through training and consultancy and to provide support to JIPM in its activities in India.

The CII-TPM Club of India has been accredited as the assessment agency for TPM awards. It is one of the five agencies accredited in the first batch outside Japan. Out of five agencies, the Japan Institute of Plant Maintenance (JIPM) considers CII as the only agency that has the capability to carry out the assessment independently by itself.

Since the last four years, India is the only country that has won the highest number of TPM awards outside Japan. India stands second in the world so far on the number of awards given on TPM since 1971. In 2006, the number of TPM awards won by Indian companies crossed the 100 mark and reached 111, which is cumulative from 1995 till 2006. This is again the highest number of awards won by any country other than Japan.

Source: Adapted from www.tpmclubindia.org, accessed July 2010.

improvement projects in a business; and leading cultural paradigm shifts from reactive to proactive asset management.

TPM awards are given to companies who have implemented the concepts of “total productive maintenance” as developed by the Japan Institute of Plant Maintenance, (JIPM), Japan and achieved excellent results. This award is challenged by companies inside and outside Japan, which has enabled good benchmarking among manufacturing companies. Some of the TPM award winners for 2008 are Brakes India, Sundaram Industries Ltd, Ispat Industries Ltd and Exide Industries Limited.

DISCUSSION FORUM

1. Name the various steps involved in the successful implementation of TPM.
2. What are the myths in the implementation of TPM?
3. Discuss TPM awards in detail.
4. What is the function of the CII-TPM Club of India?

SUMMARY

- Reliability is the probability that a product, piece of equipment or system performs its intended function for a stated period of time under specified operating conditions.
- In practice, reliability is determined by the number of failures per unit time during the duration under consideration called the failure rate (λ). The lifecycle of the product in terms of failure rate (λ) can be categorized into three categories—the early failure phase, random failure phase and the wear-out phase. The three phases of the product lifecycle may be shown using the bathtub curve.
- For items that must be replaced when a failure occurs, the reciprocal of the failure rate (having dimensions of time units per failure) is called the mean time to failure (MTTF). For repairable items, the mean time between failures (MTBF) is used. Technically, MTBF should

be used only in reference to repairable items, while MTTF should be used for non-repairable items. However, MTBF is commonly used for both repairable and non-repairable items.

- Failure modes and effects analysis (FMEA) is a methodology for analysing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product and identify actions to mitigate the failures.
- The various types of FMEA are system, design, process, service and software. There are various steps involved in the process of conducting FMEA. FMEA is designed to assist the engineer in improving the quality and reliability of design.
- TPM is a concept developed by the Japan Institute of Plant Maintenance (JIPM), Tokyo in the late 1960s. Nippon Denso of the Toyota group became the first company to obtain the TPM certification conferred by the JIPM.
- TPM is an approach with the core objective of organizing a workplace to prevent all losses and achieve zero-defects, zero-breakdowns, zero-accidents and zero-pollution in the entire production system lifecycle.
- TPM strives to achieve OEE by maximizing output while minimizing input. The input consists of labour, machine and materials. While the output consists of PQCDMS. To achieve OEE, TPM concentrates on eliminating machine downtime, speed losses and defects comprising “six big losses.” The OEE is the product of machine availability, performance rate and quality rate.
- The eight pillars of TPM are (1) autonomous maintenance, (2) focused improvements, (3) planned maintenance, (4) quality maintenance, (5) education and training, (6) development management, (7) safety, health and environment and (8) office TPM.
- Maintenance and reliability as a core business strategy is the key to successful TPM implementation. Without the support of top management, TPM will be just another “flavor of the month.” There are 12 steps in the implementation of TPM.
- There are various myths in the implementation of TPM. The most important among them are—TPM cannot be practised in public sector companies, TPM is only for auto and auto ancillary companies and TPM is only for manufacturing companies.
- TPM awards are given to companies who have implemented the concepts of “total productive maintenance” as developed by the Japan Institute of Plant Maintenance (JIPM), Japan and achieved excellent results. This award is challenged by companies inside and outside Japan. This has enabled good benchmarking among manufacturing companies.
- The CII-TPM Club of India has been providing consulting and training services to the Indian industry for the last 10 years. The training is given to develop TPM experts and TPM masters. Over a period of time, Indian companies have started successfully challenging the TPM awards.

Key Terms

Autonomous Maintenance 450	Corrective Maintenance 453
Availability 447	Daily Maintenance 453
Bathtub Curve 437	Detection 444
Breakdown Maintenance 453	Development Management 454

Early Failure	437	Probability	435
Education and Training	454	Quality Maintenance	453
Eight Pillars of TPM	449	Quality Rate	448
Failure Mode and Effects Analysis (FMEA)	440	Random Failure	436
Failure Rate	435	Reliability	435
Focused Improvements	451	Risk Priority Numbers (RPN)	444
Japan Institute of Plant Management (JIPM)	445	Severity	442
Mean Time Between Failure (MTBF)	438	Six Big Losses	447
Mean Time To Failure (MTTF)	438	Time	436
Office TPM	454	Total Productive Maintenance (TPM)	445
Operating Conditions	436	TPM Awards	457
Overall Equipment Effectiveness (OEE)	447	TPM Expert	457
Performance	436	TPM Master	457
Performance Rate	448	Wear-out Failure	437
Periodic Maintenance	453	Zero-accident	446
Planned Maintenance	453	Zero Failure	453
Predictive Maintenance	453	Zero-health Damage	454
Preventive Maintenance	453		

Case Study

TPM at MRC Bearings

MRC Bearing, the largest producer of aero-engine bearings in the world, is located in Falconer, New York. The company is the primary aerospace bearings supplier to General Electric, Pratt–Whitney and Rolls Royce, as well as to the world's leading military and helicopter programmes.

Problem Identification

In 1996, the company realised that it was behind on orders. Their customers were aggressive in their demands for cost reductions and shorter lead times. The majority of their maintenance hours were dedicated to emergency work orders. The company decided to implement a TPM programme in order to achieve a turnaround. After the implementation of TPM, the company was able to achieve a 98 per cent decrease in unplanned maintenance hours.

TPM Journey

The company started its TPM programme by focusing on a small area, which was critical to processes but was experiencing chronic problems. At first, a lot of people were skeptical and not really interested in getting involved with the TPM activities. The company had a core team of people who were excited about TPM. It also enlisted the help of people outside the organization to work with the core team.

TPM at MRC began with a week long TPM event. It started by cleaning, inspecting lubricating and performing corrective work on a piece of machinery. Once a machine was cleaned, it would be painted. At first, people were reluctant to participate in TPM events and

ridiculed the TPM programme as “Totally Painted Machines.” As time elapsed, people started appreciating the improvements brought about by TPM events. Employees who were totally against TPM started participating in TPM workouts.

MRC formed equipment improvement teams (EITs) to work on resolving equipment-related issues. The teams initially worked on a piece of equipment with chronic problems. The equipment was breaking down on a monthly basis and required three or four days each time to fix it. The team discovered the original manufacturer had used a sub-spec coupling on a drive unit. The problem was solved by upgrading to the proper coupling. The problem was solved by taking the time out to find the root cause of the failures, rather than just fixing the symptoms. In the years following this repair, the problem was completely eliminated. That success showed a lot of people in the company that TPM can make everyone’s daily life easier as well as improve productivity.

After the initial success, MRC expanded their TPM efforts to their second facility. They created a TPM Steering Committee at their second site and also created a policy group to co-ordinate the efforts of both facilities. MRC trained 10 TPM Area Co-ordinators who undertake TPM activities for one week in each month. These TPM Co-ordinators organize TPM events in their areas, also lead EITs and make sure the process keeps working. MRC has begun to create full-time TPM teams. One such team was able to correct a long-standing equipment problem. This resulted in reducing the scrap produced by that equipment to almost zero. The areas that MRC focused on were:

1. Preventive maintenance
2. Putting predictive maintenance process in place (i.e. vibration analysis equipment)
3. Cleaning the machines, resulting in inspection
4. Creating standards on the equipment for cleaning, lubrication and daily checks
5. Collecting data on downtime
6. Creating equipment improvement teams
7. Creating TPM area co-ordinators

Lessons Learnt

The most important lesson learnt was that training is the key to being successful with TPM. The company had organized some initial TPM awareness training programmes for the organization for both operators and mechanics. However, looking back they could have had achieved success faster if more training had been imparted. The support of the top management, the union, the hard work of the people at MRC and the support of their customers were the factors instrumental to the success of the TPM initiative.

Source: Adapted from “MRC Bearings’ TPM Journey: From Totally Painted Machines to Taking Pride in Our Machines,” available at www.maintenanceworld.com/Articles/marshall/mrcbearings.htm, accessed April 2010.

For Discussion

1. What were the problems faced by MRC?
2. What was the solution used to address the problems at MRC?
3. What were the attributes responsible for the successful implementation of TPM at MRC?
4. Explain the TPM journey at MRC.
5. Comment on the statement “TPM is not totally painted machines but taking pride in our machines.”

Exercise

In an engineering company, one of the machine centres is scheduled for two shift operations at the rate of 8 hours per shift. The time allowed for changing tools, shift breaks, direct plant maintenance activities, etc. is 1 hour per shift. Thus, the planned up time is 14 hours a day and 336 hours per month. The maintenance manager has analysed the downtime data for the last three months and found out that the machine centre has stopped for 262 hours due to various breakdowns distributed on 89 occasions. The production manager reported a production of 4,576 pieces during the above-mentioned period. The theoretical cycle time for producing each piece is 6 minutes and actual cycle time is 8 minutes. The quality control department rejected 456 pieces as they did not confirm to the prescribed standards.

It was also found that the failures causing the downtime were distributed as follows:

Group 1: 25 per cent were due to incorrect operation.

Group 2: 55 per cent were due to incorrect lubrication and bad adjustment.

Group 3: 20 per cent were due to sudden failures such as broken shafts and fuses.

The downtime was found to have the following time components:

Time to find the failure: 10 per cent

Time to find spare parts, tools and drawings: 20 per cent

Time lost for want of spare parts: 25 per cent

Waiting for personnel: 5 per cent

Repair time: 40 per cent

Five per cent of all maintenance jobs were planned and 95 per cent of the jobs were unplanned urgent repairs.

1. Calculate the overall equipment effectiveness (OEE) of the machine centre.
2. What is the availability?
3. What is MTTF?

Short-answer Questions

1. Define reliability.
2. What are the three phases of the product lifecycle?
3. What do you mean by FMEA?
4. Define TPM.
5. Name the eight pillars of TPM.
6. What are the six big losses?
7. Define OEE.
8. How to calculate failure rate?
9. Distinguish between MTTF and MTTB.
10. Name the different categories of TPM awards.

Match the Following

a. Autonomous maintenance	Improvement is everyone's activity
b. Focused improvement	Developing perfect machines for perfect quality
c. Planned maintenance	Improving man-hour efficiency
d. Quality maintenance	Zero accidents
e. Education and training	High equipment effectiveness
f. Development management	Multi-skilled employees
g. Safety, health and environment	Focus on prevention
h. Office TPM	Maintaining basic conditions

Discussion Questions

1. Describe the relevance of reliability engineering.
2. Draw a schematic diagram of a bathtub curve and explain the three phases of the product lifecycle.
3. Explain the OEE model with the help of a diagram.
4. Explain the procedure for conducting FMEA.
5. What is total productive maintenance? Enumerate the benefits of maintenance management?
6. Explain the eight pillars of TPM.
7. Explain the steps in implementing TPM.
8. Describe the different categories of TPM awards.

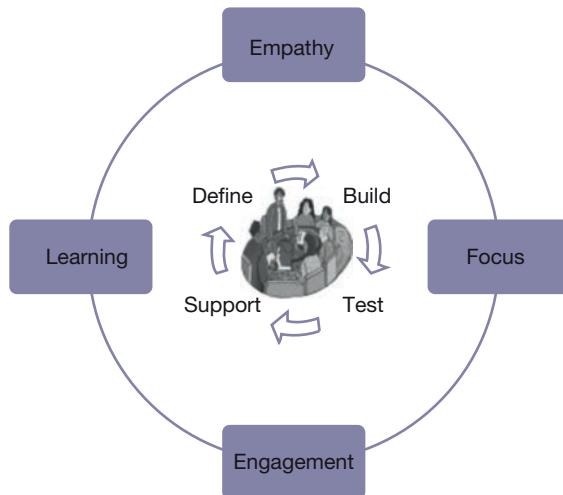
Projects

1. Visit the Web site of the Japan Institute of Plant Maintenance (JIPM) and prepare the checklist for different categories of TPM awards outside Japan.
2. Visit the Web site of a company that has received the TPM award in India and prepare a report on the steps taken by the company for getting this award.

End Notes

1. Robert C. Hansen, *Overall Equipment Effectiveness: A Powerful Production/Maintenance tool for increased profits* (Industrial Press, 2003).
2. Seiichi Nakajima, *TPM Development Programme: Implementing Total Productive Maintenance* (Cambridge, MA: Productivity Press Inc., 1989).
3. Tokutaro Suzuki, *TPM in Process Industries* (Portland: Productivity Press, 1994).
4. Benjamin W. Niebel, *Engineering Maintenance Management* (New York: Marcel Dekker Inc., 1994).
5. www.tpmclubindia.org, accessed April 2010.
6. *Ibid.*

Customer-driven Quality



CUSTOMER-DRIVEN QUALITY AT WAL-MART INC.

Quality begins and ends with customers. An organization's success depends on the number of customers it has, the quantity they buy, and the frequency of their purchases. Customer-driven quality represents a proactive approach to satisfying customer needs that is based on gathering data about customers to learn their needs and preferences and providing products and services that satisfy them. A satisfied customer will tell three more people if he/she liked the service but will tell 11 more if he/she does not like it. Finally, when a company's customers are happy with the service and the product and find enthusiastic and knowledgeable personnel who are eager to help, then there are chances that the company will continue to enjoy the lucrative patronage of their customers for a long time.

Who is a customer? Definitions of a customer are as follows:

- The most important person in any organization
- Not dependent on employers; the latter depend on the customer
- Not an interruption in our work; the customer is the purpose of the work
- A part of business and not an outsider
- Not just a statistic, they are flesh and blood creatures with feelings and emotions

- People who have needs and wants; it is the employer's job to fulfil them
- The lifeblood of any business; without them, businesses have to shut shop

Wal-Mart Inc., one of the most profitable companies in the world, attributes exceeding customer expectation to Sam Walton, the deceased CEO and the company's founder. Many years ago, Wal-Mart started gaining market share over the competition due to Sam Walton's principles regarding customer expectation. Sam Walton used proactive customer-driven quality to anticipate customer needs and to satisfy those needs as soon as they walked into a store. Wal-Mart's assurance of surpassing customer expectations makes customers want to come back to their stores again. This belief of Sam Walton helped make Wal-Mart Inc. the leading retailer in the world and has guaranteed the happiness of many loyal customers who return to his stores.

“Quality in a service or product is not what you put into it. It is what the client or customer gets out of it.”

Peter F. Drucker

Upon completion of this chapter, you will be able to:

1. Explain customer focus
2. Understand customer relationship management (CRM)
3. Discuss customer value management
4. Learn CRM in the context of B2B and B2C
5. Describe e-CRM

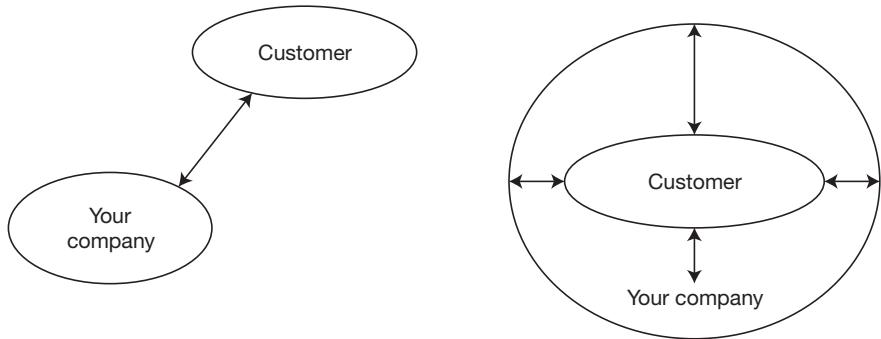
■ INTRODUCTION

A healthy organization, motivated workforce, delighted customers are all part of a cyclic phenomenon. A dedicated and loyal workforce will reflect, in a positive way, the company and its values. They will work towards taking the company towards the growth path. Increased brand value translating into augmented revenues and increased share of profits for the company will eventually trickle down to the employees, thereby enhancing employee-benefit schemes. A motivated workforce will feel an additional obligation to serve the customers better. Every organization has thus realised the growing importance of grooming its employees to make them an impressive force in the eyes of the consumers. Investing resources in well-defined recruitment policies, thorough and intensive training programmes, soft-skills encompassing business etiquette, communication proficiency, etc. are an integral part of any business.

Every individual associated with the company should be in a framework to completely understand, visualize and relate to the culture and mission statement of the organization and the direction towards which they are headed. This, in turn, calls for providing customers with quality service. A keen and unperturbed customer focus whilst completing the task at hand will translate into fulfilling the needs, requirements and also expectations of the

Bird's-eye view:

Customer satisfaction plays an **important** role within your business. Not only it is the leading indicator to measure **customer** loyalty, identify unhappy **customers**, reduce churn and increase revenue; it is also a key point of differentiation that helps you to attract new **customers** in competitive business environments.

Fig. 15.1 Customer-centric Model

existing clients as also adding new ones to the list. In the era of multiple means and unlimited choices, customer focus acts as the key differentiator and gives the competitive edge.

Quality begins and ends with customers. Gone are the days when organizations and customers were treated as two different entities. The marketplace has become very competitive, and it is no longer possible to run a business without a very strong focus on the customer as shown in Figure 15.1.

Bird's-eye view:

A **Customer** is an individual or business that purchases the goods or services produced by a business.

■ Who Is a “CUSTOMER”?

Webster defines a customer as “one that purchases a commodity or service.” This definition talks of an interface between the seller and the customer who are two different entities. Here, customers are beyond the bounds of an organization.

In the TQM perspective, a customer is anyone (organization) who receives and uses what an organization or individual provides. This definition offers an important dimension that customers are no longer just beyond the organization. Instead of being outside the organization supplying goods and services, the customers are also within the organization doing the supply. Selling is not always required for this type of customer/supplier relation. An assembly line worker’s customer is the one to whom he/she provides goods or services. A doctor’s customers are the patients. A teacher’s customers are the students. A planning manager’s customer is the production manager.

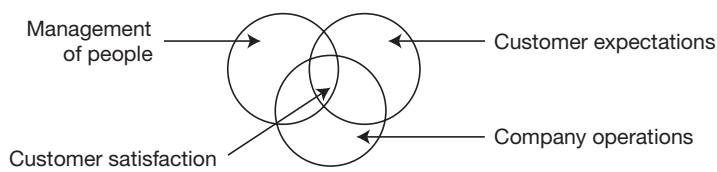
It is imperative for all internal customers in an organization to be satisfied to ensure complete satisfaction of the external customers. If one of the customers is dissatisfied, he/she can create havoc in the business process. Proactively unearthing and quenching the demands of internal customers is one of the basic requirements of TQM. However, the specification of requirements made by the internal customer should ultimately satisfy the external customer. From a company’s viewpoint, customer satisfaction is a result of the following three components as shown in the Figure 15.2.

1. Company processes (operations).
2. Company employees who deliver the product and service.
3. Customer expectations.

Customer satisfaction should not be treated as a mere slogan. The ultimate target of business is to effectively invest resources to satisfy customers through empowered people in

Bird's-eye view:

Attracting customers is the primary goal of most public-facing businesses, because it is the customer who creates demand for goods and services. Businesses often compete through advertisements or lowered prices to attract an ever-larger customer base.

Fig. 15.2 Customer Expectations

the face of market competition, so as to realise a profitable return on investment. Customer satisfaction leads to customer loyalty, which drives up market growth and share. A noted Japanese management scientist, N. Kano has identified three dimensions of customer requirements as shown in Figure 15.3. They are:

- Basic requirements:** Basic requirements relate to those that the customer takes for granted. These are never a subject of negotiation. For example, safety of an airline.
- Performance requirements:** These relate to customer expectations that are negotiated and agreed. For example, the flight schedule of an airline.
- Delight requirements:** These relate not only to meeting customer expectations but exceeding them. For example, a fashion show during a flight.

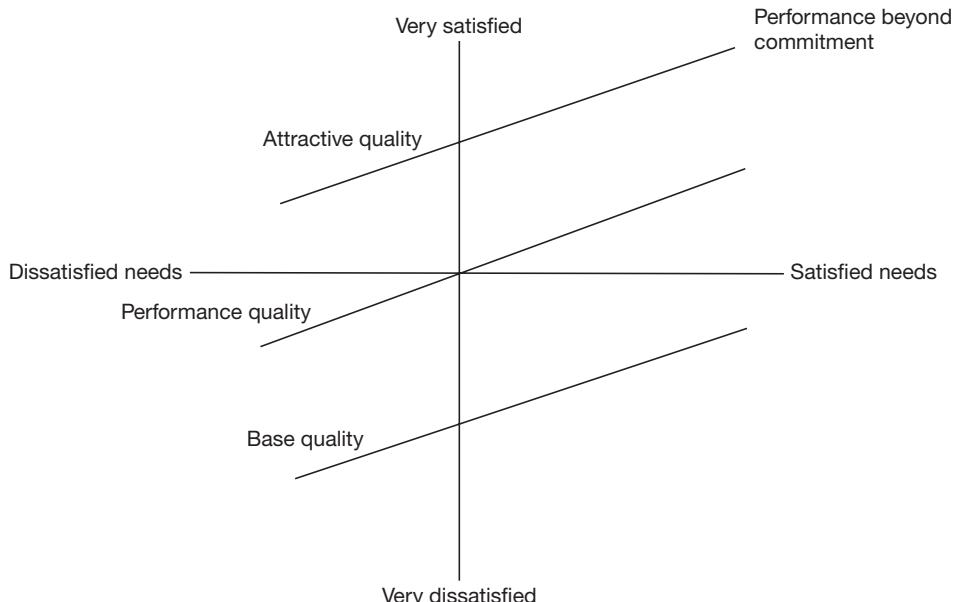
Today, competition requires not just customer satisfaction but demands customer delight. It has been found that a delighted customer takes six times less effort to retain in comparison to a fresh customer. A delighted customer not only helps bring down the cost of sales but also is the best insurance against competitive moves.

Eye icon Bird's-eye view:

The terms “customer” and “consumer” are almost synonymous. Customers are defined by their purchase of goods, or their contracting for services, as the consumer, or end user. As the term is commonly used, a customer is the end consumer of a product. This distinguishes true customers from resellers and vendors, who usually make purchases to sell later.

Eye icon Bird's-eye view:

Three dimensions of customer requirements are: Basic requirements; Performance requirements and Delight requirements.

Fig. 15.3 Three Characteristics of Customer Requirements

Developing a successful customer service system can be one of the most rewarding goals you achieve for your company. The following seven steps can be used effectively to retain customers:

1. Top management commitment to the concept of customer focus.
2. Know your customers and what they like or dislike about you.
3. Develop standards of quality service and performance.
4. Recruit, train and reward good staff.
5. Always stay in touch with customers.
6. Work towards continuous improvement of customer service and retention.
7. Reward service accomplishments by staff.

Bird's-eye view:

Customer perception refers to how customers view a certain product based on their own conclusions. These conclusions are derived from a number of factors, such as price and overall experience.

Bird's-eye view:

The Internet has transformed how people experience brands and build their perceptions. Social media and review websites provide access to reviews and details that help customers form their own perceptions about brands and their products.

■ **CUSTOMER PERCEPTIONS OF QUALITY**

One of the basic concepts of the TQM philosophy is continuous process improvement. An American Society for Quality survey on end-user perceptions of improvement factors that influenced purchases showed these rankings: (1) performance, (2) features, (3) service, (4) warranty, (5) price and (6) reputation.

■ **NEED FOR CUSTOMER FOCUS¹**

Internal customers are people working with the organization who have to be served a motivating experience for them to replicate and carry out the same to the external customers. Customer focus has to be started with employee service. Dr Kashmira Pagdiwalla, Director, HR Operations, Intas Biopharmaceuticals Limited (IBPL) echoes the same thought, "An organization will succeed only when customer needs are satisfied. Changing the business focus to a customer-centered paradigm has a broad-reaching impact across the organization. It gives many companies an opportunity to revisit their company as a whole and improve business processes and achieve significant return on investment." She goes on to say that with a proper customer-focused organization, one can:

- Build on what you accomplish each year in increasing your customer assets and verify it with hard numbers. A more structured work environment that allows for creative thinking needs to be in place.
- Establish meaningful policies and processes that produce results.
- Manage people through information instead of going through people to get the information you need.

Box 15.1 discusses the customer-centric initiatives of Fiat India.

■ **BUYER-SUPPLIER RELATIONSHIPS**

Almost every company purchases products, supplies or services for an amount that frequently equals around 50 per cent of its sales. Traditionally, most companies follow the "lowest bidder" practice where price is the critical criterion. The focus on price, even for commodity products, is changing as companies realise that careful concentration of purchases, together with long-term supplier-buyer relationships, will reduce costs and

Box 15.1 Fiat First—A Customer-centric Initiative

Fiat India, a joint venture between Fiat Group Automobiles and Tata Motors Limited, makes world-class cars available in India at competitive and affordable prices. The company specializes in localizing its cars and getting them assembled in a tailor-made way.

Fiat India rolled out its Fiat First programme in 2009 in India to provide world-class road assistance programmes to its customers in India. The programme marks an important milestone in the evolution of Fiat in India. The Fiat First programme includes:

Wide service network: Fiat has a strong network of 99 dealerships and six point of sales spanning across 77 cities in the country. All these dealerships have a separate identity for Fiat and offer an international ownership experience for customers. The company has employed 800 sales and service personnel to ensure consistent delivery of this world-class experience from the time of purchase to after sales.

Genuine spare parts at competitive prices: “Fiat First” also promises the availability of genuine spare parts at prices benchmarked with competition.

Longest warranty coverage: The company has provided extended warranty package for its Linea and Punto customers under Fiat First. The fifty-month extended warranty is inclusive of the two-year manufacturer and additional third-party warranties.

24 × 7 Road assistance programme: Fiat’s 24 × 7 assistance service can be accessed by calling a national toll free number at any time of the day or night. The services offered under road assistance programmes are parts replacement or repair of a damaged part or tyre change assistance, fuel support up to 5 litres for fuel problems, key support in the event of key loss or a lockout and battery jump start in case of engine failure. In addition to this, owners will also be offered onward journey assistance up to 50 km and towing services within a 100 km radius of a Tata–Fiat dealership or service station.

Source: Adapted from “Fiat India Launches Fiat First Programme,” 15 October 2009, available at www.motorbeam.com/cars/fiat/fiat-india-launches-fiat-first-programme, accessed April 2010.



Bird's-eye view:

Having a **customer focus** is usually a strong contributor to the overall success of a business and ensures that all aspects of the company put its customers’ satisfaction first. Also, having a customer focus usually includes maintaining an effective customer relations and service program

improve profits. Deming realised this and suggested that a long-term relationship between the purchaser and supplier is necessary for economy. If a buyer has to rework, repair, inspect or otherwise expend time and cost on a supplier’s product, the buyer is involved in a “value/quality-added” operation, which is not the purpose of having a reliable supplier. By developing perfect buyer–supplier relationship, no rework or inspection is necessary. Several guidelines will help both the supplier and customer benefit from a long-term partnering relationship:

- **Implementation of TQM by both supplier and customer:** Many customers (e.g. Motorola, Ford, Xerox) require suppliers to operationalize the basic principles of TQM. Some have even requested the supplier to apply for the Baldrige Award. This joint effort provides a common language and builds confidence between both parties.
- **Long-term commitment to TQM and to the partnering relationship between the parties:** This may mean a “lifecycle” relationship that carries partnering through the lifecycle of the product, from market research and design through production and service.
- **Reduction in the supplier base:** One or more automobile companies have reduced the number of suppliers from a thousand to a few hundreds. Why have 10 suppliers for a part when the top two will do a better job and avoid problems?
- **Get suppliers involved in the early stages of research, development and design:** Such involvement generates additional ideas for cost and quality improvement and prevents problems at a later stage of the product lifecycle.
- **Benchmarking:** Both the customer and the supplier can seek out and agree on the best-in-class products and processes.

How does one become a quality supplier? This of course depends on the criteria of the buyer. The criteria required to be certified as a quality supplier in the automobile industry are that the management philosophy of the CEO should support TQM, techniques of quality control should be in place, the desire for a long-term lifecycle relationship, best-in-class inventory and purchasing systems, facilities should be up to TQM standards, automation level should meet quality standards, R&D and design should support customer expectations and there should be a willingness to share costs.

■ DISCUSSION FORUM

1. Define the term customer.
2. Distinguish between internal customers and external customers.
3. What is the significance of developing partnership with suppliers?
4. Identify three dimensions of customer requirements.
5. What do you mean by customer satisfaction?

Bird's-eye view:

Customer relationship management (CRM) is a term that refers to practices, strategies and technologies that companies use to manage and analyze customer interactions and data throughout the customer lifecycle, with the goal of improving business relationships with customers, assisting in customer retention and driving sales growth.

■ CUSTOMER RELATIONSHIP MANAGEMENT (CRM)

Customer relationship management (CRM) has become a strategic initiative in most companies today. This is due to several reasons such as the growth of service sector industries, affordable advances in digital technology and the shift among companies from market share to share in the wallet of the customer. CRM requires a company to develop a customer-centric business model (CCM).

CRM first came into focus in the 1980s. In the budding stage, it was in the form of a customer information system (CIS). These first generation applications were single-function solutions designed to support a specific set of employees. Typical applications were at the helpdesk, sales and marketing departments or a particular function within a call centre. Then it shaped into contact management, sales force automation (SFA), call centre and customer contact centre (CCC). These CRM applications increased the functionality of the software.

These applications offered inter-operable modules that included marketing, sales, analytics, customer service and call centre support functions. Today, it has matured to CRM and also mobile CRM (m-CRM). The term CRM was first coined in the early 1990s. It is a major strategic approach to customers, and businesses are now investing millions of dollars to acquire CRM services and solutions. It is the leading business strategy of the new millennium. The scope of CRM has the customer at the centre. The other four constituencies are suppliers, owners/investors, employees and other partners, all of who must be managed and coordinated to ensure that preferred value propositions are created, communicated and delivered to the selected customer.

■ CRM DEFINED

CRM is a comprehensive strategy and process of acquiring, retaining and partnering with selective customers to create superior value for the company and the customer. It involves the integration of marketing, sales, customer service and the supply-chain functions of the organization to achieve greater efficiencies and effectiveness in delivering customer value.

The CRM methodology enables the organization to understand customer needs and behaviour in a better manner. It introduces reliable processes and procedures for interacting with customers and develops stronger relationships with them. The process helps organizations in assimilating information about customers, sales, marketing effectiveness, responsiveness and market trends. Then, this information is used to give insights into the behaviour of customers and the value of retaining those customers. The whole process is designed to reduce cost and increase profitability by retaining the loyalty of customers.

A simple installation and integration of the software package doesn't ensure success. It has to be absorbed into the system. Employees have to be convinced about its positive attributes, and they also have to be trained. The existing business processes have to be modified. The company has to decide what kind of information is to be collected about the customers, what is to be done with the information and prioritize this accumulated information. The company must drill into this database of its customers and ascertain their buying patterns, product preferences, the potential for add on sales, etc.

A good strategy is to integrate the various touch-points with customers such as marketing, sales, customer service and field support. This is achieved with the integration of the people, process and technology in the business.

■ EMERGENCE OF CRM

Developing customer relationships has historical antecedents going back into the pre-industrial era. Much of it was due to direct interaction between the producers of agricultural products and their consumers. Similarly, artisans often developed customized products for each customer. Such direct interaction led to relational bonding between the producer and the consumer. It was only after the advent of mass production in the industrial era and the advent of middlemen that interaction between producers and consumers became less frequent leading to transaction-oriented marketing. In other words, the production and consumption functions became separated leading to the marketing functions being performed by middlemen, and middlemen, in general, were oriented towards the economic aspects of buying since the largest cost was often the cost of the goods sold.

In recent years, however, several factors have contributed to the rapid development and evolution of CRM. These include the growing de-intermediation process in many industries due to the advent of sophisticated computer and telecommunication technologies that allow producers to directly interact with end-customers. For example, in many sectors such as the airlines, banking, insurance, computer software or household appliances industries, the de-intermediation process is fast changing the nature of marketing and consequently making relationship marketing more popular. Databases and direct marketing tools give these industries the means to individualize their marketing efforts. As a result, producers do not need the functions formerly performed by middlemen. Even consumers are willing to undertake some of the responsibilities of direct ordering, personal merchandising and product use related services with little help from the producers. The recent success of on-line banking, on-line investment programmes, direct selling of books, automobiles, insurance, etc. on the Internet attest to the growing consumer interest in maintaining a direct relationship with marketers.

The de-intermediation process and consequent prevalence of CRM is also due to the growth of the service economy. Since services are typically produced and delivered at the same institution, it minimizes the role of middlemen. An emotional bond also develops between the service provider and the service user creating the need for maintaining and

 **Bird's-eye view:**
Customer relationship management (CRM) is an approach to managing a company's interaction with current and potential future customers.

 **Bird's-eye view:**
The CRM approach tries to analyse data about customers' history with a company, to improve business relationships with customers, specifically focusing on customer retention, and ultimately to drive sales growth.

 **Bird's-eye view:**

In recent years, however, several factors have contributed to the rapid development and evolution of **CRM**. These include the growing deintermediation process in many industries that allow producers to directly interact with end-customers.

enhancing the relationship. It is; therefore, not difficult to see that CRM is important for scholars and practitioners of services marketing.

Another force driving the adoption of CRM has been the total quality movement. When companies embraced the TQM philosophy to improve quality and reduce costs, it became necessary to involve suppliers and customers in implementing the programme at all levels of the value chain. This created the need for closer working relationships with customers, suppliers and other members of the marketing infrastructure. Thus, several companies such as Motorola, IBM, General Motors, Xerox, Ford and Toyota formed partnering relationships with suppliers and customers to practice TQM. Other programmes such as just-in-time (JIT) supply and materials resource planning (MRP) have also made use of interdependent relationships between suppliers and customers.

With the advent of digital technology and complex products, the systems selling approach has become common. This approach has emphasized the integration of parts, supplies and the sale of services along with individual capital equipment. Customers have liked the idea of systems integration and sellers have been able to sell augmented products and services to customers. Then, the popularity of system integration began to extend to consumer packaged goods as well as to services. At the same time, some companies started to insist upon new purchasing approaches such as national contracts and master purchasing agreements, forcing major vendors to develop key account management programmes. These measures created intimacy and co-operation in the buyer—seller relationship. Instead of purchasing a product or service, customers were more interested in buying a relationship with a vendor. The key (or national) account management programme designates account managers and account teams that assess the customer's needs and then husband the selling company's resources for the customer's benefit. Such programmes have led to the establishment of strategic partnering within the overall domain of customer relationship management.

Similarly, in the current era of hyper-competition, marketers are forced to be more concerned with customer retention and loyalty. As several studies have indicated, retaining customers offers a more sustainable competitive advantage than acquiring new ones. What marketers are realising is that it costs less to retain customers than to compete for new ones. On the supply side, it pays more to develop closer relationships with a few suppliers than to work with more vendors. In addition, several marketers are concerned with keeping customers for life rather than with only making a one-time sale.

Finally, many large internationally-oriented companies are trying to become global by integrating their worldwide operations. To achieve this, they are seeking co-operative and collaborative solutions for global operations from their vendors instead of merely engaging in transactional activities with them. Such customer needs make it imperative for marketers interested in the business of companies that are global to adopt CRM programmes, particularly global account management programmes. Global account management (GAM) is conceptually similar to national account management programmes except that they have to be global in scope and thus more complex. Based on these trends, CRM solutions have emerged in three stages:

Stage 1: Specific solutions like simple automation of sales, marketing and service functions using IT.

Stage 2: Enterprise-wide CRM that is focused on capturing, sharing and leveraging customer information across marketing, sales and service and support functions from various input sources.

Stage 3: Integration of ERP and CRM solutions into end-to-end enterprise solutions with blended contact centres using web technologies and computer telephone interface.

■ SCHOOLS OF THOUGHT ON CRM

The growth of the practice of relationship marketing is supported by the growing research interest in different facets of this concept. The initial approaches of CRM can be very broadly classified as:

1. The Anglo-Australian Approach
2. The Nordic Approach
3. The North American Approach
4. The Asian (*Guanxi*) Approach

The Anglo-Australian approach integrated the contemporary theories of quality management, services marketing and customer relationship economics to explain the emergence of relationship marketing.

The Nordic approach views relationship marketing as the confluence of interactive network theory, services marketing and customer relationship economics. The interactive network theory of industrial marketing views marketing as an interactive process in a context where relationship building is an area of primary concern for marketers.

In contrast, the initial focus of the North American scholars was on the relationship between the buyer and seller operating within the context of the organizational environment, which facilitated the buyer–seller relationship.

Guanxi has become a necessary aspect of Chinese and Asian business due to the lack of codified enforceable contracts such as those found in Western markets. Guanxi determines who can conduct business with whom and under what circumstances. Business is conducted within networks, and rules based on status are invoked. Network members can only extend invitations to others to become part of their network if the invitee is a peer or a subordinate.

The broadened views of relationship marketing address a total of six key market domains and are as follows:

1. Customer markets: Existing and prospective customers as well as intermediaries.
2. Referral markets: Existing customers who recommend to other prospects and referral sources or “multipliers” such as doctors who refer patients to a hospital or a consultant who recommends a specific IT solution.
3. Influence markets: Government, consumer groups, business press and financial analysts.
4. Recruitment markets: For attracting the right employees to the organization.
5. Supplier markets: Suppliers of raw materials, components, services, etc.
6. Internal markets: The organization including internal departments and staff.

■ PURPOSE/OBJECTIVES OF CRM

CRM enables an organization to analyse the behaviour of customers and their value. The main areas of focus are customer, relationship and the management of relationships. The main objectives of implementing CRM in business strategy are:

- To simplify marketing and sales processes
- To make call centres more efficient
- To provide better customer service

Bird's-eye view:

CRM Systems help businesses develop prospects into customers by providing an efficient strategy in managing and storing information on leads.

Bird's-eye view:

The **purpose** of a **CRM** system is to attract and retain customers. Implementing a **CRM** System gives businesses the tools to manage, measure, and improve processes.

- To discover new customers and increase customer revenue
- To cross-sell products more effectively

The CRM processes should fully support the basic steps of customer lifecycle. The basic steps of customer lifecycle are:

- Attracting present and new customers
- Acquiring new customers
- Serving the customers
- Finally, retaining the customers

DISCUSSION FORUM

1. Define CRM.
2. Discuss the evolution of CRM.
3. What are the various schools of thought on CRM?
4. What are the objectives of CRM?
5. What do you mean by the term customer lifecycle?
6. What are the various steps in the customer lifecycle?

Bird's-eye view:

CRM requires that a company develop a customer-centric business model (CCM). This means that virtually every action within the model supports the strategic agenda of profitably acquiring, satisfying and retaining target customers.

■ COMPONENTS OF CRM

CRM requires that a company develop a customer-centric business model (CCM). This means that virtually every action within the model supports the strategic agenda of profitably acquiring, satisfying and retaining target customers. Whether enterprise-wide or within a subsidiary serving a particular market, a CCM should address six elements:

- Building and leveraging a sufficiently robust customer or prospect database.
- Identifying target customers or segments.
- Defining and delivering against the prescribed customer experience.
- Defining and measuring desirable business outcomes.
- Aligning the organization to deliver against customer experience requirements and desirable business outcomes.
- Creating a culture of measurement, experimentation, learning and adaptability.

■ Types of CRM

Four broad classifications are possible when it comes to the application of CRM. They are:

Bird's-eye view:

Four broad classifications of CRM are: Strategic CRM; Operational CRM; Analytical CRM and Collaborative CRM.

Strategic CRM: It is focused upon the development of a customer-centric business culture. This culture is dedicated to winning and keeping customers by creating and delivering value better than competitors.

In a customer-centric culture, you would expect resources to be allocated where they would best enhance customer value, reward systems to promote employee behaviour that enhance customer satisfaction and retention and customer information to be collected, shared and applied across the business.

Operational CRM: It is a process by which companies maximize the process of gathering and understanding customer information from all touch points, i.e. point of sale, call centres, web, etc. in an effort to increase customer loyalty and to retain them over their lifetime. It enables and streamlines communication to and from the customer.

Today, the consumer approaches the business in far too many ways than in the past. Also known as front office CRM, it involves the areas where direct customer contact occurs. These interactions are referred to as customer touchpoints.

The customer touchpoints are classified into:

- Face-to-face touchpoints: Sales/service/channel/events/stores/promotions
- Database-driven touchpoints: Telephones/e-mail/mail/SMS/fax/loyalty cards/ATMs
- Mass media: Advertising/PR/Web sites

Analytical CRM: It is also known as back-office or strategic CRM and involves understanding the customer activities that occur in the front office. It involves analysing large amounts of cross-functional data using data mining and other methods and feeding the result back to operational CRM. It also studies consumer behaviour patterns that help to know what products to position for cross-selling/up selling and the level and kind of service to deliver to meet customer demand. Analytical CRM requires technology and new business processes.

Collaborative CRM: The primary goal of organizations is to build a long-term and “profitable relationship” with the “chosen” customers. It is necessary that all concerned parts of the organization work in collaboration with aligned purpose, objective and strategy to achieve this outcome. A “lifetime” value extraction is possible only through close collaboration of internal stakeholders and customers.

Collaborative CRM is a specific functionality that enables a two-way dialogue between a company and its customers through a variety of channels to facilitate and improve the quality of customer interactions. The mandate of collaborative CRM is to manage various partners of the company be it business partners, agents, brokers, OEMs, intermediaries like distributors, dealers, resellers and retailers. By managing all these partners, it tries to facilitate the integration of various activities such as marketing, sales, service/support and quality.

■ THE LADDER OF LOYALTY

The relationships between companies and their key stakeholders are not static. They are time sensitive and driven by current circumstances. Relationship building is a long-term process. In today's marketplace, to expect a customer to be totally committed to one supplier of a product or service is unreasonable and unrealistic. The challenge for any organization is to reduce the number of times one of their key stakeholders tries the products or services offered by the competition.

The relationships between a company and customers take time to build. It cannot be done overnight. It is usually based on a sequence of events that must all be in place for a solid relationship to exist. These sequences and series of stages are often represented in terms of a relationship ladder or ladder of loyalty.

The loyalty ladder is a tool for marketing communicators. The idea is that consumers can be moved along a continuum of loyalty using a number of integrated marketing communications techniques (it is also referred to as a branding ladder). Essentially, consumers become loyal to a brand that has meaning to them in relation to a product, service, solution or experience.

Bird's-eye view:

Customer Loyalty Ladder is a systematic way of classifying customers of an organization into different categories depending upon the business level engagement of customers with the organization.

Bird's-eye view:

The **loyalty ladder** is a tool for marketing communicators. The idea is that consumers can be moved along a continuum of loyalty using a number of integrated marketing communications techniques.

 **Bird's-eye view:**

The **loyalty ladder** is a relationship marketing concept that sees customers gradually moving up through relationship levels, starting at the bottom as Suspect and ending up at the top as partners.

Fig. 15.4 Ladder of Loyalty



 **Bird's-eye view:**

The relationships between company and customers take time to build. These sequences and series of stages are often represented as ladder of loyalty. The stages of ladder of loyalty are: Suspect, Prospect, Buyer, Customer, Frequent customer, loyal customer, Advocate, Partner.

