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QUALITY MANAGEMENT

METHODICAL GUIDELINES
to practical classes and independent work
for training Masters
specialty 8 03060101 management of organizations and administration

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Preface

Managing quality is an essential and difficult challenge. Quality is essential because it brings value. Successful companies understand the powerful impact customer-defined quality can have on business. For this reason many competitive firms continually increase their quality standards. In quality management, fairness and objectivity play an almost equal role with relevance in the determination of the appropriate quality procedures.

Quality is determined by the action of many random, local and subjective factors. To prevent the influence of these factors on the quality required quality management system. In this case, need not separate isolated and sporadic efforts, and a set of measures on the continuous process of creating a product to support an appropriate level of quality. Today in quality management is essential to the existence of firms certified quality management system, which guarantees high stability and durability of product quality. Quality system certificate allows you to maintain a competitive advantage in the marketplace.

The subject of discipline are the laws governing the formation, operation and development of quality management systems, methods and tools of quality management, quality function deployment, cost analysis methods for quality. The main purpose of the discipline: the formation of a system of knowledge and practical skills in the field of quality management with the basic concepts and ideology of ISO 9000 and total quality management TQM. The development of any of the company and the level of competitiveness largely depends on how effectively organized its quality management. Knowing the essence of quality management allows students to use modern approaches in the evaluation of various organizational processes. Terms of quality management is a prerequisite for success and survival of any company.

The practical sessions cover theoretical principles according to thematic lesson plan, detailed examples and practical problems. Each practice session contains the necessary theoretical information, the order of execution of work and the sample solution that facilitates the perception of the new material, contributes to a better assimilation of the theoretical material that is of interest to students more in-depth study of the course. Developed options allow you to efficiently organize knowledge tests, to effectively understand and objectively evaluate theoretical and practical training of students in the discipline.

Topic 1
Quality standards

Learning Objectives:

1. Understand the concept of quality standards and how it relates to organizations.
2. Explain why knowledge of quality standards is important for business professionals.
3. Provide examples of using quality standards.

Quality management is a contested area, and with the plethora of differing views on what to do, and how to do it, authoritative and impartial guidance is required to help the majority of organizations make sense of the area. It should, of course, be noted that these standards and models are for guidance purposes, rather than comprehensive and complete 'how to' manuals.

ISO 9000 Series Standards

The ISO 9000 series of standards is the international standard for quality management. The objective of this series of standards is to aid supplier quality assurance and to provide a common, authoritative and widely accepted standard by which to evaluate and compare the potential of firms to meet acceptable levels of quality and reliability. The word potential is vital here, since it looks at the system and not the product.

Table 1.1

Time chart of the development of quality standards

Post 1945	NATO AQAP
1960's	Defense Standards 05-21 et seq
1972	BS 4891 Guide to Quality Assurance
1973	73/851 DC (issued by SMMT, based on 05-21)
1975	BS 5179 pt 1-3: (non-mandatory)
1979-81	BS 5750 pt 1-6: mandatory equivalent
1987	ISO 9000 Series
2000	ISO 9000 Series updated
2008	ISO 9000 Series updated

The evolution of the ISO 9000 series of standards is tied up with the development of defense standards and the British Standard BS 5750. Post 1945 it was clear to the departments of government concerned with the procurement of armaments that the quality from different suppliers was very variable. They instituted the concept of auditing suppliers to ensure that the way they did things was satisfactory, thus giving a far better chance that the quality of their final product was satisfactory. This idea was taken up over time by a variety of

organizations, most notably in the automotive sector. Many suppliers found themselves being audited by several different customers all with slightly varying requirements of their quality system. This situation became more and more chaotic with many organizations having to perform procedural summersaults to meet the needs of diverse customers. Since the aims of all these audit requirements were the same, it seemed that there was a need for some form of standardized format, perhaps independently assessed, which could be seen as satisfying all parties. From this developed the BS 5179 series of standards (based on the earlier defense standards 05-21 et seq). These were non-mandatory and developed later into their mandatory equivalents in the BS 5750 series. The ISO 9000 series were harmonized with BS5750 in 1987 and have been revised twice since to their current state.

Why *Adopt ISO 9000?*

ISO 9000 usage has more than doubled from 457,834 in December 2000 to 1,064,785 in December 2009 (ISO 9000 survey). It is clearly popular, and there are a variety of possible reasons for individual organizations to adopt the standard:

1. There are a significant number of organizations around the world which require their suppliers to hold ISO 9000 certification. This has forced some companies to adopt the standard.
2. For some companies ISO 9000 provides access to markets which would otherwise be closed to them by giving potential customers confidence to buy from them. This is particularly relevant to companies from developing countries. It is also likely that simply being seen as 'taking quality seriously' by achieving certification gives a marketing benefit.
3. More enlightened organizations see ISO9000 as a genuine opportunity to improve the way they do business.
4. In particular ISO 9000 has been seen as a stepping stone to Total Quality Management. This has been a key argument for many consultants, but the necessity of having ISO900 in order to become an excellent organization has no strong evidence base.

There is, however, research evidence to suggest that ISO 9000 certification is correlated with business improvement. Sharma (2005), Heras et al (2002) and Naveh and Marcus (2007) amongst others, have shown improvements in business performance and, in some cases been able to link this to improved profitability. A survey by the British assessment Bureau (BAB 2011) also showed that 44% of their certified clients had won new business.

ISO 9000 (2008) Principles and Content

The underlying principle of all these standards is that quality systems are based on formality since this permits objectivity. The standards attempt to formalize and standardize the general approach towards Quality (without standardizing unnecessarily the detailed activities that underpin this approach) by:

- A documented quality policy representing the management's approach to

delivering customer requirements is set out and committed to by senior management.

- The policy is deployed throughout the organization with more detailed descriptions of processes developed for implementation at lower levels in the business.
- The organization internally audits adherence to the policies and procedures, keeping records of audits and quality performance.
- The records are used as the basis for corrective and improvement actions.
- The quality system is audited by third party certification bodies to ensure compliance, and the organization works to improve the system in line with the external audit.

Process management is the approach which permeates the more modern version of the standard:

Senior management has a responsibility to ensure customer requirements are clearly identified. They deploy appropriate resources to address the requirements. The product realization (note this can also apply to a service) process takes the detailed customer requirements as an input and transforms the resources provided into a product (or service) output. The customer receives the output and the organization seeks feedback. The organization measures the product realization process (cost, efficiency, etc.) and analyses this in conjunction with the customer feedback to assess the operation of the system and drive improvement where required. This is fed back to senior management as an input to further strategic planning. Measurement and analysis of the performance of the overall quality system is also used to drive improvement at that level.

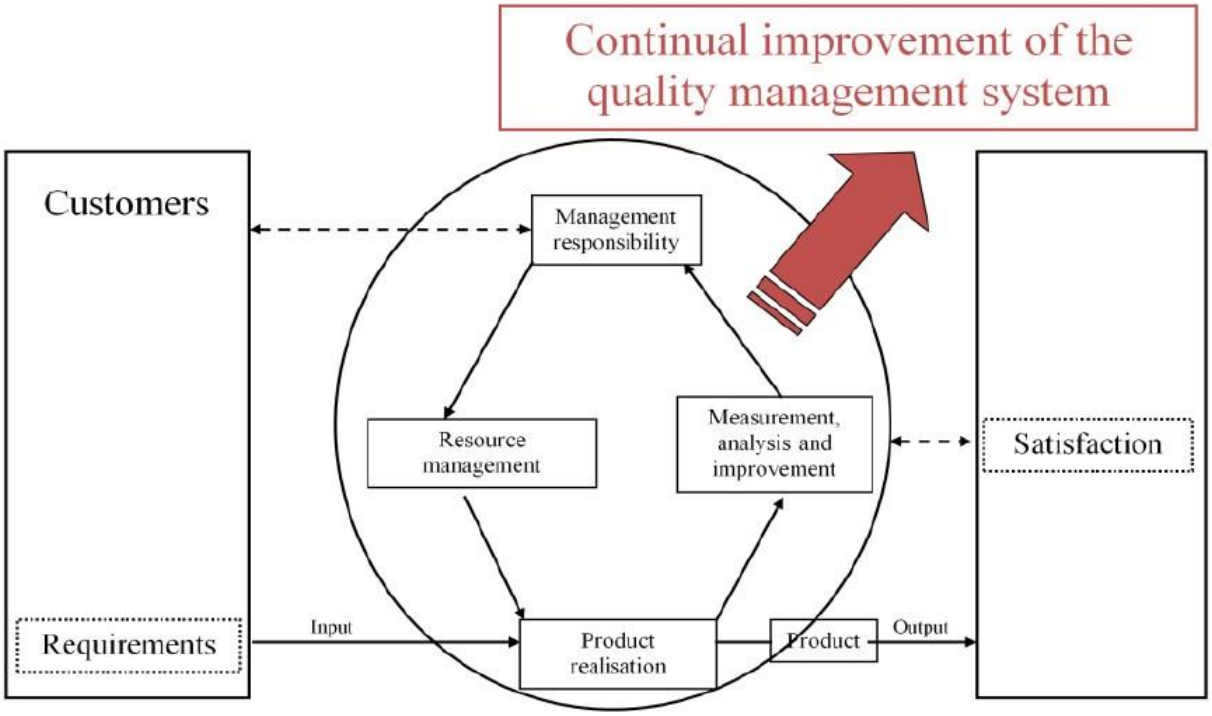

Figure 1.1. The ISO 9000 process approach to quality

The detailed clauses of the standard provide greater depth on the requirements for each element of the system. This detail will not be provided here, but can be obtained by perusing the standard or one of the many books on the topic.

Certification Process

ISO does not itself certify companies to ISO 9000. Instead each member country has an accreditation body which accredits certification bodies who deal with certification of companies. Agreements between national bodies allow for international recognition of certificates issued by Accredited Certification Bodies (ACB). Companies select an ACB and the ACB will then conduct extensive audits of the organization and deliver a report. The focus of the report is 'Non-Compliances' where the company has failed to fully meet certification criteria. Should there be no major Non-Compliances, or on acceptance of an action plan to remove such issues, a certificate will be issued. The certificate will be subject to renewal (by full audit) every three years and to 'surveillance' audits of lower intensity on an annual basis.

ISO 9000 Critique

As noted above, there is evidence that implementation of ISO 9000 has a positive business impact. The principles employed in the 2000 and 2008 versions are certainly sound, encompassing as they do the principles of management responsibility, process focus and customer satisfaction. However, ISO 9000 remains controversial. Critics of the approach cite a number of key issues:

- The values of the good practices associated with the TQM ethos which ISO 9000 is supposed to mimic are lost when they are being completed for the purposes of compliance with a standard.
- A corollary of this is that many organizations are actually adopting ISO 9000 as an end in itself, either due to misunderstanding of its purpose, or due to pressure from existing or prospective customers. These organizations are far less likely to see real benefits as, once certification is attained, they tend to drift back to 'business as usual' until the next audit is due.
- It is sometimes argued that ISO 9000 perpetuates the myth of quality as an adjunct to normal business, rather than something which is integrated with the greater whole of the business. This mentality is linked to the first two failings, and is highly damaging to the chances of improved organizational performance.
- ISO 9000 is often criticized for the cost of accreditation and associated paperwork. This is certainly a problem, but if real gains in quality and process efficiency are made then this is not an issue.
- Related to this is the fact that, in order to prove that you are doing a good job it may be necessary to create rather more paperwork than is necessary to do it. This brings the risk of over-procedurization which will make it more complicated to change the process once approved, this may stifle improvement actions due to increased bureaucracy of change. Seddon (2000), amongst others, suggests it promotes compliance over understanding and improvement.

- Customers in particular often complain that ISO 9000 certification does not guarantee good products. This seems counter intuitive, but is true, nonetheless.
- Finally, ISO 9000 is seen by many as a partial system; it talks of people involvement and leadership but fails to engage with them on any meaningful level. These are two of the most important issues in Quality Management. Peters and Waterman (2004) note that quality can fail through 'passion without system or system without passion'. ISO 9000 gives little or no attention to the passion which is required to deliver excellence.
- The competitive nature of the accreditation business has led to questions regarding the relationships between ACB and client, calling into question the impartiality of the assessment and raising concerns over the potential to sell consultancy services on the back of a failed accreditation audit.

Summary

The idea of a standard for quality management is a seductive one. It is, however, fraught with difficulty in application; particularly when the pressure to achieve accreditation from senior management or customer can be extremely high. This can lead to game-playing, a compliance mentality and other unintended negative consequences. Undoubtedly, the standard can be a useful first step on the road to excellence, but it must be recognized as just that, and even then, only when undertaken in the right spirit. ISO 9000 is not 'Quality' – more needs to be done, particularly in respect of leadership, people and customers. It may also inhibit exactly those things by being, to a degree, bureaucratic and top-down in nature.

Review & Discussion Questions

1. Why Do we Need Standards?
2. Which standards include the ISO 9000 series of standards?
3. Describe the evolution of the ISO 9000 series of standards.
4. Why Adopt ISO 9000?
5. Describe the Principles and Content of ISO 9000 (2008).
6. What is the ISO 9000 process approach to quality?
7. What is the Certification Process.
8. Define ACB.
9. Which key issues cite critics of the ISO 9000 process approach to quality?
10. What is the idea of a standard for quality management?

Topic 2
Models of Quality

Learning Objectives:

1. Define and describe the Self- Assessment Models of Quality.
2. Give examples of generally recognized awards and associated models.
3. Describe the main uses of EFQM Quality Model and RADAR self-assessment system.
4. Explain the benefits of the Self Assessment Process.

Self- Assessment Models of Quality

In addition to standards there are a number of widely recognized models of quality, where the focus is not on achievement of a certificate, but on recognition through self-assessment and associated awards.