The ladder of customer loyalty talks about the different types of customers that the company encounters. As with continuums of behaviour such as UACCA—Unawareness, Awareness, Comprehension, Conviction, Action, or AIDA—Awareness, Interest, Desire, Action. The loyalty ladder begins from a point where the consumer has not yet purchased the good. He or she then buys the product for the first time. If the trial has been a success, he or she returns to buy it again and again and finally the consumer buys no other brand. Figure 15.4 shows that there are eight identifiable steps in the development of a long-term customer relationship. These steps are discussed below:

■ Suspect

The first step begins with deciding the target market segment. Suspects are aware of the company and its products or services. However, they do not have a clear message about the brand, its promise and its values. The company needs to build the brand value and its promise in the mind of the suspect customer. The company organizes awareness and brand building activities to make the market aware of it and its products.

■ Prospect

The prospect is an individual in a retail market or an organization in the business market who fulfils the requirements of the marketers' definition of the target. The prospect will be on the verge of making the first purchase. They have accepted the invitation of the brand—its promise and its values—and it is important that the company delivers on consumer expectations to convert the prospect to a customer.

■ Buyer

The prospect becomes a buyer when he or she gets attracted by the offering of the marketer and buys the product/service. They have started to identify some preferences in their purchasing patterns in relation to the company. The organization must customize its offerings as per the buyer's buying patterns. The organization must deliver on its promises to retain the buyer.

■ Customer

A customer is someone who purchases the product or service. The relationship is now well established and on relatively firm footing. The customer has clearly demonstrated that they

prefer the company's products or services to those of the company's competitors. Relationship marketing activity should focus on delivering products and services that meet the brand promise, and deliver exceptional value for money.

■ Frequent Customer

Frequent customers have almost cemented their relationship with the organization. The customer selects the company as a supplier of choice and the company occupies a significant place in the customer portfolio.

■ Loyal Customer

The loyal customer is reluctant to switch over and has a strong positive attitude about the company and its offering. Loyal customers not only buy frequently from the organization but also have a level of emotional attachment to the organization and its products and services that will be hard for the competitors to break with tactical offers.

■ Advocate

A loyal customer becomes an advocate when he is satisfied with the organization's offering, and also recommends and influences other potential customers (friends, relatives and acquaintances) to try a similar relationship with the organization. This positive word-of-mouth has a tremendous positive impact as it helps the company obtain new customers. They should be recognized and rewarded for their recommendations.

■ Partner

This is the final step that takes the relationship to new heights. The customer is no more a customer but a partner with the company, and they can together find ways and means to gain mutual advantages from the relationship. An advocate becomes a partner when he actively involves in the decisions of the company. Any relationship that attempts to develop customer value through partnering activities is likely to create greater bonding between customers and marketers.

There are two major phases in the ladder of loyalty. Conventional marketing, wherein the marketers' emphasis during the first three steps in the ladder is on new customers by customer attraction, i.e. customer selection and acquisition. In the later phase of customer relationship marketing, the emphasis is on developing and enhancing relationships by customer retention and extension.

The ladder of loyalty is a useful model to help marketers highlight the differences between various types of people and help to produce appropriate communications for each. Such communication will be better received because they recognize the status of each person and deliver relevant messages. Salespersons can use the ladder to help them allocate their time, devise appropriate contact strategies for individual prospects according to their potential and decide what and how much to tell people about their product.

■ LEVELS OF RELATIONSHIP STRATEGIES FOR BONDING CUSTOMER RELATIONSHIP

Leonard Berry and A. Parasuraman² developed a framework for understanding bonding for customer relationship management (CRM). The framework suggests that relationship marketing can occur at different levels. Each successive level of strategy results in sustained competitive

Bird's-eye view:

The **ladder of loyalty** is a useful model to help marketers highlight the differences between various types of people and help to produce appropriate communications for each. Such communication will be better received because they recognize the status of each person and deliver relevant messages.

Bird's-eye view:

Salespersons can use the ladder to help them allocate their time, devise appropriate contact strategies for individual prospects according to their potential and decide what and how much to tell people about their product.

Bird's-eye view:

Bonding is a continuum. It extends from the first loyalty a customer feels toward a product to a full lock-in with Proprietary Standards; it is most feeble with Best Product strategies and is strongest at System Lock-In.

advantage and bonds the customer closer to the firm. The four levels of relationship strategies for bonding customer relationships are:

Level 1—Financial Bonds: (a) Volume and frequency rewards, (b) Bundling and cross-selling and (c) Stable pricing.

Level 2—Social Bonds: (a) Continuous relationships, (b) Personal relationships and (c) Social bonds among customers.

Level 3—Customization Bonds: (a) Customer intimacy, (b) Mass customization and (c) Anticipation/innovation.

Level 4—Structural Bonds: (a) Shared processes and equipment, (b) Joint investments and (c) Integrated information systems.

■ Level 1—Financial Bonds

Financial bonds tie customers primarily through financial incentives. Financial incentives do not generally provide long-term advantages to a firm. This is because unless these are combined with another type of bond, they do not differentiate the firm from its competitors in the long run. The various forms of financial bonds are discussed below:

Volume and frequency rewards: These are lower prices for larger volumes or for customers who have been patronizing the firm over time. For example, frequent flyer programmes, rewards programmes of hotels and credit cards.

Bundle and cross-selling: Many airlines in the case of frequent flyer programmes link their reward programmes with hotel chains, auto rental and credit card usage. Thus, customers enjoy even greater financial benefits in exchange for their loyalty. McDonald's has successfully used bundling strategies to create value for the customers.

Stable pricing: In order to retain customers, firms offer loyal customers the assurance of stable prices or at least lower price increases than those paid by new customers. For example, the option of earning a higher interest rate given to ICICI Bond holders whose bonds were getting redeemed if they invest the redemption amount in a fixed deposit.

One of the biggest disadvantages of financial bonds is that they can be easily imitated. Also, it attracts a lot of price sensitive customers who switch to a cheaper option at the first opportunity. Thus, financial bonds are the weakest bonds.

■ Level 2—Social Bonds

Level 2 strategies bind customers to the firm by offering more than financial incentives. Marketers try to retain customers by tailoring solutions to the changing needs of customers. The various forms of social bonds are discussed below:

Continuous relationships: These are provided to customers when companies have stable long standing dealers who bring in local market knowledge and maintain close relationships with customers. Recognizing the value of continuous relationships in building loyalty, Caterpillar Corporation (which is one of the world's largest manufacturers of mining, construction and agriculture heavy equipment) credits much of its noted success to its strong dealer network and product support services offered throughout the world.

Personal relationships: There is a focus on building deep personal relationships with customers. These are common among professional service providers (lawyers, teachers,

accountants, etc.) and their clients as well as among personal service providers (counselors, hairdressers, healthcare providers) and their clients.

Social bonds alone are much more difficult for competitors to imitate. In combination with financial incentives, social bonding strategies may be very effective. Social bonds are relatively more difficult to break and hence enduring.

■ Level 3—Customization Bonds

Level 3 strategies involve more than social ties and financial incentives. An intimate knowledge of customers and their needs developed through a learning relationship is very useful in retaining valuable customers. The various forms of customization bonds are discussed below:

Customer intimacy: This suggest that the customer is actively sharing information during interactions and contributing in the marketer's endeavour to customize products, services or any aspect of the marketing mix. This enables the organization to learn new things about the customer and add to the organization's knowledge of the customer. Marriott Hotels knows the likes, dislikes and special habits of its over five million customers. This information comes from the data entered by the employees when the customer stays at any of the Marriott hotels.

Mass customization: This refers to the use of flexible processes and organizational structures to produce varied and often individually customized products and services at the price of standardized, mass-produced alternatives. At its special outlets, Levis gives the option of buying jeans made to customer specifications. Customer can give measurements. These measurements will be passed to the factory that will make customized jeans to be delivered within a week.³

Anticipation/innovation: This brings in an element of pleasant surprise—the wow factor! The ability to customize, in combination with customer intimacy, can be used to anticipate customer needs and innovative solutions can be recommended to meet these needs. Amazon.com uses collaborative filtering techniques to anticipate customer needs. Amazon's collaborative filtering technique uses the knowledge gained by the purchase behaviour of customers with similar profiles and requirements to even anticipate the needs of a prospect who registers for using the service and in the process shares information.

Customization bonds are also difficult to break as the customer would need to start from scratch and teach the new potential provider even if the provider has the capability to meet the customer's requirements.

■ Level 4—Structural Bonds

Structural bonds are created by providing services to the client that are frequently designed right into the service delivery system for that client. The various forms of structural bonds are (a) shared processes and equipment, (b) joint investments and (c) integrated information systems.

Shared processes and equipment, joint investments and integrated information systems can be seen in the partnership between Walmart and Procter & Gamble.

Federal Express ties its customers with its Power Ships—free computers at client sites to store addresses and shipping data, print mailing labels and help track packages. The client saves time and can keep track of daily shipping records.

Structural bonds are the strongest bonds and hence the most difficult to break. As the organization moves from level 1 to level 4, they will observe the following:



Bird's-eye view:

Berry and Parasuraman have identified four levels of bonding for CRM and they are: Level 1: Financial bonds. Level 2: Social bonds, Level 3: Customisation bonds and Level 4: Structural bonds.

- As one moves from level 1 to level 4, the bonds become stronger. Structural bonds are stronger than customization bonds and customization bonds are stronger than social bonds and financial bonds.
- As the bonds become stronger, customer loyalty increases and the opportunities and scope for reaping the benefits of relationship marketing increases.

■ DISCUSSION FORUM

1. Mention the various applications of CRM.
2. Define the term ladder of loyalty.
3. Name the various stages of the ladder of loyalty.
4. Name the four levels of bonding for CRM.

Bird's-eye view:

A defection occurs whenever a customer switches to a competitor. **Customer defection** is the rate at which customers defect or stop the usage of products of a company. Business with high defection rate would be losing their existing customers. The company should aim for zero defection which aims at eliminating customer attrition.

■ CUSTOMER DEFECTS⁴

A customer defection occurs whenever a customer switches to a competitor. Customer defection is the rate at which customers stop the usage of products of a company. Businesses with high defection rates would be losing their existing customers. Customer defections can tell a firm a lot about its products and services from an external perspective, which the firm would otherwise not have known. The concern for reducing and eliminating customer attrition emerged from studies that indicated the following:

- Customers are profitable over time. The longer they stay with an organization, the more profitable they are likely to be.
- Across industries, profits can increase by 35–85 per cent by increasing customer retention by only 5 per cent.
- About 70 per cent of customers switch to competitive offerings due to the perceived indifference of the current provider.

Customer defection is often hard to define. Product-oriented companies with no focus on its customers and no market orientation will be more likely to have high customer defection. Not many of those firms will take the time to find out why they have lost customers.

■ Types of Defectors

Customers who defect may be broadly classified as:

Price defectors: These customers shift to a competitor who is offering a cheaper price. In most cases, these customers are compulsive “bargain hunters” and one may be better off by not having them. But in some cases, customers do not see value in patronizing their existing service provider as a competitor is offering similar or better service at cheaper rates.

Product defectors: Product defectors are former customers who are not satisfied with the existing products offered by the firm. This may be due to a bad experience with the product performance or availability of better products from competitors.

Service defectors: Service defectors are former customers who are dissatisfied with the service. The impact of service dissatisfaction is normally very high. At the same time, customers give enough opportunity for organizations to retain them. Customers not only expect and demand more, they are also more articulate in saying so.

Market defectors: In almost every market in every developed country of the world, competition has increased dramatically in the last 10 years. Globalization and advanced manufacturing technology have resulted in businesses becoming faster and improving product quality. Market defectors have stopped patronizing their former service providers as they have moved away.

Technology defectors: These customers would have shifted to another, normally superior technology. Examples include customers shifting from a typewriter to a word processor, from a digital diary to a PDA (personal digital assistant), a line printer to an inkjet printer and from fax to e-mail, etc.

Organizational defectors: If the customer wishes, buying the simplest product or service can be a very complex decision-making process. Individual users who belong to a group (organization, club, association, etc.) may shift to an alternate supplier because the group has switched although some of the individuals may be satisfied with the existing service provider. An example is the case of shared Internet services in an organization and the organization deciding to shift from VSNL to Spectranet.

Physical defectors: Physical factors such as a more convenient location are ranked quite low as are competitor action and invention. Marketing and competitor activity and relationship with a competitor are about 15 per cent.

The most important and common reason for customer switching is the indifference and lack of attention of the business and the lack of any reason to stay from the customer's point of view. It is important to understand why customers defect and what can be done to reduce defections. Studies have shown that about 70 per cent of the time, customer's defect due to the perceived indifference of the company personnel. Perceived indifference includes lack of proper response to any query for service, inefficient complaint handling, lack of courtesy, etc. In service businesses, where customers keep coming back and ensure a continuous stream of revenue such as in hospitality, retailing, telecom, credit cards, banking, etc. customer defection has serious implications on profitability. Unfortunately, this gets hidden because customer defection is not measured by most organizations.

■ Zero Defections⁵

Just as the quality movement in the 1980s in manufacturing focused on "zero defects," the quality revolution in services is leading the way towards zero defections. Managing for zero defections requires a mechanism to find customers who have ended their relationship with the company or are about to end it. Companies must gain intelligence in the following areas in order to manage and retain customers in the long-term:

- Companies have to know which customers are profitable.
- They must research and understand what their customer defection rate is and the specific reasons for defection. Defection analysis is a guide that helps the company to decide which service quality investments will be profitable and also to manage continuous improvement.
- They must also know the value of their customers in the long run.

■ CUSTOMER RETENTION PROGRAMMES

How can organizations retain customers? The marketing programme should be derived from and support the company's mission and business plans. The following step-by-step approach gives a methodology to develop a comprehensive customer retention programme.



Bird's-eye view:

Customers who defect may be broadly classified as: price defectors, product defectors, service defectors, market defectors, technology defectors and organizational defectors.

■ Step 1: Review the Mission Statement

The first step is to review the company's mission statement. Mission statements should be based on the needs of the customer and not just product or competition based. For example, rather than saying that the mission is "to offer the best-quality microprocessor to the Information Technology industry," the company's mission should be "to ensure the success and profitability of customers in the Information Technology industry through offering the finest quality products and services." In other words, changing the focus from internal to both internal and external (or customer) quality.

■ Step 2: Research Your Customer Base

Research the customer base to identify the most profitable customers and customer segments. There is much focus today on "one-to-one" marketing. However, many small companies cannot maintain the massive amounts of data required to market to a "segment of one" (individual customer). If the company can divide the customer base into several profitable customer segments, it can refine its marketing message to these "segments of several" rather than to "segments of one."

■ Step 3: Measure Customer Defection Rates

Measuring customer defection rates is essential to take steps to reduce customer defections. Set a goal for customer retention and communicate that goal to the rest of the company. Making customer retention a focus may also require organizational changes. Companies that operate with separate functional departments have a hard time ensuring quality for each customer's individual needs. Many companies have had to create customer teams—interdepartmental groups that focus on the success of one customer or a segment of customers.

Bird's-eye view:

Customer retention programs are aimed to reduce customer defection. There are various steps of customer retention programs and they are: Review Mission Statement, Research your customer base, Measure customer defection rates, Stay in front of customers, Take extra mileage, Create a proprietary way of communicating or servicing customers.

■ Step 4: Stay in Front of Customers

Develop contacts with the customer at least five to six times in a year. The contacts may be in the form of face-to-face meetings, electronic communications or direct mail pieces informing customers of new or other products.

■ Step 5: Take the Extra Mileage

Take extra steps to learn about businesses run by customers. This is needed in order to help them become more profitable. One company saved its customers 68 million dollars in annual costs by teaching customers how to use less of its product.

■ Step 6: Create a Proprietary Way of Communicating or Servicing Customers

Customers should know whom to contact when they have a problem or question. Information should be provided on the Internet or in customer service manuals. Constantly survey customers for feedback and ask for detailed responses.

■ ECONOMICS OF CUSTOMER RELATIONSHIP MANAGEMENT

If buying customers is the biggest expense, then continually buying new customers (buying market share) is the most expensive way to do business.

Market share or a focus on new customers comes with an assumption that you are in the business of buying products or services and selling them to customers. If, however, you

swap to the idea of buying customers, you are no longer chasing market share, you're chasing wallet share. The issue becomes, how much, how many and for how long can you sell to each customer you buy?

It is important to know that if money has been invested in buying a customer, then it makes total sense to make sure you get a full return on that customer (your investment). Chasing wallet share is as simple as remembering that you've got a loyal customer base. There should be sustained focus on maximizing returns from the current customer. Some tips to ensure a good wallet share are discussed below:

1. Customers should be fully aware of all the products and services on offer.
2. Focus on all needs of a customer. In case you cannot provide the service yourself, align with another company that can do so.
3. Set up a regular form of communication, this could be a newsletter, a direct mail piece or as simple as a monthly call.



Bird's-eye view:

Chasing wallet share is getting a loyal customer base. It's 6 times easier and cheaper to get an existing customer to buy from company again than it is to get a new customer (market share).

■ CREATING RELATIONSHIP VALUE (LIFETIME VALUE OF CUSTOMERS)

Customer lifetime value (CLV), lifetime customer value (LCV) or lifetime value (LTV) and the new concept of "customer lifecycle management" is the present value of the future cash flows attributed to the customer relationship. The use of customer lifetime value as a marketing metric tends to place greater emphasis on customer service and long-term customer satisfaction, rather than on maximizing short-term sales. CLV is defined as the present value of future cash flows minus costs through long-term customer relationships. The equation is as follows:

$$\text{Customer Lifetime Value} = \text{Customer Value} - \text{Cost (Acquisition, Retention and Service)}$$

The measures that determine customer value include:

- Frequency measures how often the customer has interacted with the company for products or service offerings. The more frequently a customer has made purchases from the company, the more likely that the customer will purchase again in the future.
- Recency measures how recently the customer purchased a product or service offering. The more recently a customer purchased a product, the more likely that the customer will purchase again.
- Average transaction size is a key indicator of future expected transaction value. Future expected transaction value is what a customer is willing to invest in products or services in exchange for the value the customer assumes the product or service will deliver. Average transaction size also indicates the volume of business that the customer is willing to transact at any time, which indicates the current and potential need.
- Buying habits and needs evolve as customers mature. Their requirements can grow in terms of volume of product purchased, product attribute requirements and service level requirements. As customers evolve, their value to the business can grow significantly if it is measured and managed appropriately.
- Customer network value gives an insight into sales to all those who were influenced—either directly or indirectly—by existing customers.

The measures that determine costs include new customer acquisition; account servicing, incentives and promotions campaigns, retention efforts and new product strategies. These expenses can vary by customer segment, by product and by channel.

 **Bird's-eye view:**

Customer Lifetime Value (CLV), Lifetime Customer Value (LCV) is a new concept of “customer life cycle management” is the present value of the future cash flows attributed to the customer relationship.

Effective customer lifetime value analysis gives companies an opportunity to increase profit and return on investment by:

- Attracting prospects with the highest potential lifetime value.
- Forging stronger, more profitable relationships with the existing customers.
- Allocating the right resources to those customers who are most likely to drive revenue and profit growth.

■ Dimensions of CLV

- The duration of the “customer lifetime.”
- The firm’s share of the wallet of its customers, i.e. what portions of the customer’s purchases in the firm’s offering categories are captured by the firm as opposed to its competitors.
- The firm’s success in terms of frequency of up and cross-selling to its customers so as to increase the levels and monetary value of their purchases over time.
- The firm’s costs of acquiring, serving and retaining its customers.

■ Customer Portfolios

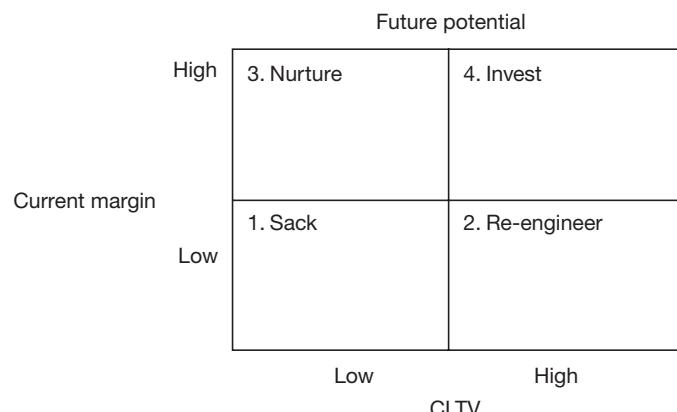
As shown in Figure 15.5, customers can be classified on the basis of the net margin presently earned in the relationship and their future LTV potential. Most businesses seem to have little idea of how their customer base is distributed among these four types. Some typical breakdowns are given below:

- | | |
|-----------------------|----------------|
| • Cell 4: Invest | 5–30 per cent |
| • Cell 3: Nurture | 25–50 per cent |
| • Cell 2: Re-engineer | 30–60 per cent |
| • Cell 1: Sack | 40–80 per cent |

The four cells in the matrix indicate four strategies.

- There will almost certainly be some customers who contribute no value now and have no future potential as shown in Cell 1.
- It may be possible to re-engineer the relationship, finding ways of stripping out cost or adding value so that the relationship becomes more profitable as shown in Cell 2.

Fig. 15.5 Customer Portfolio Analysis



- There are customers who are presently profitable but offer apparently little future potential (Cell 3). It may be possible to nurture these relationships in ways that improve LTV potential.
- There are customers with whom present and future relationships should be profitable. Companies need to invest in these customers and reward them for the value they contribute to the business. Many companies are taking actions such as prioritizing production, customizing products/services, offering flexible invoicing dates and preferential payment terms offering loyalty awards, operating a dedicated customer service line and assigning the best staff.

■ How to Make a CLTV Method Successful?

The following points should be focused on ensuring the success of a CLTV method:

- Connect with the overall strategy of the business.
- It should link with the loyalty that the company seeks to bring in.
- Referrals must be part of the component of the CLTV.
- Constant rate of retention and discount not feasible.
- Risk rate should also be associated.
- Dynamics of the different sectors must be incorporated.
- Truly customized CLTV for highly volatile sectors such as financial services and online companies.
- It should link with loyalty programmes.

■ Customer Value Management

Customer value management (CVM) offers a roadmap to acquiring, developing and retaining the most valuable customers. CVM improves customer profitability by understanding the value of each individual customer and implementing marketing strategies, retention campaigns and loyalty programmes that maximize that value.

CVM focuses on managing each customer relationship with the goal of achieving maximum lifetime profit from the entire customer base. CVM enables companies to take full advantage of the economics of loyalty by increasing retention, reducing risk and amortizing acquisition costs over a longer and more profitable period of engagement.

CVM shifts the focus of the enterprise from managing products or marketing campaigns to managing the profitability of each individual customer over the entire life of the relationship. CVM will help firms to accurately determine what drives value for customers, measure the performance relative to the competition, align efforts, focus scarce resources and create sustainable competitive advantage in the market place.

The concept of CVM is all about:

- Asking customers in your target market what they're looking for when they do business with vendors.
- Determining how customers in your target market rate the value you provide relative to the value provided by your competitors.
- Deciding what changes on your part will have the greatest positive impact on customers' perception of the relative value of your offering.
- Aligning people and processes in a common focus to deliver value.
- Providing a consistent flow of data and information to keep them aligned.
- Winning with customers, with employees and with shareholders.



Bird's-eye view:

Customer value management (CVM) offers a roadmap to acquiring, developing and retaining the most valuable customers. CVM improves customer profitability by understanding the value of each individual customer and implementing marketing strategies, retention campaigns and loyalty programmes that maximize that value.

 **Bird's-eye view:**

CVM is a powerful business tool as it links customers to KPIs by directly measuring the drivers of purchasing behaviour and the impact these have upon delivering KPIs such as market share, profit and loss, recommendation, share of wallet, ROI etc.

 **Bird's-eye view:**

CVM cycle can be broken down into three stages: acquisition; development and keeping valuable customers.

Every company in the present business environment is stressing on customer focus. However, what's lacking in most companies are useful and practical ways to capture customer needs, measure how well you're satisfying those needs and building actionable plans to improve the company's bottom line.

■ Three R's of the CVM Cycle

The customer value management cycle can be broken down into three stages:

- Right customers (acquisition)
- Right relationship (development)
- Right retention (keeping valuable customers)

Right customers: The customer value management cycle starts with identifying and acquiring the customers who will be most valuable to the company's business. All customers are not equal. Companies can no longer afford to indiscriminately recruit customers without examining their long-term value. Customer vintage analysis—examining the loyalty and profitability of customers who joined at different times through different channels adds insight into customer base. Finer segmentation and analysis of customer base reveals hidden characteristics and trends that affect value.

Right relationship: Managers must concentrate on developing relationships with loyal customers. Customers do repeat business with vendors that understand and respond to their individual needs, and respond when those needs change. Unless marketers can distinguish high potential customers from ones who will always be low-value, companies will waste resources trying to develop customers who will never grow.

For any business, the right relationship is one that maximizes that customer's lifetime value. The customer LTV is measured by using the following formula:

$$\text{LTV} = \text{Purchase Size} \times \text{Frequency} \times \text{Duration}$$

The business goal of CRM is to increase the size and frequency of purchases and extend how long the customer continues to buy. Marketers usually use loyalty measures to estimate the duration. Companies that develop the capability to track changes in the value of individual customers can guard against competitive attacks and respond quickly to changing customer behaviour to maintain and grow customer value.

Right retention: Retaining right customers and not every customer is the effective retention strategy. Marketers need to focus their retention actions on customers with the highest lifetime value. Right retention is; therefore, rooted in knowing which individuals are most valuable and why. Box 15.2 discusses how Infosys Technologies focuses on designing innovative products to ensure customer retention.

DISCUSSION FORUM

1. Define the terms customer defection and zero defection.
2. Classify the different types of defectors.
3. What do you mean by customer retention programmes? Mention the various steps.
4. Distinguish between market share and wallet share.
5. Explain the terms CLV and CVM.

Box 15.2 Infosys Focuses on Customer Delight

Infosys Technologies, a giant in Indian IT, launched Finacle Direct Banking Solution on 15 June 2009. Finacle Direct Banking Solution supports the full-fledged branchless delivery of a range of assets and liabilities, through the Internet, mobile and call centre channels. The company also offers complete operational partnership including consulting, implementation and BPO. Two leading global banks have already chosen Finacle Direct Banking Solution.

The Finacle Direct Banking Solution enables banks to expand their networks as well as offers a cost-effective strategy to expand into new geographies. Banks can convert prospects to new customers without the support of a branch using Finacle.

The main features of FDBS are new customer acquisition, online service fulfillment and business process outsourcing services. The benefits are rapid business roll-out, aggressive customer acquisition, improved cross-selling framework, robust security and customer delight.

Source: Adapted from "Finacle from Infosys Launches Direct Banking Solution to Enable Rapid Global Expansion and Customer Acquisition," 15 June 2009, available at www.infosys.com.

CUSTOMER ACQUISITION AND SEGMENTATION

All customers are not equal and; therefore, not all of them should be treated equal. Two strong keywords in the discussion of CRM concepts relate to "selectivity" and "partnership." There exist various customer hierarchies that evaluate the involvement of the customer with the company. Some of these are Prospect–Customer–Client, Supporter–Advocate–Partner or the more simplified Advocate–Buyer–Tryer. The concept of customer as a partner where the customer is willing to give inputs on a product or a service design or product or service delivery is the highest level of hierarchy. Customers behave in four different ways:

1. **Apostles:** They are loyalist customers who are completely satisfied and keep returning to the company. Their experience so far exceeds their expectations and they share their strong feelings with others.
2. **Terrorists/Defectors:** Defectors are neutral. Most of them can be converted into highly satisfied customers if a company has strong processes in place to address their needs.
3. **Mercenaries:** These customers may be completely satisfied but exhibit almost no loyalty and are often expensive to acquire and quick to depart. They chase low prices, buy on impulse, pursue fashion trends or seek change for the sake of change. They can make a company's life miserable.
4. **Hostages:** These customers either belong to the companies who operate in a monopolistic environment or they are habituated to a particular brand and demonstrate inertia in brand switching. Often these customers experience the worst a company has to offer and must accept it.

 **Bird's-eye view:**
Customer Acquisition Management (CAM) is a term used to describe the methodologies and systems to manage customer prospects and inquiries, generally generated by a variety of marketing techniques.

Customer Acquisition Management

Customer acquisition management is a term used to describe the methodologies and systems to manage customer prospects and inquiries generated by a variety of marketing techniques. It can be considered the connectivity between advertising and customer relationship management. This critical connectivity facilitates the acquisition of targeted customers in the most effective fashion.

 **Bird's-eye view:**
The **Customers** behave in four different ways: Apostles, Terrorists/Defectors, Mercenaries, and Hostages. Based on profitability and loyalty the customers are classified as: Butter fliers, strangers, barnacles and true friends.

Customer acquisition management has many similarities to lead management. A closed loop reporting system is always included in customer acquisition management. Such a reporting system typically allows the organization to quantify the effectiveness of results

of various promotional activities. This allows organizations to realise continuous improvements in both promotional activities and customer acquisition systems.

Customer acquisition management creates an orderly architecture for managing large volumes of customer inquiries or leads. The architecture must be able to organize numerous leads, at various stages of a sales process, across a distributed sales force. In order to understand this process, it is helpful to examine a simplified linear lead flow process such as advertising and CRM, customer inquiry or response, inquiry captured, inquiry filtered, lead graded and prioritized, lead distribution, sales contact, lead nurturing or retention, sales result and analysis of promotions effectiveness.

■ Linking Profitability and Loyalty

Customers can be classified into the following by linking profitability and loyalty:

Butterflies: They are short-term customers having high profit potential. There is a good fit between a customer's offerings and a customer's needs.

Strangers: They are short-term customers having lowest profit potential. There is little fit between a company's offerings and a customer's needs.

Barnacles: They are long-term customers having low profit potential. There is a limited fit between a company's offerings and a customer's needs.

True friends: They are long-term customers having highest profit potential. There is a good fit between a customer's offerings and a customer's needs.

Bird's-eye view:

Customer Lifecycle Management, or CLM is the measurement of multiple customer related metrics, which, when analyzed for a period of time, indicate performance of a business. The four customer portfolios are: Invest, Nurture, Re-engineer and Sack.

■ Customer Lifecycle Management

Customer lifecycle management or CLM is the measurement of the CRM programme's success over time—providing a person with CLM metrics from before and after the CRM implementation. CLM is the measurement of multiple customer-related metrics, which when analysed for a period of time indicates performance of a business. The overall scope of the CLM implementation process encompasses all domains or departments of an organization, which generally brings all sources of static and dynamic data, marketing processes and value-added services to a unified decision supporting platform through iterative phases of customer acquisition, retention, cross and upselling and lapsed customer win-back.

In customer relationship management, customer lifecycle is a term used to describe the progression of steps a customer goes through when considering, purchasing, using and maintaining loyalty to a product or service. Marketing analysts Jim Sterne and Matt Cutler have developed a matrix that breaks the customer lifecycle into distinct steps—getting a potential customer's attention, teaching them what you have to offer, turning them into a paying customer and then keeping them as a loyal customer whose satisfaction with the product or service urges other customers to join the cycle. The customer lifecycle is often depicted by an ellipse, representing the fact that customer retention truly is a cycle and the goal of effective CRM is to get the customer to move through the cycle again and again.

Some detailed CLM models further breakdown these phases into acquisition, introduction to products, profiling of customers, growth of customer base, cultivation of loyalty among customers and termination of customer relationship. It might be useful to understand that each customer has certain stages in the lifecycle:

Contact phase: The goal of this phase is to gain a new customer. Contact has to be made through marketing, advertising, telemarketing, personal selling, direct mail, promotion and publicity.

Acquisition phase: The goal of this phase is to increase customer retention. Information must be collected about the customer and their purchase condition must be understood. They must be offered post purchase re-assurance and the price–value relationship must be promoted.

Retention phase: The goal of this phase is to create long-term and committed loyal customers. A service philosophy must be developed and responsiveness to customers must be increased.

Loyalty phase: The main objective goal of this phase is to extend customers loyalty. Loyalty, customer lifetime value and average net worth must be defined. The costs associated with loyalty must be analysed.

■ FRAMEWORK FOR BUILDING CRM STRATEGY

In competitive markets, even satisfied customers switch or defect to competitive offers. Since loyal customers are more profitable for any organization, there is a need to identify better predictors of loyalty. Indicators of relationship strength such as trust, satisfaction and commitment are better predictors of loyalty and by including these parameters in customer satisfaction surveys; managers can modify service delivery with a focus on customer loyalty. The psychological steps across relationship stages developed by Mookerjee⁶ are explained below.

Bird's-eye view:

The various psychological stages in CRM are: switching, satisfaction, trust, commitment and loyalty.

■ Switching

Switching is very common in the initial stages of a relationship process. A prospect that gets attracted by a company's marketing programme may try out its product or service offering and becomes a customer. However, the initial interactions and experiences determine whether the customer is willing to continue or not. In the cellular service industry, the first two weeks are the most crucial. Most customers need a lot of handholding, support and technical help to start using the service. If it is handled well, customers are likely to continue using the service.

■ Satisfaction

Satisfaction is a complex emotion, which depends on the offer characteristics, expectations and usage situation. Customers are satisfied when the performance of the product or service matches or exceed their expectations. Satisfied customers are more likely to continue their patronage. Therefore, satisfaction is an important intermediate step in the relationship building process and many of the satisfied customers will become clients.

■ Trust

Satisfaction over multiple interactions leads to a stage where the customer begins to have faith in the offering and its consistency in performance. Satisfaction leads to trust when some more antecedent conditions such as shared values and goals, dependence based on stable expectation/perception of performance and perceived switching costs are fulfilled. Trust is defined as the willingness to rely on an exchange partner in whom one has confidence. It exists when a party has confidence in an exchange partner's reliability and integrity and when they share common goals and values. The concept of trust is common among marketers in the packaged goods industry, which depends on trust to build brand loyalty.

■ Commitment

Commitment to a relationship is defined as an enduring desire to maintain a valued relationship. Therefore, commitment exists only when the relationship is considered important. It can be operationalized using the two dimensions: (1) attitude towards interacting with each other and (2) the formation of bonds.

Trust and commitment are key variables because they encourage marketers to work at:

- Preserving the relationship investments with partners/clients.
- Resist short-term gains that may be the lesser than expected benefits of staying on in the relationship.
- They view potentially high-risk actions as acceptable since they expect that partners will not act opportunistically.

■ Loyalty

Loyalty is not simply repeated buying. Loyalty includes future purchase intentions, price sensitivity, and referral behaviour (positive word of mouth). In terms of measurement of loyalty or loyalty related behaviour, typical questions would refer to:

- Intentions regarding the next purchase
- Whether a change in supplier would be considered with a particular level of increase in the prices
- The number and intensity of complaints
- The tendency to talk about the supplier to other clients
- The degree of desire to share positive experience also known as word of mouth

■ TEN TIPS TO BUILD CUSTOMER LOYALTY

The key to a successful business is a steady customer base. After all, successful businesses typically see 80 per cent of their business come from 20 per cent of their customers. Too many businesses neglect this loyal customer base in pursuit of new customers. However, since the cost to attract new customers is significantly more than to maintain a relationship with existing ones, efforts toward building customer loyalty will certainly pay off. Customer loyalty is a process, a programme or a group of programmes geared toward keeping a client happy so he or she will provide more business.

The following ten ways can build customer loyalty:

1. **Develop communication channels:** Communication must be constantly maintained with customers whether by e-mail, newsletter, monthly flyer, a reminder card for a tune up or a holiday greeting card.
2. **Provide customer service:** Staff must be trained to provide excellent customer service.
3. **Develop employee loyalty:** If a company is loyal to employees, they will feel positively about their jobs and pass that loyalty along to customers.
4. **Conduct employee training:** Employees must be employed in the manner that the company wants them to interact with customers.
5. **Offer customer incentives:** Customers must be offered a reason to return to the business. For instance, a dentist may give a free dental check up to anyone who has seen him regularly for three years.

Bird's-eye view:

Customer loyalty is a process, a programme or a group of programmes geared toward keeping a client happy so he or she will provide more business.

6. **Provide product awareness:** The company should be aware of the products purchased by regular customers and these items must be kept in stock.
7. **Reliability:** Be reliable. If something goes wrong, let customers know immediately and compensate them for their inconvenience.
8. **Be flexible:** Try to solve customer problems or complaints to the best of your ability.
9. **People over technology:** A personal touch must be provided to customers in all transactions.
10. **Know customer names:** Get to know the names of regular customers and try to understand their likes and dislikes.

■ MODELS OF CRM

We will discuss the following models of CRM in this section:

1. The IDIC Model
2. The Value Discipline Model
3. The Gartner Competency Model
4. The QCi Model
5. Payne's Five-Process Model
6. The Francis Buttle Model

 **Bird's-eye view:**

There are various models in the implementation of **CRM**. They are: The IDIC model, Value discipline model, The Gartner competency model, Payne's five process model, and The Francis Buttle's model.

■ 1. The Identify, Differentiate, Interact, Customize (IDIC) Model*

The IDIC model was developed by Peppers and Rogers. The model suggests that companies should take four actions in order to build closer one-to-one relationships with customers—Identify, Differentiate, Interact and Customize. Peppers and Rogers, the proponents of one-to-one marketing, proposed the IDIC framework to explain the process of converting existing customers into loyal customers. IDIC represents the following four key steps in the relationship building process.

Identify: This step requires the company to locate and contact a large number of its customers directly and know as much detail about them as possible. This includes their names, addresses, phone numbers, account details (wherever relevant), habits, preferences, etc.

Differentiate: Customers can be differentiated on the basis of the value they represent and also on their needs. The value represented is an indication of the customer's worth to the company—the more valuable they are, the more the company should be interested in retaining them. Although the easiest measure of value is the revenue contribution of the customer, this can become tricky if the cost to serve is high for the high revenue customers. Thus, the ideal measure of customer value is the profit contribution, which in many cases is difficult to measure as the cost to customers is difficult to isolate due to sharing of overheads and lots of common services. Some customers need very standard products and services while others have very specialized needs. Customers with specialized needs create opportunities for customization. Customization helps meet these needs. Differentiation should help the company tailor its offerings to each customer to reflect their values and needs.

Interact: The purpose of interaction is to learn more about the customers starting with the more valuable customers. These interactions can happen when the customer is making a

purchase, using a service or even while the customer is making a complaint. It can be done through formal surveys, telephone interactions or self-service channels like the web, call centres or ATMs in banking services. They should add on to the existing knowledge about the customer and this should be done in a cost-effective manner by using the lowest cost electronic channels. The learning relationship gets smarter with each interaction.

Customize: The last step is the most critical as it builds upon all the learning about the customers to offer real value to them by tailoring some aspects of the service related to a product or even mass customizing the product. When the customization is done on the basis of what the customer has indicated during his interactions, it improves the ability to fit the product and service to this customer's exact needs. This helps the customer enjoy a high level of convenience, which cannot be easily duplicated by a competitor without the customer having to put in the time and effort to teach the competitor the lessons already learned by his existing company.

■ 2. The Value Discipline Model⁸

Bird's-eye view:

The more the channels to access customers and more the number of touch points with customers, greater is the need for CRM installation.

There are different ways in which companies build relationships with their customers. What is the focus area of an organization and what has to be kept at an acceptable level has to be determined by the organization at the beginning based on the strengths of product and competition. Increasingly, as products become commoditized and margins shrink, with customers unwilling to pay for features, customer intimacy starts to play a critical role that competitors find difficult to replicate. Total customer experience becomes the key. Three major factors that influence the total customer experience are—external marketplace, company's brand image and the different ways in which the company touches a customer.

Most large international corporations are working out of this discipline. The value discipline model of Michael and Fred Wiersema describes three generic value disciplines. They are:

- **Operational excellence:** The focus is on development, innovation, design, time-to-market and high margins in a short time frame.
- **Product leadership:** The focus is on development, innovation, design, time-to-market, high margins in a short timeframe. Very strong in innovation and brand marketing and operating in dynamic markets.
- **Customer intimacy:** Excel in customer attention and customer service. Tailor products and services to individual or almost individual customers. The focus is on CRM, delivering products and services on time and above customer expectations, lifetime value concepts, reliability and being close to the customer.

A CRM strategy has to be evolved to enable an organization to gain a quick, accurate knowledge about customers and use it to increase the value of current customers, keeping them for longer periods and acquiring new customers more effectively. A CRM strategy takes direction and financial goals from the business strategy and aligns with the marketing strategy.

Bird's-eye view:

Improvement in customer relationships increases customer loyalty, decreases customer turnover, increases sales revenue, and decreases marketing costs, thus increasing profit margins.

■ 3. The Gartner Competency Model

This CRM model was developed by Gartner Inc., a leading IT research and advisory company and has a significance place in CRM research. Gartner defines CRM as a business strategy that maximizes profitability, revenue and customer satisfaction by organizing around customer segments, fostering behaviour that satisfies customers and implementing customer-centric processes. To achieve the long-term value of CRM, enterprises must understand that it is a strategy involving the whole business, and thus should be approached at an enterprise level.

CRM initiatives need a framework to ensure that programmes are approached on a strategic, balanced and integrated basis. The framework, called the eight building blocks of CRM, helps organizations see the big picture, make their business case and plan their implementation. The eight building blocks of CRM are given below:

1. **CRM vision:** Creating a picture of what the customer-centric enterprise will look like in order to build a competitive position based on value propositions that are defined, communicated and personified by the enterprise brand. The CRM vision mainly addresses leadership, market position and value proposition.
2. **CRM strategy:** Developing a strategy to turn the customer base into an asset by delivering customer value propositions. This includes setting objectives and determining how resources will be used to interact with customers. It addresses objectives, segments and effective interactions.
3. **Valued customer experience:** Ensuring that the enterprise's offering and interactions deliver ongoing value to customers and achieve the desired market position. It focuses on understanding requirements, monitoring expectations, satisfaction versus competition and customer communication.
4. **Organizational collaboration:** Changing cultures, organizational structures and behaviours to ensure that employees, partners and suppliers work together to deliver customer value. It deals with culture and structure, customer understanding, people skills and competencies, incentives and compensation, employee communication and partners and suppliers.
5. **CRM processes:** Effectively managing not only customer lifecycle processes (for example, welcoming new customers, handling inquiries and complaints and winning back lost customers), but also analytical and planning processes that build knowledge of the customer. The main CRM processes are customer lifecycle and knowledge management.
6. **CRM information:** Collecting the right data and routing it to the right place. It mainly deals with data analysis.
7. **CRM technology:** Managing data and information, customer-facing applications, IT infrastructure and architecture. It deals with applications, architecture and infrastructure.
8. **CRM metrics:** Measuring internal and external indications of CRM success and failure. The parameters for measurement are value, retention, satisfaction, loyalty, cost to serve and social costs.

■ 4. The QCi Model⁹

The QCi model is the product of a consultancy firm. The model's authors describe this model as a customer management model. The heart of this model depicts a series of activities that companies need to perform in order to acquire and retain customers. The model features people performing processes and using technology to assist in those activities.

■ 5. Payne's Five-process Model¹⁰

This model was developed by Adrian Payne. The model clearly identifies five core processes in CRM—the strategy development process, the value creation process, the multi-channel integration process, the performance assessment process and the information management process. The first two represent strategic CRM; the multi-channel integration process represents operational CRM; the information management process is analytical CRM.

Bird's-eye view:

CRM initiatives need a framework to ensure that programmes are approached on a strategic, balanced and integrated basis. The framework, called the eight building blocks of CRM, helps organizations see the big picture, make their business case and plan their implementation.

■ 6. The Francis Buttle Model¹¹ (CRM Value Chain)

The CRM value chain is represented by Francis Buttle's model. The model consists of five primary stages and four supporting conditions leading towards the end goal of enhanced customer profitability. The primary stages of customer portfolio analysis, customer intimacy, network development, value proposition development and managing the customer lifecycle are sequenced to ensure that a company with the support of its network of suppliers, partners and employees, creates and delivers value propositions that acquire and retain profitable customers. The supporting conditions of leadership and culture, data and IT, people and processes enable the CRM strategy to function effectively and efficiently.

Bird's-eye view:

CRM strategy is more about identifying critical relationships between the business goals and CRM implementation strategy: business processes, people and IT tools. It is about using appropriate methods and business processes to help improve your business relationships with your customers.