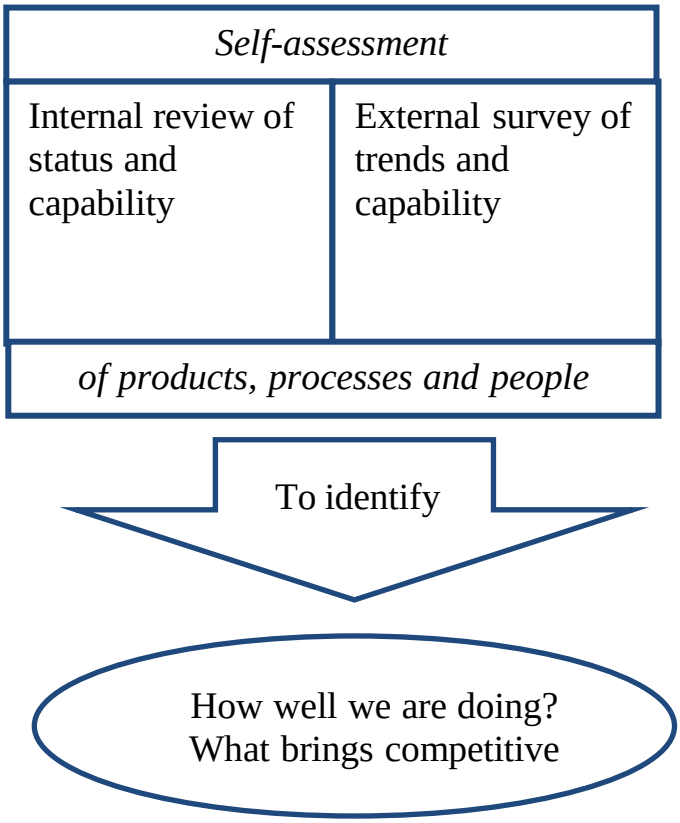

Figure 2.1 An overview of self-assessment

Self-assessment is the process of evaluating your own organization against a model for continuous improvement. By doing this, it is possible to understand both achievements and improvement opportunities.

The *objective of self-assessment* is to identify and act on the areas of the improvement process that require additional effort, while recognizing and maintaining that which is already going well (see Figure 2.2).

Self-assessment has advantages over a certification system in that it does not carry the same pressure to pass, so there is less incentive for game playing, cheating, etc.

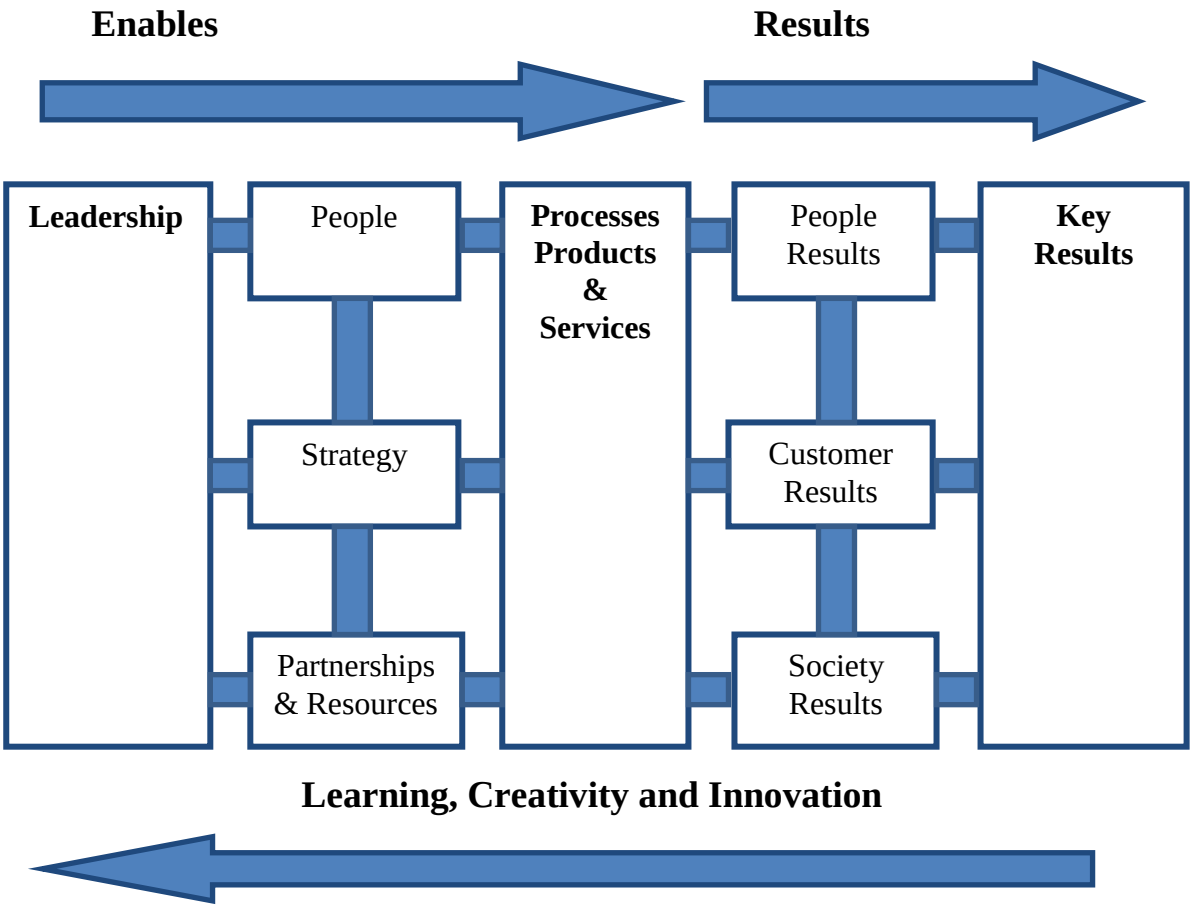

Figure 2.2. The EFQM Quality Model (EFQM.org, 2011)

There are 3 generally recognized awards and associated models:

1) The Deming Prize

The Deming Prize was named after Dr W Edwards Deming and established in 1951. It is administrated by the Japanese Union of Scientists and Engineers (JUSE) and follows the requirements of the PDCA (Plan, Do, Check, Act) cycle.

Assessment criteria are company policy and planning, organization, quality control education, quality information handling, analysis, standardization, control, quality assurance, effects and future plans of the organization. Recent winners include Tata Steel (India), Niigata Diamond Electric Company Ltd. (Japan).

2) The Malcolm Baldrige National Quality Award

The Baldrige Award was named after Malcolm Baldrige, a US Secretary of Commerce and Industry who was a champion for the quality cause, and established in 1987. It is administrated by the US Department of Commerce and Industry and closely follows the Deming Prize but with more emphasis on customer satisfaction. Assessment criteria are: leadership; strategic planning; customer focus; measurement, analysis and knowledge management; operations focus; workforce focus; results. Recent winners include Nestle Purina Petcare Co. and Advocate Good Samaritan Hospital.

3) The European Foundation for Quality Excellence Award (EQA)

This will be the main focus of this chapter. The EQA was established by a consortium of 14 European multi-national organizations in 1991. It is administrated

by the European Foundation for Quality Management (EFQM) and closely follows the Baldrige Model, with the means to facilitate comparisons both internally and externally. It has a number of guiding principles:

According to the EFQM model, an excellent organization should be Achieving a Balanced Set of Results and progress towards their vision by meeting or exceeding the expectations of stakeholders in both the short and long term. A particular focus within this is Adding Value for Customers through active engagement with their requirements and innovation. Excellent organizations have leaders who Lead with Vision, Inspiration and Integrity acting as role models for values and ethics and Succeeding Through People by valuing and empowering staff and seeking a balance between organizational and personal goals. An excellent organization will also actively and systematically Nurture Creativity and Innovation to deliver increased value and Build Partnerships for mutual success based on trust with stakeholders including customers, suppliers and wider society. Ethical organizations embed an ethical mindset within their operations and Take Responsibility for a Sustainable Future from an economic, social and ecological standpoint.

Based upon these fundamental concepts the EFQM Excellence Model is designed to provide a holistic view of an organization with respect to its journey towards excellence. It provides an over-arching framework within which other approaches, tools and techniques can be applied. Crucially, the Model considers both the achievements of an organization, and the mechanisms by which these achievements are delivered. Without sustained results, actions have been ineffective, and results without clarity on how they are achieved will not be sustainable. The enablers are those processes, systems, and behaviors that need to be in place and managed to deliver excellence (Table 2.1).

Table 2.1

The EFQM Excellence Mode

Criterion	**Requirements**
Leadership: This criterion considers how managers and employees in team leadership roles inspire and drive continuous improvement. Self-assessment should demonstrate:	Visible involvement in leading the drive for excellence. Communication of a clear vision, mission, values and structure. Timely recognition and appreciation of the efforts and successes of individuals and teams. Empowerment of individuals within the organization. Provision of appropriated resources and assistance. Involvement with customers and suppliers. Active promotion of excellence outside the organization.

Strategy: This criterion considers how senior management incorporate the values and concepts of quality in the determination, communication, review	Self-assessment should demonstrate how policy and strategy are: Formulated on the concept of excellence. Based on information that is relevant and comprehensive. Implemented throughout the organization. Communicated internally and externally. Regularly updated and improved.
People: This criterion considers how the full potential of people is released. Self-assessment should demonstrate how:	People resources are planned and improved. People are rewarded, recognized and cared for. The knowledge and competencies of the people are preserved and developed through recruitment, training and career progression. The involvement of everyone in continuous improvement is promoted and people are empowered to take appropriate action. Effective top-down, bottom-up and lateral communication is achieved.
Partnerships & Resources: This criterion considers how the organization improves its management, utilization and preservation of its resources including financial information, materials and technological resources. Self-assessment should demonstrate how	Financial resources. Information resources. Suppliers, materials, buildings and equipment. The application of technology.
Processes, Products & Services: This criterion considers how the organization identifies, reviews and, if necessary, revises all key and support processes to ensure continuous improvement. Self-	Processes critical to the success of the organization are identified The organization systematically manages its processes. The processes are reviewed and targets set for improvement. The organization stimulates innovation and creativity in process improvement. The organization implements process changes and evaluates the benefits.

The results provide the measure of actual achievement of improvement. The Model is currently used by over 30,000 organizations across Europe and the wider world (EFQM.org, 2011), and recent winners include Robert Bosch Fahrzeugelektrik Eisenach, Siemens, Congleton.

People Results: This criterion considers the perception and feelings of people in the organization. What are the successes in satisfying their needs and expectations? Self-assessment should demonstrate the organization's success in satisfying the needs and expectations of its people by measuring:

- The people's perception of the organization, using factors relating to motivation and satisfaction.
- Additional measures relating to people satisfaction.

Customer Results: This criterion considers the perception of customers of the organization and its services. What is the success in satisfying needs and expectations? Self-assessment should demonstrate the organization's success in satisfying the needs and expectations of its external customers by measuring the customer's perception of the organization's products, services and customer relationships and additional measures relating to satisfaction.

Impact on Society: This criterion considers the perception of the organization in the community, including the approach to quality of life, the environment and preservation of global resources. Self-assessment should demonstrate the organization's success in satisfying the needs and expectations of the community at large by measuring the perception of the community at large of the organization's impact on society and additional measures relating to the organization's impact on society.

Key Results: This criterion considers the organization's achievements in relation to its planned performance and the results of all key internal processes. Self-assessment should demonstrate financial measures of the organization's success (sales, gross margins, net profit, cash flow, borrowing, assets, credit ratings, ROI, long-term share holder value) and non- financial measures of the organization's success (market share, supplier performance, variability and capability, waste and non-value adding activities, cycle times).

Self Assessment Process

The approach to self assessment employed by the EFQM Excellence Model is the Results, Approaches, Deploy, Assess and Refine (RADAR) system (figure 2.3).

The senior management team must consider the strategic results they are looking for from the application of the model, and agree appropriate measurement instruments to assess how well they are delivered. They may, if they choose, benchmark current performance at this point for future reference. The next step is to develop a robust and integrated set of actions which are necessary and sufficient to deliver the results. These will need to be agreed with the individuals involved in delivering the actions, and deployed to appropriate levels in the organization. As the actions are carried out, regular assessment of both the approaches and deployment should be undertaken and refinements made as required.

The application for the award is a natural extension of the approach, and can be

undertaken whenever the company feels ready. This will give an external calibration of progress and, if successful, kudos in the marketplace.

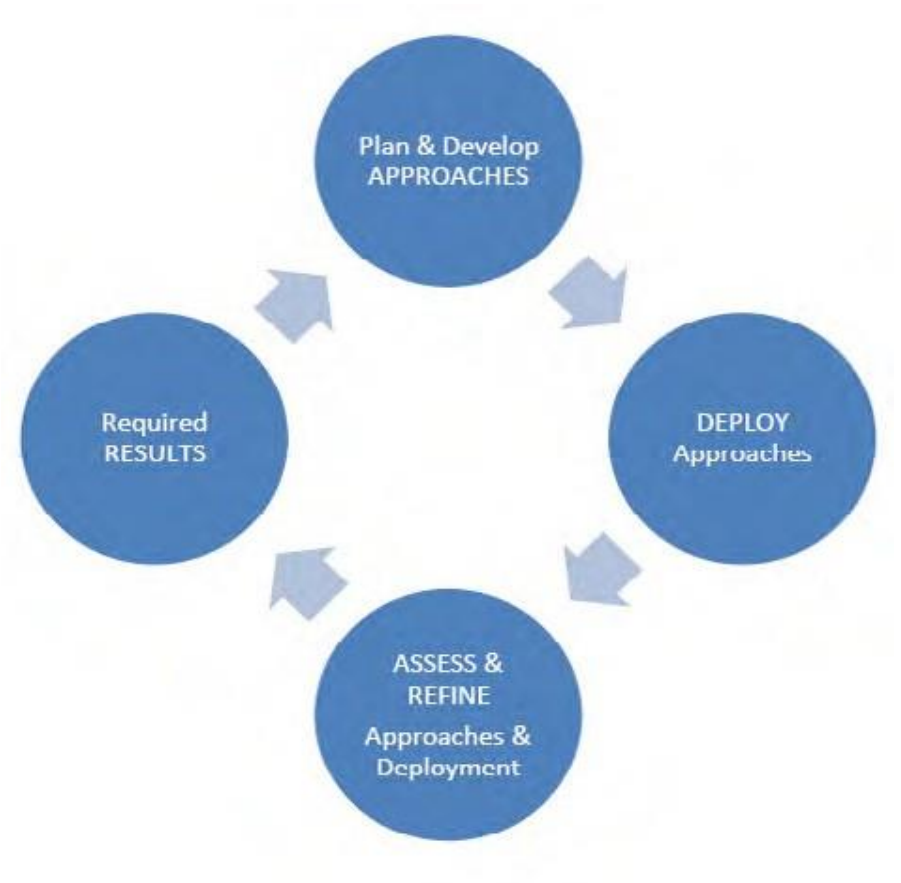

Figure 2.3. RADAR self-assessment system.