■ Implementation of CRM

The following factors need to be given due consideration to implement CRM:

- Easy interaction between customers and company, enhancing quick response to customer request and suggestions.
- Easy access to information about the company such as content of customization, advantages of the company, benefits doled out to the customers. This establishes profitable relationships with the customers based on mutual trust and respect.
- Abundant supply of customer information accumulated and integrated from different channels.
- Grow with customers, i.e. customer information should be updated along with the passage of time.
- Have a cordial relationship with other companies targeting the same customer segment.
- Customer information must be segmented to provide support for customization based on personalized information, i.e. tailoring the company's products and services accordingly.

Improvement in customer relationships increases customer loyalty, decreases customer turnover, increases sales revenue, and decreases marketing costs, thus increasing profit margins.

Box 15.3 Art of Building Customer Loyalty at Nokia

Nokia ventured into telecom in 1961, produced their first GSM mobile phone in 1991 and in 1998, became the world's number one mobile phone manufacturer.

Nokia has demonstrated its strong innovative streak in not just introducing phones and features like local language SMS, but also in marketing and distribution strategies. In order to fulfill its vision of continuous customer satisfaction, the company has introduced a wide range of phones with distinct features that meet the demands of most niche customer segments.

They have transformed the mobile telecom industry by spearheading the evolution of GSM, the world's most popular mobile telephony standard, and by extending the reach of mobile telephony far and wide across the globe. Nokia has tied up with HCL to distribute its phones in India. HCL has been able to use its strong distribution network and after-sales support to Nokia's benefit.

Nokia has been consistently focusing on building customer loyalty by focusing on the unique needs of its customers. An example is Nokia 1100, a low-cost and sturdy phone, designed exclusively for India, which went on to achieve iconic international success with over 200 million phones sold worldwide.

Source: Adapted from www.financialexpress.com, accessed April 2010.

The implementation of CRM across the organization is a long journey. Enhancing loyalty and profitability of existing customers and developing customized solutions for each customer is a capability that gets built over time. Box 15.3 discusses how multinational corporation Nokia has been highly successful in building a strong customer base.

CRM IN B2B AND B2C CONTEXT¹²

Companies that do not have repeat business from customers will not gain much from CRM. Then who benefits? The more the channels to access customers and more the number of touch points with customers, greater is the need for CRM installation. Companies benefiting from implementing CRM lie in the domains of banking, finance, insurance, airlines and hotels, telecommunications and health care.

A whole discipline of Business-to-Business (B2B) customer relationship management exists that is somewhat different from traditional consumer relationship management, Business-to-Consumer (B2C) CRM. The truth is that B2B CRM is probably older and more established than the consumer or B2C CRM, primarily because even before computers made it possible, sales representatives would keep records of individual contacts, because it was worth it to do so. There are seven basic differences between CRM in the B2C world and CRM in the B2B world.

First, in the B2B world, there are relationships within relationships. This is what is referred to when the contact is the actual person. There is a four-step methodology for building and managing relationships: identify customers; differentiate customers; interact with customers; and customize for customers. This is the “IDIC” model. In the B2B space, the “identify” task concerns itself a great deal with identifying the actual people within the business that have responsibilities for the decision. Those people might be decision makers themselves or they could be reviewers or approvers or influencers.

The second difference between relationship management within the B2C space and within in the B2B space is that in B2B you have just a few large customers, big organizations. This means that the statistical tools that are useful in B2C CRM are largely not relevant in B2B CRM.

The third difference is account development selling. Since organizations are complex, it is much more beneficial to think of a B2B company becoming a customer gradually. Efforts must be put in to develop the account and to make more contacts within the business-to-business organization.

The fourth difference is channel complexity. In the B2B world, the channel distribution process can be extremely complex.

The fifth difference is knowledge-based selling. Since the products and services sold in a B2B context are often highly complex, it is advantageous to base the sales process on educating and training the customers, much more so in B2B than in B2C CRM.

The sixth difference is infrequent purchases. In the B2B CRM world, purchases are likely to be more infrequent and farther between. This characterizes a lot of business to business operations. In many B2B companies, a large amount of effort is allocated in the CRM space to create a continuous service stream that surrounds the occasional sale of products, so that there are opportunities to maintain relationships with customers.

The final difference is that in the B2B space, it makes a great deal of sense to help clients manage themselves. If you’re selling to a business, one of the principal issues that any business is always wrestling with is, “How do I better manage my business?” If the customer relationship initiatives can be fashioned in such a manner that it enables the business to manage itself, it will lead to high value.

Bird's-eye view:

There is in fact a whole discipline of **Business-to-Business (B2B)** customer relationship management that is somewhat different from traditional consumer relationship management, **Business-to-Consumer (B2C)** CRM. There are seven basic differences between CRM in the B2C world and CRM in the B2B world.

Bird's-eye view:

Kaplan and Norton suggested that companies create **CRM scorecards** to measure CRM effectiveness. CRM is here to stay and will evolve. The desire to improve customer satisfaction and retention of customers will constantly drive the need to improve CRM systems.

■ CRM SCORECARDS

Kaplan and Norton suggested that companies create CRM scorecards to reflect: (1) customer outcomes, (2) internal business processes, (3) financial objectives and (4) learning and growth. This is almost identical to four categories of measures of CRM effectiveness: (1) CRM customer cycle, (2) company, (3) e measures (effectiveness, efficiency and employee satisfaction), (3) customer and company worth and (4) customer knowledge.

DISCUSSION FORUM

1. Which are the four ways in which customers behave?
2. How are customers classified based on profitability and loyalty?
3. Define the terms—CAM and CLM.
4. Which are the various psychological stages in CRM?
5. Name the various models in the implementation of CRM.
6. What are the types of companies that benefit from implementing CRM?
7. Distinguish between CRM in the B2C world and CRM in the B2B world.
8. How is the effectiveness of CRM measured?

■ ROLE OF IT IN CRM

CRM is more than just software. Information Technology (IT) in CRM has three key elements—customer touch points, applications and data stores.

Customer touch points are vital if the business has a marketing orientation and focuses upon the customer and his or her current and future needs. This is the interface between the organization and its customers. For example, when you buy a new car from a dealership, the dealership is a contact point. The salesperson is a contact point. You go home and look at the car manufacturer's Web site, and then send the company an e-mail. Both are contact points.

Applications are essentially the software and programmes that support the process. Applications serve marketing (for example, data mining software and permission marketing), sales (for example, monitoring customer touch points) and service (for example, customer care).

Data stores contain data on every aspect of the customer and the customer lifecycle (CLC). For example, an organization keeps data on the products you buy, when you buy them and where they are sent. Data is also kept on the web pages that you visit and the products that you consider, but then do not buy. Leads are stored here.

Data mining is where an organization evaluates large data stores for patterns, or relationships between groups or individuals (or segments). Applications present "patterns" in a format that can be used for marketing decision making.

Permission marketing is where a customer elects to accept (or "opt-in" to) marketing material from an organization. For example, when you buy insurance and the vendor asks if you wish to receive further details from them or similar organizations. It is called so because marketers need your "permission" to market to you. Permission marketing can occur at any of the customer touch points.

■ e-CRM¹³

Many companies have used the opportunities offered by the Internet to reduce customer-service costs, tighten customer relationships, further personalize marketing messages and enable mass customization. Along with the creation of Sales Force Automation (SFA), where electronic methods were used to gather data and analyse customer information, the Internet can be seen as the foundation of what we know as e-CRM today. We can define e-CRM as activities designed to manage customer relationships by using the Internet, web browsers or other electronic touch points.

Channels, through which companies can communicate with its customers, are growing by the day, and as a result, getting their time and attention has turned into a major challenge. One of the reasons e-CRM is so popular nowadays is that digital channels can create unique and positive experiences—not just transactions—for customers. An extreme example of the creation of experiences in order to establish customer service is the use of virtual worlds such as Second Life. Through this so-called e-CRM, companies are able to create synergies between virtual and physical channels and reaching a very wide consumer base.

Furthermore, Information Technology has helped companies to even further differentiate between customers and address a personal message or service. Some examples of tools used in e-CRM are:

- Personalized Web pages where customers are recognized and their preferences are shown.
- Customized products or services (Dell).

CRM programmes should be directed towards customer value that competitors cannot match. However, in a world where almost every company is connected to the Internet, e-CRM has become a requirement for survival, not just a competitive advantage. Box 15.4 discusses the e-CRM implementation at Aviva Life Insurance.

■ DIFFERENT LEVELS OF E-CRM

Three different levels can be distinguished in defining the scope of e-CRM:

- **Foundational services:** This includes the minimum necessary services such as Web site effectiveness and responsiveness as well as order fulfillment.

Box 15.4 e-CRM Implementation at Aviva

Aviva Life Insurance, which entered the market in 2002, has made a mark in the Indian insurance industry. The company has benefited enormously from the implementation of e-CRM in its operations.

Aviva decided to implement a CRM suite even before it commenced operations in India. The intention was to have a better interface with customers and to integrate its customer facing departments. It selected Talisma's e-CRM suite from among four other vendors after a stringent evaluation. All the modules except the chat module were implemented in a period of six months.

Talisma's e-CRM suite has been instrumental in helping the company launch new products and services to differentiate it from its competitors. It was able to share real-time customer information across different customer-facing departments across locations. This has helped departments track customer details and respond to queries at short notice. The company's sales and marketing operations have been integrated through the deployment of the e-CRM suite. Aviva is now able to modify its products and services to the tastes and requirements of customers.

Source: Adapted from Abhinav Singh, "Aviva Uses CRM to Insure Success," 12 April 2004, available at www.expresscomputeronline.com/20040412/ebusiness01.shtml.

Bird's-eye view:

CRM is more than just software. Information Technology (IT) in CRM has three key elements, namely Customer Touch Points, Applications, and Data Stores.

Bird's-eye view:

We can define e-CRM as activities to manage customer relationships by using the Internet, web browsers or other electronic touch points. Different levels of e-CRM are: Foundational services, Customer-centered services and value added services.

- **Customer-centered services:** These services include order tracking, product configuration and customization as well as security/trust.
- **Value-added services:** These are extra services such as online auctions and online training and education.

Self-services are becoming increasingly important in CRM activities. The rise of the Internet and e-CRM has boosted the options for self-service activities. A critical success factor is the integration of such activities into traditional channels. An example was Ford's plan to sell cars directly to customers via its Web site, which provoked an outcry among its dealers network. CRM activities are mainly of two different types—reactive service and proactive service.

Reactive service is where the customer has a problem and contacts the company. Proactive service is where the manager does not wait for the customer to contact the firm. The manager contacts the customer directly to establish a dialogue and solve problems.

Bird's-eye view:

Some of the benefits of CRM are: Enhanced customer loyalty, increased revenues, Better stand against global competition.

■ **Benefits of CRM**

The benefits of adopting CRM processes are:

- Develop better communication channels
- Collect customer related data
- Create detailed profiles of individual customers
- Increased customer satisfaction
- Access to customer account history, order information and customer information at all touch points
- Identify new selling opportunities
- Increased market share and profit margin and revenues
- Reduced costs of buying and using product and services
- Better stand against global competition

■ **CRM FUTURE**

CRM is here to stay and will evolve. The desire to improve customer satisfaction and retention of customers will constantly drive the need to improve CRM systems. The economy is now driven by customers and not by sellers as in the past. There are different type of customers, different types of business models and selling strategies. Technology will add more functional tools in CRM applications as there is more demand for knowledge management systems, sales coaching systems and service intelligence systems. Information today is in the form of maps, charts and graphs generated by report writers and visual profiling programmes. These will give way to voice activated and speech feedback tools and other elaborate visual aids using 3-D and CAD style graphics.

DISCUSSION FORUM

1. Which are the three key elements of IT in CRM?
2. Define the term e-CRM.
3. Name the different levels of e-CRM.
4. Discuss the benefits of CRM.

SUMMARY

- Quality begins with customers and ends with customers. The marketplace has become very competitive, and it is no longer possible to run a business without a very strong focus on the customer.
- Internal customers have to be served a motivating experience for them to replicate and carry out the same to the external customers. Customer focus has to be started with internal customers.
- The three dimensions of customer requirements identified by Kano are basic requirements, performance requirements and delight requirements. Customer satisfaction is the result of company processes, company employees who deliver products and services and customer expectations.
- CRM is a comprehensive strategy and a process of acquiring, retaining and partnering with selective customers to create superior value for the company and the customer.
- Developing customer relationships has historical antecedents going back into the pre-industrial era. In recent years, however, several factors have contributed to the rapid development and evolution of CRM. Another force driving the adoption of CRM has been the total quality movement.
- The various schools of thought on CRM are—the Anglo-Australian Approach, the Nordic Approach, the North American Approach and the Asian (Guanxi) Approach. The objectives of CRM are to simplify marketing and sales process, to make call centres more efficient, to provide better customer service, to discover new customers and increase customer revenue and to cross-sell products more effectively.
- CRM processes support the customer lifecycle. The basic steps of customer lifecycle are attracting present and new customers, acquiring new customers, serving the customers and finally, retaining the customers. CRM requires that a company develop a customer-centric business model (CCM). The applications of CRM are broadly classified into four types—strategic CRM, operational CRM, analytical CRM and collaborative CRM.
- The relationships between company and customers take time to build. These sequences and series of stages are often represented in the ladder of loyalty. The stages of ladder of loyalty are suspect, prospect, buyer, customer, frequent customer, loyal customer, advocate and partner.
- Berry and Parasuraman have identified four levels of bonding for CRM. They are—Level 1: Financial bonds, Level 2: Social bonds, Level 3: Customization bonds and Level 4: Structural bonds.
- A defection occurs whenever a customer switches to a competitor. Customer defection is the rate at which customers defect or stop the usage of the products of a company. Businesses with high defection rates would be losing their existing customers. The company should aim for zero defection, which aims at eliminating customer attrition.
- Customers who defect may be broadly classified as price defectors, product defectors, service defectors, market defectors, technology defectors and organizational defectors.
- Customer retention programmes are aimed to reduce customer defection. There are various steps in customer retention programmes and they are review mission statement, research your customer base, measure customer defection rates, stay in front of customers, take extra mileage, create a proprietary way of communicating or servicing customers.

- Chasing wallet share is getting a loyal customer base. It's six times easier and cheaper to get an existing customer to buy from a company again than it is to get a new customer (market share).
- Customer lifetime value (CLV) is the present value of the future cash flows attributed to the customer relationship.
- Customer value management (CVM) is managing each customer relationship with the goal of achieving maximum lifetime profit from the entire customer base. Customer value management enables companies to take full advantage of the economics of loyalty by increasing retention, reducing risk and amortizing acquisition costs over a longer and more profitable period of engagement.
- All customers are not equal and therefore not all of them should be treated equal. There exist various customer hierarchies that evaluate the involvement of the customer with the company.
- Customers behave in four different ways—apostles, terrorists/defectors, mercenaries and hostages. Based on profitability and loyalty, customers are classified as butter fliers, strangers, barnacles and true friends.
- Customer acquisition management (CAM) is a term used to describe the methodologies and systems to manage customer prospects and inquiries generated by a variety of marketing techniques.
- Customer lifecycle management or CLM is the measurement of multiple customer-related metrics, which when analysed for a period of time, indicate the performance of a business. The four customer portfolios are invest, nurture, re-engineer and sack.
- The various psychological stages in CRM are switching, satisfaction, trust, commitment and loyalty.
- There are various models in the implementation of CRM. They are—the IDIC model, value discipline model, the Gartner competency model, Payne's five-process model and Francis Buttle's model.
- The more the channels to access customers and more the number of touch points with customers, the greater is the need for CRM installation. Improvements in customer relationships increases customer loyalty, decreases customer turnover, increases sales revenue and decreases marketing costs.
- There are seven basic differences between CRM in the B2C world and CRM in the B2B world.
- CRM is more than just software. Information Technology (IT) in CRM has three key elements, namely customer touch points, applications and data stores.
- We can define e-CRM as activities to manage customer relationships by using the Internet, web browsers or other electronic touch points.
- Different levels of e-CRM are foundational services, customer-centered services and value-added services.
- Some of the benefits of CRM are enhanced customer loyalty, increased revenues and a better stand against global competition.
- Kaplan and Norton suggested that companies create CRM scorecards to measure CRM effectiveness. The desire to improve customer satisfaction and retention of customers will constantly drive the need to improve CRM systems.

Key Terms

Advocate 477	Financial Bonds 478
Analytical CRM 475	Foundational Services 497
Apostles 487	Francis Buttle's Model 494
Applications 470	Frequent Customer 477
Attractive Quality 467	Hostages 487
B2B 495	Lifetime Customer Value 483
B2C 495	Loyal Customer 477
Barnacles 488	Loyalty 490
Base Quality 467	Market Defectors 481
Basic Requirements 467	Market Share 470
Butter Fliers 488	Mercenaries 487
Buyer 476	Operational CRM 475
Buyer-Supplier Relationship 468	Organizational Defectors 481
Collaborative CRM 475	Partner 477
Commitment 490	Payne's Five-process Model 493
Company Processes 466	Performance Quality 467
CRM 470	Performance Requirement 467
CRM Scorecard 496	Price Defectors 480
Customer 466	Product Defectors 480
Customer Acquisition 487	Prospect 476
Customer Centric Business Model 474	Satisfaction 489
Customer Defections 480	Service Defectors 480
Customer Expectations 466	Social Bonds 478
Customer Focus 466	Strangers 488
Customer Lifecycle 474	Strategic CRM 474
Customer Lifecycle Management 488	Structural Bonds 479
Customer Lifetime Value 483	Suspect 476
Customer Retention Programmes 481	Switching 489
Customer Satisfaction 466	Technology Defectors 481
Customer Segmentation 487	Terrorists/Defectors 487
Customer Touch Points 496	The Anglo-Australian Approach 473
Customer Value Management 485	The Asian (Guanxi) Approach 473
Customer-centered Services 498	The CRM Value Chain 494
Customization Bonds 479	The Gartner Competency Model 492
Data Stores 496	The IDIC Model 500
Delight Requirements 467	The Ladder of Loyalty 475
Economics of CRM 482	The Nordic Approach 473
e-CRM 497	The North American Approach 473

True Friends 488	Value-added Services 498
Trust 489	Wallet Share 483
Value Discipline Model 492	Zero Defections 481

Case Study

Customer Relationship Management at Bharti

Bharti Tele-ventures is one of India's leading private sector telecom operators. Its cellular business, Airtel, is a leading mobile telephony brand. Like any telecom organization, Bharti considers information technology as a key business enabler. According to Amrita Gangotra, vice-president of Information Technology at Bharti, IT works as a support system as well as a key business driver.

The company has a wide area network (WAN) in place with a mix of leased lines and E1 and E3 lines. The company extends different applications to its dealers and partners through its extranet. The company also has procured a range of high-end servers from Sun and HP. The company also has a storage area network (SAN) in place because its daily storage requirements are in terabytes.

The main data centre is located in Gurgaon, Haryana. Bharti has procured billing, fraud management, revenue assurance and data warehousing software.

The Case for CRM

During the initial stages of its operations, the company's systems were run manually. Only 40 per cent of customer issues were getting resolved. The company decided to equip itself with tools that would help in resolving 90 per cent of its customer issues. The company decided to opt for a CRM solution to manage customer expectations and provide them with innovative products and services.

Oracle CRM Platform

Bharti wanted to fulfill its vision of providing the same quality of services anywhere and at any time. The company was particular that its customers should get the same quality of service no matter which of its call centres he or she contacts. It evaluated many options before choosing its centralized CRM tool. The factors considered were proper workflow automation, facilitation of knowledge sharing and integration with the billing system. After a thorough evaluation exercise, it decided to go ahead with the Oracle CRM platform.

Rolling Out

After the company started its operations in Delhi, it acquired many circles and sought new licenses in other circles. The CRM tool was implemented immediately whenever it obtained a new license. However, the company had to put in place a phased migration strategy in the acquired circles, which had an existing subscriber base. The migration had to be done in such a manner that the existing customer base did not suffer. The migration was completed in a phased manner by the first quarter of 2004. The biggest challenge for Bharti was to have a unified process in place. They also faced the challenge of imparting training. The company was successfully able to overcome the technical difficulties that it faced during implementation.

The CRM strategy at Bharti revolves around two aspects—operational CRM and analytical CRM. Operational CRM revolves around improving the workflow of call centres and

helping them in their day-to-day activities. Analytical CRM provides staff with the required information on customers and is used for business development.

The company has successfully used its CRM solution to provide products tailor-made to the needs of its customers. Thus, customers receive more value for money. Customers now have access to different schemes and services depending on airtime usage. Bharti has also managed to segregate its workflow with the help of the CRM tool.

Source: Adapted from “CRM Responsible for Magic at Bharti,” 5 January 2004, available at www.expresscomputeronline.com/20040105/ebusiness01.shtml.

For Discussion

1. Why did Bharti Tele-ventures opt for a CRM solution?
2. What were the challenges faced by Bharti in its CRM implementation process?
3. Discuss the strategy used by the company for implementing CRM and why.
4. Explain the various benefit received by Bharti after implementing CRM.

Short-answer Questions

1. Define customer focus.
2. Mention the factors responsible for customer satisfaction.
3. Name the three dimensions of customer requirements.
4. Define CRM.
5. Name the various schools of thought on CRM.
6. What is the purpose of CRM?
7. Define customer lifecycle.
8. Mention the various steps for implementing the customer lifecycle.
9. Name the various types of CRM applications.
10. Define ladder of loyalty.
11. Name the series of stages of ladder of loyalty.
12. Which are the four levels of bonding for CRM?
13. Define customer defections.
14. Define zero defections.
15. Name the various types of defectors.
16. What do you understand by the term customer retention programme?
17. Distinguish between “market share” and “wallet share.”
18. What is the equation for calculating the customer lifetime value?
19. Define customer value management.
20. Which are the four ways in which customers behave?
21. How are customers classified based on profitability and loyalty?
22. Define the terms—CAM and CLM.
23. Which are the various psychological stages in CRM?
24. Name the various models in the implementation of CRM.

25. Name the types of companies that benefit from implementing CRM.
26. Distinguish between CRM in the B2C world and CRM in the B2B world.
27. Which are the three key elements of IT in CRM?
28. Define the term e-CRM.
29. Name the different levels of e-CRM.
30. What are the benefits of CRM?
31. What is a CRM scorecard?

Match the Following

a. Suspect	The customer makes the first purchase
b. Prospect	Comes across company's promotion
c. Buyer	Makes additional purchases being satisfied with the company's offerings
d. Customer	Purchases products/services on a frequent basis
e. Frequent customer	Customer is resistant to switch, develops emotional attachment
f. Loyal customer	Involved in the decisions of the company
g. Advocate	Customer fits the target market profile
h. Partner	Satisfied with the company's offering and brings referrals

Discussion Questions

1. Explain customer-driven quality.
2. Draw and explain a schematic diagram of Kano's model of customer satisfaction.
3. Explain the guidelines for establishing a long-term partnership with suppliers.
4. "CRM is concerned with managing one's current customer base and is not concerned with the process of acquiring new customers." Comment.
5. What are the main challenges that companies encounter when trying to implement a CRM system?
6. How can companies develop various bonds with their customers?
7. In a B2B environment, how is CRM seen as the foundation of the sales function.

Projects

1. For a specific output of your department in an organization, sketch a simple flow diagram of the journey of the output throughout the organization. Then, prepare a list of the internal and external customers.
2. Compute your CLV at McDonald's, indicating all components and considerations.
3. Prepare a list of companies for which CRM systems would be extremely valuable. Also prepare a list of companies for which a CRM system would not have much value.

4. Identify a loyalty programme in a company and prepare a report on the impact of loyalty and benefits derived by the customer from this programme.
5. Select an organization, where you purchase products/services from and identify organization's touch points. Are they effective? Can they be improved? If so, why?

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TQM in Services



QUALITY SERVICES AT HOUSING DEVELOPMENT FINANCE CORPORATION LIMITED

TQM evolved out of applications in manufacturing companies such as Toyota, IBM, and Motorola. In the 1990s, service companies began to realize that they could benefit from quality management. This is important as the service sector is the largest segment of the US economy, employing almost three times as many people as manufacturing industries. The service sector covers a very wide spectrum of differentiated organizations such as health-care, education, banking, insurance, hotels, transport, and so on, to name a few. It involves a very large number of people in a variety of work processes.

Reserve Bank of India (RBI) is taking initiatives for implementing TQM practices in banking sector for improving and upgrading the professional skills of the employees. RBI also suggests different public sector banks and commercial banks to adopt TQM practices and implement the same for their employees. TQM practices can be adopted in banks which would be a successful strategy to meet the new challenges. In the service industries like banking, most of the basic operation involves direct interaction of the employees with the customers. The growth of a bank is heavily dependent on customer satisfaction, and due to the availability of varied options, customers can shift to other banks or any other financial institution in no time.

The Housing Development Finance Corporation Limited (HDFC) was amongst the first to receive an 'in principle' approval from the RBI to set up a bank in the private sector, as part of RBI's liberalization of the Indian Banking Industry in 1994. HDFC Bank began operations in 1995 with a simple mission, that is, to be a 'World-class Indian Bank'. HDFC Bank has a global presence and has been adjudged the winner in the Finance category and conferred the 'Quality Excellence Award for Best Customer Service Result' at The National Quality Excellence Awards-2013 programme in Mumbai presented by the Stars of the Industry Group and World CSR Day.

"The goal as a company is to have customer service that is not just the best, but legendary."

Sam Walton

Upon completion of this chapter, you will be able to:

1. Understand the similarities and differences between products and services
2. Explain the classification of services
3. Define service quality
4. Measure service quality
5. Discuss the various models used for improvements in service quality

■ INTRODUCTION

The service sector is an important sector in the world economy today. For instance, more than 60 million people work in the service industry in the USA. The more complex the international economy, the more the services needed to address problems in sectors such as law, health accounting and education, which are some professional service areas that parallel retail stores, financial institutions and charitable organizations.

The service sector is one of the important sectors for the social growth of a country. Globally, the service sector is the largest and fastest growing sector contributing to the global output and employing more people than any other sector. In alignment with global trends, the Indian service sector has witnessed a major boom and is one of the prime contributors to both employment and the national income in recent times. About 60 per cent of India's economy is largely driven by the service sector followed by the manufacturing sector and the agricultural sector. The Indian economy has moved from being an agriculture-based economy to a knowledge-based economy. The important service industries are Information Technology, Information Technology Enabled Services (ITES), Retailing, Financial Services, Banking, Insurance, Health care, Education, Media and Entertainment.

The TQM approach focuses on connecting the organization with the customer at every stage of the business process. The challenge of TQM in services lies in establishing smooth connectivity between business processes so as to retain the customer. Implementing an effective TQM mechanism in the service industry requires patience and commitment on the part of the management and the workforce to satisfy the customer.

Bird's-eye view:

The TQM approach focuses on connecting the organization with the customer at every stage of the business process. The challenge of TQM in services lies in establishing smooth connectivity between business processes so as to retain the customer.

Bird's-eye view:

Implementing an effective TQM mechanism in the service industry requires patience and commitment on the part of the management and the workforce to satisfy the customer.

 **Bird's-eye view:**

Service can be defined as “any primary or complementary activity that does not directly produce a physical product, i.e. the non-goods part of the transaction between the buyer (customer) and seller (provider).”

 **Bird's-eye view:**

Services and Products have similarities as well as differences. In services, how the service is provided is more important whereas in products, the customer considers what is being provided.

 **Bird's-eye view:**

“Quality” in a service organization is a measure of the extent to which the service delivered meets the customer’s expectations. One primary difference is that products are tangible and services are intangible. Another difference is that the manufacturing system is relatively closed, whereas the service system is relatively open.

 **Bird's-eye view:**

Service standards are more demanding because customers are becoming increasingly sensitive to quality. The focus has shifted from efficiently “manufactured” service items towards a more flexible model of responding to a more quality-sensitive customer.

■ SERVICE INDUSTRY AND QUALITY¹

Service can be defined as “any primary or complementary activity that does not directly produce a physical product, i.e. the non-goods part of the transaction between the buyer (customer) and seller (provider).” Quality has traditionally been related to the manufacturing industry. Due to the improvements in technology and automation over the last century, more and more of the workforce in both the developing and developed nations have shifted towards the service industry. This trend will continue. It is, therefore, important to understand the special characteristics of quality as applied to the service sector.

Services and products have similarities as well as differences. In services, how the service is provided is more important whereas in products, the customer considers what is being provided. “Quality” in a service organization is a measure of the extent to which the service delivered meets the customer’s expectations. The nature of most services is such that the customer is present in the delivery process. Table 16.1 illustrates the differences between manufacturing and service organizations. One primary difference is that products are tangible and services are intangible. Another difference is that the manufacturing system is relatively closed, whereas the service system is relatively open.

The challenge of business is to deal effectively with customers. Customer standards are usually transitory and changing. Identifying and controlling the factors that govern standards is very difficult. The challenge of service is translating customer needs such as timeliness, cleanliness and friendliness into service standards. Service is categorized as a variation of manufacturing. Many service organizations use the manufacturing model approach and profit by it. The fast food outlets epitomize the use of services by the manufacturing model—make the hamburger efficiently, with low skills and minimum pay, and then market it heavily. Fast food outlets like McDonald’s and Burger King concentrate on manufacturing meals. Marks & Spencer used a similar philosophy to manage its stores during the 1980s and is widely known as the “factory less manufacturer.”

The competitive advantage of service organizations lies in their quality leadership in the marketplace. How the front-line employee delivers the service is the major issue. For instance, all of three companies discussed above are fully aware of this trend and provide intensive training for their staff focusing on quality, service and delivery. Every employee at McDonald’s believes in service, cleanliness and value for money. The most important thing to know about intangible products is that the customers usually do not know what they are getting until they get it.

■ VALUE IN THE SERVICE INDUSTRY²

Like their manufacturing counterparts, most successful service organizations have adopted a new model since the 1980s. They shifted the emphasis from financially optimizing assets to customer satisfaction. The emphasis has shifted from emulating old-design manufacturing to making the core technology flexible, highlighting the key role of the front-line employee to satisfy customers.

Service standards are more demanding because customers are becoming increasingly sensitive to quality. The focus has shifted from efficiently “manufactured” service items towards a more flexible model of responding to a more quality-sensitive customer. At Rover Cars, they use the term “Extraordinary Customer Satisfaction” to express their focus on the customer. The system has moved from the closed system of the old-design organization to the open system of the new design, incorporating the customer’s requirements at the centre of their operations.

Table 16.1 Comparing Manufacturing and Service Characteristics

Manufacturing Industry	Service Industry
Products are transformed from materials	Services do not exist until they are provided when the customers request for them
They have physical dimensions and attributes, take up space in inventory, are depreciated and often wear out	They take up no space, cannot be inventoried and have no shelf life
Products can be evaluated against specifications and criteria	Service quality is evaluated against satisfaction of the customer
Customer needs and performance standards are easy to identify and measure	Customer needs and performance standards are often difficult to identify and measure because the customers define what they are, and each customer is different
The goal in manufacturing is uniformity	The production of services requires a higher degree of customization than does manufacturing
Manufacturing produces tangible, visible products.	The output of many service systems is intangible
Manufactured goods can be recalled or replaced by the manufacturer	Poor service can only be followed up by apologies and reparations
Manufactured goods are produced prior to consumption. Goods can be stored, inventoried, or inspected prior to delivery	Services are produced and consumed simultaneously. Many services must be performed at the convenience of the customer. Services cannot be stored, inventoried or inspected prior to delivery. Much more attention must be paid to training and building quality into services as a measure of quality assurance
Manufacturing is performed away from the customer	Customers are often involved in the service process and are present while it is being performed
Manufacturing is more capital intensive	Services are generally labour intensive
Total quality principles are easy to apply	Total quality principles are difficult to apply

Quality processes are directly related to value. The value-added approach can be either explicit or implicit. Explicit value can be measured and can be clearly defined or visible. Implicit value is not easily converted to currency and is related to perceived performance needs or image.

Table 16.2 lists the five ways in which an organization such as a restaurant can incorporate quality into its service. Strategic resource allocation in the organization determined to meet/exceed customer needs will enable a careful design and flawless delivery of the service. Such a strategy limits, if not eliminates the need for resource allocation for inspection and fixing activities.

Many organizations work hard to design quality and think through delivery barriers. For example, the Ritz Hotel builds quality into its operations by allocating major resources to service recovery. It recognizes that its customers will not come back if Ritz makes errors. At Safeway Superstores, they guarantee “Refund and Replace.” If their customer finds defects in the goods purchased, an appropriate substitute plus a full refund is provided.

 **Bird's-eye view:**
Quality processes are directly related to **value**. The value-added approach can be either explicit or implicit. Explicit value can be measured and can be clearly defined or visible. Implicit value is not easily converted to currency and is related to perceived performance needs or image.

Table 16.2 Building Quality in Service Organizations

Quality Points	Service Organizations
Design it in	Heavy emphasis on service re-designs on meeting changing needs and constant revision of service attributes. Provide low-fat food to health-conscious customers and monitor changes in taste
Build it in	This refers to the service delivery. The customer is part of this setting. The front-line person is a major player. A dinner is cooked and served according to the customer requirements
Inspect it in	Inspection occurs during the delivery of the service. This function is minimized in the new-design setting. The responsibility for quality rests with the cook and the attending steward
Fix it in	In the new-design organization, 100 per cent satisfaction is guaranteed. If not satisfactory, the meal must be immediately replaced to satisfy the customer
Educate it in	Inform the customers about the changes and the benefits. Introduce the new food range (see the first point above)

DISCUSSION FORUM

1. Explain the relevance of TQM in the service industry.
2. Discuss the differences between manufacturing and service industries.
3. Explain how to deliver value in the service industry.

Bird's-eye view:

In the service process matrix, the **Services** are categorized into four categories. They are: service factory, service shop, mass service and professional service. This matrix considers one variable, which is the degree of interaction and customization.

■ CLASSIFICATION OF SERVICES

Schmenner³ categorized services into four categories in the service process matrix as shown in Figure 16.1. The four categories are named service factory, service shop, mass service and professional service. This matrix considers one variable, which is the degree of interaction and customization. The services categorized in service shop and professional services fall within a high degree of interaction and customization.

For example, in professional services provided by lawyers, every lawsuit involves different sections of the law and has its own unique points to be considered. In hospitals, every patient has a unique problem and the doctor has to provide a customized prescription for the problem. Similarly, in auto repair shops, every vehicle coming for service has unique repair requirements.

There are two types of parameters considered in the service process matrix. The first parameter is the degree of interaction and customization and the second parameter is the degree of labour intensity. The degree of labour intensity is measured by the ratio of labour cost to capital cost.

The services categorized under service factory and mass service have a low degree of interaction and customization. For example, airlines provide very few options to the passengers—the business class and economy class of services. The customers are rarely provided with customized services. The menu service onboard has mainly two options—non-vegetarian and vegetarian. Similarly, in schools, every student in a class is given the same standard treatment and education.

Fig. 16.1 The Service Process Matrix

		Degree of interaction and customization	
		Low	High
Low degree of labour intensity	Service factory	<ul style="list-style-type: none"> • Freight services • Hotels, inns and motels • Airline services • Amusement parks 	<ul style="list-style-type: none"> • Auto/electronic service centres • Hospital and nursing homes
	Mass service	<ul style="list-style-type: none"> • Schools and colleges • Retail shops • Wholesalers and distributors • Selling of insurance policies 	<ul style="list-style-type: none"> • Specialist doctors • Lawyers and tax consultants • Financial consultants • Engineers and architects
High degree of labour intensity	Service shop		

Mass service and professional services have a high degree of labour intensity. For example, services provided by architects, accountants, etc. The cost of capital is low since there is no requirement for costly equipment. A team of professionals may be involved, thereby accounting for high labour costs.

Service factories and service shop have a low degree of labour intensity. For example, in the airlines industry, the cost of capital required is quite high as the cost of equipment is very high compared to labour costs. In the case of hospitals also, the cost of equipment such as X-ray machines, pathology labs, surgical equipment, CAT scan machines, etc. is very high compared to the cost of labour.

From the point of view of service quality, it is easier to manage the category of services coming under the service factory as these involve a low degree of labour intensity as well as a low degree of interaction and customization, while it is most difficult to manage the service quality of the professional services category, which involves a high degree of interaction and customization and a high degree of labour intensity. For service shop and mass services that involve a low-high combination of the two variables in the matrix, service quality management has a moderate level of difficulty.

■ DEFINING SERVICE QUALITY

Quality is much easier to define when manufacturing tangible products. Manufacturing quality may simply involve conformance to specifications. A manufacturer can evaluate the level of a product's quality based on what was produced relative to the design specifications. A defect occurs when a product fails to meet set specifications. The specifications come from product engineers who may be designing the product based on what market research data show that customers want. It may also come from some other type of communication that indicates customer wants and needs.

In services, evaluating the level of quality is much more elusive. Quality specifications for services come from multiple sources simultaneously, and these include the company and the individual customers. The company presents specifications as standard operating procedures.

Bird's-eye view:

Service quality is often defined as the satisfaction of customer expectations. **Service quality** is an achievement in customer **service**. It reflects at each **service** encounter. Customers form **service** expectations from past experiences, word of mouth and advertisement.

 **Bird's-eye view:**

Service Quality can thus be defined as the difference between customer expectations; of the service and the perceived service. If expectations are greater than performance, then perceived quality is less than satisfactory and; hence, customer dissatisfaction occurs.

Customers present specifications based on their personal expectations of what their service experience will be. Misalignment between company and customer specifications for the service process leads to dissatisfaction, even when the process goes exactly as it was designed. The misalignment of specifications can be avoided through communication. However, if the service performance does not address individual customer needs, the customer will not require the service.

Service quality is often defined as the satisfaction of customer expectations. One of the basic concepts of the TQM philosophy is continuous process improvement. This concept implies that there is no acceptable quality level because the customer's needs and expectations are constantly changing and becoming more dependent.

Service quality can thus be defined as the difference between customer expectations; of the service and the perceived service. If expectations are greater than performance, then perceived quality is less than satisfactory and; hence, customer dissatisfaction occurs.

An American Society for Quality survey on end-user perceptions of improvement factors that influenced purchase showed the following rankings.

- Performance
- Features
- Service
- Warranty
- Price
- Reputation

The factors of performance, features, service and warranty are part of the product or service quality. Therefore, it is evident that product quality and service are more important than the price. Organizations that focus on improving the quality of service succeed in the long run. Box 16.1 discusses service quality at Kingfisher Airlines.

Box 16.1 Service Quality at Singapore Airlines (SIA)

Singapore Airlines is a global company dedicated to providing air transport services of the highest quality. Singapore Airlines (SIA) is consistently recognized as the world's best airline. It is regularly voted for 'best business class', 'best cabin crew service', 'best in-flight food', 'best for punctuality and safety', 'best for business travellers', 'best air cargo carrier', and 'Asia's most admired company'. As well as being the 'best', SIA is also one of the most profitable airlines. The company's senior management explains how their customer service advantage has been maintained, revealing that customer satisfaction need not necessarily be traded off for profitability.

What really helps the airline stand apart is not the seats or the food or even the entertainment (though it has all that), but the service it provides for its customers. People who work for the airline are trained to treat passengers with respect and care—something that is increasingly unusual these days. Profitable every year since the beginning, Singapore Airlines (SIA) frequently wins international awards for top customer service and in-flight quality. Here's how they do it:

1. Clarity and commitment
2. Continuous training
3. Career development
4. Internal communication
5. Consistent external communication
6. Connection with customers

7. Benchmarking
8. Improvement, investment, and innovation
9. Rewards and recognition
10. Professionalism, pride, and profits

Source: Adapted from www.airlinequality.com/airline-reviews/singapore-airlines accessed July 2016.

■ Performance

Performance involves “fitness for use.” This indicates that the product and service is ready to be used by the customer at the time of sale. Other considerations are:

- Availability, which is the probability that the product will operate when needed.
- Reliability, which is freedom from failure over time.
- Maintainability, which is the ease of keeping the product operational.

■ Features

The identifiable features or attributes of a product or service are psychological, time-oriented, contractual, ethical and technological. Features are secondary characteristics of a product or service. For example, the primary function of an automobile is transportation whereas the stereo system fitted in a car is a secondary characteristic and is termed a feature.

■ Service

Services are emphasized to give customers added value. Customer service is intangible and cannot be quantified. It is easier to achieve product excellence than provide excellent customer satisfaction.

■ Warranty

The warranty of a product represents a commitment to guarantee a level of service sufficient to satisfy the customer. The warranty of a product represents an organization's public promise of product quality with a guarantee to give customer satisfaction.

■ Price

Today's customers are willing to pay a higher price to obtain value. Customers are constantly evaluating the products and services of an organization against those of its competitors to determine who provides the greater value. However, in our highly competitive environment, each customer's concept of value is continuously changing. Everyone having contact with the customer must make ongoing efforts.

■ 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 and not just the product. Customers are willing to pay a premium for a trusted brand name, which often becomes part of a customer's life. It cost five times more to win over new customers than it does to retain an existing customer. An effective marketing retention strategy is achieved through the use of feedback gathered using information-collecting tools.

Bird's-eye view:

According to an **American Society for Quality** survey on end-user perceptions of improvement factors that influenced purchase in the order of preference are: Performance; Features; Service; Warranty; Price and Reputation.

 **Bird's-eye view:**

Employees and information technology are the two main components of the service quality system.

■ Components of Service Systems Quality

Many service organizations such as hotels, airlines, banks and financial services have well-developed quality systems. Employees and information technology are the two main components of the service quality system.

Employees: Motivated employees are the key to improved services. The service quality systems begin with a commitment to the customers. Customers evaluate a service primarily by the quality of human contact. Research has demonstrated that when a service employee's job satisfaction is high, customer satisfaction is high, and that when job satisfaction is low, customer satisfaction is low. Many service companies act on the motto "If we take care of our employees, they will take care of our customers." For example, ICICI OneSource is able to improve service quality because of its focus on employee recruitment, training and promotion programmes.

The Taj group of hotels is a service company with an exemplary focus on its people. All employees are treated just as guests would be treated. The company's focus is on developing a skilled and empowered workforce operating with joy and pride by ensuring that everyone knows what they are supposed to do, by monitoring how well they do it and by providing the authority to make changes as necessary.

Information technology: Information technology is essential for quality in modern service organizations because of the high volumes of information they must process and because customers demand service at ever-increasing speed. Information technology incorporates computing, communication, data processing and various other means of converting data into useful information. The intelligent use of information technology not only leads to improved quality and productivity, but also to competitive advantage, particularly when technology is used to better serve the customer and to make it easier for customers to do business with the company.

Many service industries exploit information technology to improve customer service. One way of gaining a competitive edge is by differentiating the services provided to customers. For example, there has been a tremendous improvement in the service levels of banks after the advent of ATMs and online banking services. Oberoi Hotels has used IT effectively to improve service quality. IT has been used to create a database of all their guests and their preferences. The knowledge about individual customer preferences, difficulties encountered during their previous stays, details about the family and personal interests and preferred credit cards is stored in the database accessible to every hotel in the group. This guest profiling system allows each customer to be treated as an individual, and it gives front-desk employees immediate access to information such as whether the guest smokes, whether he or she prefers scented or unscented soap and what kind of pillow he or she prefers.

■ Dimensions of Service Quality

Customers do not perceive quality in a one-dimensional way, but rather judge quality based on multiple factors relevant to the context. There are five specific dimensions of service quality that apply across a variety of service contexts; they are reliability, responsiveness, assurance, empathy and tangibles. These are explained below:

Reliability: It is defined as the ability to perform the promised service dependably and accurately. Reliability means that the company delivers on its promises about providing service, delivery, pricing and problem resolution. Customers want to do business with companies that keep their promises, particularly promises about the service outcomes and core service attributes.

Responsiveness: This dimension emphasizes attentiveness and promptness in dealing with customer requests, questions, complaints and problems. It is the willingness to help customers and to provide prompt service. Responsiveness is communicated to customers by the length of time they have to wait for assistance, or answers to questions or attention to problems. It also captures the notion of flexibility and ability to customize the service to customer needs.

In order to excel in the dimension of responsiveness, a company must be certain to view the process of service delivery and the handling of requests from the customers' point of view rather than from the company's point of view. To distinguish themselves on the responsiveness front, companies need responsive front-line people in all contact positions and well-staffed customer service departments.

Assurance: It is defined as employees' knowledge and courtesy and the ability of the firm and its employees to inspire trust and confidence. Assurance is likely to be particularly important for services that the customer perceives as involving high-risk and/or about which they feel uncertain with regard to their ability to evaluate outcomes. For example, medical, banking, insurance, brokerage and legal services.

In case of a professional service provider, a visible evidence of degrees, honours and awards and special certifications may give a new customer confidence in a professional service provider. In case of insurance companies, trust and confidence are embodied in the organization itself. In case of insurance agents, securities brokers or counselors, public relations officers, the company seeks to build trust and loyalty between key contact people and individual customers. In this case, trust and confidence is embodied in the person who links the customer to the company.

Empathy: It is defined as the caring, individualized attention that the firm provides to its customers. The essence of empathy is conveying, through personalized or customized service, that customers are unique and special.

Tangibles: It is defined as the appearance of physical facilities, equipment, personnel and communication materials. These provide physical representations or images of the e-service that new customers and existing customers will use to evaluate quality. Although tangibles are often used by service companies to enhance their image, provide continuity and signal quality to customers, most companies combine tangibles with another dimension to create a service quality strategy for the firm.

■ Process of Service Quality Management

1. Setting the right standard: It is necessary to have the right standard for service quality or else the quality assurance process will deliver inappropriate levels of service. Quality standards are not just related to manufacturing, but cover all other functions.

2. Implementing quality service: The implementation process involves total commitment from all the levels of the organization. Team efforts play an important role. Effective implementation of service quality is possible through excellent internal programmes such as TQM.

3. Monitoring service quality: Some of the tools and techniques that are used to monitor service quality are statistical tools, quality function deployment, internal performance analysis and customer satisfaction analysis.

Box 16.2 discusses the measures taken by Meenakshi Mission Hospital and Research Centre to ensure service quality.

Bird's-eye view:

There are five specific dimensions of **service quality** that apply across a variety of service contexts; they are reliability, responsiveness, assurance, empathy and tangibles.

Box 16.2 Service Quality Department at MMHRC

Meenakshi Mission Hospital and Research Centre (MMHRC) is the first hospital in India to set up a service quality department. The organization is focused towards patient care. Some of the quality-conscious approaches adopted by the hospital are:

Quality Management System

Customer satisfaction and continual improvement are given priority with ISO 9001:2000 set objectives. Around 115 departments are audited once every four months.

Feedback Solutions

The hospital has a feedback system in place to measure the quality of service rendered. Feedbacks are important tools to measure the services rendered. The ward secretaries administer a prescribed format when the patient is discharged after their stay at MMHRC. The quality service department analyses and interprets customer satisfaction and amicably resolves the customer complaints. Minimization of customer complaints and speedy remedial actions are the quality parameters set for this department.

Kaizen Day

A “Kaizen day” is organized once in four months. The main reason for the Kaizen day is to celebrate quality failures through well-enacted role-plays, which are powerful tools to change attitudes. Employees are encouraged to discuss the root causes for failures in detail to prevent such happenings in future. Various awards such as Extra mile, Best Employee and Spark Master Award are given to the employees.

Thank you Board

The appreciation given by the patients are posted on a wall named the “Thank you wall.” This is an important source of motivation for the employees.

Source: Adapted from www.meenakshimission.org, accessed July 2016.

 **Bird's-eye view:**

A variety of tools are available to determine **customer expectations**. Some of them are customer satisfaction surveys, employee feedback, focus groups, toll-free telephone numbers, report cards and the Internet.

■ Tools Used for Determining Customer Expectations

A variety of tools are available to determine customer expectations. Some of them are customer satisfaction surveys, employee feedback, focus groups, toll-free telephone numbers, report cards and the Internet. They are explained below:

Customer satisfaction survey: Customers are essential for the survival of businesses. The best way to find out whether customers are satisfied is to ask them. Organizations need to retain existing customers while targeting new customers. Measuring customer satisfaction provides an indication of how successful the organization is at providing products and/or services to the market. The best time to conduct a customer satisfaction survey is when the experience is fresh in their minds. The following questions may be asked:

- How satisfied are you with the purchase you made (of a product or service)?
- How satisfied are you with the service you received?
- How satisfied are you with our company overall?
- How likely are you to buy from us again?
- How likely are you to recommend our products/services to others?
- How likely are you to recommend our company to others?

There are many ways to ask customers whether they are satisfied with the company, its products, and the services they have received. Customers can be met face-to-face, they can be called on the phone and they can be mailed a questionnaire, etc.

An effective customer satisfaction survey programme should focus on measuring customer perceptions of how well the company delivers on the critical success factors and dimensions of the business. These usually include factors such as service promptness, staff responsiveness and an understanding of the customer's problem.

The most important thing about conducting a customer satisfaction survey is what the company does with the data collected. Key driver analysis is the study of the relationships among many factors to identify the most important ones. Key driver analysis has many applications. One of the most common is in the area of customer satisfaction and loyalty.

The answers obtained from different customers must be compiled. The company needs to look for trends and differences by region and/or product. The most important thing is to act on the information. The company needs to fix the things the customers have complained about, investigate their suggestions, and improve itself and its products in those areas that mean the most to the customers. The company also needs to give feedback to the customers stating that their answers were appreciated.

Employee feedback: Employees are often an untapped source of information. Employees can offer insight into conditions that inhibit service quality in the organization. Although customer research reveals what is happening, employee research reveals why it is happening. Employee feedback should be proactively solicited.

Focus groups: A focus group is a research method used to find out what the customers are really thinking. A group of customers is assembled in a meeting room to answer a series of questions. A skilled moderator, who probes into the participants' thoughts, ideas, perceptions, or comments, asks carefully structured questions. The moderator has a clear understanding of the type of information wanted and a plan for obtaining it. Meetings are designed to focus on current, proposed and future products and services. The people selected to participate have the same profile as the customers that the organization is trying to attract. As an incentive to participate, these people are reimbursed for their time. Focus groups are sometimes used internally in organizations to examine internal issues.

Toll-free telephones numbers: Toll-free service phone 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 have decided not to buy the product or those who have discovered some likable features in a competitor's product.

Report card: The report card is a very effective information-gathering tool. It is usually sent to each customer on a quarterly basis. The data are analysed to determine areas for improvement.

The Internet: 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. News groups, electronic bulletin boards and mailing lists can be scanned using key word searches, if one knows that a company's product is of interest to participants in certain activities, hobbies or professions. Ideally, messages that compare a company's products with those of its competitors can be uncovered. Though it can be a source of creative ideas, one of the drawbacks of monitoring Internet conversations is that the conversations can be unfocussed.

Bird's-eye view:

There are many ways to ask **customers** whether they are satisfied with the company, its products, and the services they have received. Customers can be met face-to-face, they can be called on the phone and they can be mailed a questionnaire, etc.

DISCUSSION FORUM

1. Define service quality.
2. Which are the four categories of service quality?
3. Which are the factors that influence the customer's buying decisions?
4. Name the steps involved in the service quality management process.
5. Which are the tools used for determining customer expectations?

Bird's-eye view:

SERVQUAL, later called **RATER**, is a quality management framework. SERVQUAL was first published in 1977 by Valarie Zeithaml, A. Parasuraman & Leonard Berry to measure quality in the service sector.

■ THE SERVQUAL MODEL

Measuring the quality of a service can be a very difficult exercise. Unlike products where there are particular specifications such as length, depth, width, weight, colour, a service can have numerous intangible or qualitative specifications. In addition, there is the expectation of the customer with regard to the service, which can vary considerably based on a range of factors such as prior experience, personal needs and what other people may have told them.

SERVQUAL⁴ is the most popular method of service quality measurement in almost all the service industries. Service quality and satisfaction with the services provided are best understood when services are viewed via the Gaps Model of service quality. The model essentially points out the mismatch between the way customers perceive service quality and the way the service provider interprets/perceives customers' expectations of service quality (Gap 1). This mismatch, when coupled with improper service designs and standards (Gap 2), inadequate service delivery (Gap 3) and mismatched external communication (Gap 4) adds up to total customer dissatisfaction (Figure 16.2).

Thus, essentially, service quality can be understood only by customer expectations and not by any other methodology. Services are intangible, perishable, inseparable and variable. Measurement of service quality requires models and methods that examine the various biases that come with human interaction.

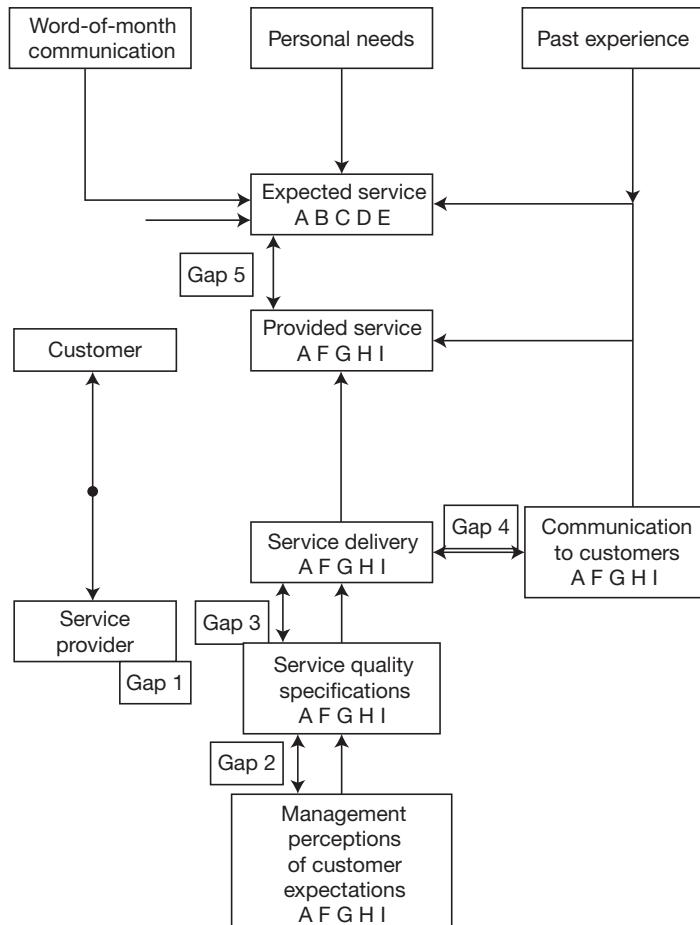
Many service providers suffer from false illusions that they are giving the best service to the customers. They overlook the fact that there is always the threat of a competitor who might provide better services at a lesser cost. Customers can always switch over to new service providers as services are not like products, which tend to create loyalty. Consumers falling under the laggard category far exceed the consumers who are first movers and innovators. It is difficult for them to abandon their cherished products.

Services tend to be more homogeneous and can be easily switched over to, if a better service is offered. Service companies for the same reason use positioning strategies that focus more on intangible benefits and associations that a customer relates to when using their services. For example, a restaurant manager knows that customers need not come to his restaurant every time as people tend to try out different places to eat. Thus, he has to think out of the box to retain the customers.

The concept of service quality gaps and SERVQUAL is an effective approach to study and analyse the differences between customer expectations and perceptions. Service specification form an integral part of the Service Quality (SERVQUAL) conceptual model shown in Figure 16.2. This model measures tangible and intangible service elements. It investigates discrepancies or gaps in the customer-supplier chain to highlight target areas where quality may be improved. The model shows that the customer expected service A-B-C-D-E, but at the end, as a result of the five gaps in the operations received A-F-G-H-I instead.

Valarie A. Zeithaml, A. Parasuraman and Leonard L. Berry propounded a model of service quality popularly known as the "Gap Model" in 1985. This model has five gaps between

Fig. 16.2 Conceptual Model of Service Quality (SERVQUAL)



various elements in the design and delivery of a service. These gaps are the discrepancies or hurdles in the ultimate customer satisfaction. They are explained below:

Gap 1: Customers' expectations versus management perceptions: This gap exists due to differences between consumer expectations and management perceptions of consumer expectations. This results from the lack of a marketing-research orientation, inadequate upward communication and too many layers of management.

Gap 2: Management perceptions versus service specifications: This gap exists due to differences between management perceptions of consumer expectations and service quality specifications. This is a result of inadequate management commitment to service quality, a perception of unfeasibility, inadequate task standardization and an absence of goal setting.

Gap 3: Service specifications versus service delivery: This gap exists due to differences between service quality specifications and the service actually delivered. These result from role ambiguity and conflict, poor employee-job fit and poor technology-job fit, inappropriate supervisory control systems, lack of perceived control and lack of teamwork.

Bird's-eye view:

SERVQUAL is the most popular method of service quality measurement in almost all the service industries. Service quality and satisfaction with the services provided are best understood when services are viewed via the Gaps Model of service quality.

Gap 4: Service delivery versus external communication: This gap exists due to differences between service delivery and what is communicated about the service to consumers. This is as a result of inadequate horizontal communication and propensity to over-promise.

Gap 5: The discrepancy between customer expectations and their perceptions of the service delivered: This gap exists due to the differences between consumer expectations and perceptions. These result from the influences exerted from the customer's side and the shortfalls (gaps) on the part of the service provider. In this case, customer expectations are influenced by the extent of personal needs, word of mouth recommendations and past service experiences.

Valarie A. Zeithaml, A. Parasuraman and Leonard L. Berry also suggest that the criteria used by consumers, which are important in moulding their expectation and perceptions of service fit ten dimensions:

👁 Bird's-eye view:

The **SERVQUAL** instrument has been the predominant method used to measure consumers' perceptions of service quality. **SERVQUAL** is a questionnaire designed to measure the gap between the expectations and perceptions of a customer from a particular service. This questionnaire has the five categories: tangibles, reliability, responsiveness, assurance and empathy.

1. **Tangibles:** Physical evidence.
2. **Reliability:** Getting it right the first time and honouring promises.
3. **Responsiveness:** Willingness, readiness to provide service.
4. **Communication:** Keeping customers informed in a language they can understand.
5. **Credibility:** Honesty and trustworthiness.
6. **Security:** Physical, financial and confidentiality.
7. **Competence:** Possession of required skills and knowledge of all employees.
8. **Courtesy:** Politeness, respect and friendliness.
9. **Understanding:** Knowing the customer, his needs and requirements.
10. **Access:** Ease of approach and contact.

These ten dimensions vary with respect to how easy (or difficult) it is to evaluate them. Some such tangible factors are known in advance, but most are criteria related to experience and can only be evaluated during or after consumption. Some factors such as competence and security may be difficult or impossible to evaluate, even after purchase. In general, customers rely on experience when evaluating services.

The SERVQUAL instrument has been the predominant method used to measure consumers' perceptions of service quality. SERVQUAL is a questionnaire designed to measure the gap between the expectations and perceptions of a customer from a particular service. This questionnaire has the following five categories—tangibles, reliability, responsiveness, assurance and empathy.

In the SERVQUAL instrument, 22 statements measure the performance across these five dimensions, using a seven-point Likert Scale measuring both customer expectations and perceptions. It is important to note that without adequate information on both the quality of services expected and perceptions of services received, feedback from customer surveys can be highly misleading from both a policy and an operational perspective. The following section discusses the application of the SERVQUAL approach in education.

■ SERVQUAL Applications in Education

Higher educational institutions have a multiplicity of customer's expectations and perceptions to consider. Teaching and learning plans for each individual module need to specify the aims and objectives, purpose, credit value and module level, weekly syllabus, delivery format, assessment format and reading list.

The benefits of service specification are wide reaching and are significant to all stakeholders. The stakeholder's concept is important for service quality. The stakeholders in the case

of higher educational institutions are students, parents, sponsoring employers, and employers of graduates, government bodies, franchise colleges, exchange colleges, academic staff, management, administration, professional bodies and other educational institutions. The five gaps in accordance with the SERVQUAL model are:

Gap 1: Between customers' expectations and management's perceptions of customer's expectations: An example of this gap are courses requiring hands-on experience—such as computing and design—where students may, erroneously, expect a greater emphasis on practical and technical study at the expense of academic rigour.

Gap 2: Between management's perceptions of customers' expectations and service quality specifications: Here, both students and future employees are customers of the educational system. Students' lack of understanding and employees' particular focus and requirements may bias or limit the expectations of both.

Gap 3: Between service quality specifications and service delivery: In a modular system, it is not uncommon for a module to be designed by one member of the academia and taught by another member who may apply his/her interpretation or expertise to deliver to the specification. The contents of the module must be regularly reviewed and its continuous improvement should be encouraged.

Gap 4: Between service delivery and external communications to customers: In order to identify and minimize a chance of occurrence of this gap, it is necessary to develop a two-way informal and formal communication method and feedback system between the academic institution and students.

Gap 5: Between customers' expectations and perceived service: Students who use workshops, laboratory and studio facilities during peak hours may perceive that facilities are inadequate. In reality, the facilities may be operating at 50 per cent capacity over the working week.

Almost all regular activities in the academic cycle may be analysed to determine which operations can benefit from improvement. Merely closing the gaps described above and satisfying the specifications does not constitute quality service. Quality is delighting the customer by continuously meeting and improving upon the agreed requirements.

■ Schools of Quality

Educators are beginning to realise that current systems of instruction do not encourage or in some cases even permit quality education. Many of them are now examining TQM as a possible workable philosophy to create new type of schools—schools of quality—which are based upon a way of schooling that better suits the imperative of the twenty-first century than the factory-model system of schooling currently practised in many parts of the world.

What are such “schools of quality” like? How do they differ from today’s schools? Schools of quality are grounded in four fundamental assumptions, which Bonsting¹⁵ called the Four Pillars of Schools of Quality.

The first pillar is a customer-supplier focus. The entire organization must be dedicated to meeting human needs by building relationships of mutual support with people inside and outside the school. The role of a student is dual. As a worker, the student’s product is his personal growth and continuous improvement that he presents to teachers or future employers (customers). As a customer, he expects high quality teaching, security and care from the school staff (workers, suppliers). Satisfaction of customers in both cases is required.

Bird's-eye view:

Educators are beginning to realise that current systems of instruction do not encourage or in some cases even permit quality education. Many of them are now examining TQM as a possible workable philosophy to create new type of schools.

Bird's-eye view:

Schools of quality—which are based upon a way of schooling that better suits the imperative of the twenty-first century than the factory-model system of schooling currently practiced in many parts of the world.

This may not be fully symbolized by letters or grades. Marks, in fact, detract from the prime objective of education, which is developing young people's sense of taking pride in a successfully completed job. In schools of quality, tests and other assessments are much more an indication of the teacher's success through the success of their students.

The second pillar is a personal dedication by everyone to continuous improvement, little by little, day by day, within one's sphere of influence. For instance, student groups and teacher groups might form support teams to provide mutual support in academic and personal matters on a regular basis. Continuous improvement is much easier to integrate into operations if people interact and share experiences.

The third pillar is a process/systems approach. Deming has hypothesized that as much as 80 per cent of all things that go wrong in any organization are not entirely attributable to individuals, but rather to the system in which they work. In schools, teachers and students combine efforts to continuously improve the system of teaching and learning, as teachers and administrators work together to improve the system of rules, expectations, policies and other factors, which constitute the operational culture of the school. Parents, families, business leaders and the people of the community are invited to join this collaborative work for the long-term benefit of the young people and generations to follow.

The final pillar is consistent quality leadership. This is the most crucial of the four pillars. The ultimate success of the ongoing quality transformation is the responsibility of the top management and can only be achieved over time through constant dedication to the principles and practices of TQM. Leaders must construct fearless work environments in which coercion is set aside to permit risk-taking and temporary failures leading to continuous improvement. Consequently, the school management should encourage the design of innovative curriculums, the use of new teaching methods and more joint projects with external organizations and potential employers of the students.

Service quality is important in contemporary organizations because customer expectations are demanding and competition is increasing. However, this is part of the modern day business environment. Organizations should see this trend as an opportunity rather than a threat.

■ SERPVAL Scale⁶

Personal values are the final frontier in a purchase decision. As per the classic services marketing model, a customer looks at the following dimensions before making the purchase:

- The service attributes:** Core functional attributes or rather service attributes that define the basic usefulness of the service.
- The service quality:** This is the gap between the customer expectations and the actual performance of the service delivery.
- Service value:** Tradeoff between the perception of what is received and given.
- Service personal values:** They are the key elements that may make it possible to better understand consumer behaviour.

The SERPVAL scale is a multidimensional scale for measuring service personal values. It has three dimensions—service value to peaceful life, service value to social recognition and service value to social integration. The SERPVAL scale can be used to pursue highly service-oriented business strategy. It can be used for benchmarking purposes, as this scale can be used to identify whether or not a company's marketing strategies are consistent with customer expectations. Managers by using this scale can also better understand the reasons behind service usage. Even consumers can examine whether the relationship with a service provider provides real value to their lives.

👁 Bird's-eye view:

The SERPVAL scale is a multidimensional scale for measuring service personal values. It has three dimensions—service value to peaceful life, service value to social recognition and service value to social integration. The SERPVAL scale can be used to pursue highly service-oriented business strategy. It can be used for benchmarking purposes, as this scale can be used to identify whether or not a company's marketing strategies are consistent with customer expectations.

👁 Bird's-eye view:

The SERPVAL scale can be used to pursue highly service-oriented business strategy. It can be used for benchmarking purposes, as this scale can be used to identify whether or not a company's marketing strategies are consistent with customer expectations.

DISCUSSION FORUM

1. What is the SERVQUAL model?
2. Which are the four pillars of schools of quality?
3. Which are the five gaps identified in the SERVQUAL model?
4. Which are the five generic dimensions of SERVQUAL?
5. What is the SERPVAL model?

HOSPITALITY SECTOR

Hospitality is about serving the guests so that they experience a “feel-good-effect.” Today, the hospitality sector is one of the fastest growing sectors in India. It is expected to grow at the rate of 8 per cent between 2007 and 2016. Many renowned global players in the hospitality industry are coming to India to capture the growing Indian market. Trends that will shape the future of hospitality sector are low cost carriers, budget hotels, service apartments, technology and loyalty travel. The top players in the Indian hospitality sector include ITC Hotels, Indian Hotels Company Ltd. (The Taj Hotels Resorts and Palaces), Oberoi Hotels (East India Hotels), Hotel Leela Ventures, Asian Hotels Ltd, Hotel Corporation of India and ITDC Hotels.

Classification of the Hospitality Industry

The industry can be classified into four segments⁷:

Five-star and five-star deluxe: These account for 30 per cent of the industry. These are mainly situated in the business districts of metro cities and cater to business travellers and foreign tourists. These are considered to be very expensive.

Heritage hotels: These are characterized by less capital expenditure and greater affordability and include hotels situated in forts, palaces, castles, lodges, etc.

Budget hotels: Budget hotels cater mainly to domestic travellers who favour reasonably priced accommodations with limited luxury. These are characterized by good services and special seasonal offers.

Unclassified: This segment accounts for about 19 per cent of the industry. These are low-priced motels spread throughout the country. A low pricing policy is their only selling point.

Hotel ratings should be regarded only as general guidelines designed to assist guests in making hotel reservations decisions. The hotel industry has elaborate criteria in terms of service quality for categorizing hotels as Star and Diamond.

Star Rating

The Star classification guidelines are instituted by the Department of Tourism in order to be at par with international standards. The Star classifications of hotels are a function of the services provided by them. They are explained below:

Five-stars/grand heritage hotels/deluxe resorts (deluxe): These are luxurious hotels that offer a high degree of personal service. The hotel lobbies are sumptuous and rooms are equipped with stylish furnishing and quality linen. The amenities often include VCR, CD, stereo, a Jacuzzi tub and an in-room video library, heated pools and many more. A fitness centre, valet parking and concierge service round out the experience. There are multiple restaurants on site

Bird's-eye view:

The **Star classification** guidelines are instituted by the Department of Tourism in order to be at par with international standards. The Star classifications of hotels are a function of the services provided by them.

Bird's-eye view:

Stars are often used as symbols for classification purposes. They are used by reviewers for ranking things such as films, TV shows, restaurants, and hotels. For example, a system of one to five stars is commonly employed to categorize hotels, with five stars being the highest quality.

Bird's-eye view:

AAA Diamond ratings for hotels represent a combination of the overall quality, range of facilities, and level of services offered by the property. The descriptive ratings are assigned exclusively to properties that meet and uphold AAA's rigorous Approval standards.

with extensive, exquisite menus. The room-service facility is also available 24×7. A concierge is available to assist guests. The typical national chains include Taj Hotels, Oberoi Hotels, etc.

Four-stars (superior): These are formal, large hotels with smart reception areas, front desk and bellhop services. The level of service is above average and rooms are well furnished with brilliant illumination. A variety in restaurant dining is available here. The amenities offered are room service, valet parking facilities, fitness centres, one or more pools and concierge services. A formal professional service is provided and the staff anticipates and responds to guests' needs. The Hyatt and Marriott are example of hotel chains in this bracket.

Three-stars/heritage hotels/resorts (first-class): These hotels are usually located near a major expressway, business centre and/or shopping area, offer more spacious accommodation that include nice, spacious rooms and decorative lobbies. On-site restaurants may be average in size but will offer breakfast, lunch and dinner. Valet parking, room service, a small fitness centre and a pool are often available. Staff will be skilled in responding to the needs of the guests, and there will be a dedicated receptionist on duty. The Trident is an example of a hotel chain in this bracket.

Two-stars (moderate): These hotels are generally part of a chain that offers consistent quality and limited amenities. The hotel is usually small to medium-sized and conveniently located in the proximity of moderately priced attractions. The rooms will have a telephone and a television. Some hotels offer limited restaurant service on-site but may not have the convenience of room service. The staff is smartly turned out and provides competent, often informal service. The Days Inn chain is an example of a hotel chain in this bracket.

One-star/budget hotels/motels (economy): These hotels are usually located near affordable attractions, major intersections and entertainment channels linked conveniently by public transportation. The atmosphere will be more personal and furnishings and facilities will be clean but basic. They may not have a restaurant on-site but will usually be within walking distance to some good low-priced dining area. The RTDC chain is an example of hotels in this bracket.

■ Diamond Rating⁸

The American Automobile Association (AAA) has provided a Diamond Rating system that covers all of North America including Mexico and the Caribbean as well as Canada and all the states in the US. A hotel must meet 27 basic requirements, covering comfort, cleanliness and safety to become AAA approved. AAA annually evaluates 55,000 lodging establishments and restaurants and rates them on a scale of one to five diamonds. AAA Diamond ratings system evaluates the service, amenities and décor of each hotel.

One diamond properties meets AAA's basic standards for comfort, cleanliness and hospitality, while five diamond properties are the premier establishments that provide the ultimate in quality and service.

Five-diamond: These establishments are the ultimate in sophistication, luxury and quality of service offered. The hallmarks at this level include meticulous service, exceeding guest expectations and maintaining an impeccable standard of excellence. For example, the Ritz Carlton, Sarasota.

Four-diamond: The fundamental hallmarks at this level include an extensive array of amenities combined with a high degree of hospitality, service, and attention to detail. Accommodations

Bird's-eye view:

- ❖ Budget-oriented, offering basic comfort and hospitality.
- ❖ Affordable, with modestly enhanced facilities, decor and amenities.
- ❖ Distinguished, multi-faceted with enhanced physical attributes, amenities and guest comforts.
- ❖ Refined, stylish with upscale physical attributes, extensive amenities and a high degree of hospitality, service and attention to detail.
- ❖ Ultimate luxury, sophistication and comfort with extraordinary physical attributes, meticulous personalized service, extensive amenities and impeccable standards of excellence.

are progressively more refined and stylish. For example, Disney's Grand Floridian Resort and Spa, Gaylord Palms Resort, Hyatt Regency Grand Cypress.

Three-diamond: Properties are multifaceted with a distinguished style, including marked upgrades in the quality of physical attributes, amenities and the level of comfort provided. These establishments appeal to the traveler with comprehensive needs.

For example, Nickelodeon Family Suites, Holiday Inn Express Lake Buena Vista, Disney's Animal Kingdom lodge.

Two-diamond: They provide modest enhancements to the overall physical attributes, design elements, and amenities of the facility typically at a moderate price. These establishments appeal to the traveller seeking more than the basic accommodation.

For example, Disney's Pop Century Resort, Best Western Lakeside.

One-diamond: The establishments have basic buildings and landscaping. They meet the basic requirements pertaining to comfort, cleanliness and hospitality. These establishments typically appeal to the budget-minded traveller. They provide essential, no-frills accommodation. For example, Motel 6 Orlando-Kissimmee Main Gate East.

■ IMPROVING THE SERVICE QUALITY

Parasuraman, Berry and Zeithaml maintain that the following nine lessons are essentials for improving service quality across service industries:

1. **Listening:** Understand what customers really want through continuously listening to the expectation and perceptions of existing customers and potential customers.
2. **Reliability:** Reliability is the single-most important dimensions of service quality and must be a service priority.
3. **Basic service:** Service companies must deliver the basics and do what they are supposed to do keep promises, use common sense, listen to customers, keep customers informed and be determined to deliver value to customers.
4. **Service design:** Develop a holistic view of the service while managing its many details.
5. **Recovery:** Service companies should encourage customers to complain (and make it is easy for them to do so) if they encounter a service problem, respond quickly and personally and develop a problem resolution system.
6. **Fair play:** Service companies must make special efforts to be fair and to demonstrate fairness to customers and employees.
7. **Teamwork:** Teamwork is what enables large organizations to deliver service with care and attentiveness by improving employee motivation and capabilities.
8. **Employee research:** Conduct research with employees to reveal why service problems occur and what companies must do to solve problems.
9. **Servant leadership:** Quality service comes from inspired leadership throughout the organization, from excellent service system designs and from the effective use of information and technology.

■ Pre-requisites for Achieving Service Quality

Quality is not an event but it is an on-going process. As far as service organizations are concerned, quality is not the responsibility of the Quality Control Department only; rather it is a

Bird's-eye view:

AAA Diamond ratings for restaurants represent a combination of the overall food, service, décor and ambiance offered by the establishment. The descriptive ratings are assigned exclusively to establishments that meet and uphold AAA's rigorous Approval standards.

Bird's-eye view:

- ❖ Simple, economical food, often quick-serve, in a functional environment.
- ❖ Familiar food, often cooked to order, served in casual surroundings.
- ❖ Trendy cuisine, skillfully prepared and served, with expanded beverage options, in an enhanced setting.
- ❖ Distinctive fine-dining.
- ❖ Creative preparations, skillfully served, often with wine steward, amid upscale ambience.
- ❖ Leading-edge cuisine
- ❖ of the finest ingredients, uniquely prepared by an acclaimed chef, served by expert service staff led by maître d' in extraordinary surroundings.

 **Bird's-eye view:**

Quality is not an event but it is an on-going process. As far as service organizations are concerned, quality is not the responsibility of the Quality Control Department only; rather it is a matter to be taken care of by the entire business system.

matter to be taken care of by the entire business system. The following are the pre-requisites for achieving service quality.

- 1. Visionary leader:** The presence of a visionary leader at the top is a necessary element for achieving quality. The vision of the leader guides the organizational effort into achieving a high standard of service quality. A visionary leader through his verbal and symbolic communication shows others where the future lies.
- 2. Setting high performance standards:** It must be made clear to every employee that one is expected to give one's best. Casual attitudes will not work and will not be accepted in any case.
- 3. Management's commitment and support:** The process of quality improvement should receive total commitment and support from the top management.
- 4. Preparing the employees:** The organization needs to prepare employees so that they are capable of delivering quality service. Employee training programmes to cultivate and develop technical and inter-personal relations and communication skills need to be organized. Box 16.3 discusses the importance given to training at the Apollo Clinic.
- 5. System for addressing customer complaints:** There should be a system for handling complaints and suggestions. The customer should be informed about the action taken and thanked for giving suggestions.
- 6. System for monitoring service quality:** Commitment to quality also means that services delivered must be continuously monitored to assess as to what extent the customers are satisfied with the service offering of the firm. Internal performance analysis, customer satisfaction analysis and specialist marketing research are the improvements which are included where needed.

Box 16.3 Service Quality at the Apollo Clinic

The Apollo Group is at the forefront of creating service quality standards in the healthcare industry. At the Apollo Clinic, one can avail of the widest range of services that could be provided under one roof—consultations, preventive health checks, diagnostics, laboratory, dentistry procedures, treatment room, and pharmacy and telemedicine consultation.

Apollo is able to deliver high standards of service because of the stringent training given to employees. The entire staff is put through a four-week rigorous training session, which includes areas such as patient care, clinical and non-clinical procedures in the Clinic, query and objection handling, software training, etc. Apollo has tied up with institutions such as the Indian Institute of Management, Bangalore for training of franchisees, NIS Sparta for training of Front Office and Sales staff and Wipro for software training.

Clinical and Non-Clinical Standard Operating Procedures (SOPs) have been developed specifically designed keeping in mind the patients' requirements. This means that none of the usual issues that one associates with a primary health clinic would be seen at the Apollo Clinic. The difference can be noticed from the moment one walks into the Clinic. The front desk staff is fully equipped to understand and address most customer queries. Waiting times are significantly reduced by efficient scheduling. Doctors and other staff explain all procedures to the customers before carrying them out. At the Clinic, daily controls in the laboratories are performed, to ensure that quality is maintained—again something that is not commonly addressed in most clinics. Quality control samples are taken every two months by an independent team to confirm quality. Even basic requirements like home delivery of medicines or delivery of sample collection containers are provided for.

A number of mechanisms have been set up for continuous quality review and improvement. Patient feedback is an important component of this, and the Clinic takes it very seriously. In addition,

independent quality audits are conducted on a periodic basis, the results of which are used to further enhance quality.

Source: Adapted from www.apollohospitals.com, accessed July 2016.

DISCUSSION FORUM

1. How do you measure service quality in hotels?
2. Discuss the star rating system of hotels.
3. Explain AAA's diamond rating system.
4. What are the essential requirements for improving service quality across service industries?
5. What are the pre-requisites for achieving service quality?

SUMMARY

- Services and products have similarities as well as differences. In services, how the service is provided is more important whereas in products the customer considers what is being provided.
- “Quality” in service organizations is a measure of the extent to which the service delivered meets the customer’s expectations. The nature of most of the services is such that the customer is present in the delivery process. This means that the perception of quality is influenced not only by the service outcome but also by the service process.
- Customer satisfaction is at the core of every transaction in service industries. Service standards are more demanding because customers are becoming increasingly sensitive to quality. The focus has shifted from efficiently “manufactured” service items towards a more flexible model of responding to a more quality-sensitive customer.
- Schmenner categorized services into four categories in the service process matrix. They are service factory, service shop, mass service and professional service. Factors that influence the customer’s buying decisions are performance, features, service, warranty, price and reputation.
- The service quality management involves setting the right standard, implementing quality service and monitoring service quality. Tools used for determining customer expectations are customer satisfaction surveys, employee feedback, focus groups, toll-free telephone numbers, report cards and the Internet.
- SERVQUAL is the most popular method of service quality measurement in almost all the service industries. The concept of service quality gaps and SERVQUAL is an effective approach to study and analyse the differences between customer expectations and perceptions. Service specification forms an integral part of the service quality (SERVQUAL) conceptual model.
- The SERPVAL scale is a multidimensional scale for measuring service personal values. It has three dimensions—service value to peaceful life, service value to social recognition and service value to social integration.
- The hotel industry has elaborate criteria for categorizing hotels into star and diamond ratings. Hotel star ratings are systems that rank hotels according to quality. Star rating systems are intended to serve as guidelines for guests who are making hotel reservations.

Star ratings from one to five are used to assess the standard of quality. AAA diamond rating criteria are broad guidelines for rating hotels. Diamond ratings from one to five are used to assess the standard of quality.

- Parasuraman, Berry and Zeithaml offer nine lessons essential for improving service quality across service industries—listening, reliability, basic service, service design recovery, fair play, teamwork, employee research and servant leadership.
- The pre-requisites for achieving service quality are visionary leadership, setting high performance standards, management commitment and support, preparing the employees, systems for addressing customer complaints and systems for monitoring service quality.

Key Terms

Basic Service	525	Reliability	514
Customer Satisfaction Survey	516	Report Card	517
Diamond Rating	524	Reputation	513
Employee Feedback	517	Servant Leadership	525
Employee Research	525	Service Design Recovery	528
Fair Play	525	Service Shop	510
Features	513	Star Rating	523
Focus Groups	517	SERPVAL	522
Internet	517	Service	513
Listening	525	Service Factory	510
Mass Service	511	SERVQUAL	518
Performance	513	Toll-free Telephone Numbers	516
Price	513	Teamwork	525
Professional Service	507	Warranty	513

Case Study

Hotel Valuation Services (HVS)

Hotel Valuation Services (HVS) was founded in 1980 by Steve Rushmore. It is the world's leading consulting and services organization focused on the hotel, restaurant, shared ownership, gaming and leisure industries. Rushmore began his career as a consultant in the hospitality division of a prominent New York City real estate firm. He quickly realised that a limited body of knowledge was available to assess the value of hotels. He founded HVS to fill this perceived gap.

The HVS method of providing an economic study and appraisal for hotels and motels immediately became the industry standard. HVS is focused on the hotel, restaurant, timeshare, gaming and leisure industries. The company has more than 300 consultants offering specialized services through its network of 25 offices worldwide.

Studies conducted by HVS indicate that 2010 is going to be a challenging year for the Indian hospitality industry.

Challenges for the Hospitality Sector

The tourism industry is highly susceptible to changes in the macro-environment. The aviation and hospitality sectors are among the first to get affected by an adverse environment and also the last to recuperate.

The main challenges faced by the hospitality sector in India include lack of infrastructure and facilities, lack of human resources and training, the hotel rating system not being at par with international standards, intense competition from global players and multiplicity of taxes.

HVS Recommendations

HVS has made the following recommendation in order to address the challenges faced by the hotel industry:

- Grant hotels industry status across India
- Include tourism as a subject in the Concurrent List of the Constitution of India
- Grant hotels infrastructure status under Sec 80-IA of IT Act
- Impose a single uniform luxury tax, based on the actual room tariff only, across all Indian states
- Impose uniform tax rates on rooms, food and beverages, and liquor across the country
- Give incentives, in the form of tax breaks, to re-invested capital in the hotel industry
- Extend the benefits of Sec 80-ID to other parts of India
- Develop a more scientific rating system to truly benchmark hotel quality

Hotel Rating Process

Various approaches are used across the globe to classify hotels. The most common approaches followed are:

Registration: This involves a basic level listing of properties that meet agreed minimum standards.

Classification: Hotels are classified into various categories based on the amenities offered. All establishments have to follow certain minimum standards.

Grading: Hotels are graded according to the quality of services delivered to customers. Assessment of this nature is highly complex and time consuming.

Hotel Rating System in India

India has been using the “Classification” system with mixed results for over four decades. HVS recommends that the present rating system in India should be upgraded to the “Grading” system to enable it to employ a more discretionary approach to the process. Hotels, motels and other lodging in India are inspected and categorized according to their products and services by the Hotel and Restaurant Approval and Classification Committee (HRACC), a body instituted by the Ministry of Tourism. However, the checklist used by HRACC has some serious shortcomings. The minimum standards are too weak and lenient. Hotels that do not adhere to minimum standards are penalized. However, benefits are not offered to hotels that offer services above the minimum standards. The checklist focuses on physical infrastructure alone and is not very effective in assessing the quality of services.

The present system needs a complete overhaul in order to remain relevant in the dynamic market scenario. Safety and hygiene should be the first parameters in the classification process. The government should focus on the safety and hygiene parameters than on the commercial

aspects of classification. The HRACC classification should be revamped so that it provides a more accurate indication of a hotel's quality and services.

Source: Adapted from www.expresshospitality.com, accessed May 2010.

For Discussion

1. What are the challenges facing the Indian hospitality industry?
2. What is HVS? What are the recommendations of HVS mentioned in this case study?
3. What are the limitations of the present hotel rating system in India?
4. If you are hired as the consultant, what measures do you suggest to improve the present hotel rating system in India?

Short-answer Questions

1. Define service quality.
2. Mention the four categories of service quality.
3. Differentiate between service systems and manufacturing systems.
4. Name any five tools used for determining customer expectations.
5. Why are SERVQUAL instruments used?
6. Name the four pillars of schools of quality.
7. Name five generic dimensions of the SERVQUAL model.
8. Why are SERPVAL instruments used?
9. Which are the three dimensions of the SERPVAL model?
10. Which are the two types of quality ratings used in the hotel industry?
11. How to improve service quality.
12. What are the pre-requisites for achieving service quality?

Match the Following

a. SERVQUAL	Satisfaction of customer expectations
b. SERPVAL	Identifies five gaps
c. Star rating	Measuring service personal values
d. AAA Diamond rating	Instituted by the department of tourism
e. Service quality	Classified into five diamonds

Discussion Questions

1. Differentiate between manufacturing and service industry.
2. What is service quality? What are the internal and external measures of service quality?
3. Explain the significance of the service industry in the emerging economy.

4. Classify the various types of services into categories with respect to degree of labour intensity and degree of interaction and customization. How difficult is it to manage the service quality for services in these categories?
5. What is the Gap Model of service quality measurement? What are the limitations of the SERVQUAL instrument?
6. What are the criteria for rating of hotels in star and diamond categories?

Projects

1. Apply the SERVQUAL instrument and measure the service quality of your institute and prepare a report.
2. Visit a star rated hotel in your area (less than five-star) and analyse what has to be done to improve its rating.

End Notes

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Quality Management System



INTEGRATED MANAGEMENT SYSTEM

ISO stands for International Organization for Standardization. It is autonomous, non-government organization, and world's largest voluntary standards developer. ISO is made up of 163 member countries who are the national standard bodies around the world. The central secretariat of ISO is based in Geneva, Switzerland. ISO is derived from the Greek word *isos*, meaning equal. Whatever the country, whatever the language, we are always ISO.

ISO's international standards ensure that products and services are safe, reliable, and of good quality. For business, they are strategic tools that reduce costs by minimizing waste and errors, and increasing productivity. They help companies to access new markets, level the playing field for developing countries, and facilitate free and fair global trade.

An integrated management system (IMS) combines all related components of a business into one system for easier management and operations. Quality (QMS), Environmental (EMS), and Occupation Health and Safety Management Systems (OHSMS) are often combined and managed as an IMS. These systems are not separate systems that are later joined together, rather they are integrated with linkages so that similar processes are seamlessly managed and executed without duplication.

"Trade depends on quality"

Prof. W. Edwards Deming

Upon completion of this chapter, you will be able to:

1. Discuss ISO
2. Identify the organizations promoting quality movement in India
3. Describe the benefits of ISO certification
4. Explain QMS, EMS, and OHSMS

INTRODUCTION

ISO (International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). It is the world's largest developer of standards. ISO's principal activity is the development of international standards through ISO technical committees. The objective of ISO standards is to contribute to making the development, manufacturing, and supply of products and services more efficient, safer, and cleaner. Therefore, ISO aims to make trade between countries easier and fairer, and provide governments with a technical base for health, safety, and environmental legislation.

ISO is a network of the national standards institutes of 163 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. ISO is a non-governmental organization; its members are not delegations of national governments. However, many of its member institutes are part of the governmental structure of their respective countries or are mandated by their governments. Other members have their roots uniquely in the private sector, having been set up by national partnerships of industry associations. As such, ISO occupies a position between the public and private sector.

Bird's-eye view:

ISO is an independent, non-governmental international organization with a membership of 163 national standards bodies with a Central Secretariat in Geneva, Switzerland, that coordinates the system.

INSTITUTIONS PROMOTING QUALITY MOVEMENT IN INDIA

There are number of institutions in India, which provides strategic direction to the quality movement in the country. They are Bureau of Indian Standards (BIS), Quality Council of India (QCI), and Confederation of Indian Industry's Institute of Quality (CII-IQ). Box 17.1 provides information on BIS, Box 17.2 provides information on QCI, and Box 17.3 provides information on CII-IQ.