Benefits of the Self Assessment Process

Well planned and executed self-assessment, including follow-up action, can deliver significant benefits, including:

- Gaining consensus on what has been achieved and what still needs to be done, thus enabling managers to prioritise action based on facts and identified needs.
- Providing data to compare with, and learn from, 'world class' organizations in addition to learning from each other.
- Providing a practical tool to driving continuous improvement and data on improvements over time for an objective review of progress.
- Providing a common approach to use in all departments and on all sites and minimizing the effort needed to develop assessment methods at different sites.
- Enabling everyone to contribute to the assessment process, thereby bringing ownership of the results and proposed actions. Enabling staff to see the impact of their improvement efforts.
- Enabling senior managers to drive the improvement process and to empower their staff to exercise initiative at their own level.
- Demonstrating the long-term commitment and consistency of purpose.

Integrating improvement activity into everyday life by focusing on business results.

Summary

It is very useful for organizations pursuing Quality (or Excellence) to have some form of roadmap. This needs to be an enabling model, which sets out broad principles and the direction of travel without imposing unnecessary constraints on how exactly to move forward. Such constraints would reduce the effectiveness of any approach by reducing the opportunity for innovation and sensible customization based on the unique situation of the organization.

The ISO 9000 standard is mandated in many cases by customers or market norms. It has the benefit of wide recognition and a general market advantage, but suffers from the problems of pressure to achieve the standard and a scope (especially in application) which lacks significant focus on leadership, people and results.

The broader self-assessment models are focused more on improvement than attainment of a standard or award, and thus perhaps represent a sounder approach which allows for more honesty and integrity in assessing opportunities and progress. The basis tends to be wider, considering both results and the sustainability of those results through the approaches which delivered them.

Review & Discussion Questions:

1. Explain in detail what a Self- Assessment Model of Quality is.
2. Write short notes on the following:
    a) The Deming Prize
    b) The Malcolm Baldrige National Quality Award
    c) The European Foundation for Quality Excellence Award (EQA)
3. Describe the EFQM Quality Model.
4. What are the fundamental concepts of the EFQM Excellence Model?
5. Describe the Criterions and Requirements of the EFQM Excellence Model.
6. Which criterion considers the perception and feelings of people in the organization?
7. Which criterion considers the perception of customers of the organization and its services?
8. Which criterion considers the perception of the organization in the community, including the approach to quality of life, the environment and preservation of global resources?
9. Which criterion considers the organization's achievements in relation to its planned performance and the results of all key internal processes?
10. Describe RADAR self-assessment system.
11. Briefly describe the benefits of the Self-Assessment Process.
12. Describe the benefits and problems of the ISO 9000 standard.

Topic 3
Six Sigma and Quality Management

Learning Objectives:

1. Define Six Sigma as a business management strategy.
2. Identify the key roles for Six Sigma successful implementation.
3. Describe the quality management tools and methods used in Six Sigma.

Six Sigma is a business management strategy, originally developed by Motorola in 1986. Six Sigma became well known after Jack Welch made it a central focus of his business strategy at General Electric in 1995, and today it is widely used in many sectors of industry. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes. It uses a set of quality management methods, including statistical methods, and creates a special infrastructure of people within the organization ("Black Belts", "Green Belts", etc.) who are experts in these methods. Each Six Sigma project carried out within an organization follows a defined sequence of steps and has quantified financial targets (cost reduction and/or profit increase).

The term *Six Sigma* originated from terminology associated with manufacturing, specifically terms associated with statistical modeling of manufacturing processes. The maturity of a manufacturing process can be described by a *sigma* rating indicating its yield, or the percentage of defect-free products it creates. A six sigma process is one in which 99.99966% of the products manufactured are statistically expected to be free of defects (3.4 defects per million). Motorola set a goal of "six sigma" for all of its manufacturing operations, and this goal became a byword for the management and engineering practices used to achieve it.

Methods

Six Sigma projects follow two project methodologies inspired by Deming's Plan-Do-Check-Act Cycle. These methodologies, composed of five phases each, bear the acronyms DMAIC and DMADV.

- DMAIC is used for projects aimed at improving an existing business process. DMAIC is pronounced as "duh-may-ick".
- DMADV is used for projects aimed at creating new product or process designs. DMADV is pronounced as "duh-mad-vee".

DMAIC

The DMAIC project methodology has five phases:

- Define the problem, the voice of the customer, and the project goals, specifically.
- Measure key aspects of the current process and collect relevant data.
- Analyze the data to investigate and verify cause-and-effect relationships. Determine what the relationships are, and attempt to ensure that all factors have been considered. Seek out root cause of the defect under investigation.
- Improve or optimize the current process based upon data analysis using techniques such as design of experiments, poka yoke or mistake proofing, and

standard work to create a new, future state process. Set up pilot runs to establish process capability.

- Control the future state process to ensure that any deviations from target are corrected before they result in defects. Implement control systems such as statistical process control, production boards, visual workplaces, and continuously monitor the process.

Some organizations add a *Recognize* step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology.

DMADV or DFSS

The DMADV project methodology, also known as DFSS ("Design For Six Sigma"), features five phases:

1. *Define* design goals that are consistent with customer demands and the enterprise strategy.
2. *Measure* and identify CTQs (characteristics that are Critical To Quality), product capabilities, production process capability, and risks.
3. *Analyze* to develop and design alternatives, create a high-level design and evaluate design capability to select the best design.
4. *Design* details, optimize the design, and plan for design verification. This phase may require simulations.
5. *Verify* the design, set up pilot runs, implement the production process and hand it over to the process owner(s).

Quality management tools and methods used in Six Sigma

Within the individual phases of a DMAIC or DMADV project, Six Sigma utilizes many established quality-management tools that are also used outside Six Sigma (Check sheet, Control chart, Correlation, Design of experiments, Histograms, Pareto analysis, Pareto chart, Root cause analysis, Run charts, Scatter diagram, Stratification and other methods).

Six Sigma identifies several key roles for its successful implementation.

- Executive Leadership includes the CEO and other members of top management. They are responsible for setting up a vision for Six Sigma implementation. They also empower the other role holders with the freedom and resources to explore new ideas for breakthrough improvements.
- Champions take responsibility for Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from upper management. Champions also act as mentors to Black Belts.
- Master Black Belts, identified by champions, act as in-house coaches on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts. Apart from statistical tasks, they spend their time on ensuring consistent application of Six Sigma across various functions and departments.
- Black Belts operate under Master Black Belts to apply Six Sigma methodology to specific projects. They devote 100% of their time to Six Sigma. They primarily focus on Six Sigma project execution, whereas Champions and Master Black Belts focus on identifying projects/functions for Six Sigma.

- Green Belts are the employees who take up Six Sigma implementation along with their other job responsibilities, operating under the guidance of Black Belts.

Some organizations use additional belt colors, such as Yellow Belts, for employees that have basic training in Six Sigma tools and generally participate in projects and 'white belts' for those locally trained in the concepts but do not participate in the project team.

Origin and meaning of the term "six sigma process"

The term "six sigma process" comes from the notion that if one has six standard deviations between the process mean and the nearest specification limit, as shown in the graph, practically no items will fail to meet specifications. This is based on the calculation method employed in process capability studies.

Capability studies measure the number of standard deviations between the process mean and the nearest specification limit in sigma units. As process standard deviation goes up, or the mean of the process moves away from the center of the tolerance, fewer standard deviations will fit between the mean and the nearest specification limit, decreasing the sigma number and increasing the likelihood of items outside specification.