Box 17.1 Bureau of Indian Standards (BIS)

The Bureau of Indian Standards (BIS) is the national Standards Body of India working under the aegis of Ministry of Consumer Affairs, Food & Public Distribution, Government of India. It is established by the Bureau of Indian Standards Act, 1986, which came into effect on 23 December 1986. The minister in charge of the Ministry or Department having administrative control of the BIS is the ex-officio President of the BIS.

The organization was formerly known as the Indian Standards Institution (ISI), set up under the Resolution of the then Department of Industries and Supplies No. 1 Std.(4)/45, dated 3 September 1946. The ISI was registered under the Societies Registration Act, 1860. As a corporate body, it has 25 members drawn from Central or State Governments, industry, scientific and research

institutions, and consumer organizations. Its headquarters is in New Delhi, with regional offices in Kolkata, Chennai, Mumbai, Chandigarh, and Delhi, and 20 branch offices. It also works as WTO-TBT enquiry point for India.

One of the major functions of the Bureau is the formulation, recognition, and promotion of the Indian Standards. As on 31 August 2013, 19,067 standards formulated by BIS are in force. These cover important segments of economy, which help the industry in upgrading the quality of their products and services. BIS is a founder member of International Organization for Standardization (ISO). It represents India in the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the World Standards Service Network (WSSN).

BIS has identified 14 sectors that are important to Indian Industry. For formulation of Indian Standard, it has separate Division Council to oversee and supervise the work. The standards are regularly reviewed and formulated in line with the technological developments to maintain harmony with the International Standards.

ISI mark is a certification mark for industrial products in India. The mark certifies that a product confirms to the Indian Standard, mentioned as IS:xxxx on top of the mark, developed by the Bureau of Indian Standards (BIS), the national standards body of India. The *ISI mark* is by far the most recognized certification mark in the Indian subcontinent. The name ISI is an abbreviation of *Indian Standards Institute*, the former name of the *Bureau of Indian Standards*. The ISI mark is mandatory for certifying products to be sold in India, like many of the electrical appliances viz; switches, electric motors, wiring cables, heaters, kitchen appliances etc., and other products like portland cement, LPG valves, LPG cylinders, automotive tyres etc. But in the case of most other products it is voluntary.

All foreign manufacturers of products who intend to export to India are required to obtain a BIS product certification license. Towards this, BIS launched its Product Certification Scheme for overseas manufacturers in the year 1999. Under the provisions of this scheme, foreign manufacturers can seek certification from BIS for marking their product(s) with BIS Standard Mark. If or otherwise, the foreign manufacturer has not signed a MoU with BIS, it has to set up a liaison office in India with the permission of Reserve Bank of India. Otherwise, an authorized representative or agent needs to be appointed by the foreign firm.

Source: Adapted from www.bis.org.in last accessed, July 2016

Box 17.2 Quality Council of India

The Quality Council of India (QCI) is a pioneering experiment of the Government of India in setting up organizations in partnership with the Indian industry. Quality Council of India is a non-profit autonomous society registered under Societies Registration Act XXI of 1860 to establish an accreditation structure in the country and to spread quality movement in India by undertaking a National Quality Campaign. The Mission of QCI is to lead nationwide quality movement in India by involving all stakeholders for emphasis on adherence to quality standards in all spheres of activities primarily for promoting and protecting the interests of the nation and its citizens.

In order to achieve its mission QCI is playing a pivotal role by propagating, adoption, and adherence to quality standards in all important spheres of activities including education, healthcare, environment protection, governance, social sectors, infrastructure sector and such other areas of organized activities that have significant bearing in improving the quality of life and well-being of the citizens of India and without restricting its generality shall inter-alia include:

- To lead nationwide quality movement in the country through National Quality Campaign aimed at creating awareness amongst citizens, empowering them to demand quality in all spheres of activities, and promoting and protecting their well-being by encouraging manufacturers and suppliers of goods and service providers for adoption of and adherence to quality standards and tools.
- To develop apropos capacities at the level of governments, institutions, and enterprises for implementing and institutionalizing continuous quality improvement.

Bird's-eye view:

There are number of institutions in India, which provides strategic direction to the **quality movement** in the country like Bureau of Indian Standards (BIS), Quality Council of India (QCI), and Confederation of Indian Industry's Institute of Quality (CII-IQ) etc.

- To develop, establish, and operate national accreditation programmes in accordance with the relevant international standards and guides for the conformity assessment bodies certifying products, personnel, management systems, carrying out inspection and for the laboratories undertaking testing and calibration, and such other areas of organized activities that have significant bearing in improving the quality of life and well-being of the citizens of India.
- To develop, establish, and operate national accreditation programmes for various service sectors such as education, healthcare, environment protection, governance, social sectors, infrastructure sector, vocational training, and so on, to site a few, as may be required, based on national/international standards and guidelines and where such standards are not available to develop accreditation standards to support accreditation programs.
- To build capacities in the areas of regulation, conformity assessment, and accreditation to overcome TBT/SPS constraints.
- To encourage development and application of third party assessment model for use in government, regulators, organizations, and society.
- To promote quality competitiveness of India's enterprises especially MSMEs through adoption of and adherence to quality management standards and quality tools.
- To promote the establishment of quality improvement and benchmarking centre, as a repository of best international/national practices and their dissemination among the industry in all the sectors.
- To facilitate effective functioning of a national information and enquiry services on standards and quality including an appeal mechanism to deal with unresolved complaints.

Source: Adapted from <http://www.qcin.org/about-qci.php> accessed July 2016

Box 17.3 CII Institute of Quality

CII Institute of Quality is the leading authority in quality enhancement among organizations and industries. Over the past century, CII has provided Indian industries with the support, systems, and tools to make a mark in the competitive world. It is realized that the best way to enhance an organization's competitiveness is through the quality route.

What started as the Total Quality Management Division (TQMD) of CII in the mid-eighties has now evolved as CII Institute of Quality. As a champion of the quality movement, CII IQ is powered by the responsibility of enriching the lives of its members, improving their workplaces, and making the world, at a large, a better place by applying quality tools, techniques, and systems. CII IQ provides the best of its kind training and consulting services to organizations to help improve their performance and set a standard of excellence.

CII IQ has tied up with several international organizations to bring their best practices to India. It has helped several organizations improve their total QMS besides helping them win recognitions such as the Deming Prize and the Japan Quality Medal. CII IQ opens a world of opportunities to improve the quality of workplace, communities, and lives by providing information, contacts, and more. It realizes the importance of creating sustainable programs that are critical to an organization's QMS.

Source: Adapted from <http://www.cii-iq.in/index.php/about-us> accessed July 2016

■ DEVELOPMENT OF THE ISO 9000 STANDARDS

Quality management focuses on activities carried out by the organizations to fulfil customers' quality requirements and applicable regulatory requirements, while aiming to enhance customer satisfaction and achieve continual improvement in performance. ISO 9000 series of standards is the internationally recognized standard for Quality Management Systems (QMS). It is the most widely used QMS standard in the world. ISO 9001 provides a framework and set of principles that ensure a common-sense approach to the management of your organization to

Bird's-eye view:

The ISO 9000 family of international quality management standards and guidelines has earned a global reputation as a basis for establishing effective and efficient quality management systems.

consistently satisfy customers and other stakeholders. In simple terms, it provides the basis for effective processes and effective people to deliver an effective product or service time after time.

ISO 9000 contains detailed explanations of the seven quality management principles in addition to many helpful tips on how to ensure these are reflected in the way you work. It also contains many of the terms and definitions used in ISO 9001 and constitutes a useful companion document to help you build a successful QMS. ISO 9004 provides guidance on how to achieve sustained success with your QMS. This International Standard applies the framework developed by ISO to improve alignment among its International Standards for management systems. This International Standard relates to ISO 9000 and ISO 9004 as follows:

Bird's-eye view:

The **ISO 9000** family addresses various aspects of quality management and contains some of ISO's best known standards.

1. **ISO 9000 quality management systems:** Fundamentals and vocabulary provides essential background for the proper understanding and implementation of this International Standard.
2. **ISO 9004 managing for the sustained success of an organization:** A quality management approach provides guidance for organizations that chose to progress beyond the requirements of this International Standard.

The ISO 9000 standards were issued in 1987 and represent requirements for the development and implementation of QMS in an organization. On 15 December 2000, the revised and improved ISO 9001:2000 was published to replace the three 1994 versions of ISO 9001, ISO 9002, and ISO 9003. ISO 9001:2008 was officially released on 13 November 2008 and provides a set of standardized requirements for a QMS. The fifth edition ISO 9001:2015 cancels and replaces the fourth edition (ISO 9001:2008), which has been technically revised, through the adoption of a revised clause sequence, the revised quality management principles, and new concepts.

ISO 9001:2015

Bird's-eye view:

Standards in the **ISO 9000 family** include:

- ISO 9001:2015 - sets out the requirements of a quality management system
- ISO 9000:2015 - covers the basic concepts and language
- ISO 9004:2009 - focuses on how to make a quality management system more efficient and effective
- ISO 19011:2011 - sets out guidance on internal and external audits of quality management systems.

ISO 9001:2015 published on 23 September 2015 replaces the previous editions, and the certification bodies are provided with three years times to migrate certificates to the new version. The three pillars of the ISO 9001:2015 standard are process approach, risk-based thinking, and continual improvement. ISO 9001:2015 is more compatible with other management systems such as ISO 14001:2015 Environmental Management System (EMS) and ISO 45001:2016 Occupation Health and Safety Management System, making it more effective and efficient to integrate with various other management systems.

Two of the most important objectives in the revision of the ISO 9000 series of standards are (a) to develop a simplified set of standards that will be equally applicable to small as well as medium and large organizations and (b) the amount and detail of documentation required should be more relevant to the desired results of the organization's process activities. ISO 9001:2015 QMS-requirements have achieved these objectives, and the purpose of this additional guidance is to explain the intent of the new standard with specific regard to documented information. The changes are done in:

- Structure—which follows the 10 section structure defined in Annex SL
- Key concepts
- Terminology

All the requirements of ISO 9001:2015 are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides. ISO 9001:2015 specifies requirements for a QMS when an organization:

- Needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements
- Aims to enhance customer satisfaction through the effective application of the system including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements.

■ Benefits of ISO 9001 Certification

1. **Customer satisfaction:** Deliver products that consistently meet customer requirements.
2. **Reduced operating costs:** Continual improvement of processes and resulting operational efficiencies means money saved.
3. **Improved stakeholder relationships:** Improve the perception of your organization with staff, customers, and suppliers.
4. **Legal compliance:** Understand how statutory and regulatory requirements impact your organization and its customers.
5. **Improved risk management:** Greater consistency and traceability of products and services mean problems are easier to avoid and rectify.
6. **Proven business credentials:** Independent verification against a globally recognized industry standard speaks volumes.
7. **Ability to win more business:** Procurement specifications often require certification as a condition to supply, so certification opens doors.

■ Quality Management Principles

The QMS standards of the ISO 9000 series are based on eight quality management principles. These principles collectively form a basis for performance improvement and organizational excellence. These principles have been discussed in detail in Chapter 3. Any organization can benefit from implementing ISO 9001, as its requirements are underpinned by the following eight universal management principles:

- Customer-focused organization
- Leadership
- Involvement of people
- Ensuring a process approach
- Systematic approach to management
- Factual approach to decision making
- Mutually beneficial supplier relations
- Continuous improvement

Bird's-eye view:

The adoption of a QMS should be a strategic decision of an organization. Large and even small companies have gained great benefits from using QMS by discovering cost and efficiency savings.

DISCUSSION FORUM

1. What is ISO?
2. How many times were the standards revised?
3. Which is the latest version of ISO and what are the major changes it introduces?
4. What are the quality management principles on which the QMS standards are based?
5. What are the benefits of ISO certification?
6. Identify the organizations providing strategic direction to quality movement in India.

■ QUALITY MANAGEMENT SYSTEMS: AN INTRODUCTION

The adoption of a QMS should be a strategic decision of an organization. The QMS requirements specified in this International Standard are complementary to requirements for

products and services. The design and implementation of an organization's qualified management system is influenced by:

- Its organizational environment, changes in that environment, and the risk associated with that environment;
- Its varying needs;
- Its particular objectives;
- The products it provides;
- The processes it employs;
- Its size and organizational structure.

Risk-based thinking enables an organization to determine the factors that could cause its processes and its QMS to deviate from the planned results and to put in place the preventive controls to minimize negative effects to make maximum use of opportunities as they arise. Consistently meeting the requirements and addressing the future needs and expectations pose a challenge for organizations in an increasingly dynamic and complex environment. To achieve this objective, the organization might find it necessary to adopt various forms of improvement in addition to correction and continual improvement, such as breakthrough change, innovation, and re-organization. In this International Standard, the following verbal forms are used:

- “Shall” indicates a requirement;
- “Should” indicates a recommendation;
- “May” indicates a permission;
- “Can” indicates a possibility or a capability.

Bird’s-eye view:

ISO 9000 standards promote the adoption of a process approach when developing, implementing, and improving the effectiveness of a QMS to enhance customer satisfaction by meeting customer requirements.

■ PROCESS APPROACH

ISO 9000 standards promote the adoption of a process approach when developing, implementing, and improving the effectiveness of a QMS to enhance customer satisfaction by meeting customer requirements. An organization has to determine and manage numerous linked activities to function effectively. A process is an activity or activities that use resources to transform input into outputs. Sometimes, the output from one process directly forms the input for the next.

Understanding and managing interrelated processes as a system contribute to the organization’s effectiveness and efficiency in achieving its intended results. This approach enables the organization to control the interrelationships and interdependencies among the processes of the system, so that the overall performance of the organization can be enhanced.

For organizations that are in the process of implementing or yet to implement a QMS, ISO 9001:2015 emphasizes a process approach. This includes determining the processes necessary for the effective implementation of the QMS, determining the interactions between these processes, and documenting the processes to the extent necessary to assure their effective operation and control. (It may be appropriate to document the processes using process mapping tools. It is emphasized, however, that documented process mapping tools are *not* a requirement of ISO 9001:2015). Analysis of the processes should be the driving force for defining the amount of documented information needed for the QMS, taking into account the requirements of ISO 9001:2015. It should *not* be the documented information that drives the processes.

The process approach enables an organization to plan its processes and their interactions. The PDCA cycle enables an organization to ensure that its processes are adequately

Bird’s-eye view:

The most popular **ISO 9001** is the international standard that specifies requirements for a quality management system (QMS). Organizations use the standard to demonstrate the ability to consistently provide products and services that meet customer and regulatory requirements.

resourced and managed, and that the opportunities for improvement are determined and acted on. Management of the processes and the system as a whole can be achieved using the PDCA cycle with an overall focus on risk-based thinking aimed at taking advantage of the opportunities and preventing undesirable results. The application of the process approach in a QMS enables the following:

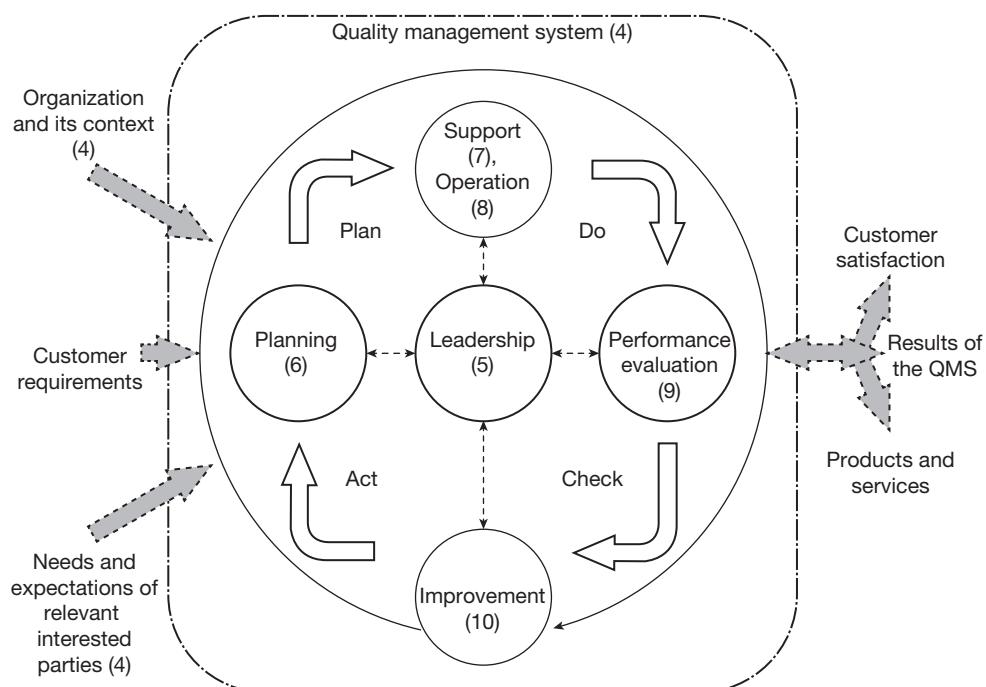
1. Understanding and consistency in meeting requirements;
2. Consideration of processes in terms of added value;
3. Achievement of effective process performance;
4. Improvement of processes based on evaluation of data and information.

The model of a process-based QMS is shown in Figure 17.1. The PDCA cycle can be applied to all processes and to the QMS as a whole. Figure 17.1 illustrates how Clauses 4 to 10 can be grouped in relation to the PDCA cycle.

The PDCA cycle can be briefly described as follows:

1. **Plan:** Establish the objectives of the system and its processes, and the resources needed to deliver the results in accordance with customers' requirements and the organization's policies, and identify and address risks and opportunities;
2. **Do:** Implement what was planned;
3. **Check:** Monitor and (where applicable) measure processes and the resulting products and services against policies, objectives, requirements, and planned activities, and report the results;
4. **Act:** Take actions to improve performance, as necessary.

Fig. 17.1 Quality Management System Model



Note: Numbers in brackets refer to the clauses in this International Standard.

Eye Bird's-eye view:

The **PDCA cycle** can be applied to all processes and to the QMS as a whole. The PDCA cycle enables an organization to ensure that its processes are adequately resourced and managed, and that the opportunities for improvement are determined and acted on.

Eye Bird's-eye view:

PDCA (plan-do-check-act, sometimes seen as plan-do-check-adjust) is a repetitive four-stage model for continuous improvement (CI) in business process management.

■ ISO 9001:2015 QUALITY MANAGEMENT SYSTEMS REQUIREMENTS

The adoption of a QMS is a strategic decision for an organization to improve its overall performance and provide a sound basis for sustainable initiatives. The standard consists of 10 clauses. Clauses 1 to 3 are basic clauses and Clauses 4 to 10 are main clauses. The requirements to be met for ISO 9001:2015 Quality Management Systems are given in Table 17.1.

■ Basic Clauses

Clauses 1 to 3 are termed as basic clauses. Clause 1 discusses the scope of ISO 9001:2015. All the requirements of QMS are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides. The scope of the standard specifies the requirements for a QMS when an organization:

- Needs to demonstrate its ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements;
- Aims to enhance customer satisfaction through the effective application of the system including processes for improvement of the system and the assurance of conformity to customer and applicable statutory and regulatory requirements (legal requirements).

Clause 2 is normative references. The following documents, in whole or in part, are normatively referenced and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000:2015, Quality Management Systems—Fundamentals and Vocabulary

Clause 3 is terms and definitions. For the purposes of this document, the terms and definitions given in ISO 9000 apply. Throughout the text of this International Standard, wherever the term “product” occurs, it can also mean “service.”

■ ISO 9001:2015 Structure

The new 9001:2015 standard comprises 10 clauses instead of the previous eight used in the ISO 9001:2008. The QMS requirements are given in Table 17.1.

1. Scope
2. Normative References
3. Terms and Definitions
4. Context of the Organization
5. Leadership
6. Planning
7. Support
8. Operation
9. Performance Evaluation
10. Improvement

Table 17.1 QMS Requirements

Clause No.	Contents
1	Scope
2	Normative references
3	Terms and definitions
4	Context of the organizations
4.1	Understanding the organization and its context
4.2	Understanding the needs and expectations of interested parties
4.3	Determining the scope of the QMS
4.4	QMS and its processes
5	Leadership
5.1	Leadership and commitment
5.2	Quality Policy
5.3	Organizational roles, responsibilities, and authorities
6	Planning
6.1	Actions to address risks and opportunities
6.2	Quality objectives and planning to achieve them
6.3	Planning of changes
7	Support
7.1	Resources
7.2	Competence
7.3	Awareness
7.4	Communication
7.5	Documented information
8	Operation
8.1	Operational planning and control
8.2	Requirements for products and services
8.3	Design and development of products and services
8.4	Control of externally provided processes, products, and services
8.5	Production and service provision
8.6	Release of products and services
8.7	Control of nonconforming outputs
9	Performance evaluation
9.1	Monitoring, measurement, analysis, and evaluation
9.2	Internal audit
9.3	Management review
10	Improvement
10.1	General
10.2	Nonconformity and corrective action

 **Bird's-eye view:**

ISO 9001 was first published in 1987 by the International Organization for Standardization (ISO), an international agency composed of the national standards bodies of more than 160 countries. The current version of ISO 9001 was released in September 2015.

 **Bird's-eye view:**

The **ISO 9001:2015** Quality Management System replaces the previous version ISO 9001:2008. ISO 9001:2015 consists of 10 clauses. Clauses 1 to 3 are basic clauses and Clauses 4 to 10 are main clauses.

(Continued)

Table 17.1 (Continued)

Clause No.	Contents
10.3	Continual improvement
Annex A	Clarification of new structure, terminology, and concepts
Annex B	Other International Standards on QMS developed by ISO/TC176
Bibliography	

■ Main Clauses

Bird's-eye view:

The most noticeable change to the standard is its new structure known as the High-Level Structure. ISO 9001:2015 now follows the same overall structure as other ISO management system standards, making it easier for anyone using multiple management systems.

Clauses 4 to 10 are termed as main clauses. Clause 4 relates to context of the organization, and it has four sub-clauses.

Clause 4: Context of the Organization

This clause requires the companies to identify, monitor, and review external and internal issues that are relevant to its purpose and its strategic direction that affect its performance which could have an impact on its QMS. Most successful businesses will already be monitoring such issues; however, they are now required to provide evidence of this for assessment purposes.

Clause 4.2: Understanding the Needs and Expectations of Interested Parties

Organizations are required to identify “relevant requirements” or “relevant interested parties,” and once identified, the organizations have to monitor and review such information. Interested parties could be groups or individuals (such as suppliers, employees, shareholders, neighbours, etc.) who could impact on the organization’s ability to provide the product and/or service that meet their customer’s requirements, as well as those of any legal and regulatory nature. Organizations are required to provide evidence of this for assessment purposes.

Clause 4.3: Determining the Scope of the Quality Management System

The scope of the QMS sets its boundaries, identifying what requirements of the QMS are applicable and what are not. It should be done with consideration of the organization’s context (what your company does, what it wants to achieve, who you supply to, etc.) as well as the products and/or services it supplies, and the scope shall be documented.

Clause 4.4: Quality Management System and its Processes

This clause requires organizations to establish processes that, once established, are maintained and continually improved. Organizations are also asked to set performance indicators that enable effective operation and control of the processes established by the organization.

Clause 5: Leadership

Clause: 5.1. Leadership and Commitment

Clause: 5.1.1 Leadership and Commitment to Quality Management System

This clause will require management to demonstrate their leadership and commitment to the QMS by taking responsibility for the effective running of the organization’s QMS. They can do this by ensuring that the organization’s quality policy, quality objectives, and commitment are consistent with the organization’s overall business plan.

Top management shall also ensure that the requirements of the QMS are aligned with the organization’s business practices and they should promote awareness of the system throughout their organization.

Clause 5.1.2: Customer Focus

Top management are required to take the lead in demonstrating customer commitment within the organization by ensuring that all applicable statutory, regulatory, and customer requirements are identified and achieved while, at the same time, ensuring that the organization continues to provide the products and services expected by their customer and the focus is on enhancing customer satisfaction.

Clause 5.2: Quality Policy

Clause 5.2.1: Establishing the Quality Policy

Top managements are required to establish a quality policy that is in line with the purpose and context of the organization (see Clause 4.1) while, at the same time, providing a framework for the organization's quality objectives and the basis on which the improvements in the QMS can be achieved.

Clause 5.2.2: Communicating the Quality Policy

The policy shall be available as documented information and communicated and understood throughout the organization and by relevant interested parties.

Clause 5.3: Organizational Roles, Responsibilities, and Authorities

Top managements need to ensure that individuals are assigned relevant roles, responsibility, and authority to enable them to carry out their duties in line with the requirements of the QMS. The roles, responsibilities, and authorities are communicated and understood within the organization.

Clause 6: Planning

Clause 6.1: Actions to Address Risks and Opportunities

Clause 6.1.1: Consider Risks and Opportunities

Organizations are required to think about the internal and external issues they face and the relevant requirements of their interested parties and how this may impact on their QMS. The organization must then determine the risks and opportunities that need to be addressed in order to provide confidence that the QMS can achieve its intended outcomes and to achieve continual improvement.

Clause 6.1.2: Plan to Manage Risks and Opportunities

Once the organization has identified the risks and opportunities it faces, it must then determine how it wishes to address these; however, the organization may take an informed decision not to address the risk and taking no action beyond identifying and evaluating the risk or opportunity.

Clause 6.2: Quality Objectives and Planning to Achieve them

Clause 6.2.1: Establish Quality Objectives for all Relevant Areas

This clause requires an organization to set quality objectives for relevant areas within its QMS. It is for the organization to decide which areas are relevant. The quality objectives must be consistent with the organization's quality policy and be relevant to products and services it provides, and the enhancement of customer satisfaction. Quality objectives must be measurable, taken into account the applicable customers, statutory, and regulatory requirements, and be monitored in order to determine whether they are being met. They must also be communicated across the organization and be updated as and when the need arises.



Bird's-eye view:

ISO 9001:2015:

Puts greater emphasis on leadership engagement; Helps address organizational risks and opportunities in a structured manner; Uses simplified language and a common structure and terms, which are particularly helpful to organizations using multiple management systems.

 **Bird's-eye view:**

For organizations wishing to demonstrate conformity with the requirements of ISO 9001:2015, for the purposes of certification/registration, contractual, or other reasons, it is important to remember the need to provide evidence of the effective implementation of the QMS.

Clause 6.2.2: Develop Plans to Achieve Objectives and Evaluate Results

The organization must undertake planning in order to determine how its quality objectives will be achieved.

Clause 6.3: Planning of Changes

When the organization decides that there is a need to change the QMS, they are to be carried out in a controlled manner. Changes need to be planned and then acted upon. The organization needs to be clear as to what it is attempting to achieve.

Clause 7: Support

Clause 7.1: Resources

Clause 7.1.1: General

This requires an organization initially to determine and then subsequently provide the resources necessary to establish, implement, maintain, and continually improve its QMS.

Clause 7.1.2: People

This requires an organization to have adequate people necessary for the effective operation of its QMS and its processes in order that it can consistently meet customer, statutory, and regulatory requirements.

Clause 7.1.3: Infrastructure

It requires an organization to identify, provide, and maintain the infrastructure necessary to enable processes to operate effectively.

Clause 7.1.4: Environment for the Operation of Processes

This requires an organization to determine, provide, and maintain a suitable environment for the business to operate.

Clause 7.1.5: Monitoring and Measuring Resources

Here, an organization uses monitoring or measuring tools to demonstrate that its products and services conform to the requirements, and it must make sure that it provides the necessary resources to ensure that its monitoring and measuring results are valid.

Clause 7.1.6: Organizational Knowledge

This requires an organization to ensure that it has or obtains the knowledge necessary to respond to the changing business environments, changing customer needs and expectations, and, where applicable, related improvement initiatives.

Clause 7.2: Competence

The organization must determine the competency levels necessary for those people performing work under its control. Once these competency levels have been determined, the organization must then ensure that those people possess the necessary competencies either on the basis of their education, training, or experience.

Clause 7.3: Awareness

The requirements apply to all persons doing work under the organization's control, and this can include contractors also. People doing work under the organization's control are to be aware of the organization's quality policy, any quality objectives that are relevant to them, how they are contributing to the effectiveness of the QMS, and the implications for not conforming to the QMS requirements.

Clause 7.4: Communication

An organization must determine how it wishes to communicate on QMS matters, to whom it will communicate, and when such communications will be made.

Clause 7.5: Documented Information**Clause 7.5.1: General**

An organization's QMS should include documented information required by the standard and that identified by the organization as being necessary for the effective operation of their QMS.

Clause 7.5.2: Creation and Updating

When documented information is created or updated, the organization must ensure that it is appropriately identified, described, reviewed, and approved for suitability and adequacy.

Clause 7.5.3: Control of Documented Information**Clause 7.5.3.1: Control Organisation's QMS Documents and Records**

An Organization is required to control documented information in order to ensure that it is available where needed and that it is suitable for use.

 **Bird's-eye view:**

Organizations may be able to demonstrate conformity without the need for extensive **documented information**. It must be stressed that, according to ISO 9001:2015 clause 7.5.3 Control of documented information requirements, documents may be in any form or type of medium.

Clause 7.5.3.2: Control How QMS Documents and Records are Controlled

The organization must determine how it will distribute, access, retrieve, and use documented information.

Clause 8: Operation**Clause 8.1: Operational Planning and Control**

This requires an organization to plan, implement, and control processes identified in Clause 4.4 in order to meet the requirements for the delivery of their products and services and to put into place the actions determined as a result of risk assessment.

Clause 8.2: Determination of Requirements for Products and Services

This requires an organization to put processes in place to enable communication with clients on matters related to their products and services. Here, to put in place the processes to ensure product or service requirements are known and that any statutory and regulatory requirements including customer requirements are also known. To review the requirements related to their products and services and those specified by their customer, including any statutory and regulatory requirements are also known.

Clause 8.3: Design and Development of Products and Services

This requires an organization, who designs and develops their own products and services, to implement a design and development process, plan and control the design and development of products or services, determine specific inputs into its design and development process, apply controls to design and development process, ensure that outputs from design and development process meet the input requirements, and that the changes to design and development input or output must be controlled.

 **Bird's-eye view:**

The definition of "document" in ISO 9000:2015 clause 3.8.5 gives the following examples: paper; magnetic; electronic or optical computer disc; photograph; master sample.

Clause 8.4: Control of Externally Provided Products and Services

This requires an organization to ensure that externally provided products and services meet the specified requirements, and that they shall decide the type and extent of controls it wishes to apply and the information it needs to give to external providers.

 **Bird's-eye view:**

To claim conformity with ISO 9001:2015, the organization has to be able to provide objective evidence of the effectiveness of its processes and its quality management system.

 **Bird's-eye view:**

Clause 3.8.3 of ISO 9000:2015 defines “objective evidence” as “data supporting the existence or verity of something” and notes that “objective evidence may be obtained through observation, measurement, test, or other means.”

Clause 8.5: Production and Service Provision

This requires an organization to control the way they supply their products and services, to be able to identify and trace their product and service, to take care of property belonging to customers or external providers (if necessary), and to preserve its products and services. It also requires an organization to decide on the extent of post-delivery activities and to control of changes made to the provision of their products or services.

Clause 8.6: Release of Products and Services

This requires an organization to carry out checks to ensure its products and services are correct and meet all the necessary requirements before releasing to their customers.

Clause 8.7: Control of Nonconforming Process Outputs, Products, and Services

This requires an organization to ensure that any issues or problems with their products and services are identified and controlled so that they are not used or delivered to their customers. Actions will be taken to correct any problems, if found, and this includes where the product or service has been delivered.

Clause 9: Performance Evaluation

Clause 9.1: Monitoring, Measurement, Analysis, and Evaluation

This requires an organization to decide what needs to be monitored and measured to ensure that they fully understand the performance of their management system. The organization shall monitor their customer’s satisfaction in relation to their opinion of their products and services, and they shall analyse and evaluate data and information relevant to their business and management system operation.

Clause 9.2: Internal Audit

This requires an organization to carry out internal audits of their management system at regular intervals and to create a structure to plan, establish, implement, and maintain an audit programme that will detail the objectives of the audit programme including the scope, who will be carrying out the audit, and when the audit will take place. Results of these audits will be made available to senior managers to review at their management review meeting.

Clause 9.3: Management Review

This requires an organization’s top management to review the organization’s management system at regular intervals using information gathered during the review period.

Clause 10: Improvement

Clause 10.1: General

This requires an organization to find opportunities for improvement in relation to their management system with a view to enhance customer satisfaction.

Clause 10.2: Nonconformity and Corrective Action

This requires an organization to act when nonconformity is identified, take action to control and correct it, and deal with any consequences. They should also take action to ensure that the issue does not occur elsewhere.

Clause 10.3: Continual Improvement

This requires an organization to continually improve the performance of their management system.

Annex A (informative): Clarification of New Structure, Terminology, and Concepts

Annex A is entitled “Clarification of new structure, terminology, and concepts,” and this is what it exactly does: it gives further explanation on some of the changes and updates to ISO 9001. Annex A is informative, and it explains the new structure of the 2015 revision together with key new terms and concepts. Annex A is split into eight sections that give further explanation. Annex A explains the concepts that are included in the requirements and can help you to make sure that you have properly interpreted what the requirements are intended to say.



Bird's-eye view:

Objective evidence does not necessarily depend on the existence of documented information, except where specifically mentioned in **ISO 9001:2015**.

1. **A1 structure and terminology:** In this section, the annex explains that the structure of the clauses is meant to be clearer; it is not intended to dictate how the documented information is to be organized or those terms already in use need to change. It then proceeds to explain the changes in terminology in the new standard, such as the term “Environment for the operation of processes” rather than “work environment,” and the removal of the management representative from the standard requirements.
2. **A2 product and service:** This section explains that although ISO 9001:2008 used the term “product” to mean both products and services, the ISO 9001:2015 standard uses “products and services” throughout the standard to highlight that there is a difference between products and services in the application of the requirements. It is important to note that this implies that the requirements are applicable to the services provided by the company, such as delivery of products and not just the services of a service-based company.
3. **A3 understanding the needs and expectations of interested parties:** This section specifies that even though ISO 9001:2015 demands that you identify the requirements of interested parties, it is the company that decides if a requirement of an interested party is relevant to the QMS. Requirements that are not relevant to the QMS are not intended to be controlled by ISO 9001:2015.
4. **A4 Risk-based thinking:** While this seems to be a new concept in the ISO 9001 standard, it has been considered around the quality community for a few years and has been implicit in previous editions of ISO 9001. The details highlight that planning for risk is a key purpose of a QMS, but there is no requirement for formal risk management or a documented risk management process within the ISO 9001:2015 requirements.
5. **A5 Applicability:** Where the previous version of the standard allowed for exclusions, this standard uses the term “applicability” and defines in clause 4.3 the conditions when an organization can decide that a requirement is not applicable to their QMS.
6. **A6 Documented information:** The annex explains that the term “documented information” has come into use to align ISO 9001 with other management system standards, rather than using separate terms like “documented procedure” or “records,” but the organization needs to determine what documented information needs to be maintained.
7. **A7 Organizational knowledge:** The annex explains how organizational knowledge is meant to address the need for organizations to manage the knowledge necessary to safeguard the organization from loss of knowledge and encourage the acquisition of organizational knowledge.
8. **A8 Control of externally provided processes, products, and services:** In this section, it is explained that the requirements in Clause 8.4 are intended to be applicable to purchasing from suppliers, arrangements with associate companies, and outsourcing processes to external providers. The organization is no longer to consider only suppliers for these requirements.

Annex B (informative): Other International Standards on Quality Management and QMS Developed by ISO/TC 176

Annex B lists all ISO standards related to ISO 9001 and clauses to which each of the listed standards is referring. Annex B of the DIS, which “introduces the seven quality management principles on which the ISO portfolios of quality management standards are based.” The document names the seven principles, “provides a ‘statement’ describing each principle and a ‘rationale’ explaining why an organization should address the principle.” The seven principles include customer focus, leadership, engagement of people, process approach, improvement, evidence-based decision making, and relationship management. Note that this annex is “informational,” and so, it is not in any way a requirement of the standard.

Bird's-eye view:

Where the organization has no specific documented information for a particular activity, and this is not required by the standard, it is acceptable for this activity to be conducted using as a basis the relevant clause of ISO 9001:2015. In these situations, both internal and external audits may use the text of ISO 9001:2015 for conformity assessment purposes.

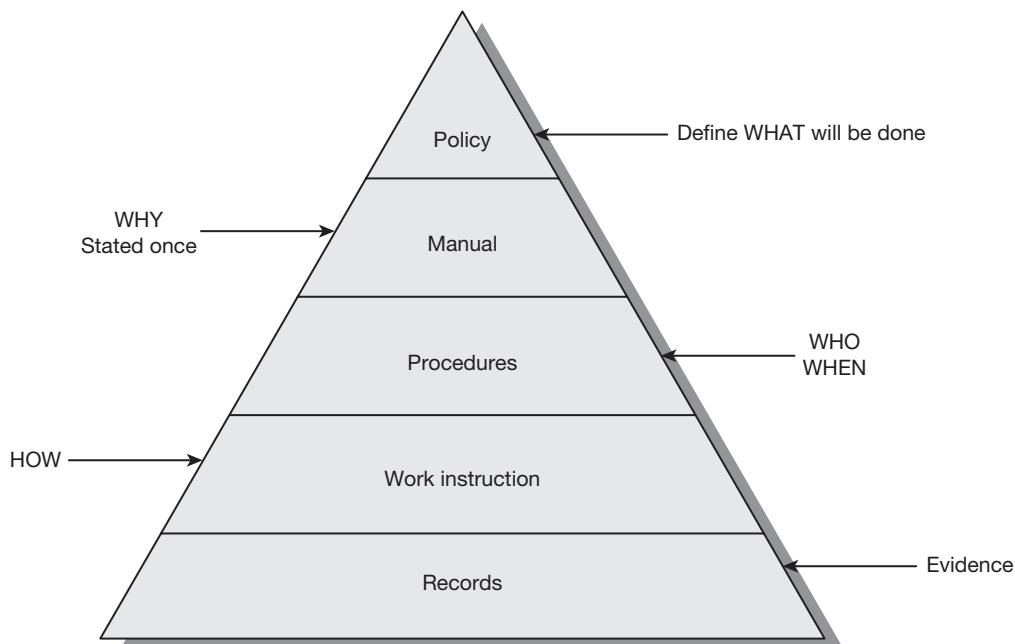
■ Mandatory Documents and Records Required by ISO 9001:2015

A particular support requirement is now considered as documented information. Gone are the terms documents, documented procedures, and records; everything is now known as documented information whether that is records, procedures, processes, and so on, and in whatever form, for example, paper, electronic, and so on. Documented information can be used to communicate a message, provide evidence of what was planned and what was actually been done, or knowledge sharing. Documentation Information is the information required to be controlled and maintained by an organization and the medium on which it is contained. It can be in any format and media and from any source such as paper, magnetic, electronic, or optical computer disc, photograph, master sample, and so on. It can also be referred as follows:

- QMS, including related processes;
- Information created in order for the organization to operate (documentation);
- Evidence of results achieved (records).

ISO 9001:2015 allows an organization flexibility in the way it chooses to document its QMS. This enables each individual organization to determine the correct amount of documented information needed in order to demonstrate the effective planning, operation, and control of its processes, implementation, and continual improvement of the effectiveness of its QMS. It is stressed that ISO 9001 requires (and always has required) a “Documented quality management system,” and not a “system of documents.” Some of the main objectives of an organization’s documented information are as follows:

1. **Communication of information:** It is used as a tool for information transmission and communication. The type and extent of the documented information will depend on the nature of the organization’s products and processes, the degree of formality of communication systems, and the level of communication skills within the organization, and the organizational culture.
2. **Evidence of conformity:** Provision of evidence that what was planned and what has actually been done.
3. **Knowledge Management:** The inclusion of Knowledge Management within the recently released ISO 9001:2015 marks a huge change within the world of KM. For the first time, one of the global business standards explicitly mentions knowledge as a resource, and specifies expectations for the management of that resource. This provides a long-awaited level of legitimacy for KM which could be a game-changer.
4. **To disseminate and preserve the organization’s experiences:** A typical example would be a technical specification, which can be used as a base for design and development of a new product or service.

Fig. 17.2 The Documentation Pyramid

Source: <http://www.iso9000resources.com> last accessed July 2016.

The document requirements are shown in Figure 17.2. The following are the documents an organization needs to produce to be compliant with ISO 9001:2015 (please note that some of the documents will not be mandatory if the company does not perform relevant processes):

- Scope of the QMS (Clause 4.3)
- Quality policy (Clause 5.2)
- Quality objectives (Clause 6.2)
- Criteria for evaluation and selection of suppliers (Clause 8.4.1)

And, here are the mandatory records (note that records marked with * are only mandatory in cases when the relevant clause is not excluded):

- Monitoring and measuring equipment calibration records* (Clause 7.1.5.1)
- Records of training, skills, experience and qualifications (Clause 7.2)
- Product/service requirements review records (Clause 8.2.3.2)
- Record about design and development outputs review* (Clause 8.3.2)
- Records about design and development inputs* (Clause 8.3.3)
- Records of design and development controls* (Clause 8.3.4)
- Records of design and development outputs *(Clause 8.3.5)
- Design and development changes records* (Clause 8.3.6)
- Characteristics of product to be produced and service to be provided (Clause 8.5.1)
- Records about customer property (Clause 8.5.3)
- Production/service provision change control records (Clause 8.5.6)
- Record of conformity of product/service with acceptance criteria (Clause 8.6)

Bird's-eye view:

All the documented information that forms part of the **QMS** has to be controlled in accordance with clause 7.5 Documented information.

Bird's-eye view:

Clause 7.5.1 General explains that the quality management system documentation shall include: a) documented information required by this International standard; b) documented information determined by the organization as being necessary for the effectiveness of the quality management system.

- Record of nonconforming outputs (Clause 8.7.2)
- Monitoring and measurement results (Clause 9.1.1)
- Internal audit program (Clause 9.2)
- Results of internal audits (Clause 9.2)
- Results of the management review (Clause 9.3)
- Results of corrective actions (Clause 10.1)

■ Non-mandatory Documents

Bird's-eye view:

The extent of the QMS documented information can differ from one organization to another due to the: a) size of organization and its type of activities, processes, products and services; b) complexity of processes and their interactions, c) competence of persons.

There are numerous non-mandatory documents that can be used for ISO 9001 implementation. The non-mandatory documents to be most commonly used:

- Procedure for determining context of the organization and interested parties (Clauses 4.1 and 4.2)
- Procedure for addressing risks and opportunities (Clause 6.1)
- Procedure for competence, training and awareness (Clauses 7.1.2, 7.2, and 7.3)
- Procedure for equipment maintenance and measuring equipment (Clause 7.1.5)
- Procedure for document and record control (Clause 7.5)
- Sales procedure (Clause 8.2)
- Procedure for design and development (Clause 8.3)
- Procedure for production and service provision (Clause 8.5)
- Warehousing procedure (Clause 8.5.4)
- Procedure for management of nonconformities and corrective actions (Clauses 8.7 and 10.2)
- Procedure for monitoring customer satisfaction (Clause 9.1.2)
- Procedure for internal audit (Clause 9.2)
- Procedure for management review (Clause 9.3)

DISCUSSION FORUM

1. Discuss the quality management system model.
2. What are the requirements of ISO 9001: 2015?
3. Which are the basic clauses and main clauses in ISO 9001?

■ ISO 14000 SERIES

ISO 14000 is a series of international, voluntary environmental management standards, guides, and technical reports. The standards specify requirements for establishing an environmental policy, determining environmental impacts of products or services, planning environmental objectives, implementing programs to meet objectives, and conducting corrective action and management review.

The primary objective of the ISO 14000 series of standards is to promote effective EMS in organizations. The standards seek to provide cost-effective tools that make use of best practices for organizing and applying information about environmental management. The first EMS standard, British Standard-BS 7750, was published in 1992 by the British Standard

Institute (BSI). In 1996, the International Organization for Standardization (ISO) created the ISO 14000 family of standards. ISO 14001 underwent revision in 2004. The current revision of ISO 14001 was published in September 2015.