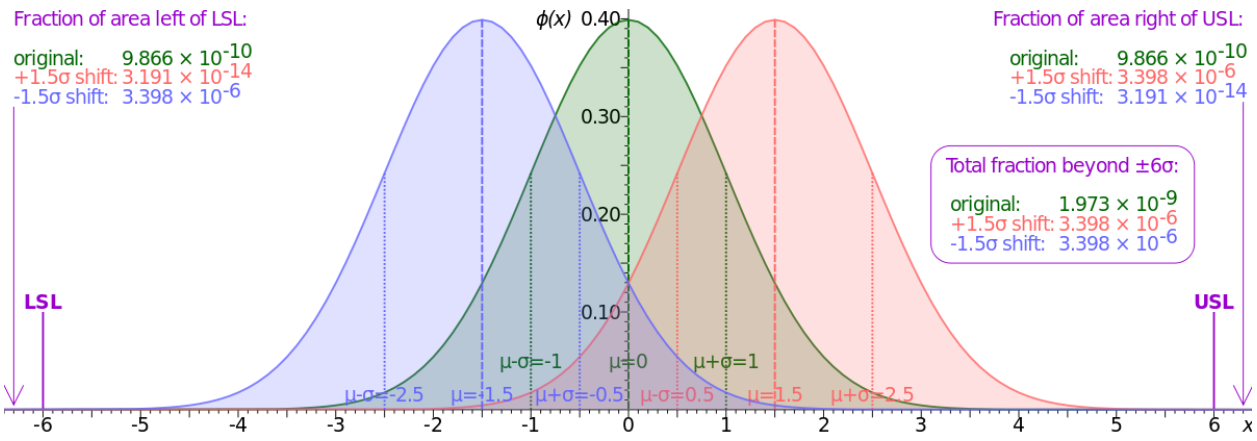

Figure 3.1 Graph of the normal distribution

Graph of the normal distribution, which underlies the statistical assumptions of the Six Sigma model. The Greek letter σ (sigma) marks the distance on the horizontal axis between the mean, μ, and the curve's inflection point. The greater this distance, the greater is the spread of values encountered. For the green curve shown above, μ = 0 and σ = 1. The upper and lower specification limits (USL and LSL, respectively) are at a distance of 6σ from the mean. Because of the properties of the normal distribution, values lying that far away from the mean are extremely unlikely. Even if the mean were to move right or left by 1.5σ at some point in the future (1.5 sigma shift, colored red and blue), there is still a good safety cushion. This is why Six Sigma aims to have processes where the mean is at least 6σ away from the nearest specification limit.

Role of the 1.5 sigma shift

Experience has shown that processes usually do not perform as well in the long term as they do in the short term. As a result, the number of sigmas that will fit between the process mean and the nearest specification limit may well drop over time, compared to an initial short-term study. To account for this real-life increase in process variation over time, an empirically-based 1.5 sigma shift is introduced into the calculation. According to this idea, a process that fits 6 sigma between the process mean and the nearest specification limit in a short-term study will in the long term fit only 4.5 sigma ‑ either because the process mean will move over time, or because the long-term standard deviation of the process will be greater than that observed in the short term, or both.

Hence the widely accepted definition of a six sigma process is a process that produces 3.4 defective parts per million opportunities (DPMO). This is based on the fact that a process that is normally distributed will have 3.4 parts per million beyond a point that is 4.5 standard deviations above or below the mean (one-sided capability study). So the 3.4 DPMO of a six sigma process in fact corresponds to 4.5 sigma, namely 6 sigma minus the 1.5-sigma shift introduced to account for long-term variation. This allows for the fact that special causes may result in a deterioration in process performance over time, and is designed to prevent underestimation of the defect levels likely to be encountered in real-life operation.

Sigma levels

The table below gives long-term DPMO values corresponding to various short-term sigma levels.. It must be understood that these figures assume that the process mean will shift by 1.5 sigma toward the side with the critical specification limit. In other words, they assume that after the initial study determining the short-term sigma level, the long-term Cpk value will turn out to be 0.5 less than the short-term Cpk value. So, for example, the DPMO figure given for 1 sigma assumes that the long-term process mean will be 0.5 sigma beyond the specification limit (Cpk = ‑0.17), rather than 1 sigma within it, as it was in the short-term study (Cpk = 0.33). Note that the defect percentages indicate only defects exceeding the specification limit to which the process mean is nearest. Defects beyond the far specification limit are not included in the percentages.

Table 3.1

Sigma level	**DPMO**	**Percent defective**	**Percentage yield**	**Short-term C_{pk}**	**Long-term C_{pk}**
1	691,462	*69%*	31%	0.33	-0.17
2	308,538	31%	69%	0.67	0.17
3	66.807	6.7%	93.3-3	1.00	0.5
4	6.210	0.62%	99.38%	1.33	0.83
5	233	0.023%	99.977%	1.67	1.17
6	**3.4**	**0.00034%**	99.99966%	**2.00**	**1.5**
7	0.019	0.0000019%	99.9999981%	2.33	1.83

A control chart depicting a process that experienced a 1.5 sigma drift in the process mean toward the upper specification limit starting at midnight. Control charts are used to maintain 6 sigma quality by signaling when quality professionals should investigate a process to find and eliminate special-cause variation.