The ISO 14000 family was developed in response to a recognized industry need for standardization. With different organizational approaches to environmental management, comparisons of systems and collaboration had proved difficult. ISO 14001:2015 is the most popular standard of the ISO 14000 family, which also includes standards such as the following:

- ISO 14004: General guidelines on principles, systems, and support techniques
- ISO 14006: Guidelines for incorporating eco design
- ISO 14015: Environmental assessment of sites and organizations (EASO)
- ISO 14020: Environmental labels and declarations
- ISO 14031: Environmental performance evaluation
- ISO 14040: Life cycle assessment
- ISO 14050: Vocabulary
- ISO 14063: Environmental communication
- ISO 14064: Greenhouse gases
- ISO 19011: Guidelines for auditing management systems

■ Key Benefits of Environmental Management System

There are many reasons for an organization to take a strategic approach for improving its environmental performance. Users of the standard have reported that ISO 14001 helps in the following:

- Demonstrating compliance with current and future statutory and regulatory requirements.
- Increasing leadership involvement and engagement of employees.
- Improving company's reputation and the confidence of stakeholders through strategic communication.
- Achieving strategic business aims by incorporating environmental issues into business management.
- Providing a competitive and financial advantage through improved efficiencies and reduced costs.
- Encouraging better environmental performance of suppliers by integrating them into the organization's business systems.

Bird's-eye view:

ISO 14000 is a series of environmental management standards developed and published by the International Organization for Standardization (ISO) for organizations.

■ Requirements of ISO 14001:2015

All ISO standards are reviewed every five years to establish if a revision is required in order to keep it current and relevant for the marketplace. ISO 14001 is the international standard that specifies requirements for an effective EMS. ISO 14001:2015 is designed to respond to latest trends and ensure it is compatible with other management system standards. The key changes relate to the following:

- Increased prominence of environmental management within the organization's strategic planning processes
- Greater focus on leadership
- Addition of proactive initiatives to protect the environment from harm and degradation, such as sustainable resource use and climate change mitigation

Bird's-eye view:

The **ISO 14000** standards provide a guideline or framework for organizations that need to systematize and improve their environmental management efforts.

Fig. 17.3 Implementation of EMS

 **Bird's-eye view:**

ISO 14001 is an internationally agreed standard that sets out the requirements for an environmental management system. It helps organizations improve their environmental performance through more efficient use of resources and reduction of waste, gaining a competitive advantage and the trust of stakeholders.

- Improving environmental performance added
- Life cycle thinking when considering environmental aspects
- Addition of communication strategy

ISO 14001 provides a framework that an organization can follow, rather than establishing environmental performance requirements. Implementing an EMS, as described in the current ISO 14001 standard, is a solid way to identify and control the effects of your company on the environment. It is based on five environmental management principles. They are environmental policy, environmental plan, plan implementation, monitoring and corrective actions, and management review and is shown in Figure 17.3. ISO 14001:2015 now requires the following:

1. Environmental management to be more prominent within the organization's strategic direction.
2. A greater commitment from leadership.
3. The implementation of proactive initiatives to protect the environment from harm and degradation, such as sustainable resource use and climate change mitigation.
4. A focus on life cycle thinking to ensure consideration of environmental aspects from development to end-of-life.
5. The addition of a stakeholder-focused communication strategy. It also allows for easier integration into other management systems—thanks to the same structure, terms, and definitions.

At the highest level, ISO 14001:2015 covers the topics such as context of the organization, leadership, planning, support, operation, performance evaluation, and improvement with regard to EMS. The requirements of ISO 14001:2015 is given in Table 17.2.

Table 17.2 EMS Requirements

Clause No.	Contents
1	Scope
2	Normative references
3	Terms and definitions
4	Context of the organizations
4.1	Understanding the organization and its context
4.2	Understanding the needs and expectations of interested parties
4.3	Determining the scope of the environment management system
4.4	EMS and its processes
5	Leadership
5.1	Leadership and commitment
5.2	Environmental Policy
5.3	Organizational roles, responsibilities and authorities
6	Planning
6.1	Actions to address risks and opportunities
6.2	Environmental objectives and planning to achieve them
7	Support
7.1	Resources
7.2	Competence
7.3	Awareness
7.4	Communication
7.5	Documented information
8	Operation
8.1	Operational planning and control
8.2	Emergency preparedness and response
9	Performance evaluation
9.1	Monitoring, measurement, analysis and evaluation
9.2	Internal audit
9.3	Management review
10	Improvement
10.1	General
10.2	Nonconformity and corrective action
10.3	Continual improvement
Annex A	Guidance on the use of this International Standard
Annex B	Correspondence between ISO 14001:2015 and ISO 14001:2004
Bibliography	

 **Bird's-eye view:**

ISO 14001:2015 specifies the requirements for an environmental management system that an organization can use to enhance its environmental performance.

 **Bird's-eye view:**

ISO 14001:2015 is intended for use by an organization seeking to manage its environmental responsibilities in a systematic manner that contributes to the environmental pillar of sustainability.

 **Bird's-eye view:**

ISO 14001 certification can assure stakeholders that environmental management system (EMS) meets international industry specific environmental standards. Every company whether it is large and small; industrial, manufacturing, services, or trade related had an impact on the environment and can therefore benefit from ISO 14001 certification.

■ Mandatory Documents and Records Required by ISO 14001:2015

Following are the documents you need to produce if you want to be compliant with ISO 14001:

- Scope of the EMS (Clause 4.3)
- Environmental policy (Clause 5.2)
- Risk and opportunities to be addressed and processes needed (Clause 6.1.1)
- Criteria for evaluation of significant environmental aspects (Clause 6.1.2)
- Environmental aspects with associated environmental impacts (Clause 6.1.2)
- Significant environmental aspects (Clause 6.1.2)
- Environmental objectives and plans for achieving them (Clause 6.2)
- Operational control (Clause 8.1)
- Emergency preparedness and response (Clause 8.2)

The required mandatory records are as follows:

- Compliance obligations record (Clause 6.1.3)
- Records of training, skills, experience, and qualifications (Clause 7.2)
- Evidence of communication (Clause 7.4)
- Monitoring and measurement results (Clause 9.1.1)
- Internal audit program (Clause 9.2)
- Results of internal audits (Clause 9.2)
- Results of the management review (Clause 9.3)
- Results of corrective actions (Clause 10.1)

Apart from the above mentioned mandatory records, there are numerous non-mandatory documents that can be used for ISO 14001 implementation. However, commonly used non-mandatory documents are as follows:

- Procedure for determining context of the organization and interested parties (Clauses 4.1 and 4.2)
- Procedure for identification and evaluation of environmental aspects and risks (Clauses 6.1.1 and 6.1.2)
- Competence, training, and awareness procedure (Clauses 7.2 and 7.3)
- Procedure for communication (Clause 7.4)
- Procedure for document and record control (Clause 7.5)
- Procedure for internal audit (Clause 9.2)
- Procedure for management review (Clause 9.3)
- Procedure for management of nonconformities and corrective actions (Clause 10.2)

■ OCCUPATIONAL HEALTH AND SAFETY MANAGEMENT SYSTEMS

An Occupational Health and Safety Management System (OHSMS) is a coordinated and systematic approach to managing health and safety risks. OHSMSs help organizations to continually improve their safety performance and compliance to health and safety legislation

and standards. In doing so, they establish safer working environments that protect people at work by eliminating, or better managing, health and safety hazards. The salient features of OHSMS are as follows:

- Ensures that your health and safety management is aligned with the strategic direction of the organization;
- Improves integration with other management system standards;
- Increases involvement of the leadership team;
- Improves occupational health and safety performance.

OHSMS helps organizations to continually improve their health and safety performance. ISO 45001 OHSMS was intentionally developed to be compatible with the ISO 9001 (Quality) and ISO 14001 (Environmental) management systems standards for easier integration of quality, environmental, and occupational health and safety management systems by organizations. ISO 45001 outlines the requirements for an OHSMS to enable an organization to control its OH&S risks and improve its performance. Similar to ISO 14001, it does not state performance criteria or dictate the design of a management system.

ISO 45001:2016 replaces ISO 18001:2007. The draft of ISO 45001 provides us with some insight into what documents will be required by this new standard. Compared to OHSAS 18001, there are not too many changes, but the requirements for documentation are simpler and less demanding, following the logic of new versions of other ISO standards.

ISO 45001 Occupational health and safety management systems—requirements will help organizations reduce this burden by providing a framework to improve employee safety, reduce workplace risks, and create better, safer working conditions, all over the world. The standard is developed by a committee of occupational health and safety experts, and will follow other generic management system approaches such as ISO 14001 and ISO 9001. ISO 45001 is intended for use by any organization, regardless of its size or the nature of its work, and can be integrated into other health and safety programmes such as employees' wellness and wellbeing. It also addresses many, if not all, legal requirements in this area.

Bird's-eye view:

An Occupational Health and Safety Management System (**OHSMS**) is a coordinated and systematic approach to managing health and safety risks. OHSMSs help organisations to continually improve their safety performance and compliance to health and safety legislation and standards.

■ Requirements of ISO 45001:2016

The new ISO high level structure (HLS) brings a common framework to all management systems. This helps to keep consistency, align different management system standards, offer matching sub-clauses against the top level structure, and apply common language across all standards. With the new standard in place, organizations will find it easier to incorporate their OHSMS into core business processes and get more involvement from senior management. The Plan-Do-Check-Act (PDCA) cycle can be applied to all processes and to the OHSMS as a whole.

Clause 1—Scope: This clause details the scope of international standard, which specifies the requirements for an OHSMS with guidance for its use. It enables organizations to provide safe and healthy working conditions for the prevention of work-related injury and ill health and proactively improve its OHSMS performance.

Clause 2—Normative references: There are no normative references within the standard. The clause is retained in order to maintain the same numbering scheme as all the other ISO management system standards.

Clause 3—Terms and definitions: The terms are listed relative to their conceptual importance (and thus where they occur in the standard). Terms and definitions have been extended

 **Bird's-eye view:**

ISO 45001 Occupational health and safety management systems—requirements will help organizations reduce this burden by providing a framework to improve employee safety, reduce workplace risks, and create better, safer working conditions, all over the world. The standard is developed by a committee of occupational health and safety experts, and will follow other generic management system approaches such as ISO 14001 and ISO 9001.

from 23 in OHSAS 18001 to 37 in ISO/DIS 45001 and provide further guidance and clarity to avoid misunderstanding. A number of new definitions have been added and some of the existing definitions were revised including those relating to worker participation, consultation, OH&S risk, OH&S opportunity, OH&S performance, and injury and ill health amongst others.

Clause 4—Context of the organization: This clause establishes the context of the OHSMS and underpins the rest of standard. It gives an organization the opportunity to identify and understand the external and internal factors and interested parties that affect the intended outcome(s) of the OHSMS. It also in part addresses the concept of preventive action. Requirement of Clause 4 is to establish, implement, maintain, and continually improve the OHSMS in accordance with the requirements of the standard.

Clause 5—Leadership and worker participation: This clause places requirements on “top management,” which is the person or group of people who directs and controls the organization at the highest level. Top management must take overall responsibility and accountability for the protection of workers’ work-related health and safety, and need to develop, lead, and promote a culture that supports the OHSMS. They must ensure that the requirements are integrated into the organization’s processes and that the policy and objectives are compatible with the strategic direction of the organization. They also need to establish the OH&S policy, and the standard defines the characteristics and properties that the policy has to include.

Top management need to ensure that the importance of effective OHSMS is communicated and understood by all parties and that the OHSMS achieves its intended outcomes. Moreover, this clause contains the requirement to establish, implement, and maintain an OH&S policy in consultation with workers at all levels. This must include commitments to provide safe and healthy working conditions, satisfying legal requirements, setting OH&S objectives, and continual improvement. Finally, top management need to assign and communicate responsibilities, accountabilities, and authorities for relevant roles within the system, including workers at each level within the organization assuming responsibility for those aspects of the OHSMS over which they have control.

Clause 6—Planning: Planning has always been a familiar element in OHSMS, but now there is an increased focus on ensuring that it is considered with the outputs of Clause 4 “context of the organization.” Planning should be seen as an on-going process that anticipates changing circumstances.

Clause 7—Support: This clause begins with a requirement that organizations shall determine and provide the necessary resources to establish, implement, maintain, and continually improve the OHSMS. These cover human resources, natural resources, infrastructure, and financial resources. In simple words, this is a very powerful requirement covering all OH&S resource needs.

Clause 8—Operation: This clause deals with the execution of the plans and processes that are the subject of previous clauses. Operational planning and controls should be established to meet the requirements of the OHSMS including controls to reduce OH&S risks to levels as low as reasonable practical.

Clause 9—Performance evaluation: Organizations have to determine what information they need to evaluate OH&S performance and effectiveness. Working backwards from this “information need” will help to identify what specifically needs to be measured and

monitored, when, by who, and how. The frequency of monitoring and measuring should be appropriate to the size and nature of the organization, its OH&S performance, and with regard to changes in OH&S risk. Documented information that provides evidence of this must be retained.

Clause 10—Improvement: Due to the new structure and risk focus of the standard, there are no preventive action requirements in this clause. However, there are some new detailed corrective action requirements. The requirement for continual improvement has been extended to continually improve the suitability and adequacy of the OHSMS as well as its effectiveness through continual improvement objectives.

■ Benefits of an OHSMS

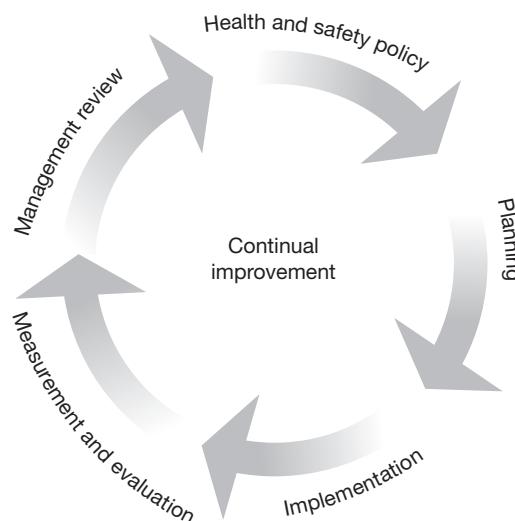
ISO/DIS 45001 brings occupational health and safety management and continual improvement into the heart of an organization. This new standard is an opportunity for organizations to align their strategic direction with their OHSMS. In addition, there is an increased focus on improving occupational health and safety performance and culture. The benefits of ISO 45001 are as follows:

- Reduce work-related injuries, ill health, and death.
- Eliminate or minimize OH&S risks.
- Demonstrate corporate responsibility and meet supply chain requirements.
- Protect brand reputation.
- Motivate and engage staff through consultation and participation.

■ Five Steps of an OHSMS

There are five steps to an effective OHSMS, and these steps form a continual cycle of improvement as shown in the Figure 17.4.

Fig. 17.4 Five Steps of an OHSMS



Bird's-eye view:

Adopting and implementing a structured health and safety management system based on standards such as **OHSAS** can provide significant benefits to organizations, including better awareness of hazards and reduced risk, leading to fewer lost time incidents and injuries, and improved health and safety in the work place.

 **Bird's-eye view:**

Quality, the environment, and health and safety are all unified by the concept of risk. Using three separate management systems within one organization is clearly time consuming, expensive, and inefficient. **By integrating these management systems**, an organization can minimize duplication of align objectives and reduce costs.

1. **Top management commitment and policy:** The policy is a general plan of intent that guides or influences future decisions. It is the basis upon which measurable objectives and targets and the OHSMS is developed.
2. **Planning:** Plan how to deliver the OHS policy, objectives, and targets to ensure hazards arising from work activities are identified so that risks can be assessed and then controlled.
3. **Implementation:** Implement the plan by developing the capabilities and support mechanisms necessary to achieve the OHS policy, objectives, and targets.
4. **Measurement and evaluation:** Measure, monitor, and evaluate OHS performance to determine the effectiveness of risk management, and, if necessary, take preventative and corrective action.
5. **Review and improvement:** Review and continually improve the OHSMS with the objective of improving OHS performance.

■ Documentation Requirements

The requirements for documented information are spread throughout the standard; in summary, they are as follows:

1. Scope of the OHSMS (Clause 4.3)
2. OH&S Policy (Clause 5.2)
3. Organizational roles, responsibilities, accountabilities, and authorities (Clause 5.3)
4. OH&S risks and OH&S opportunities that need to be addressed, and the processes needed to address them to the extent necessary to have confidence that the processes have been carried out as planned (Clause 6.1.1)
5. Methodologies and criteria for the assessment of OH&S risks (Clause 6.1.2.2)
6. Applicable legal requirements and other requirements (Clause 6.1.3)
7. OH&S objectives and plans to achieve them (Clause 6.2.2)
8. Evidence of competence (Clause 7.2)
9. Evidence of relevant communications (Clause 7.4)
10. Documented information required by the International Standard as well as documented information, determined by the organization, as being required for the effectiveness of the OHSMS (Clause 7.5.1)
11. Documented information of external origin determined by the organization, which is necessary for the planning and operation of the OHSMS (Clause 7.5.3)
12. Documented information to the extent necessary to have confidence that the processes have been carried out as planned and in relation to any situations where the absence of such could lead to deviations from the OH&S policy and OH&S objectives (Clause 8.1.1)
13. Processes and plans for responding to potential emergency situations (Clause 8.6)
14. Evidence of monitoring, measurement, analysis, and evaluation results (Clause 9.1.1)
15. Evidence of compliance evaluation results (Clause 9.1.2)
16. Evidence of the implementation of the audit programme and the audit results (Clause 9.2.2)
17. Evidence of the results of the management reviews (Clause 9.3)

18. Information of the nature of the incidents or nonconformities and any subsequent actions taken, and the results of any corrective action taken including their effectiveness (Clause 10.1)
19. Evidence of the results of continual improvement (Clause 10.2)

■ Integrated Management System

Quality, the environment, and health and safety are all unified by the concept of risk. Using three separate management systems within one organization is clearly time-consuming, expensive, and inefficient. By integrating these management systems, an organization can minimize duplication of align objectives and reduce costs. An integrated management system (IMS) describes several previously separate management systems grouped together to form a single system. A management system is integrated when at least two out of three possible systems (quality, environment, and health and safety) are integrated.

The aim of an integrated system is to streamline the processes even further and avoid duplication. However, just because a system is integrated, it does not mean less attention is paid to auditing individual systems. The system must conform to the requirements of the individual standards in order to maintain a high level of credibility and effectiveness. Implementing IMS requires preparing integrated QMS/EMS/OHSAS Manual and documenting procedures required by ISO 9000/ISO 14000 and OHSAS 45000 standards.

The three management systems share many common requirements and the continual improvement goals. They differ in their approach and degree of prescription, but the ISO 9001, the ISO 14001, and ISO 45001 standards are compatible in content, terminology, and many of the requirements. If an organization wants to have one comprehensive management systems covering health and safety, environmental, and quality, then there are many common requirements which do not need to be repeated. It is often more efficient to combine the three systems (QMS, EMS, and OHSMS) into one and share the common clauses and procedures. Rather than having parallel (duplicate) manuals and other documentation, an organization can add OHSMS and EMS requirements to the common QMS manual, procedures, and instructions. Integrating an IMS can be more effective and efficient than maintaining individual systems. There are seven common elements in ISO 9001, ISO 14001, and OHSAS 45001:

- Structure and responsibility
- Training, awareness, and competence
- Document control
- Records
- Corrective and preventive action
- Internal audits
- Management review

DISCUSSION FORUM

1. What are the requirements of ISO 14001:2015?
2. What are the requirements of ISO 45001:2016?
3. Discuss the key benefits of EMS and OHSMS.
4. Discuss Integrated Management System.
5. Which are the common elements in QMS, EMS, and OHSMS?

SUMMARY

- ISO (International Organization for Standardization) is the world's largest developer of standards. ISO's principal activity is the development of international standards. The Central Secretariat of ISO is based in Geneva, Switzerland, that coordinates the system.
- The ISO 9000 standards were issued in 1987 and represent requirements for the development and implementation of a QMS in an organization. The ISO 9000 family of standards represents *an international consensus on good quality management practices*. It consists of standards and guidelines relating to QMS and related supporting standards.
- The ISO 9000 standards were introduced for first time in the year 1987. It was revised in the year 1994. In the year 2000, the revised and updated version was introduced, and in the year 2008, again it was revised. Now, the latest version is ISO 9001:2015.
- ISO 9001:2015 published on 23 September 2015 replaces previous editions. The three pillars of the ISO 9001:2015 standard are process approach, risk-based thinking, and continual improvement. ISO 9001:2015 is more compatible with other management systems, such as ISO 14001:2015 EMS and ISO 45001:2016 Occupation Health and Safety Management System, making it more effective and efficient to integrate management systems.
- Two of the most important objectives in the revision of the ISO 9000 series of standards are (a) to develop a simplified set of standards that will be equally applicable to small as well as medium and large organizations and (b) the amount and detail of documentation required should be more relevant to the desired results of the organization's process activities.
- There are number of institutions in India, which provides strategic direction to the quality movement in the country. They are: Bureau of Indian Standards (BIS); Quality Council of India (QCI) and Confederation of Indian Industry's Institute of Quality (CII-IQ).
- The 9001:2015 standard comprises of ten clauses. The QMS requirements are: Scope; Normative Reference; Terms and Definitions; Context of the Organization; Leadership; Planning; Support; Operation; Performance Evaluation and Improvement.
- EMS refers to the management of an organization's environmental programs in a comprehensive, systematic, planned, and documented manner. It includes the organizational structure, planning, and resources for developing, implementing, and maintaining policy for environmental protection.
- EMS is based on five environmental management principles. They are environmental policy, environmental plan, plan implementation, monitoring and corrective actions, and management review.
- ISO 14000 is a series of international, voluntary environmental management standards, guides, and technical reports. The standards specify requirements for establishing an environmental policy, determining environmental impacts of products or services, planning environmental objectives, implementing programs to meet objectives, and conducting corrective action and management review.
- The primary objective of the ISO 14000 series of standards is to promote effective EMS in organizations. The standards seek to provide cost-effective tools that make use of best practices for organizing and applying information about environmental management.
- The ISO 14001 Certification is an EMS Standards—this standard provided the requirement of EMS and guideline for use. The ISO 14001 standard is a specific standard for

EMS. The ISO 14001 (EMS) is applicable to any organization that wishes to demonstrate sound environmental performance of the organization by controlling the impacts of their activities, products, and services on the environment, consistent with their environmental policy and objectives, and complying with applicable legal and regulatory requirements.

- ISO 14001:2015 provides a framework that an organization can follow, rather than establishing environmental performance requirements. Implementing an EMS, as described in the current ISO 14001 standard, is a solid way to identify and control the effects of your company on the environment.
- An Occupational Health and Safety Management System (OHSMS) is a coordinated and systematic approach to manage health and safety risks. OHSMSs help organizations to continually improve their safety performance and compliance to health and safety legislation and standards. In doing so, they establish safer working environments that protect people at work by eliminating, or better managing, health and safety hazard.
- ISO 45001 will require an organization to look beyond its immediate health and safety issues and take into account what the wider society expects of it. Organizations will have to think about their contractors and suppliers as well as the effects their activities have on neighbouring communities.
- ISO 45001 *Occupational health and safety management systems—requirements*, that will help organizations reduce this burden by providing a framework to improve employee safety, reduce workplace risks, and create better, safer working conditions, all over the world.
- An Integrated Management System (IMS) combines all related components of a business into one system for easier management and operations. Quality (QMS), Environmental (EMS), and Occupation Health and Safety management systems (OHSMS) are often combined and managed as an IMS. These systems are not separate systems that are later joined together, rather they are integrated with linkages so that similar processes are seamlessly managed and executed without duplication.

Key Terms

Authority 535	Factual approach to decision making 537
Basic clauses 540	IMS 532
Bureau of Indian Standards (BIS) 533	Infrastructure 534
Confederation of Indian Industry's Institute of Quality (CII-IQ) 533	Involvement of people 537
Continual improvement 535	ISO 14000 550
Corrective action 541	ISO 9000 535
Customer focus 537	Leadership 537
Customer requirement 537	Main clauses 540
Customer satisfaction 535	Management review 541
Design and development output 549	Measurement 541
Documentation 536	Monitoring and measuring equipment 549
EMS 561	OHSMS 532

PDCA 538	Quality policy 541
Preventive action 556	Records 547
Procedures 548	Release of product 547
Process approach 536	Responsibility 535
QMS 532	Scope normative reference 560
Quality Council of India (QCI) 534	Terms and definitions 536
Quality manual 564	Verification 537
quality objectives 541	Work environment 547

Case Study

Implementing Quality Management System at Hyundai Motors

Hyundai Motors India Limited, a 100 per cent subsidiary of the South Korea-based Hyundai Motor Company, started its operations in 1996. In September 1998, Hyundai India started mass production of its well-known hatchback “Santro.” It launched its second model “Accent” in October 1999. It started establishing its products in the global market in 2000. It launched its super luxury sedan “Sonata” in July 2001.

As per Hyundai India’s policy, quality simply does not mean meeting specifications. Quality for Hyundai India means meeting customer requirements and exceeding their expectations. The company also concentrates on indirect customers and was the first to introduce MPFI (Multi-point fuel injection) in 1998 for the small car segment, even when the Euro II standards were not mandatory. This case study focuses on how Hyundai has been able to successfully adopt the automotive standard QS 9000.

QS 9000

QS 9000 is a sector specific common supplier quality standard for the automotive industry. In 1988, Chrysler Corporation, Ford Motor Company and General Motors Corporation came together to form the Supplier Quality Requirements Task Force to standardize reference manuals, reporting formats and technical nomenclature for all documents related to supplier requirements. In 1992, the task force harmonized the fundamental supplier quality systems manuals and assessment tools. This gave rise to Quality System Requirements QS 9000—a common supplier quality requirements standard that was adopted by all three automotive companies. It is based on the ISO 9001. However, it contains additional requirements peculiar to the automotive industry. Today many automotive companies have adopted QS 9000.

QS 9000 defines the fundamental quality system expectations of Chrysler, Ford, General Motors and other subscribing companies for internal and external suppliers of production and service parts and materials. QS 9000 is a harmonization of Chrysler’s Supplier Quality Assurance Manual, Ford’s Q-1011 Quality Systems Standard and General Motors’ NAO Targets for Excellence and supersedes all editions of these documents. The benefits of QS 9000 certification include improved quality, improved efficiency, improved delivery and company morale, improved internal and external communication.

The QS 9000 applies to all internal or external, potential or existing suppliers' vendors/sub-contractors of production materials, production or service parts, heat-treating, painting, plating, finishing services who supply to OEM (Original Equipment manufacturers) customers subscribing to the QS 9000 standard.

QS 9000 is a supplement to ISO 9000 with additional requirements for each ISO 9001. The standard has undergone two revisions since its inception. The third edition of QS 9000 standard comprises two primary sections. Section I deals with ISO 9000-based requirements and sector specific requirements while Section II deals with customer-specific requirements.

QS 9000 at Hyundai

Hyundai India was certified to QS 9000 in January 2002. QS 9000 is a customer-driven automotive standard that focuses on defect prevention, continuous improvement and reduction of wastage or variation in the supply chain, development of sub-contractors, product quality, cost, delivery and service. It is based on a preventive methodology and uses disciplined problem-solving methods.

Benefits of QS 9000 Certification for Hyundai

After QS 9000 certification, activities were streamlined and a focused approach to planning was established. A team of professionals started concentrating on solving problems and identifying potential areas of improvement. The main benefits of QS 9000 were:

- The attitude of workers improved. They felt encouraged to come out with more ideas on mistake-proofing, defect-prevention, statistical analysis of a particular activity, etc.
- The company was able to identify potential failures of the product and take control measures in time by adoption of Failure Mode and Effect Analysis (FMEA).
- Hyundai was able to measure the customer satisfaction/dissatisfaction levels, whereby they were able to improve products through process control.
- Hyundai has been able to improve the direct pass ratio of vehicles. The field claims on product have also reduced.
- Customer complaints were analysed by the auditors at length and they also looked at the corrective and preventive action plan. By adopting QS 9000, the company has eliminated all unrelated/waste processes, non-value added solutions, thereby focusing only on the customer requirements.
- Employees could relate to QS 9000, as it was close to their work. The employees became more proactive.

The company also realised the importance of the competence of the certification body in implementing a standard. The full objective of the standard can be achieved only if the certification body is competent.

Source: Adapted from www.tuv-sud.in, accessed May 2010.

For Discussion

1. Why did Hyundai decide to implement the QS 9000 system?
2. What is the difference between ISO 9000 and QS 9000?

3. Explain the QS 9000 system.
4. What were the benefits of QS 9000 implementation at Hyundai?

Short-answer Questions

1. What is ISO?
2. What is ISO 9000?
3. What are the ISO 9000 series of standards?
4. What is the scope of ISO 9001:2015?
5. What are the clauses of ISO 9001 QMS?
6. What is meant by the “quality policy” of an organization?
7. What is the purpose of the quality manual?
8. What is meant by “process approach”?
9. What are the main benefits of implementing QMS?
10. Which are the organizations promoting quality movement in India?
11. What are the requirements of ISO 14001:2015
12. What are the main benefits of implementing EMS?
13. What are the requirements of ISO 45001:2016?
14. What are the main benefits of implementing OHSMS?
15. Which are the common elements in QMS, EMS, and OHSMS?
16. What are the benefits of IMS?

Match the Following

- | | |
|-----------------------|---|
| a. Quality policy | forms are developed and maintained to record data |
| b. Quality objectives | defines what will be done by the organization |
| c. Quality manual | how work is done to meet customer expectations |
| d. Procedures | provide an adequate description of the QMS |
| e. Work instructions | specifies way to carry out a process or an activity |
| f. Records | describes critical activities |

Discussion Questions

1. Describe QMS.
2. Narrate historical background giving details of origin of quality and evolution of ISO 9000.
3. What are the requirements of ISO 9001:2015?
4. What are the benefits of QMS, EMS, and OHSMS?
5. Explain the organizations supporting quality movement in India?
6. Describe the requirements of ISO 14001:2015.
7. Discuss the requirements of ISO 45001:2016.
8. Explain integrated management system.

Projects

1. Prepare an action plan for implementing IMS in your organization.
2. How do you propose to develop documentation of your organization?
3. Individually or with a team of three or more people, determine which three EMS benefits would be most important for a hospital, oil company, pharmaceutical company, university, food processor, paint manufacturer, and paper manufacturer.

End Notes

1. Applying ISO 9000 Quality Management Systems, International Trade Centre, UNCTAD/WTO, Geneva, Switzerland.
2. ISO 9000 Quality Management Systems: Guidelines for Enterprises in Developing Countries, International Trade Centre UNCTAD/WTO, Geneva, Switzerland.
3. www.iso.org
4. http://www.iso.org/iso/iso_catalogue/management_standards
5. ISO 9001 Fitness Checker, International Trade Centre UNCTAD/WTO, Geneva, Switzerland.
6. ISO 9000 Quality Systems Handbook, David Hoyle, Elsevier.
7. ISO 9001:2015 Quality Management Systems—Requirements Standard by International Organization for Standardization, 09/15/2015.
8. ISO 14001:2015 EMS—Requirements with Guidance for Use, Standard by International Organization for Standardization, 09/01/2015.
9. The Integrated Use of Management System Standards, handbook/manual/guide by International Organization for Standardization, 01/01/2008.

18

Management Audit



NATIONAL ACCREDITATION BOARD FOR CERTIFICATION BODIES

The National Accreditation Board for Certification Bodies (NABCB) provides accreditation to certification and inspection bodies based on assessment of their competence as per the Board's criteria and in accordance with international standards and guidelines.

NABCB is internationally recognized and represents the interests of the Indian industry at international forums through membership and active participation with the objective of becoming a signatory to international Multilateral/Mutual Recognition Arrangements (MLA/MRA). NABCB provides service to the satisfaction of its customers in accordance with the national and international norms. It is committed to provide equal opportunity to all the applicants with highest regard to transparency, integrity, and confidentiality. The Board has decided to provide accreditation services to certification and inspection bodies established

as legal entities within the SAARC nations. However, relevant locations of the certification and inspection bodies in other countries may be included in the accreditation process.

NABC is a member of International Accreditation Forum (IAF) and Pacific Accreditation Cooperation (PAC) as well as signatory to its MLAs for Quality Management Systems, Environmental Management Systems, and Product Certification. NABC is also a full member of International Laboratory Accreditation. The objectives of NABC are as follows:

- To be equally accessible to all the certification body applicants who wish to be accredited to the criteria of the Board within its scope and capability and within the geographical limitations decided by the Board.
- To upgrade criteria of accreditation in line with international improvements and to foster improvement in the quality of certification process with the support of certification bodies.
- To be impartial in its decision on criteria and process of accreditation.
- To seek mutual recognition of the accreditation schemes internationally.
- To be independent of any undue influence of any stakeholder and to conduct its business professionally.

“Quality is never an accident; it is always the result of high intention, sincere effort, intelligent direction, and skilful execution; it represents the wise choice of many alternatives”.

—William A. Foster

Upon completion of this chapter, you will be able to:

1. Identify different types of audit
2. Explain the guidelines for auditing management systems
3. Identify the role of certification bodies
4. Identify the steps to certification
5. Explain analysis of registration requirements

INTRODUCTION

An ISO audit, basically, means checking to ensure whether you are actually doing what you say you are doing. During an ISO audit, you will verify that the management system is in compliance with the relevant ISO standard and check to ensure that the actions taken to meet the quality objectives of the organization are suitable. Auditing is the onsite verification activity, such as inspection or examination, of a process or quality system, to ensure compliance to requirements. An audit can apply to an entire organization or might be specific to a function, process, or production step.

ISO first published audit standard in the year 2002. The standard was revised in the year 2011. The new and the latest ISO 19011:2011 has been rewritten, reorganized, and expanded. As it is a new standard, many sections have been strengthened and improved. ISO 19011:2011 is a management system auditing standard. It is used to carry first- and second-party audits. As defined in ISO 19011:2011—*Guidelines for auditing management systems*, an audit is a

Bird's-eye view:

An **ISO Audit** is a basic term which means, checking to ensure that you are actually doing what you had promised to do.

"systematic, independent, and documented process for obtaining audit evidence (records, statements of fact, or other information that are relevant and verifiable) and evaluating it objectively to determine the extent to which the audit criteria (set of policies, procedures, or requirements) are fulfilled." Several audit methods may be employed to achieve the audit purpose.

ISO 19011:2011 is used to carry out first- and second-party audits for risk management systems, quality management systems, energy management systems, safety management systems, health management systems, service management systems, records management systems, disaster management systems, document management systems, food safety management systems, emergency management systems, sustainability management systems, environmental management systems, business continuity management systems, information security management systems, supply chain security management systems, transportation safety management systems, organizational resilience management systems, and occupational health and safety management systems.

■ ISO 19011:2011 VERSUS ISO 19011:2002

Bird's-eye view:

ISO first published audit standard in the year 2002. The standard was revised in the year 2011. The new and the latest ISO 19011:2011 has been rewritten, reorganized, and expanded. As it is a new standard, many sections have been strengthened and improved. ISO 19011:2011 is a management system auditing standard. It is used to carry first- and second-party audits.

ISO first published audit standard in 2002. The second edition was published on November 15, 2011. It cancels and replaces the first edition. If you compare the first and the second edition, you will notice some important differences.

■ New Scope

Perhaps the major difference between the two editions relates to the scope of the standard. The old standard applied only to quality and environmental management systems, whereas the new standard now applies to all types of management systems.

■ New Focus

There are two auditing standards that apply to management systems: ISO 19011:2011 and ISO IEC 17021:2015. The relationship between these two standards has now been clarified. ISO 19011:2011 applies to first- and second-party audits, whereas ISO 17021:2015 applies to third-party audits.

■ New Principle

The new standard is now all about confidentiality and information security. It recommends handling information with due care and discretion. In addition, it wants to protect information that is sensitive or confidential. In general, it now specifies to be careful about how you and your clients manage information acquired during the course of an audit.

■ New Concept

The new standard now wants you to think about risk and expects you to consider the risks that could affect the achievement of audit program objectives. It also suggests you to allocate audit program resources so that more significant matters receive priority. Adding more resources to more important matters is called *risk-based auditing*.

■ New Method

The new standard now emphasizes to consider using *remote audit methods* in addition to *onsite audit methods*. Remote audit methods are carried out away from the auditee's physical location. They include long distance interviews and the use of interactive electronic communications.

■ New Annexes

Finally, the standard now has two annexes. Annex A describes the type of knowledge and skill that management system auditors should have, and Annex B is designed to help auditors to plan and perform their work.

■ Purpose of Audits

ISO 19011 distinguishes between internal and external auditors. *Internal auditors* perform first-party audits, whereas *external auditors* perform second- and third-party audits.

An auditor may specialize in different types of audits based on the audit purpose, such as to verify compliance, conformance, or performance. Some audits have special administrative purposes such as auditing documents, risk, performance, or following up on completed corrective actions.

■ Types of Audit

ISO 19011:2011 also distinguishes between combined audits and joint audits. When two or more management systems of different disciplines are audited together at the same time, it is called a combined audit, and when two or more auditing organizations cooperate to audit a single auditee organization, it is called a joint audit.

There are three discrete types of audits: product (which includes services), process, and system. However, other methods, such as a desk or document review audit, may be employed independently or in support of the three general types of audits.

Some audits are named according to their purpose or scope. The purpose of a management audit relates to management interests such as assessment of area performance or efficiency.

An audit may also be classified as internal or external depending on the interrelationships among participants. Internal audits are performed by employees of an organization. External audits are performed by an outside agent. Internal audits are often referred to as first-party audits, whereas external audits can be either second- or third-party audits.

Product Audit

An examination of a particular product or service (hardware, processed material, or software) to evaluate whether it conforms to the requirements, that is, specifications, performance standards, and customer requirements.

Process Audit

It is a verification to confirm whether the processes are working within the established limits. It evaluates an operation or method against predetermined instructions or standards to measure conformance to these standards and the effectiveness of the instructions. Such an audit may:

1. Check conformance to defined requirements such as time, accuracy, temperature, pressure, composition, responsiveness, amperage, and component mixture.
2. Examine the resources (equipment, materials, and people) applied to transform the inputs into outputs, the environment, the methods (procedures and instructions) followed, and the measures collected to determine process performance.
3. Check the adequacy and effectiveness of the process controls established by procedures, work instructions, flowcharts, and training and process specifications.

System Audit

It is an audit conducted on a management system. It can be described as a documented activity performed to verify, by examination and evaluation of objective evidence, that applicable

Bird's-eye view:

An **auditor** may specialize in different types of audits based on the audit purpose, such as to verify compliance, conformance, or performance.

There are three discrete **types of audits**: product (which includes services), process, and system. An audit may also be classified as internal or external depending on the interrelationships among participants. Internal audits are performed by employees of an organization. External audits are performed by an outside agent. Internal audits are often referred to as first-party audits, whereas external audits can be either second- or third-party audits.

elements of the system are appropriate and effective and have been developed, documented, and implemented in accordance and in conjunction with specified requirements.

A quality management system audit evaluates an existing quality program to determine its conformance to company policies, contract commitments, and regulatory requirements.

Similarly, an environmental system audit examines an environmental management system, a food safety system audit examines a food safety management system, and safety system audits examine the safety management system.

Bird's-eye view:

There are three types of audits: first-, second-, and third-party audits. First-party audits are internal audits. Second- and third-party audits are external audits. First- and second-party audits use ISO 19011:2011, whereas third-party audit use ISO IEC 17021:2015.

Internal and External Audits: First-, Second-, and Third-Party Audits

There are three types of audits: first-, second-, and third-party audits. First-party audits are internal audits. Second- and third-party audits are external audits. First- and second-party audits use ISO 19011:2011, whereas third-party audit use ISO IEC 17021:2015 as shown in Table 18.1.

A *first-party audit* is performed within an organization to measure its strengths and weaknesses against its own procedures or methods and/or against external standards adopted by (voluntary) or imposed on (mandatory) the organization. A first-party audit is an internal audit conducted by auditors who are employed by the organization being audited but who have no vested interest in the audit results of the area being audited.

Organizations use *first-party audits* to audit their own performance. First-party audits are used to confirm or improve the effectiveness of management systems. They are also used to declare that an organization complies with a standard (this is called a *self-declaration*).

A *second-party audit* is an external audit performed on a supplier by a customer or by a contracted organization on behalf of a customer. A contract is in place, and the goods or services are being, or will be, delivered. Second-party audits are subject to the rules of contract law, as they are providing contractual direction from the customer to the supplier. Second-party audits tend to be more formal than first-party audits because audit results could influence the customer's purchasing decisions.

A *third-party audit* is performed by an audit organization independent of the customer-supplier relationship and is free of any conflict of interest. Independence of the audit organization is a key component of a third-party audit. Third-party audits may result in certification, registration, recognition, award, license approval, a citation, a fine, or a penalty issued by the third-party organization or an interested party.

■ ISO 19011:2011 VERSUS ISO IEC 17021:2015

Table 18.1 shows how the ISO 19011 and ISO IEC 17021 standards are related. As you can see, ISO 19011 should be used if you are interested in first- or second-party audits and ISO IEC 17021 should be used if you are interested in third-party audits.

Table 18.1 ISO 19011:2011 vs. ISO IEC 17021:2015

Internal Audits		External Audits	
First-party	Second-party	Third-party	
ISO 19011	ISO 19011	ISO IEC 17021	
Organizations audit themselves.	Customers audit their suppliers. Regulators and other interested parties audit organizations.	Certification bodies and regulators audit organizations	

DISCUSSION FORUM

1. What is an ISO audit?
2. Discuss the purpose of audits.
3. What are the different types of audits?
4. Distinguish between ISO 19011:2011 and ISO IEC 17021:2015.

GUIDELINES FOR AUDITING MANAGEMENT SYSTEMS ISO 19011:2011

Clause 1: Scope

This international standard provides guidance on auditing management systems including the principles of auditing, managing an audit programme, and conducting management system audits, as well as guidance on the evaluation of competence of individuals involved in the audit process, including the person managing the audit programme, auditors, and audit teams. It is applicable to all organizations that need to conduct internal or external audits of management systems or manage an audit programme. The application of this international standard to other types of audits is possible, provided that special consideration is given to the specific competence needed.

Bird's-eye view:

ISO 19011:2011 is applicable to all organizations that need to conduct internal or external audits of management systems or manage an audit programme.

Clause 2: Normative Reference

No normative references are cited. This clause is included in order to retain clause numbering identical with other ISO management system standards.

Clause 3: Audit Terms and Definitions

The following terms and definitions apply.

1. **Auditee:** An auditee is an organization (or part of an organization) that is being audited. Organizations can include companies, corporations, enterprises, firms, charities, associations, and institutions. Organizations can be either incorporated or unincorporated and can be privately or publicly owned.
2. **Auditor:** An auditor is a person who carries out audits. Auditors collect evidence in order to evaluate how well audit criteria are being met. They must be objective, impartial, independent, and competent.
3. **Audit client:** An audit client is any person or organization that requests an audit. Internal audit clients can be either the auditee or audit program manager, whereas external audit clients can include regulators or customers or any other parties that have a legal or contractual right or obligation to carry out an audit.
4. **Audit conclusions:** Audit conclusions are drawn by the audit team after the audit has been completed and after audit findings and audit objectives have been considered. Audit findings result from a process that evaluates audit evidence and compares it against audit criteria.
5. **Audit criteria:** Audit criteria include policies, procedures, and requirements. Audit evidence is used to determine how well audit criteria are being met. Audit evidence is used to determine how well policies are being implemented, how well procedures are being applied, and how well requirements are being followed.

When requirements are used as audit criteria, auditors often use the terms conformity and nonconformity to indicate whether or not requirements are being met. However, when legal requirements are used as audit criteria, auditors tend to use the terms compliance and noncompliance (instead of conformity and nonconformity).