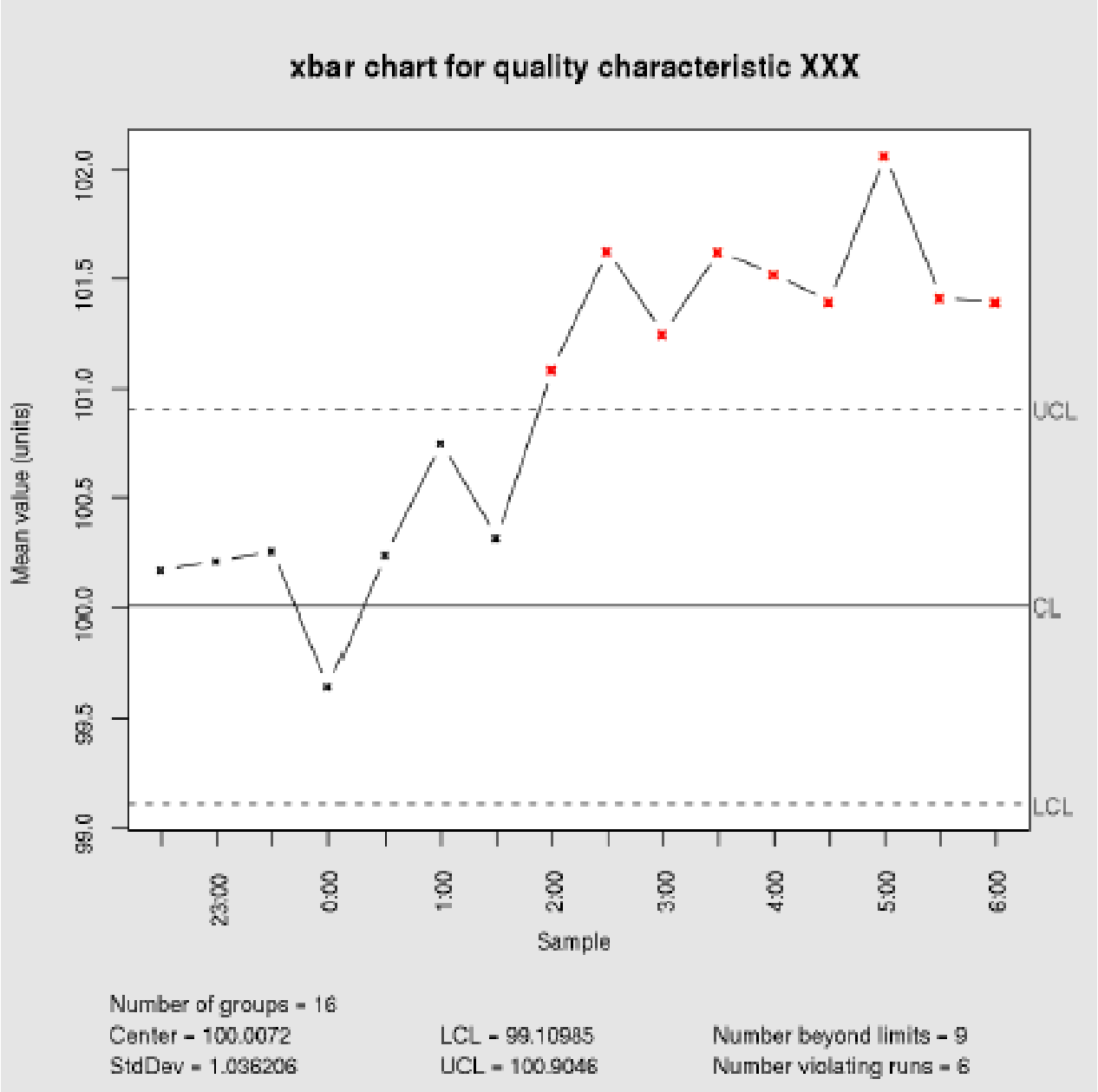

Figure 3.2 Control chart

Application of Six Sigma

Six Sigma mostly finds application in large organizations. An important factor in the spread of Six Sigma was GE's 1998 announcement of $350 million in savings thanks to Six Sigma, a figure that later grew to more than $1 billion. According to industry consultants like Thomas Pyzdek and John Kullmann, companies with fewer than 500 employees are less suited to Six Sigma implementation, or need to adapt the standard approach to make it work for them. This is due both to the infrastructure of

Black Belts that Six Sigma requires, and to the fact that large organizations present more opportunities for the kinds of improvements Six Sigma is suited to bringing about.

Review & Discussion Questions:

1. Explain the term Six Sigma.
2. What methods does "six sigma" use?
3. Describe the DMAIC project methodology.
4. Describe the five phases of "Design For Six Sigma" (DFSS).
5. What quality management tools are used in Six Sigma?
6. Which key roles does "Six Sigma" identify for its successful implementation?.
7. What is the origin and meaning of the term "six sigma process"?
8. Describe the graph of the normal distribution.
9. What is the role of the 1.5 sigma shift?
10. What can you tell about Sigma levels?
11. What is the application of Six Sigma?
12. How does Six Sigma work?

Topic 4
Customers and Quality

Learning Objectives:

1. Explain the term 'customer satisfaction' and pervasive myths which inhibit good practice.
2. Describe the issues associated with Value Analysis
3. Describe the process of Translating Requirements into Design Features.

The term 'customer satisfaction' is now very prevalent in most organizations, which is clearly a good thing. However, there is significant evidence that the practice of customer focus lags behind the rhetoric. In particular there are pervasive myths which inhibit good practice.

*Myth 1***:** We Know What Customers Want Better Than They Do

We often consider ourselves 'expert' in our customers' requirements. We, after all, have been in this business for a long time; we have much more experience than the typical customer, who may have only bought a few of our products. We are technically much more au fait with the product, and with those of our competitors.

Customers may not be expert in the technicalities of the product, but they do know what the need the product to do for them.

*Myth 2***:** Responding to Complaints Improves Satisfaction

Customer complaints clearly need to be dealt with effectively. An unhappy customer is a negative advocate in respect of your organization; they will be sharing their experiences and dissatisfaction. However, too many companies rely solely on feedback from customers to drive their improvement processes.

*Myths 3 & 4***:** Customer Satisfaction and Customer Loyalty

Customer satisfaction is a cherished notion. If the Customer value conforms to the equation below, when the results equal the expectation, and then the customer value is zero.

RESULTS – EXPECTATIONS = VALUE

This implies that satisfaction is the absolute minimum that should be expected, and that its achievement does little or nothing to enhance company performance in terms of retention of customers, or profitability. Exceeding expectations (and thus generating positive value) needs to be the goal. Similarly, the concept of customer loyalty is not helpful. They will stick with a brand as long as they perceive value there, but desert it as soon as they see more value elsewhere. Our goal needs to be to create (and maintain) customer preference for our offering.

*Myth 5***:** Customer Satisfaction has a Linear Relationship with Performance

The Kano model of quality (see Figure 4.1) indicates that the simplistic view of customers having requirements which improve satisfaction in a linear fashion depending upon the degree to which they are met does not fully reflect the complex nature of the process of satisfying customers.

For example, excitement quality refers to giving the customer something he didn't know he wanted. Clearly, no customer can be dissatisfied because you didn't

give them something they didn't know they wanted but if you do then you have a chance of obtaining extraordinary customer satisfaction. In this case we have a nonlinear interdependence between customers' requirements and their satisfaction.

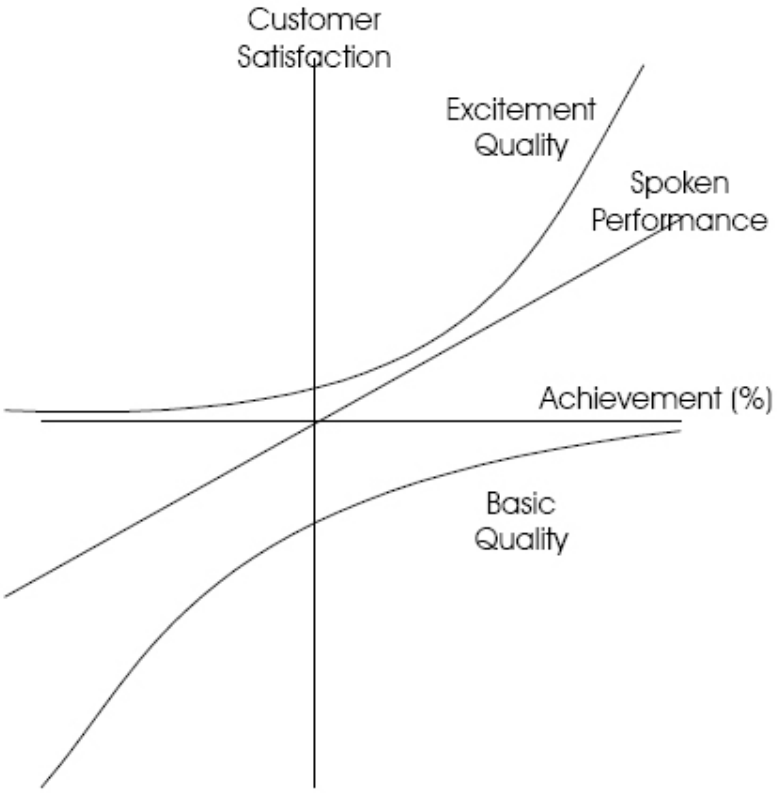

Figure 4.1. The Kano model of quality

Internal and External Customers

Quality thinking encourages us to think about whoever receives our work as a customer, internal or external.