6. **Audit evidence:** Audit evidence includes records, factual statements, and other verifiable information that is related to the audit criteria being used. Audit criteria include policies, procedures, and requirements. Audit evidence can be either qualitative or quantitative. Objective evidence is information that shows or proves that something exists or is true.
7. **Audit findings:** It results from a process that evaluates audit evidence and compares it against audit criteria. *Audit findings* can show that audit criteria are being met (conformity) or that they are not being met (nonconformity). They can also identify best practices or improvement opportunities.
Audit evidence includes records, factual statements, and other verifiable information that is related to the audit criteria being used. *Audit criteria* include policies, procedures, and requirements.
8. **Audit plan:** An audit plan specifies how you intend to conduct a particular audit. It describes the activities you intend to carry out in order to achieve your audit objectives. An audit is an evidence gathering process. Audit evidence is used to evaluate how well audit criteria are being met.
9. **Audit program:** An *audit program* (or programme) is a set of arrangements that are intended to achieve a specific audit purpose within a specific time frame. It includes all the activities and resources needed to plan, organize, and conduct one or more audits. ISO 19011 expects organizations to appoint audit program managers. They are responsible for setting objectives, assigning responsibilities, allocating resources, and monitoring performance.
10. **Audit scope:** The scope of an audit is a statement that specifies the focus, extent, and boundary of a particular audit. The scope can be specified by defining the physical location of the audit, the organizational units that will be examined, the processes and activities that will be included, and the time period that will be covered.
11. **Audit team:** An audit team is made up of one or more auditors, one of whom is appointed to be the audit leader. The audit team may also include audit trainees. When necessary, audit teams are also supported by guides and technical experts. Guides and technical experts assist auditors but they do not act as auditors.
12. **Competence:** It means being able to apply knowledge and skill to achieve intended results. Being competent means having the knowledge and skill that you need and knowing how to apply it.
13. **Conformity:** It is the “fulfilment of a requirement.” To conform means to meet or comply with requirements. There are many types of requirements such as management system requirements, customer requirements, contractual requirements, regulatory requirements, statutory requirements, and so on.
14. **Guide:** Guides are appointed by auditee organizations to help auditors. However, they may not influence or interfere with the conduct of an audit. Guides are expected to identify potential interviewees, to confirm interview schedules, to arrange access to auditee locations, and to make sure that auditors and observers are familiar with all relevant safety and security procedures. They may also be asked to help auditors, collect information, and provide clarification.



Bird's-eye view:

ISO 19011:2011 provides valuable information on how to improve an audit program systematically. One aspect of such improvement is continuously ensuring the audit program objectives are in line with the management system policies and objectives.

15. **Management system:** A *management system* is a set of interrelated or interacting elements that organizations use to establish and implement policies and set and achieve objectives. There are many types of *management systems* such as quality management systems, environmental management systems, emergency management systems, food safety management systems, occupational health and safety management systems, information security management systems, and business continuity management systems.
16. **Nonconformity:** Nonconformity is the “non-fulfilment of a requirement.” It is a failure to comply with requirements. A requirement is a need, expectation, or obligation. It can be stated or implied by an organization, its customers, or other interested parties.
17. **Observer:** Observers accompany auditors and witness audit activities. However, they are not audit team members and therefore do not perform audit functions. They may not influence or interfere with the audit. Observers can represent auditee organizations, regulators, or any other interested party.
18. **Risk:** It is the “effect of uncertainty on objectives” and an effect is a positive or negative deviation from what is expected. Hence, risk is a chance and that there will be a positive or negative deviation from the objective you hope to achieve.
19. **Technical expert:** Technical experts support audit teams by providing specific expertise or knowledge about the organization, process, or activity being audited or about the auditee’s language or culture. They do not act as auditors.



Bird's-eye view:

An area of increasing importance in auditing management systems and business in general is the concept of risk.

Clause 4: Audit Principles

Auditing is characterized by reliance on a number of principles. These principles should help to make the audit an effective and reliable tool in support of management policies and controls, by providing information on which an organization can act in order to improve its performance. Adherence to these principles is a prerequisite for providing audit conclusions that are relevant and sufficient and for enabling auditors, working independently from one another, to reach similar conclusions in similar circumstances. It is based on the following six principles:

1. **Integrity:** The foundation of professional auditors and the person managing an audit programme should perform their work with honesty, diligence, and responsibility; should observe and comply with any applicable legal requirements; should demonstrate their competence while performing their work; perform their work in an impartial manner, that is, remain fair and unbiased in all their dealings; should be sensitive to any influences that may be exerted on their judgement while carrying out an audit.
2. **Fair presentation:** It is the obligation to report truthfully and accurately. The audit findings, audit conclusions, and audit reports should reflect truthfully and accurately the audit activities. Significant obstacles encountered during the audit and unresolved diverging opinions between the audit team and the auditee should be reported. The communication should be truthful, accurate, objective, timely, clear, and complete.
3. **Due professional care:** It is the application of diligence and judgement in auditing. Auditors should exercise due care in accordance with the importance of the task they perform and the confidence placed in them by the audit client and other interested parties. An important factor in carrying out their work with due professional care is having the ability to make reasonable judgements in all audit situations.
4. **Confidentiality:** It is the security of the information. Auditors should exercise discretion in the use and protection of information acquired in the course of their duties. Audit information should not be used inappropriately for personal gain by the auditor or the

audit client, or in a manner detrimental to the legitimate interests of the auditee. This concept includes the proper handling of sensitive or confidential information.

5. **Independence:** It is the basis for the impartiality of the audit and objectivity of the audit conclusions. Auditors should be independent of the activity being audited wherever practicable and should in all cases act in a manner that is free from bias and conflict of interest. For internal audits, auditors should be independent from the operating managers of the function being audited. Auditors should maintain objectivity throughout the audit process to ensure that the audit findings and conclusions are based only on the audit evidence. For small organizations, it may not be possible for internal auditors to be fully independent of the activity being audited, but every effort should be made to remove bias and encourage objectivity.
6. **Evidence-based approach:** It is the rational method for reaching reliable and reproducible audit conclusions in a systematic audit process. Audit evidence should be verifiable. It will, in general, be based on samples of the information available, since an audit is conducted during a finite period of time and with finite resources. An appropriate use of sampling should be applied, since this is closely related to the confidence that can be placed in the audit conclusions.

Bird's-eye view:

Auditing is characterized by reliance on six principles. They are: Integrity, Fair presentation, Due professional care, Confidentiality, Independence and evidence-based approach.

■ Clause 5: Managing an Audit Programme

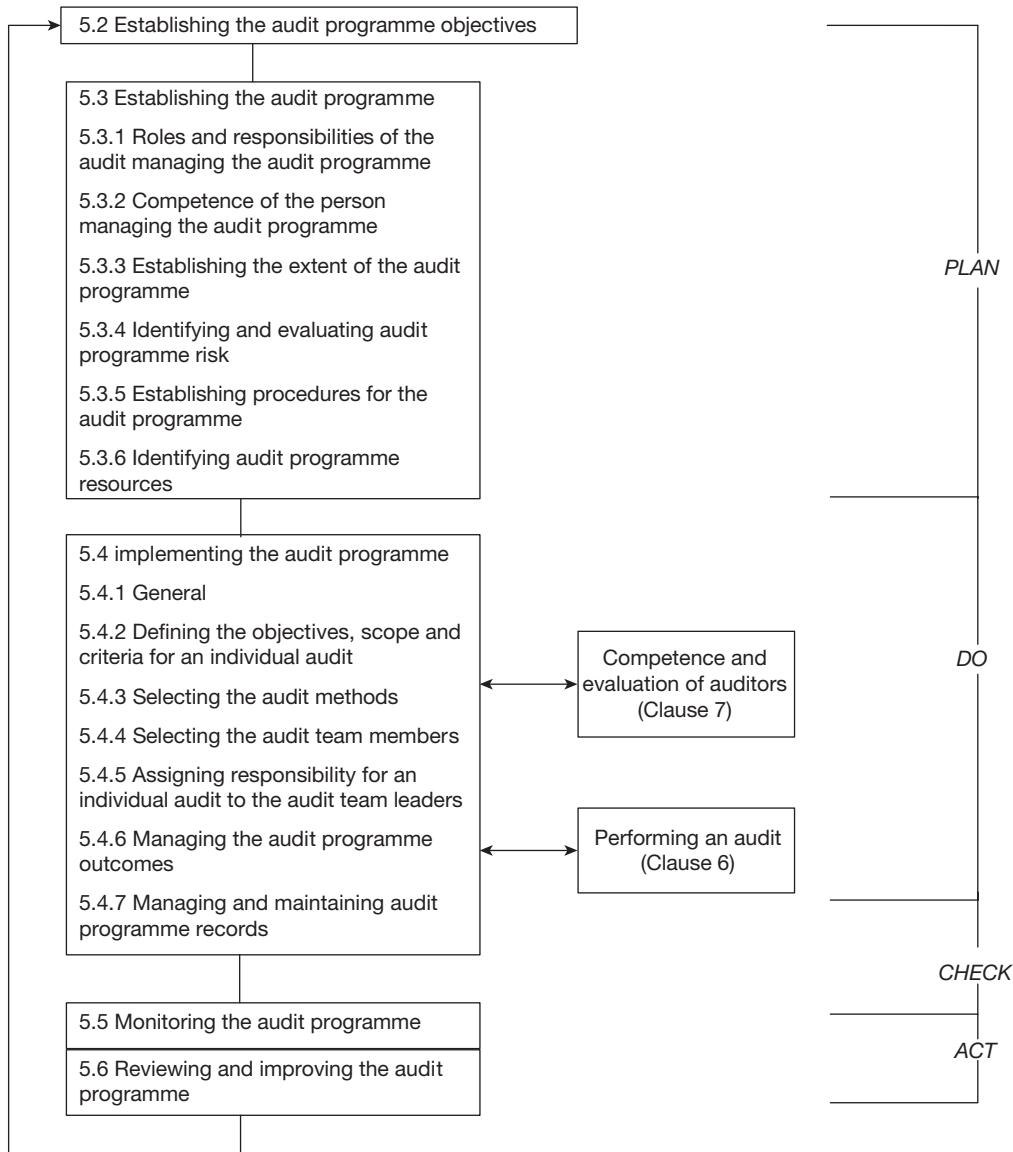
■ Clause 5.1: Create Your Audit Program

An organization needing to conduct audits should establish an audit programme that contributes to the determination of the effectiveness of the auditee's management system. The audit programme can include audits considering one or more management system standards that are conducted either separately or in combination. The top management should ensure that the audit programme objectives are established and should assign one or more competent persons to manage the audit programme. The extent of an audit programme should be based on the size and nature of the organization being audited, as well as on the nature, functionality, complexity, and the level of maturity of the management system. Priority should be given to allocating the audit programme resources to audit those matters of significance within the management system. These may include the key characteristics of product quality or hazards related to health and safety, or significant environmental aspects and their control.

The audit programme should include information and resources necessary to organize and conduct its audits effectively and efficiently within the specified time frames and can also include objectives for the audit programme and individual audits, extent/number/types/duration/locations/schedule of the audits, audit programme procedures, audit criteria, audit methods, selection of audit teams, necessary resources including travel and accommodation, and processes for handling confidentiality, information security, health and safety, and other similar matters. The implementation of the audit programme should be monitored and measured to ensure whether its objectives have been achieved. The audit programme should be reviewed in order to identify the possible improvements. Figure 18.1 illustrates the process flow for the management of an audit programme.

■ Clause 5.2: Establish the Audit Programme Objectives

The top management should ensure that the audit programme objectives are established to direct the planning and conduct of audits and should ensure that the audit programme is implemented effectively. Audit programme objectives should be consistent with and support management system policy and objectives.

Fig. 18.1 Process Flow for the Management of an Audit Programme

Note 1: Figure 18.1 Illustrates the application of the Plan–Do–Check—Act Cycle in this international standard.

Note 2: Clause/Sub-clause numbering refers to the relevant clauses/Sub-clauses of this international standard.

■ Clause 5.3: Establishing the Audit Programme

■ Clause 5.3.1: Roles and Responsibilities of the Person Managing the Audit Programme

The person managing an audit programme should inform the top management of the contents of the audit programme and, where necessary, request its approval. The person managing the audit programme should establish the extent of the audit programme, identify and evaluate the risks for the audit programme, establish audit responsibilities, establish procedures

Bird's-eye view:

An organization needing to conduct audits should establish an **audit programme** that contributes to the determination of the effectiveness of the auditee's management system. The audit programme

can include audits considering one or more management system standards that are conducted either separately or in combination.

Bird's-eye view:

The person managing the **audit programme** should engage in appropriate continual professional development activities to maintain the necessary knowledge and skills to manage the audit programme.

for audit programmes, determine necessary resources, ensure the implementation of the audit programme including the establishment of audit objectives, scope, and criteria of the individual audits, determine the audit methods, select the audit team, evaluate the auditors, ensure that appropriate audit programme records are managed and maintained, and monitor, review, and improve the audit programme.

■ Clause 5.3.2: Competence of the Person Managing the Audit Programme

The person managing the audit programme should engage in appropriate continual professional development activities to maintain the necessary knowledge and skills to manage the audit programme. The person managing the audit programme should have the necessary competence to manage the programme and its associated risks effectively and efficiently, as well as should possess knowledge and skills in the areas such as audit principles, procedures, and methods; management system standards and reference documents; activities, products, and processes of the auditee; applicable legal and other requirements relevant to the activities and products of the auditee; customers, suppliers, and other interested parties of the auditee, where applicable.

■ Clause 5.3.3: Establishing the Extent of the Audit Programme

The person managing the audit programme should determine the extent of the audit programme, which can vary depending on the size and nature of the auditee, as well as on the nature, functionality, complexity, and the level of maturity of, and matters of significance to, the management system to be audited.

■ Clause 5.3.4: Identifying and Evaluating Audit Programme Risks

There are many different risks associated with establishing, implementing, monitoring, reviewing, and improving an audit programme that may affect the achievement of its objectives. The person managing the programme should consider these risks in its development. These risks may be associated with: planning, for example, failure to set relevant audit objectives and determine the extent of the audit programme; resources, for example, allowing insufficient time for developing the audit programme or conducting an audit; selection of the audit team, for example, the team does not have the collective competence to conduct audits effectively; implementation, for example, ineffective communication of the audit programme; records and their controls, for example, failure to adequately protect audit records to demonstrate audit programme effectiveness; monitoring, reviewing, and improving the audit programme, for example, ineffective monitoring of audit programme outcomes.

■ Clause 5.3.5: Establishing Procedures for the Audit Programme

The person managing the audit programme should establish one or more procedures for addressing the areas such as planning and scheduling audits considering audit programme risks, ensuring information security and confidentiality, assuring the competence of auditors and audit team leaders, selecting appropriate audit teams and assigning their roles and responsibilities, conducting audits including the use of appropriate sampling methods, conducting audit follow-up, if applicable, reporting to the top management on the overall achievements of the audit programme, maintaining audit programme records, monitoring and reviewing the performance and risks, and improving the effectiveness of the audit programme.

■ Clause 5.3.6: Identifying Audit Programme Resources

When identifying resources for the audit programme, the person managing the audit programme should consider the financial resources necessary to develop, implement, manage, and improve the audit activities; audit methods; the availability of auditors and technical experts having competence appropriate to the particular audit programme objectives; the extent of the audit programme and audit programme risks; travelling time and cost, accommodation, and other auditing needs; the availability of information and communication technologies.

■ Clause 5.4: Implementing the Audit Programme

■ Clause 5.4.1: General

The person managing the audit programme should implement the audit programme by means of communicating the pertinent parts of the audit programme to relevant parties and informing them periodically of its progress; defining objectives, scope, and criteria for each individual audit; coordinating and scheduling audits and other activities relevant to the audit programme; ensuring the selection of audit teams with the necessary competence; providing necessary resources to the audit teams; ensuring the conduct of audits in accordance with the audit programme and within the agreed time frame; ensuring that audit activities are recorded and records are properly managed and maintained.

■ Clause 5.4.2: Defining the Objectives, Scope, and Criteria for an Individual Audit

Each individual audit should be based on documented audit objectives, scope, and criteria. These should be defined by the person managing the audit programme and be consistent with the overall audit programme objectives. The audit objectives define what is to be accomplished by the individual audit and may include determination of the extent of conformity of the management system to be audited, or parts of it, with audit criteria; determination of the extent of conformity of activities, processes, and products with the requirements and procedures of the management system; evaluation of the capability of the management system to ensure compliance with legal, contractual, and other requirements to which the organization is committed; evaluation of the effectiveness of the management system in meeting its specified objectives; identification of areas for potential improvement of the management system.

The audit scope should be consistent with the audit programme and audit objectives. It includes factors such as physical locations, organizational units, activities, and processes to be audited, as well as the time period covered by the audit. The audit criteria are used as a reference against which conformity is determined and may include applicable policies, procedures, standards, legal requirements, management system requirements, contractual requirements, sector codes of conduct, or other planned arrangements.

In the event of any changes to the audit objectives, scope, or criteria, the audit programme should be modified, if necessary. When two or more management systems of different disciplines are audited together (a combined audit), it is important that the audit objectives, scope, and criteria are consistent with the objectives of the relevant audit programmes.

Bird's-eye view:

The person managing the **audit programme** should select and determine the methods for effectively conducting an audit depending on the defined audit objectives, scope, and criteria.

■ Clause 5.4.3: Selecting the Audit Methods

The person managing the audit programme should select and determine the methods for effectively conducting an audit depending on the defined audit objectives, scope, and criteria. When two or more auditing organizations conduct a joint audit of the same auditee, the

persons managing the different audit programmes should agree on the audit method and consider implications for resourcing and planning the audit. If an auditee operates two or more management systems of different disciplines, then combined audits may be included in the audit programme.

Note: Guidance on how to determine audit methods is given in Annex B.

Bird's-eye view:

The person managing the **audit programme** should appoint the members of the audit team including the team leader and any technical experts needed for the specific audit. An audit team should be selected, taking into account the competence needed to achieve the objectives of the individual audit within the defined scope.

■ Clause 5.4.4: Selecting the Audit Team Members

The person managing the audit programme should appoint the members of the audit team including the team leader and any technical experts needed for the specific audit. An audit team should be selected, taking into account the competence needed to achieve the objectives of the individual audit within the defined scope. If there is only one auditor, then the auditor should perform all applicable duties of an audit team leader. In deciding the size and composition of the audit team for the specific audit, consideration should be given to the following:

- The overall competence of the audit team needed to achieve audit objectives, taking into account audit scope and criteria
- Complexity of the audit and if the audit is a combined or joint audit
- The audit methods that have been selected
- Legal and contractual requirements and other requirements to which the organization is committed
- The need to ensure the independence of the audit team members from the activities to be audited and to avoid any conflict of interest [see principle (e) in Clause 4]
- The ability of the audit team members to interact effectively with the representatives of the auditee and to work together
- The language of the audit, and the auditee's social and cultural characteristics.

These issues may be addressed either by the auditor's own skills or through the support of a technical expert.

To assure the overall competence of the audit team, the following steps have to be adhered:

- Identification of the knowledge and skills needed to achieve the objectives of the audit
- Selection of the audit team members so that all of the necessary knowledge and skills are present in the audit team.

If all the necessary competence is not covered by the auditors in the audit team, then technical experts with additional competence should be included in the team. Technical experts should operate under the direction of an auditor but should not act as auditors.

Auditors-in-training may be included in the audit team but should participate under the direction and guidance of an auditor. Adjustments to the size and composition of the audit team may be necessary during the audit, that is, if a conflict of interest or competence issue arises, then it should be discussed with the appropriate parties (e.g., audit team leader, the person managing the audit programme, audit client, or auditee) before doing any adjustments.

Note: Clause 7 contains guidance on determining the competence required for the audit team members and describes the processes for evaluating auditors.

■ Clause 5.4.5: Assigning Responsibility for an Individual Audit to the Audit Team Leader

The person managing the audit programme should assign the responsibility for conducting the individual audit to an audit team leader. The assignment should be made in sufficient

time before the scheduled date of the audit in order to ensure the effective planning of the audit. When a joint audit is conducted, it is important to reach agreement among the organizations conducting the audits, before the audit commences, on the specific responsibilities of each party, particularly with regard to the authority of the team leader appointed for the audit. To ensure effective conduct of the individual audits, the following information should be provided to the audit team leader:

- Audit objectives
- Audit criteria and any reference documents
- Audit scope, including identification of the organizational and functional units and processes to be audited
- Audit methods and procedures
- Composition of the audit team
- Contact details of the auditee, the locations, dates, and duration of the audit activities to be conducted
- Allocation of appropriate resources to conduct the audit
- Information needed for evaluating and addressing identified risks to the achievement of the audit objectives

The assignment information should also cover the areas, as appropriate: working and reporting language of the audit where this is different from the language of the auditor or the auditee or both; audit report contents and distribution required by the audit programme; matters related to confidentiality and information security, if required by the audit programme; any health and safety requirements for the auditors; any security and authorization requirements; any follow-up actions, e.g. from a previous audit, if applicable; coordination with other audit activities, in the case of a joint audit.

■ Clause 5.4.6: Managing the Audit Programme Outcome

The person managing the audit programme should ensure that the activities to be performed for audit program review and approval of audit reports including evaluating the suitability and adequacy of audit findings, review of root cause analysis and the effectiveness of corrective actions and preventive actions, distribution of audit reports to the top management and other relevant parties, and determination of the necessity for any follow-up audit.

■ Clause 5.4.7: Managing and Maintaining Audit Programme Records

The person managing the audit programme should ensure that audit records are created, managed, and maintained to demonstrate the implementation of the audit programme. Processes should be established to ensure that any confidentiality needs associated with the audit records are addressed. The form and level of detail of the records should demonstrate that the objectives of the audit programme have been achieved. Records related to the audit program should include the following:

- Records related to the audit programme, such as documented audit programme objectives and extent; those addressing audit programme risks; reviews of the audit programme effectiveness.
- Records related to each individual audit, such as audit plans and audit reports; nonconformity reports; corrective and preventive action reports; audit follow-up reports, if applicable.



Bird's-eye view:

The person managing the **audit programme** should ensure that audit records are created, managed, and maintained to demonstrate the implementation of the audit programme. Processes should be established to ensure that any confidentiality needs associated with the audit records are addressed.

- Records related to audit personnel covering topics such as competence and performance evaluation of the audit team members; selection of audit teams and team members; maintenance and improvement of competence.

Bird's-eye view:

The person managing the **audit programme** should review the audit programme to assess whether its objectives have been achieved. Lessons learned from the audit programme review should be used as inputs for the continual improvement process for the programme.

■ **Clause 5.5: Monitoring the Audit Programme**

The person managing the audit programme should monitor its implementation considering the need to:

- Evaluate conformity with audit programmes, schedules, and audit objectives;
- Evaluate the performance of the audit team members;
- Evaluate the ability of the audit teams to implement the audit plan;
- Evaluate feedback from top management, auditees, auditors, and other interested parties.

Some factors may determine the need to modify the audit programme such as audit findings, demonstrated level of management system effectiveness, changes to the client's or the auditee's management system, changes to standards, legal and contractual requirements, and other requirements to which the organization is committed, and change of supplier.

■ **Clause 5.6: Reviewing and Improving the Audit Programme**

The person managing the audit programme should review the audit programme to assess whether its objectives have been achieved. Lessons learned from the audit programme review should be used as inputs for the continual improvement process for the programme. The audit programme review should consider the following:

- Results and trends from audit programme monitoring
- Conformity with audit programme procedures
- Evolving needs and expectations of interested parties
- Audit programme records
- Alternative or new auditing methods
- Effectiveness of the measures to address the risks associated with the audit programme
- Confidentiality and information security issues relating to the audit programme

The person managing the audit programme should review the overall implementation of the audit programme, identify areas of improvement, amend the programme if necessary, review the continual professional development of auditors in accordance with Clauses 7.4, 7.5, and 7.6, and report the results of the audit programme review to the top management.

■ **Clause 6: Performing an Audit**

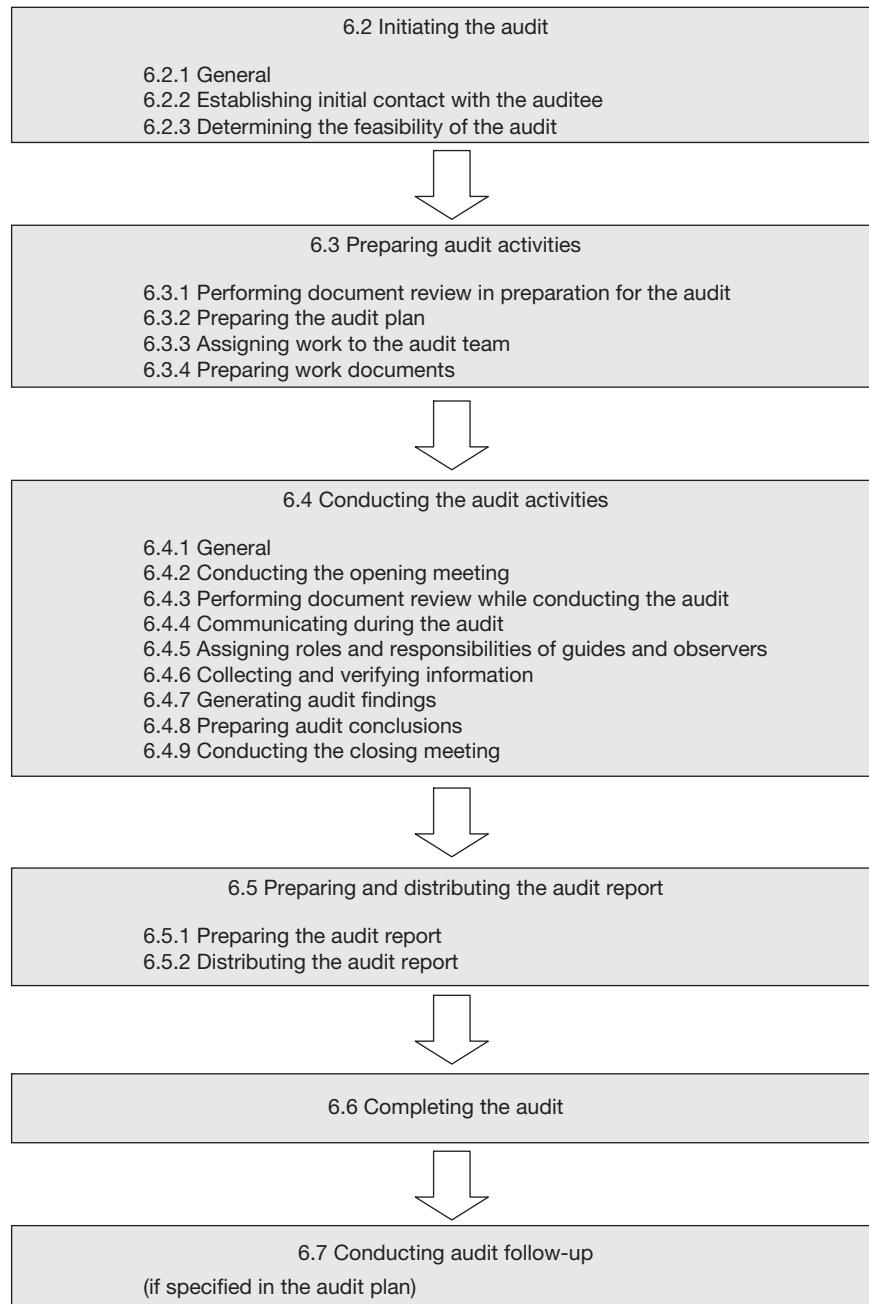
■ **Clause 6.1: General**

This clause contains guidance on preparing and conducting audit activities as part of an audit programme. Figure 18.2 provides an overview of typical audit activities. The extent to which the provisions of this clause are applicable depends on the objectives and scope of the specific audit.

Clause 6.2: Initiating an Audit

When an audit is initiated, the responsibility for conducting the audit remains with the assigned audit team leader (see Clause 5.4.5) until the audit is completed (see Clause 6.6). To initiate an audit, the steps in Figure 18.2 should be considered; however, the sequence can differ depending on the auditee, processes, and specific circumstances of the audit.

Fig. 18.2 Typical Audit Activities



Bird's-eye view:

When an **audit** is initiated, the responsibility for conducting the audit remains with the assigned audit team leader until the audit is completed

■ Clause 6.2.2 Establishing Initial Contact with the Auditee

The initial contact with the auditee for the audit can be informal or formal and should be made by the audit team leader. The purposes of the initial contact are to establish communications with the auditee's representatives; confirm the authority to conduct the audit; provide information on the audit objectives, scope, methods, and audit team composition including technical experts; request access to relevant documents and records for planning purposes; determine applicable legal and contractual requirements and other requirements relevant to the activities and products of the auditee; confirm the agreement with the auditee regarding the extent of the disclosure and the treatment of confidential information; make arrangements for the audit including scheduling the dates; determine any location-specific requirements for access, security, health, and safety; agree on the attendance of the observers and the need for guides for the audit team; determine any areas of interest or concern to the auditee in relation to the specific audit.

■ Clause 6.2.3: Determining the Feasibility of the Audit

The feasibility of the audit should be determined to provide reasonable confidence that the audit objectives can be achieved. The determination of feasibility should consider the factors such as the availability of sufficient and appropriate information for planning and conducting the audit, adequate cooperation from the auditee, and adequate time and resources for conducting the audit. When an audit is not feasible, then an alternative should be proposed to the audit client in agreement with the auditee.

■ Clause 6.3: Preparing Audit Activities

■ Clause 6.3.1: Performing Document Review in Preparation for the Audit

The relevant management system documentation of the auditee should be reviewed in order to gather information to prepare audit activities and applicable work documents (see Clause 6.3.4), for example, on processes and functions and should establish an overview of the extent of the system documentation to detect possible gaps. Guidance on how to perform a document review is provided in Clause B.2. The documentation should include, as applicable, management system documents and records, as well as previous audit reports. The document review should take into account the size, nature, and complexity of the auditee's management system and organization, and the audit objectives and scope.

Bird's-eye view:

The audit team leader should prepare an audit plan based on the information contained in the audit programme and in the documentation provided by the auditee.

Bird's-eye view:

The audit plan should consider the effect of the audit activities on the auditee's processes and provide the basis for the agreement among the audit client, audit team, and the auditee regarding the conduct of the audit.

■ Clause 6.3.2: Preparing the Audit Plan

■ Clause 6.3.2.1: Study Source Documents

The audit team leader should prepare an audit plan based on the information contained in the audit programme and in the documentation provided by the auditee. The audit plan should consider the effect of the audit activities on the auditee's processes and provide the basis for the agreement among the audit client, audit team, and the auditee regarding the conduct of the audit. The plan should facilitate the efficient scheduling and coordination of the audit activities in order to achieve the objectives effectively.

The amount of detail provided in the audit plan should reflect the scope and complexity of the audit, as well as the effect of uncertainty on achieving the audit objectives. In preparing the audit plan, the audit team leader should be aware of: the appropriate sampling techniques (see Clause B.3), the composition of the audit team and its collective competence, and the risks to the organization created by the audit. For example, risks to the organization may result from the presence of the audit team members influencing health and safety, environment, and

quality, and their presence presenting threats to the auditee's products, services, personnel, or infrastructure (e.g., contamination in clean room facilities). For combined audits, particular attention should be given to the interactions between operational processes and the competing objectives and priorities of the different management systems.

■ Clause 6.3.2.2: Prepare Official Audit Plan

The scale and content of the audit plan may differ, for example, between initial and subsequent audits, as well as between internal and external audits. The audit plan should be sufficiently flexible to permit changes which can become necessary as the audit activities progress. The audit plan should cover the audit objectives; the audit scope, including identification of the organizational and functional units, as well as processes to be audited; the audit criteria and any reference documents; the locations, dates, and expected time and duration of audit activities to be conducted, including meetings with the auditee's management; the audit methods to be used, including the extent to which audit sampling is needed to obtain sufficient audit evidence and the design of the sampling plan, if applicable; the roles and responsibilities of the audit team members, as well as guides and observers; the allocation of appropriate resources to critical areas of the audit.

The audit plan may also cover identification of the auditee's representative for the audit; the working and reporting language of the audit where this is different from the language of the auditor or the auditee or both; the audit report topics; logistics and communications arrangements, including specific arrangements for the locations to be audited; any specific measures to be taken to address the effect of uncertainty on achieving the audit objectives; matters related to confidentiality and information security; any follow-up actions from a previous audit; any follow-up activities to the planned audit; coordination with other audit activities, in case of a joint audit. The audit plan may be reviewed and accepted by the audit client and should be presented to the auditee. Any objections by the auditee to the audit plan should be resolved between the audit team leader, the auditee, and the audit client.

■ Clause 6.3.3: Assigning Work to the Audit Team

The audit team leader, in consultation with the audit team, should assign responsibility to each team member for auditing specific processes, activities, functions, or locations. Such assignments should take into account the independence and competence of auditors and the effective use of resources, as well as different roles and responsibilities of auditors, auditors-in-training, and technical experts. Audit team briefings should be held, as appropriate, by the audit team leader in order to allocate work assignments and decide possible changes. Changes to the work assignments can be made as the audit progresses in order to ensure the achievement of the audit objectives.

Bird's-eye view:

The **audit team leader**, in consultation with the audit team, should assign responsibility to each team member for auditing specific processes, activities, functions, or locations.

■ Clause 6.3.4: Preparing Work Documents

The audit team members should collect and review the information relevant to their audit assignments and prepare work documents, as necessary, for reference and for recording audit evidence. Such work documents may include checklists, audit sampling plans, and forms for recording information such as supporting evidence, audit findings, and records of meetings. The use of checklists and forms should not restrict the extent of audit activities, which can change as a result of information collected during the audit. Guidance on preparing work documents is given in Clause B.4. Work documents, including records resulting from their use, should be retained at least until audit completion or as specified in the audit plan. Retention of documents after audit completion is described in Clause 6.6.

Those documents involving confidential or proprietary information should be suitably safeguarded at all times by the audit team members.

■ Clause 6.4: Conducting the Audit Activities

■ Clause 6.4.1: General

Audit activities are normally conducted in a defined sequence as indicated in Figure 18.2. This sequence may be varied to suit the circumstances of specific audits.

Bird's-eye view:

The purpose of the **opening meeting** is to confirm the agreement of all parties (e.g., auditee and audit team) to the audit plan, introduce the audit team, and ensure that all planned audit activities can be performed.

■ Clause 6.4.2: Conducting the Opening Meeting

The purpose of the opening meeting is to confirm the agreement of all parties (e.g., auditee and audit team) to the audit plan, introduce the audit team, and ensure that all planned audit activities can be performed. An opening meeting should be held with the auditee's management and, where appropriate, those responsible for the functions or processes to be audited. During the meeting, an opportunity to ask questions should be provided.

The degree of detail should be consistent with the familiarity of the auditee with the audit process. In many instances, for example, internal audits in a small organization, the opening meeting may simply consist of communicating that an audit is being conducted and explaining the nature of the audit. For other audit situations, the meeting may be formal and records of attendance should be kept.

The meeting should be chaired by the audit team leader, and the items should be considered, as appropriate, are introduction of the participants, including observers and guides, and an outline of their roles; confirmation of the audit objectives, scope, and criteria; confirmation of the audit plan and other relevant arrangements with the auditee, such as the date and time for the closing meeting, any interim meetings between the audit team and the auditee's management, and any late changes; presentation of the methods to be used to conduct the audit, including advising the auditee that the audit evidence will be based on a sample of the information available; introduction of the methods to manage risks to the organization which may result from the presence of the audit team members; confirmation of formal communication channels between the audit team and the auditee; confirmation of the language to be used during the audit; confirmation that, during the audit, the auditee will be kept informed of audit progress; confirmation that the resources and facilities needed by the audit team are available; confirmation of matters relating to confidentiality and information security; confirmation of relevant health and safety, emergency, and security procedures for the audit team; information on the method of reporting audit findings including grading, if any; information about conditions under which the audit may be terminated; information about the closing meeting; information about how to deal with possible findings during the audit; information about any system for feedback from the auditee on the findings or conclusions of the audit including complaints or appeals.

■ Clause 6.4.3: Performing Document Review While Conducting the Audit

The auditee's relevant documentation should be reviewed to determine the conformity of the system, as far as documented, with audit criteria and gather information to support the audit activities. Guidance on how to perform a document review is provided in Clause B.2. The review may be combined with the other audit activities and may continue throughout the audit, provided that this is not detrimental to the effectiveness of the conduct of the audit.

If adequate documentation cannot be provided within the time frame given in the audit plan, then the audit team leader should inform both the person managing the audit

programme and the auditee. Depending on the audit objectives and scope, a decision should be made as to whether the audit should be continued or suspended until documentation concerns are resolved.

■ Clause 6.4.4: Communicating During the Audit

During the audit, it may be necessary to make formal arrangements for communication within the audit team, as well as with the auditee, the audit client, and potentially with external bodies (e.g., regulators), especially where legal requirements require the mandatory reporting of non-compliances.

The audit team should confer periodically to exchange information, assess audit progress, and reassess work between the audit team members, as needed. During the audit, the audit team leader should periodically communicate the progress of the audit and any concerns to the auditee and audit client, as appropriate. Evidence collected during the audit that suggests an immediate and significant risk to the auditee should be reported without delay to the auditee and, as appropriate, to the audit client. Any concern about an issue outside the audit scope should be noted and reported to the audit team leader for possible communication to the audit client and auditee.

When the available audit evidence indicates that the audit objectives are unattainable, the audit team leader should report the reasons to the audit client and the auditee to determine appropriate action. Such action may include reconfirmation or modification of the audit plan, changes to the audit objectives or audit scope, or termination of the audit. Any need for changes to the audit plan, which may become apparent as auditing activities progress, should be reviewed and approved, as appropriate, by both the person managing the audit programme and the auditee.



Bird's-eye view:

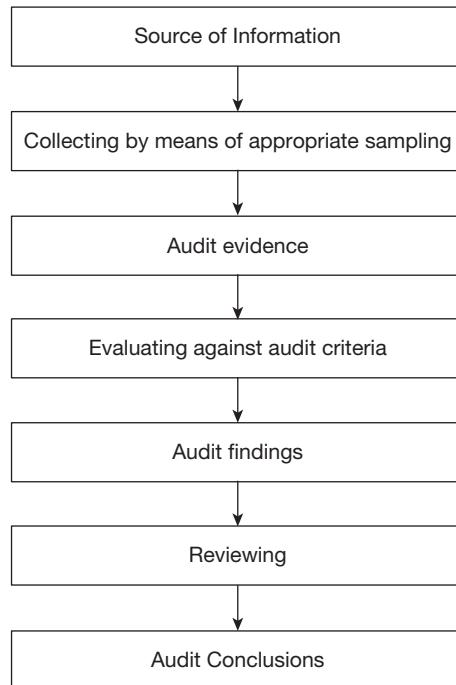
During the audit, it may be necessary to make formal arrangements for communication within the audit team, as well as with the auditee, the audit client, and potentially with external bodies (e.g., regulators), especially where legal requirements require the mandatory reporting of non-compliances.

■ Clause 6.4.5: Assigning Roles and Responsibilities of Guides and Observers

Guides and observers (e.g., regulator or other interested parties) may accompany the audit team. They should not influence or interfere with the conduct of the audit. If this cannot be assured, then the audit team leader should have the right to deny observers from taking part in certain audit activities. For observers, any obligations in relation to health and safety, security, and confidentiality should be managed between the audit client and the auditee. Guides, appointed by the auditee, should assist the audit team and act on the request of the audit team leader. Their responsibilities should include assisting the auditors in identifying individuals to participate in interviews and confirming timings, arranging access to specific locations of the auditee, ensuring that rules concerning location, safety, and security procedures are known and respected by the audit team members and observers, witnessing the audit on behalf of the auditee, providing clarification, and assisting in collecting information.

■ Clause 6.4.6: Collecting and Verifying Information

During the audit, information relevant to the audit objectives, scope, and criteria, including information relating to interfaces between functions, activities, and processes, should be collected by means of appropriate sampling and should be verified. Only information that is verifiable should be accepted as audit evidence. Audit evidence leading to audit findings should be recorded. If, during the collection of evidence, the audit team becomes aware of any new or changed circumstances or risks, these should be addressed by the team accordingly. Guidance on sampling is given in Clause B.3. Figure 18.3 provides an overview of the process from collecting information to reaching audit conclusions. Methods of collecting

Fig. 18.3 Overview of the Process of Collecting and Verifying Information

information include interviews, observations, and review of documents including records. Guidance on sources of information is given in Clause B.5. Guidance on visiting the auditee's location is given in Clause B.6. Guidance on how to conduct interviews is given in Clause B.7.

■ Clause 6.4.7: Generating Audit Findings

Bird's-eye view:

Audit evidence should be evaluated against the audit criteria in order to determine audit findings. Audit findings can indicate conformity or nonconformity with audit criteria.

Audit evidence should be evaluated against the audit criteria in order to determine audit findings. Audit findings can indicate conformity or nonconformity with audit criteria. When specified by the audit plan, individual audit findings should include conformity and good practices along with their supporting evidence, opportunities for improvement, and any recommendations to the auditee.

Nonconformities and their supporting audit evidence should be recorded, and nonconformities may be graded. They should be reviewed with the auditee in order to obtain acknowledgement that the audit evidence is accurate and that the nonconformities are understood. Every attempt should be made to resolve any diverging opinions concerning the audit evidence or findings, and unresolved points should be recorded. The audit team should meet as needed to review the audit findings at appropriate stages during the audit. Additional guidance on the identification and evaluation of audit findings is given in Clause B.8.

■ Clause 6.4.8: Preparing Audit Conclusions

The audit team should confer prior to the closing meeting in order to review the audit findings and any other appropriate information collected during the audit against the audit objectives, agree on the audit conclusions, thereby taking into account the uncertainty inherent in the audit process, prepare recommendations, if specified by the audit plan, and discuss audit follow-up, as applicable.

Audit conclusions can address issues such as the extent of conformity with the audit criteria and robustness of the management system including the effectiveness of the management system in meeting the stated objectives; the effective implementation, maintenance, and improvement of the management system; achievement of audit objectives, coverage of audit scope, and fulfilment of audit criteria; root causes of findings, if included in the audit plan; similar findings made in different areas that were audited for the purpose of identifying trends. If specified by the audit plan, audit conclusions can lead to recommendations for improvement or future auditing activities.

■ Clause 6.4.9: Conducting the Closing Meeting

A closing meeting, facilitated by the audit team leader, should be held to present the audit findings and conclusions. Participants in the closing meeting should include the management of the auditee and, where appropriate, those responsible for the functions or processes that have been audited, and may also include the audit client and other parties. If applicable, the audit team leader should advise the auditee of situations encountered during the audit that may decrease the confidence that can be placed in the audit conclusions. If denied in the management system or by agreement with the audit client, then the participants should agree on the time frame for an action plan to address the audit findings.

The degree of detail should be consistent with the familiarity of the auditee with the audit process. For some audit situations, the meeting may be formal and minutes including records of attendance should be kept. In other instances (e.g., internal audits), the closing meeting is less formal and may consist solely of communicating the audit findings and audit conclusions. Any diverging opinions regarding the audit findings or conclusions between the audit team and the auditee should be discussed and, if possible, resolved. If not resolved, this should be recorded. If specified by the audit objectives, recommendations for improvements may be presented. It should be emphasized that recommendations are not binding. The points to be explained to the auditee in the closing meeting include advising that the audit evidence collected was based on a sample of the information available, the method of reporting, the process of handling of audit findings and possible consequences, presentation of the audit findings and conclusions in such a manner that they are understood and acknowledged by the auditee's management, and any related post-audit activities (e.g., implementation of corrective actions, audit complaint handling, and appeal process).

Bird's-eye view:

A closing meeting, facilitated by the audit team leader, should be held to present the audit findings and conclusions. Participants in the closing meeting should include the management of the auditee and, where appropriate, those responsible for the functions or processes that have been audited, and may also include the audit client and other parties.

■ Clause 6.5: Preparing and Distributing the Audit Report

■ Clause 6.5.1: Preparing the Audit Report

The audit team leader should report the audit results in accordance with the audit programme procedures. The audit report should provide a complete, accurate, concise, and clear record of the audit and should include or refer to the audit objectives, audit scope (particularly identification of the organizational and functional units or processes audited), identification of the audit client, identification of audit team and auditee's participants in the audit, the dates and locations where the audit activities were conducted, the audit criteria, the audit findings and related evidence, the audit conclusions, and a statement on the degree to which the audit criteria have been fulfilled.

The audit report can also include or refer to the audit plan including time schedule, a summary of the audit process including any obstacles encountered that may decrease the reliability of the audit conclusions, confirmation that the audit objectives have been achieved within the audit scope in accordance with the audit plan, areas (if any) not covered within the audit scope, a summary covering the audit conclusions and the main audit findings that support

them, any unresolved diverging opinions between the audit team and the auditee, opportunities for improvement (if specified in the audit plan), good practices identified, agreed follow-up action plans (if any), a statement about the confidential nature of the contents, any implications for the audit programme or subsequent audits, and the distribution list for the audit report. The audit report can be developed before the closing meeting.

■ Clause 6.5.2: Distributing the Audit Report

The audit report should be issued within an agreed period of time. If it is delayed, then the reasons should be communicated to the auditee and the person managing the audit programme. The audit report should be dated, reviewed, and approved, as appropriate, in accordance with audit programme procedures. The audit report should then be distributed to the recipients as defined in the audit procedures or audit plan.

Bird's-eye view:

The **audit** is completed when all planned audit activities have been carried out, or as otherwise agreed with the audit client (e.g., there might be an unexpected situation that prevents the audit being completed according to the plan). Documents pertaining to the audit should be retained or destroyed by agreement between the participating parties and in accordance with audit programme procedures and applicable requirements.

■ Clause 6.6: Completing the Audit

The audit is completed when all planned audit activities have been carried out, or as otherwise agreed with the audit client (e.g., there might be an unexpected situation that prevents the audit being completed according to the plan). Documents pertaining to the audit should be retained or destroyed by agreement between the participating parties and in accordance with audit programme procedures and applicable requirements.

Unless required by law, the audit team and the person managing the audit programme should not disclose the contents of documents, any other information obtained during the audit, or the audit report to any other party without the explicit approval of the audit client and, where appropriate, the auditee. If disclosure of the contents of an audit document is required, then the audit client and auditee should be informed as soon as possible. Lessons learned from the audit should be entered into the continual improvement process of the management system of the audited organizations.

■ Clause 6.7: Conducting Audit Follow-up

The conclusions of the audit can, depending on the audit objectives, indicate the need for corrections or for corrective, preventive, or improvement actions. Such actions are usually decided and undertaken by the auditee within an agreed timeframe. As appropriate, the auditee should keep the person managing the audit programme and the audit team informed of the status of these actions. The completion and effectiveness of these actions should be verified. This verification may be part of a subsequent audit.

■ Clause 7: Competence and Evaluation of Auditors

■ Clause 7.1: General

Confidence in the audit process and the ability to achieve its objectives depend on the competence of those individuals who are involved in planning and conducting audits, including auditors and audit team leaders. Competence should be evaluated through a process that considers personal behaviour and the ability to apply the knowledge and skills gained through education, work experience, auditor training, and audit experience. This process should take into consideration the needs of the audit programme and its objectives. Some of the knowledge and skills described in Clause 7.2.3 are common to the auditors of any management system discipline, and others are specific to individual management system disciplines. It is not necessary for each auditor in the audit team to have the same competence; however, the overall competence of the audit team needs to be sufficient to achieve the audit objectives.

The evaluation of auditor competence should be planned, implemented, and documented in accordance with the audit programme including its procedures to provide an outcome that is objective, consistent, fair, and reliable. The evaluation process includes the following four main steps:

1. Determine the competence of audit personnel to fulfil the needs of the audit programme
2. Establish the evaluation criteria
3. Select the appropriate evaluation method
4. Conduct the evaluation

The outcome of the evaluation process should provide a basis for the following: selecting the audit team members as described in Clause 5.4.4, determining the need for improved competence (e.g., additional training), and on-going performance evaluation of auditors.

Auditors should develop, maintain, and improve their competence through continual professional development and regular participation in audits (see Clause 7.6). A process for evaluating auditors and audit team leaders is described in Clause 7.4 and 7.5. Auditors and audit team leaders should be evaluated against the criteria set out in Clauses 7.2.2 and 7.2.3. The competence required of the person managing the audit programme is described in Clause 5.3.2.

Bird's-eye view:

The **evaluation of auditor** competence should be planned, implemented, and documented in accordance with the audit programme including its procedures to provide an outcome that is objective, consistent, fair, and reliable.

■ Clause 7.2: Determining Auditor Competence to Fulfil the Needs of the Audit Programme

■ Clause 7.2.1: General

In deciding the appropriate knowledge and skills required of the auditor, the following should be considered:

- The size, nature, and complexity of the organization to be audited;
- The management system disciplines to be audited;
- The objectives and extent of the audit programme;
- Other requirements, such as those imposed by external bodies, where appropriate;
- The role of the audit process in the management system of the auditee;
- The complexity of the management system to be audited;
- The uncertainty in achieving audit objectives.

■ Clause 7.2.2: Personal Behaviour

Auditors should possess the necessary qualities to enable them to act in accordance with the principles of auditing as described in Clause 4. Auditors should exhibit the following professional behaviour during the performance of audit activities:

- Ethical (i.e. fair, truthful, sincere, honest, and discreet);
- Open-minded (i.e., willing to consider alternative ideas or points of view);
- Diplomatic (i.e., tactful in dealing with people);
- Observant (i.e., actively observing physical surroundings and activities);
- Perceptive (i.e., aware of and able to understand situations);
- Versatile (i.e., able to readily adapt to different situations);
- Tenacious (i.e., persistent and focused on achieving objectives);
- Decisive (i.e., able to reach timely conclusions based on logical reasoning and analysis);

- Self-reliant (i.e., able to act and function independently whilst interacting effectively with others);
- Acting with fortitude (i.e., able to act responsibly and ethically, even though these actions may not always be popular and may sometimes result in disagreement or confrontation);
- Open to improvement (i.e., willing to learn from situations, and striving for better audit results);
- Culturally sensitive (i.e., observant and respectful to the culture of the auditee);
- Collaborative (i.e., effectively interacting with others, including audit team members and the auditee's personnel).

■ Clause 7.2.3: Knowledge and Skills

Bird's-eye view:

Auditors should possess the knowledge and skills necessary to achieve the intended results of the audits they are expected to perform. All auditors should possess generic knowledge and skills, and also, they are expected to possess some discipline and sector-specific knowledge and skills. Audit team leaders should have the additional knowledge and skills necessary to provide leadership to the audit team.

■ Clause 7.2.3.1: General

Auditors should possess the knowledge and skills necessary to achieve the intended results of the audits they are expected to perform. All auditors should possess generic knowledge and skills, and also, they are expected to possess some discipline and sector-specific knowledge and skills. Audit team leaders should have the additional knowledge and skills necessary to provide leadership to the audit team.

■ Clause 7.2.3.2: Generic Knowledge and Skills of Management System Auditors

Auditors should have knowledge and skills in the areas outlined below.

1. ***Audit principles, procedures, and methods:*** Knowledge and skills in this area enable the auditor to apply the appropriate principles, procedures, and methods to different audits, and to ensure that audits are conducted in a consistent and systematic manner.
2. ***Management system and reference documents:*** Knowledge and skills in this area enable the auditor to comprehend the audit scope and apply audit criteria.
3. ***Organizational context:*** Knowledge and skills in this area enable the auditor to comprehend the auditee's structure and business and management practices. It should cover organizational types, governance, size, structure, functions and relationships, general business and management concepts, processes and related terminologies (e.g., planning, budgeting, and management of personnel), and cultural and social aspects of the auditee.
4. ***Applicable legal and contractual requirements and other requirements that apply to the auditee:*** Knowledge and skills in this area enable the auditor to be aware of, and work within, the organization's legal and contractual requirements. Knowledge and skills specific to the jurisdiction or to the auditee's activities and products should cover laws and regulations, their governing agencies, basic legal terminologies, and contracting and liability.

■ Clause 7.2.3.3: Discipline and Sector-specific Knowledge and Skills of Management System Auditors

Auditors should have the discipline and sector-specific knowledge and skills that are appropriate for auditing the particular type of management system and sector. It is not necessary for each auditor in the audit team to have the same competence; however, the overall competence of the audit team needs to be sufficient to achieve the audit objectives.

■ Clause 7.2.3.4: Generic Knowledge and Skills of an Audit Team Leader

Audit team leaders should have additional knowledge and skills to manage and provide leadership to the audit team in order to facilitate the efficient and effective conduct of the audit. An audit team leader should have the knowledge and skills necessary to do the following:

- Balance the strengths and weaknesses of the individual audit team members.
- Develop a harmonious working relationship among the audit team members.
- Manage the audit process.
- Represent the audit team in communications with the person managing the audit programme, audit client, and auditee.
- Lead the audit team to reach the audit conclusions.
- Prepare and complete the audit report.

■ Clause 7.2.3.5: Knowledge and Skills for Auditing Management Systems Addressing Multiple Disciplines

Auditors who intend to participate as an audit team member in auditing management systems addressing multiple disciplines should have the competence necessary to audit at least one of the management system disciplines and an understanding of the interaction and synergy between the different management systems. Audit team leaders conducting audits of management systems addressing multiple disciplines should understand the requirements of each management system standards and recognize the limits of their knowledge and skills in each disciplines.



Bird's-eye view:

Auditors who intend to participate as an audit team member in auditing management systems addressing multiple disciplines should have the competence necessary to audit at least one of the management system disciplines and an understanding of the interaction and synergy between the different management systems.

■ Clause 7.2.4: Achieving Auditor Competence

Auditing knowledge and skills can be acquired using a combination of the following:

1. Formal education/training and experience that contribute to the development of knowledge and skills in the management system discipline and the sector the auditor intends to audit.
2. Training programmes that cover generic auditor knowledge and skills.
3. Experience in a relevant technical, managerial, or professional position involving the exercise of judgement, decision making, problem solving, and communication with managers, professionals, peers, customers, and other interested parties.
4. Audit experience acquired under the supervision of an auditor in the same discipline.

■ Clause 7.2.5: Audit Team Leaders

An audit team leader should have acquired additional audit experience to develop the knowledge and skills described in Clause 7.2.3. This additional experience should have been gained by working under the direction and guidance of a different audit team leader.

■ Clause 7.3: Establishing the Auditor Evaluation Criteria

The criteria should be qualitative (such as having demonstrated personal behaviour, knowledge, or the performance of the skills in training or in the workplace) and quantitative (such as the years of work experience and education, number of audits conducted, and hours of audit training).

■ Clause 7.4: Selecting the Appropriate Auditor Evaluation Method

The evaluation should be conducted using two or more of the methods selected from those given in Table 18.2. Using Table 18.2, the following should be noted:

1. The methods outlined represent a range of options and may not apply in all situations.
2. The various methods outlined may differ in their reliability.
3. Combination of methods should be used to ensure an outcome that is objective, consistent, fair, and reliable.

■ Clause 7.5: Conducting Auditor Evaluation

The information collected about the person should be compared against the criteria given in Clause 7.2.3. When a person expected to participate in the audit programme does not fulfil the criteria, then additional training, work, or audit experience should be undertaken and a subsequent re-evaluation should be performed.

■ Clause 7.6: Maintaining and Improving Auditor Competence

Auditors and audit team leaders should continually improve their competence. Auditors should maintain their auditing competence through regular participation in management system audits and continual professional development. Continual professional development

Bird's-eye view:

Auditors and **audit team leaders** should continually improve their competence. Auditors should maintain their auditing competence through regular participation in management system audits and continual professional development.

Table 18.2 Possible Evaluation Methods

Evaluation Method	Objectives	Examples
Review of records	To verify the background of the auditor	Analysis of records of education, training, employment, professional credentials, and audit experience
Feedback	To provide information about how the performance of the auditor is perceived	Surveys, questionnaires, personal references, testimonials, complaints, performance evaluation, and peer review
Interview	To evaluate personal behaviour and communication skills, to verify information and test knowledge, and to acquire additional information	Personal interviews
Observation	To evaluate personal behaviour and the ability to apply knowledge and skills	Role playing, witnessed audits, and on-the-job performance
Testing	To evaluate personal behaviour and knowledge and skills and their application	Oral and written exams, and psychometric testing
Post-audit review	To provide information on the auditor performance during the audit activities and to identify strengths and weaknesses	Review of the audit report, interviews with the audit team leader, the audit team, and, if appropriate, feedback from the auditee

involves the maintenance and improvement of competence. This may be achieved through means such as additional work experience, training, private study, coaching, attendance at meetings, seminars and conferences, or other relevant activities. The person managing the audit programme should establish suitable mechanisms for the continual evaluation of the performance of the auditors and audit team leaders. The continual professional development activities should take into account the changes in the needs of the individual and the organization responsible for the conduct of the audit, the practice of auditing, relevant standards, and other requirements. Table 18.3 provides the requirements of ISO 19011:2011.

■ Annex A (Informative)

It gives guidance and illustrative examples of discipline-specific knowledge and skills of auditors.

■ Annex B (Informative)

It provides additional guidance for auditors for planning and conducting audits.

Table 18.3 Requirements of ISO 19011:2011

Clause No.	Contents
1	Scope
2	Normative Reference
3	Terms and Definitions
4	Principles of auditing
5	Managing an audit programme
5.1	General
5.2	Establishing the audit programme objectives
5.3	Establishing the audit programme
5.4	Implementing the audit programme
5.5	Monitoring the audit programme
5.6	Reviewing and improving the audit programme
6	Performing an audit
6.1	General
6.2	Initiating the audit
6.3	Preparing audit activities
6.4	Conducting the audit activities
6.5	Preparing and distributing the audit report
6.6	Completing the audit
6.7	Conducting audit follow-up
7	Competence and evaluation of auditors
7.1	General
7.2	Determining auditor competence to fulfil the needs of the audit programme
7.3	Establishing the auditor evaluation criteria

Bird's-eye view:

The person managing the **audit programme** should establish suitable mechanisms for the continual evaluation of the performance of the auditors and audit team leaders.

(Continued)

Table 18.3 (Continued)

Clause No.	Contents
7.4	Selecting the appropriate auditor evaluation method
7.5	Conducting auditor evaluation
7.6	Maintaining and improving auditor competence
Annex A (informative)	Guidance and illustrative examples of discipline-specific knowledge and skills of auditors
Annex B (INFORMATIVE)	Additional guidance for auditors for planning and conducting audits
Bibliography	

Source: www.iso.org/19011auditing, accessed August 2016.

■ ISO/IEC 17021:2015

Bird's-eye view:

ISO/IEC 17021:2015 contains principles and requirements for the competence, consistency, and impartiality of bodies providing audit and certification of all types of management systems. Certification bodies operating to ISO/IEC 17021:2015 do not need to offer all types of management system certification. Certification of management systems is a third-party conformity assessment activity, and therefore, bodies performing this activity are third-party conformity assessment bodies.

ISO/IEC 17021:2015 contains principles and requirements for the competence, consistency, and impartiality of bodies providing audit and certification of all types of management systems. Certification bodies operating to ISO/IEC 17021:2015 do not need to offer all types of management system certification. Certification of management systems is a third-party conformity assessment activity, and therefore, bodies performing this activity are third-party conformity assessment bodies.

Third-party management systems certification is a frequently specified requirement to operate in the global market place. It can demonstrate compliance to a standard; that is, a code of practice or regulatory requirements. It can also deliver internal business improvement. Certification of a management system, such as the environmental management system, quality management system, or occupation health and safety management system of an organization, is one means of providing assurance that the organization has implemented a system for the management of the relevant aspects of its activities, products, and services in line with the organization's policy and the requirements of the respective international management system standard.

This part of ISO/IEC 17021 specifies requirements for bodies providing audit and certification of management systems. It gives generic requirements for such bodies performing audit and certification in the field of quality, the environment, and other types of management systems. Such bodies are referred to as certification bodies. Observance of these requirements is intended to ensure that certification bodies operate management system certification in a competent, consistent, and impartial manner, thereby facilitating the recognition of such bodies and the acceptance of their certifications on a national and international basis. This part of ISO/IEC 17021 serves as a foundation for facilitating the recognition of management system certification in the interests of international trade. The contents of ISO/IEC 17021-1:2015 is given in Table 18.4.

Table 18.4 Requirements of ISO/IEC 17021-1:2015

Clause No.	Contents
1	Scope
2	Normative Reference

(Continued)

Table 18.4 (Continued)

Clause No.	Contents
3	Terms and Definitions
4	Principles
4.1	General
4.2	Impartiality
4.3	Competence
4.4	Responsibility
4.5	Openness
4.6	Confidentiality
4.7	Responsiveness to complaints
4.8	Risk based approach
5	General requirements
5.1	Legal & contractual matters
5.2	Management & Impartiality
5.3	Liability & Financing
6	Structure requirements
6.1	Organizational Structure
6.2	Operational control
7	Resource Requirements
7.1	Competence of Personnel
7.2	Personnel involved in the certification
7.3	Use of Individual external audit
7.4	Personnel records
7.5	Outsourcing
8	Information requirements
8.1	Public information
8.2	Certification documents
8.3	Reference to certification
8.4	Confidentiality
8.5	Information exchange between auditors
9	Process requirements
9.1	Pre-Certification activities
9.2	Planning audits
9.3	Initial Certification
9.4	Conducting Audits
9.5	Certification decision
9.6	Maintaining Certification
9.7	Appeals

 **Bird's-eye view:**

Third-party management systems certification is a frequently specified requirement to operate in the global market place. It can demonstrate compliance to a standard; that is a code of practice or regulatory requirements.

(Continued)

Table 18.4 (Continued)

Clause No.	Contents
9.8	Complaints
9.9	Clients records
10	Management system requirements
10.1	Options
10.2	Option A: General Management
10.3	Option B: Management system
Annex A	Required knowledge and Skill of auditors
Annex B	Possible evaluation methods
Annex C	Example of a process flow chart
Annex D	Desired Personal Behaviour
Annex E	Audit and Certification Process
	Bibliography

Source: www.iso.org/ ISO/IEC 17021 auditing, accessed August 2016.

Certification of a management system provides independent demonstration that the management system of the organization:

- conforms to specified requirements;
- is capable of consistently achieving its stated policy and objectives;
- is effectively implemented.

Bird's-eye view:

ISO/IEC 17021 consists of seven parts under the general title *Conformity assessment—requirements for bodies providing audit and certification of management systems*.

ISO/IEC 17021 consists of the following parts under the general title *Conformity assessment—requirements for bodies providing audit and certification of management systems*:

- Part 1: Requirements
- Part 2: Competence requirements for auditing and certification of environmental management systems [Technical Specification]
- Part 3: Competence requirements for auditing and certification of quality management systems [Technical Specification]
- Part 4: Competence requirements for auditing and certification of event sustainability management systems [Technical Specification]
- Part 5: Competence requirements for auditing and certification of asset management systems [Technical Specification]
- Part 6: Competence requirements for auditing and certification of business continuity management systems [Technical Specification]
- Part 7: Competence requirements for auditing and certification of road traffic safety management systems [Technical Specification]

■ Four Phases of an Audit

1. **Audit preparation:** Audit preparation consists of everything that is done in advance by interested parties such as the auditor, the lead auditor, the client, and the audit program manager to ensure that the audit complies with the client's objective. The preparation stage of an audit begins with the decision to conduct the audit. Preparation ends when the audit itself begins.

2. **Audit performance:** The performance phase of an audit is often called the fieldwork. It is the data-gathering portion of the audit and covers the time period from arrival at the audit location up to the exit meeting. It consists of activities including onsite audit management, meeting with the auditee, understanding the process and system controls, verifying that these controls work, communicating among team members, and communicating with the auditee.
3. **Audit reporting:** The purpose of the audit report is to communicate the results of the investigation. The report should provide correct and clear data that will be effective as a management aid in addressing important organizational issues. The audit process may end when the report is issued by the lead auditor or after follow-up actions are completed.
4. **Audit follow-up and closure:** According to ISO 19011, Clause 6.6, “The audit is completed when all the planned audit activities have been carried out, or otherwise agreed with the audit client.” Clause 6.7 of ISO 19011 continues by stating that verification of follow-up actions may be part of a subsequent audit.



Bird's-eye view:

There are **four phases** of an audit: audit preparation; audit performance; audit reporting and audit follow-up and closure.

DISCUSSION FORUM

1. Discuss the main features of auditing management system- ISO 19011:2011.
2. What are the competency required by the auditors?
3. Explain the main features of ISO IEC 17021-2015.
4. Which are the steps for implementing a TQM programme?

CERTIFICATION

A certification body that is accredited by a single or multiple accreditation body/bodies, based on its compliance to the applicable standards and the competence of their managerial and technical resources can issue accreditation certificates with the logo of the accreditation body (choice of the organization seeking certification). These certificates are issued by them only after they have physically verified that the organization is complying with the requirements of ISO standards or other applicable standards and the scope of the certificate is part of their scope of accreditation. Quality Council of India provides the list of certification bodies in India.

The International Organization for Standardization’s Committee on Conformity Assessment (CASCO) has produced a number of standards related to the certification process, which are used by certification bodies. When choosing a certification body, the following guidelines need to be followed:

- Evaluate several certification bodies.
- Check if the certification body uses the relevant CASCO standard.
- Check if it is accredited. Accreditation is not compulsory, and non-accreditation does not necessarily mean it is not reputable, but it does provide independent confirmation of competence. To find an accredited certification body, contact the national accreditation body in your country or visit the International Accreditation Forum.
- Qualifications, training, and ongoing competence monitoring of staff.
- Technically competent people that have the relevant experience and sector expertise.
- The certification is recognized by procurers in domestic and overseas markets. The certification independently and impartially verifies compliance to a standard.



Bird's-eye view:

A **certification body** that is accredited by a single or multiple accreditation body/bodies, based on its compliance to the applicable standards and the competence of their managerial and technical resources can issue accreditation certificates with the logo of the accreditation body.

 **Bird's-eye view:**

The International Organization for Standardization's Committee on Conformity Assessment (**CASCO**) has produced a number of standards related to the certification process, which are used by certification bodies.

Accreditation is the independent evaluation of certification bodies against the standard ISO/IEC 17021:2015 (requirements for bodies providing audit and certification of management systems) to ensure their impartiality, competence, and consistency. The standard sets out the principles and requirements for the competence, consistency and impartiality of bodies providing audit and certification of management systems' services. In many countries, accreditation is not mandatory. It should be noted that the fact that a certification body is not accredited does not, by itself, mean that it is not a reputable organization. However, many certification bodies choose to seek accreditation in order to be able to demonstrate an independent confirmation of their competence and independence. The Accreditation bodies for higher education is given in Boxes 18.1 and 18.2.

Box 18.1 National Assessment and Accreditation Council (NAAC)

Education plays a vital role in the development of any nation. Therefore, there is a premium on both quantity (increased access) and quality (relevance and excellence of academic programmes offered) of higher education. The NAAC has been set up to facilitate the volunteering institutions to assess their performance vis-a-vis set parameters through introspection and a process that provides space for participation of the institution.

Assessment and Accreditation is broadly used for understanding the "Quality Status" of an institution. In the context of higher education, the accreditation status indicates that the particular Higher Educational Institutions (HEI)—a College, a University, or any other recognized Unit therein meets the standards of quality as set by the Accreditation Agency, in terms of its performance, related to the educational processes and outcomes, thereby covering the curriculum, teaching–learning, evaluation, faculty, research, infrastructure, learning resources, organization, governance, financial well-being, and student services. Accreditation facilitates the following:

- Institution to know its strengths, weaknesses, and opportunities through an informed review process
- Identification of internal areas of planning and resource allocation
- Collegiality on the campus
- Funding agencies to look for objective data for performance funding
- Institutions to initiate innovative and modern methods of pedagogy
- New sense of direction and identity for institutions
- Society to look for reliable information on quality education offered
- Employers to look for reliable information on the quality of education offered to the prospective recruits
- Intra and inter-institutional interactions

Source: http://www.naac.gov.in/process_for_accreditation.asp, last accessed August 2016

Box 18.2 National Board of Accreditation (NBA)

The National Board of Accreditation (NBA), India was initially established by AICTE (All India Council of Technical Education) under section 10(u) of AICTE act, in 1994 for periodic evaluations of technical institutions and programmes basis according to specified norms and standards as recommended by AICTE council.

NBA in its present form came into existence as an autonomous body with effect from 7th January 2010 with the objective of Assurance of Quality and Relevance of Education, especially of the programmes in professional and technical disciplines such as Engineering and Technology, Management, Architecture, Pharmacy, and Hospitality through the mechanism of accreditation of programs offered by technical institutions. NBA has introduced a new process, parameters, and criteria

for accreditation. These are in line with the best international practices and oriented to assess the outcomes of the programme.

The purpose of the accreditation by NBA is to promote and recognize excellence in technical education in colleges and universities—at both the undergraduate and postgraduate levels. Institutions, students, employers, and the public at large all benefit from the external verification of quality provided through the NBA accreditation process. They also benefit from the process of continuous quality improvement that is encouraged by the NBA's developmental approach to promote excellence in technical education. The purpose and impact of accreditation go far beyond the quality assurance of an institution/programme. Major impacts of accreditation system are summarized as follows:

- Encourages quality improvement initiatives by institutions
- Improves students' enrolment both in terms of quality and quantity
- Helps the institution in securing necessary funds
- Enhances employability of graduates
- Facilitates transnational recognition of degrees and mobility of graduates and professionals
- Motivates faculty to participate actively in academic and related institutional departmental activities
- Helps create sound and challenging academic environment in the institution and contributes to social and economic development of the country by producing high quality technical manpower

Source: <http://www.nbaind.org/En/1045-why-accreditation.aspx>, last accessed August 2016

Bird's-eye view:

Accreditation is the independent evaluation of certification bodies against the standard **ISO/IEC 17021:2015** to ensure their impartiality, competence, and consistency.

■ Steps to ISO Certification

Achieving certification to standards like ISO certification can seem daunting. In this section, we have provided step-by-step approach and detailed about what is required from you as well as your chosen Certification Body for helping those new to the implementation process. Steps to ISO Certification is given in Box 18.3.

Box 18.3 Steps to ISO Certification

1. Client completes and reviews an ISO 9001 application via web, phone, or email with a sales engineer; the client then signs a 3-year quotation and returns it to the PRI Registrar office. Hence, the sales engineer can schedule your initial assessment.
2. An auditor will then be assigned taking into consideration factors such as geographic location, industry knowledge, and scope experience.
3. All Registrar clients are assigned a client manager. Your personal client manager will contact you within a week of your signing. Client managers will assist you with audit coordination throughout the certification process.
4. Forty-five days prior to the audit, a member of the PRI Registrar team will alert the client to print and make all required documents located in the Enterprise Quality Management (EQM) system available to the auditor.
5. Thirty days prior to the audit, the auditor will forward a copy of the audit plan to the client. The audit is performed in accordance to the audit plan.
6. Upon completion of the audit, the auditor generates an audit report identifying any non-conformances (NCR) to the ISO standard. The report and NCRs are entered onto the EQM system. The client works with the auditor to resolve and NCRs using the EQM system.
7. The audit documentation is then reviewed by a third-party expert for approval (assessments and re-assessments only).
8. Once the expert approves the closure of the NCRs, the certificate of registration is issued and sent to the client. The auditor then works with the client to set up subsequent surveillance audits to assure adherence to the ISO 9001 standard over the three-year certification period

Source: http://www.priregistrar.org/pri-registrar/pdf/iso_process.pdf, last accessed August 2016

Step 1: Make the Right Choice

At present, the first step for any organization is making sure that the standard you have chosen is the right fit for your organization. It is worth noting that in order to become certified, you must have been operating for at least three months. This is so you, at least, have some processes in place that can be assessed.

It is necessary to engage with any industrial or professional associations that may be actively involved in to see how ISO certification has worked for other members. You could also speak to certified clients or suppliers as well as using Government resources like Business Link for a wealth of information on ISO standards.

Bird's-eye view:

Auditors work for or contract to Registrars to perform registration assessments and surveillances. They are the “front line” in the process.

Step 2: Review the Standard

Buying a copy of the standard can be useful; however, it is not necessarily required. In truth, the jargon involved may even put you off! This is why the ISO have developed a couple of handbooks that breakdown the ISO 9001 and ISO 14001 standards to make them more accessible.

Step 3: Communicate the Goal

Implementing an ISO management system needs to be an organization-wide target developed by senior management. Ongoing effort will be needed to ensure good habits are maintained throughout the process; therefore, a “champion” will be needed, or a dedicated team if you work in a larger organization. This person or team will also need to be responsible for developing the actual management system. Gaining buy-in is one of the biggest challenges on the route to achieving certification.

Step 4: Establish Training Requirements

If you are completely new to the world of ISO standards, then a training course can be beneficial to give confidence and genuine skills to help in the implementation process. Even if you are fairly experienced, a refresher course ensures that you will get the most out of the standard.

Bird's-eye view:

The Registrars are responsible for ensuring Auditors meet qualification requirements. Their requirements include training in auditing, ISO 9001 training, and at least one member of the audit team must have experience in the industrial sector of the company being audited.

Step 5: Use a Consultant

However, it is acceptable to independently source a consultant to help you along the process. They can help advice on an implementation strategy, and a good consultant should increase the value of the process.

The use of a consultant does not remove your responsibility for establishing and implementing your ISO management system. Therefore, it is in your own interest that you and your management are actively involved with the consultant throughout. Beware of any “readymade” management systems that may not suit your organization.

Step 6: Select a Certification Body

It is important to know exactly what you are signing up to when agreeing to proceed with a Certification Body. The popular ISO management standards are based on a 3-year cycle. Some Certification Bodies will expect you to sign up to a minimum 3-year contract to suit. Whilst only an annual visit is required, there are some who will insist seeing you more frequently. It is important you clarify this when obtaining quotes and check for other hidden costs such as “registration” and travel fees.

Step 7: Develop a Management System

The ISO management standards are designed to be generic that is applicable to organizations of all sizes and industry sectors. Whilst the standards provide a framework for good management practice, specifying things that need to be included, they do not tell you how to do them. Consequently, there is considerable freedom in meeting the requirements of the standards.

The fundamental part of achieving certification to an ISO standard is forming a Management System; a Quality Management System (QMS) for ISO 9001 and an Environmental

Management System (EMS) for ISO 14001. The Management System is formed of processes for management activities, provision of resources, production realization, measurement, analysis, and improvement.

Step 8: Stage 1 Audit

The process starts with what is known as a “Stage 1 Audit.” This is when an auditor reviews your existing systems and provides you with a gap analysis report that will identify the actions required to meet the standard. This can be used as a helpful action plan, and therefore, do not worry if you think you are under prepared. Many organizations find that they already have a number of required processes in place. They just need better documentation and communication of what processes are mandatory and who has responsibility for what.

Step 9: Stage 2 Audit

Once your organization is ready and has filled the gaps highlighted in Stage 1 report, an auditor will visit you again to carry out what is known as the “Stage 2 Audit.” This will reveal the effectiveness of your management system and whether it meets all the requirements of the specific ISO standard you wish to be certified to (e.g., ISO 9001 and/or ISO 14001). If you are fully compliant, you will be recommended for certification. The auditor’s report will then be checked via an approval process and if no anomalies are identified, certification is officially awarded.

Step 10: Maintain your Management System

The maintenance of your management system is where the hard work really starts. Continued buy-in from everyone is important for implementation to succeed and for you to gain the true benefit of becoming certified.

In-house communication and training should be carried out regularly to ensure ongoing awareness and engagement with staff. More formally, internal audits should also be carried out to ensure the requirements of the standard are continually met. A management review should then be held to set out corrective actions as required.

■ International Organization for Standardization Registrars

A registrar is an organization that conducts audits by individual auditors. Auditors are skilled in quality systems and the manufacturing and service environments in which an audit will be performed. The registrar develops an audit team of one or more auditors to evaluate a company’s quality program and then report back to the registrar. An organization that wants to become registrar must be accredited by National Accreditation Board.

An accredited registrar, also called an accredited *certification body* (CB), is an organization accredited by a recognized accrediting body for its competence to audit and issue *certification* confirming that an organization meets the requirements of a standard (e.g., ISO 9001 or ISO 14001).

ISO certification or registration is accomplished by a registrar through a series of document reviews, facility visits, and audits. The registrar’s auditors review a company’s procedures, processes, and operations to see if the company conforms to the ISO quality management system standards. The registrar looks at a variety of things, including the company’s administrative, design and production processes, quality system documentation, personnel training records, management reviews, and internal audit processes. The registration process might typically include initial document review that describes the company’s quality management system followed by the development of an audit plan and then the audit itself. This is usually followed by semi-annual or annual surveillance audits to make sure the quality system is being maintained. The registration process can take from several weeks up to a year, depending on how ready the company is for registration.

Registrar selection can be based on the qualification and experience, certification recognition, time and cost constraints, auditor qualifications, and the ability of the registrar to perform multiple types of audits tailored to the organization’s needs.

Bird's-eye view:

A registrar is an organization that conducts audits by individual auditors. Auditors are skilled in quality systems and the manufacturing and service environments in which an audit will be performed.

Bird's-eye view:

The registrar develops an audit team of one or more auditors to evaluate a company’s quality program and then report back to the registrar. An organization that wants to become registrar must be accredited by National Accreditation Board.

■ Registration Process

The registration process has six basic steps: application for registration, document review, pre-assessment, assessment, registration, and follow-up surveillance. Registrars require a completed application to begin the registration process. The application contains the rights and obligations of both parties that determines standard the applicant will use for the registration and leads to the formalized contract for services.

Bird's-eye view:

The registration process has six basic steps: application for registration, document review, pre-assessment, assessment, registration, and follow-up surveillance.

After accepting the application and setting a time frame for registration, the registrar will review the documentation. The registrar then compares the organization's documentation with the appropriate standard to determine if the intent of the standard has been met. The pre-assessment is a broad overview of the organizations' operations to determine an initial preparedness for a full assessment or audit. A pre-assessment could identify a major deficiency or lack of documentation that can be corrected before the audit takes place, thus enhancing the possibility of approval on the first audit attempt.

After determining that the organization's documents conform to the selected standard, the lead auditor will conduct an opening meeting to introduce the audit team, scope of the audit, and audit schedule. Then, a full audit or assessment is performed. Typically, an audit will take two or four days and will involve two or more auditors at the organization's facility. The client of the audit should be in charge and should demand capable, honest, and meaningful examinations in return for the money invested. The organization's internal audits should lead to continual improvement; the third-party audit process should verify that the organization's management system is performing effectively.

The lead auditor will conduct a closing meeting, which will consist of a verbal summary of the audit findings and a recommendation concerning registration. If the applicant has only minor non-compliances, the recommendation would be for registration. If one or more major non-compliances are registered but appear to be easily corrected, the recommendation may be for a conditional approval pending corrective action. The recommendation for disapproval will be made if it is determined that procedures have not been implemented or at least one element of the standard has not been addressed.

After registration is approved, the registrar will conduct surveillance audits at intervals of six months to a year. These audits will not be full audits but random checks of some elements to ensure that the system continues to function. The duration of registration is for three years, after that the organization must be recertified.

DISCUSSION FORUM

1. Explain the role of ISO certification bodies.
2. What is accreditation?
3. Discuss the steps to ISO certification
4. What are the criteria to select registrar?
5. What are the steps in the registration process?

SUMMARY

- An ISO Audit is a basic term that means checking to ensure you are actually doing what you say you are doing. During an ISO audit you verify that the management system is in compliance with the relevant ISO standard. Check to ensure that the actions taken to meet the quality objectives of the organization are suitable. Auditing is the on-site verification

activity such as inspection or examination of a process or quality system to ensure compliance to requirements. An audit can apply to an entire organization or might be specific to a function, process, or production step.

- There are three discrete types of audits: product (which includes services), process, and system. There are three types of audits: first-party, second-party, and third-party. First-party audits are internal audits. Second- and third-party audits are external audits. For first-party and second-party audits use ISO 19011:2011, whereas for third-party audit use ISO IEC 17021 2015.
- The International Organization for Standardization (ISO) is the world's largest developer and publisher of international standards. The ISO is a network of the national standards institutes of 162 countries, one member per country, with a Central Secretariat in Geneva, Switzerland, that coordinates the system. It is a nongovernmental organization that forms a bridge between the public and private sectors. Further, it enables a consensus to be reached on solutions that meet both the requirements of business and the broader needs of society ISO have published an updated edition of the ISO 19011:2011 auditing standard that will save money, time, and resources by providing a uniform approach to multiple management system audits.
- A certification body that is accredited by a single or multiple accreditation body/bodies based on its compliance to the applicable standards and the competence of their managerial and technical resources can issue accreditation certificates with the logo of the accreditation body (choice of the organization seeking certification). These certificates are issued by them only after they have physically verified that the organization is complying with the requirements of ISO standards or other applicable standards and the scope of the certificate is part of their scope of accreditation. Quality Council of India provides the list of certification bodies in India.
- Accreditation is the independent evaluation of certification bodies against the standard ISO/IEC 17021 (requirements for bodies providing audit and certification of management systems) to ensure their impartiality, competence, and consistency. The standard sets out the principles and requirements for the competence, consistency, and impartiality of bodies providing audit and certification of management systems services.
- A registrar is an organization that conducts audits by individual auditors. Auditors are skilled in quality systems and the manufacturing and service environments in which an audit will be performed. The registrar develops an audit team of one or more auditors to evaluate a company's quality program and then report back to the registrar. An organization that wants to become registrar must be accredited by National Accreditation Board. The registration process has six basic steps: application for registration, document review, pre-assessment, assessment, registration, and follow-up surveillance.

Key Terms

Accreditation 597	Certification 567
Assessment 598	Checklist 583
Audit 567	Client 568
Auditee 568	Closing meeting 584
Auditing 567	Compliance 567
Auditor 569	Compliance audit 572

Conformance	569	Product	569
Conformity	572	Product audit	569
Corrective action	569	Quality audit	570
Customer	569	Quality improvement	606
Defect	606	Quality policy	596
Deviation	573	Registrar	600
Entities	567	Regulation	590
Evaluation	569	Standard	567
Examination	567	Surveillance audit	599
External audit	569	System audit	569
Internal audit	569	Testing	592
Nonconformity	573	Third party audit	568
Objective evidence	569	Validation	605
Opening meeting	584	Verification	567
Process audit	569		

Case Study

Supplier Quality Audit at Tata Motors

Tata Motors Private Limited is a leading manufacturer of trucks in India and India's largest automobile company. It is the second-largest manufacturer of passenger vehicles in the world. The company is the world's fifth-largest medium and heavy commercial vehicles manufacturer and the world's second-largest medium and heavy bus manufacturer.

Tata Indica

Ratan Tata, the chairman of Tata Motors, had always dreamed of building the country's first indigenous small car. In 1995, the company announced that it planned to build the Tata Indica, a car as spacious as the Ambassador, priced close to the Maruti 800 and shaped like the Zen. Tata Motors had to face many challenges in the process of designing and building the Indica.

Exhibit 18.1 Components Outsourced by Tata Motors

Sl No.	Components	Supplier
1.	Five door hatch back	IDEA Italy
2.	Engine	Institute Francais, France
3.	Assembly line	Nissan's plant, Australia
4.	Presses	Mercedes Benz
5.	Pistons and piston rings	India Pistons
6.	Electrical components and fuel injection systems	Lucas-TVS
7.	Steering systems	Rane TRW Steering system
8.	Clutch facings and rear drum brake linings	Sundaram Brake linings (SBL)
9.	Seating systems	Tata-Johnson Controls
10.	Radiators	Tata-Toyo
11.	Rear view mirrors	Tata-Ficosa
12.	Front and rear bumper, dash board, inside trims	Tata-Auto plastics
13.	Air-conditioning kits	Subros Ltd
14.	Wind screens and windows	Asahi Glass
15.	Fuel lines	Imperial Auto
16.	Differential assemblies	Sona Koyo Steering
17.	Sheet metal items	IBM tools

Outsourcing

Tata Motors had to take its primary make or buy decisions for the key inputs such as design, engine and transmission. Outsourcing was one of the most difficult aspects of producing the Indica. The company did not have the expertise either to design a car or to build an engine for it. It had to create a supplier base from scratch. The company decided to shop globally for the best deals and use its own expertise to make whatever modifications were needed. Exhibit 18.1 provides a list of components outsourced for developing the Indica.

Supplier Quality Audit

After making the make or buy decisions, the next step was to identify the suppliers. Most of the parts and components were sourced locally. Only about two per cent of the component value was secured from other global players. Localization of the components was the most important challenge for the company. The Indica was totally indigenous.

Tata Motors undertook supplier audits to select and monitor suppliers during the development of the Indica. Supplier audit is an integral part of the decision process for supplier selection. It enables guarantees regarding design, manufacturing, system, product, raw material and services. It also enables answering to regulatory requirements which impose these audits. A supplier quality audit team was formed with a view to ensuring acceptable supplier quality, which became very critical. The yardstick employed by the company for selecting suppliers was the ability to supply components at the negotiated quality, cost and quantities. The selection of supplier by the team involved following steps:

- An initial assessment team from Tata Motors evaluated the supplier
- Self-evaluation of the supplier based on the format provided by the company
- Quality system survey design validation

- Manufacturing validation
- Product Part Approval Process (PPAP) for certifying the product quality

Tata Motors also set up Supplier Quality Improvement Teams to improve the vendors' systems to ensure that they produced defect-free parts. It applied a thirteen-step quality improvement programme covering supplier self-evaluation, thorough design-validation and audit of supplier quality. Another key to the company's successful vendor-base was a modern system of process management. Tata Motor's target-costing was broken up into vendor-wise cost targets, and the suppliers had to carry out their own value-engineering exercises to lower cost and improve quality.

Source: Adapted from www.tatamotors.com, last accessed April 2016.

For Discussion

1. What were the challenges faced by TATA Motors while selecting its suppliers for Indica?
2. What were the reasons for setting up a supplier quality team at TATA motors?
3. What was the approach followed by the supplier quality audit team?
4. What is the difference between supplier quality audit and third party quality audit?

Short-answer Questions

1. Define ISO audit.
2. Name the standards used for guiding auditing management system.
3. What are the audit objectives?
4. Distinguish corrective action vs. preventive action.
5. Name the types of audits.
6. What is non-conformity?
7. Name the various steps for managing audit programs?
8. What is the use of checklist in auditing?
9. Differentiate major and minor non-conformity.
10. What are the attributes of an auditor?
11. What are the various resources required for carrying an audit?
12. What is the purpose of an audit?
13. List the steps to ISO certification.
14. How would you determine the selection of a registrar?
15. What is the role of NABCB?

Match the Following

a. First-party audit	Measure the level of product conformity to specified standards
b. Second-party audit	Evaluate the manufacturing or processing quality
c. Third party audit	Audit carried out by a supplier on his own system
d. System audit	Audit conducted by one organization over another
e. Process audit	Audit conducted by recognized certification bodies
f. Product audit	Examination of management system of an organization

Discussion Questions

1. How would you perform monitoring and measurement of an auditing management system?
2. Why do you consider internal audit as a vital tool in auditing management system?
3. Who are the customers in first-party, second-party and third-party audit?
4. Explain accreditation.
5. Explain the important points in audit performance.
6. Explain registration process.

Projects

1. Visit the website of Quality Council of India and identify the approved certification bodies regarding
 - a. QMS (http://www.qcin.org/nabcb/accreditation/reg_bod_qms.php)
 - b. EMS (http://www.qcin.org/nabcb/accreditation/reg_bod_ems.php)
 - c. OHSMS (http://www.qcin.org/nabcb/accreditation/reg_bod_ohsms.php)

End Notes

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