Figure 4.2. Internal Customer Chain

Of course, the mentality of seeing the whole organization as serving the needs of the final customer needs to be paramount. It is not appropriate to make internal customers happy at the expense of external ones. However, if we recognize the focus of the system as satisfying the final customer, then we should do our best to support our internal customers where this does not compromise this objective.

Value Analysis

Value is a complex measure which is shaped by a number of factors:

- Freedom from faults.
- Degree to which requirements/expectations are met.
- Emotional engagement with the product/service.
- Quality of contact with the supplier.
- Cost of the product or service.

Freedom from faults speaks for itself, the product or service must be delivered to the customer as specified. Failure to do this reduces value. Equally, it is apparent that the degree to which customer needs and expectations (basic quality, spoken performance and excitement quality aspects) are met is significant to the value the customer will place upon the product.

More complicated is the emotional engagement with the product or service; this is a combination of things such as: ergonomics, perceived social and cultural cachet, brand perception, aesthetics, linkage to self-image, etc. A product which looks beautiful (to the customer in question), fits their values (for example, eco-friendly), is seen as aspiration in the media and popular opinion, is easy (or ideally elegant) to use, and is associated with a brand which has high value for the customer will score highly on this element.

Quality of contact with the supplier (whether web or direct) is also a major factor, customers often cite feeling important and cared for as a crucial factor in their decision to do business with a particular organization. Again, this is itself a complex issue with ease of interaction, perceived competence and degree of responsiveness of staff playing a part, among other things.

Finally, cost is important in assessing value; importantly, this does not just mean purchase price, customers are often sophisticated in assessing longer term costs (running, taxation and insurance costs for cars are a good example).

This complicated context means that it is crucial, if we are to understand what the customer values, that we take a relatively sophisticated approach to customer requirements data.

Requirements Gathering.

Customer requirement gathering is often regarded as an unfortunate necessity. This may account for the half-hearted way in which many organizations approach the task. It will often be out-sourced to market research companies, for example. Listening to your customers is probably the single most important thing you can do as an organization, you should take the opportunity to get as many of your people as possible face to face with the customer. Especially people like designers. Often we take a very uninspired questionnaire based approach, where people are asked what they want from a product or service. This may well be fine for generating ‘spoken performance’ requirements, but is unlikely to provide insights into ‘basic’ or ‘excitement’ features. Be creative; engage with your customer in more direct ways. Send designers to where the customer is.

There is no single answer to the best way of gathering customer requirements, but there is a need for careful consideration of this area.

Translating Requirements into Design Features.

Sadly, the difficulty with customer requirements does not stop when you have

accurately captured them all. It is a complicated matter to ensure that the final design of the product or service effectively addresses the revealed customer value. Historically, the approach was for the marketing department to hand over the requirements document to the designers, who would then develop a design for approval through the organization's New Product Development (NPD) process. This is fraught with difficulty as there is rarely a very strong check on the accuracy of the translation from the requirements to the final design. This has led to many products failing to meet market expectations. The fact that failure rates of new products has been stuck at around 30 percent for a long time, and this does not speak well of the effectiveness of the translation.

Quality Function Deployment (QFD) is a rigorous, and highly necessary, technique which allows the whole of the NPD process to be driven by the customer requirements. This essentially uses matrices to develop an understanding of which design features affect which customer requirements, and to what degree. From this (and an understanding of the relative importance of requirements to the customer) it is possible to assess where to put development effort for maximum customer benefit.

This approach is very practical; it does, however, require a customer-centric mentality in the company to allow it to work to best effect. The application of QFD can easily be derailed if individuals choose to ignore or creatively interpret the customer requirements for their own purposes. Unless the cliché that the customer is at the center of all we do proves to be true, no process will compensate.

Summary

'Customer focus' is often a trite phrase used by organizations in order to fall in line with current thinking. Sadly, the superficial way in which it is treated means that it often rings hollow. It is important to understand the (complex) ways in which our products and services deliver value to the customer, and how we can manage the process of value creation in the NPD process.

Review & Discussion Questions:

1. Explain the term 'customer satisfaction'.
2. Briefly describe the pervasive myths which inhibit good practice.
3. Describe the Kano model of quality.
4. Explain the differences in Internal and External Customers.
5. Explain the term "Customer Value".
6. Describe the factor "Freedom from faults".
7. What do you understand by the factor "Degree to which requirements/expectations are met."
8. Explain the factor "Emotional engagement with the product/service"?
9. What do you understand by the factor "Quality of contact with the supplier".
10. Describe the cost factor in Value Analysis.
11. Write short notes on the Requirements Gathering.
12. What are the Translating Requirements into Design Features? Illustrate your answer with examples.

Topic 5
Quality Function Deployment

Learning Objectives:

1. Explain the process of Quality Function Deployment.
2. Describe the Relationship matrix.
3. Explain the Waterfall relationship of QFD matrices.

A critical aspect of building quality into a product is to ensure that the product design meets customer expectations. This typically is not as easy as it seems. Customers often speak in everyday language. For example, a product can be described as "attractive," "strong," or "safe." However, these terms can have very different meaning to different customers. What one person considers to be strong, another may not. To produce a product that customers want, we need to translate customers' everyday language into specific technical requirements. However, this can often be difficult. A useful tool for translating the voice of the customer into specific technical requirements is quality function deployment (QFD). Quality function deployment is also useful in enhancing communication between different functions, such as marketing, operations, and engineering. A tool used to translate the preferences of the customer into specific technical requirements.

QFD is a "method wily to transform qualitative user demands into quantitative parameters, to deploy the functions forming quality, and to deploy methods for achieving the design quality into subsystems and component parts, and ultimately to specific elements of the manufacturing process.", as described by Dr. Yoji Akao, who originally developed QFD in Japan in 1966, when the author combined his work in quality assurance and quality control points with function deployment used in value engineering.

QFD is designed to help planners focus on characteristics of a new or existing product or service from the viewpoints of market segments, company, or technology-development needs. The technique yields charts and matrices.

QFD helps transform customer needs (the voice of the customer - VOC) into engineering characteristics (and appropriate test methods) for a product or service, prioritizing each product or service characteristic while simultaneously setting development targets for product or service.

QFD enables us to view the relationships among the variables involved in the design of a product, such as technical versus customer requirements. This can help us analyze the big picture—for example, by running tests to see how changes in certain technical requirements of the product affect customer requirements. An example is an automobile manufacturer evaluating how changes in materials affect customer safety requirements. This type of analysis can be very beneficial in developing a product design that meets customer needs, yet does not create unnecessary technical requirements for production.

QFD begins by identifying important customer requirements, which typically come from the marketing department. These requirements are numerically scored

based on their importance, and scores are translated into specific product characteristics. Evaluations are then made of how the product compares with its main competitors relative to the identified characteristics. Finally, specific goals are set to address the identified problems. The resulting matrix looks like a picture of a house and is often called the house of quality. Next we will consider the example of manufacturing a backpack to show how we would use QFD.We will start with a relationship matrix that ties customer requirements to product characteristics, shown in Figure 5.1.

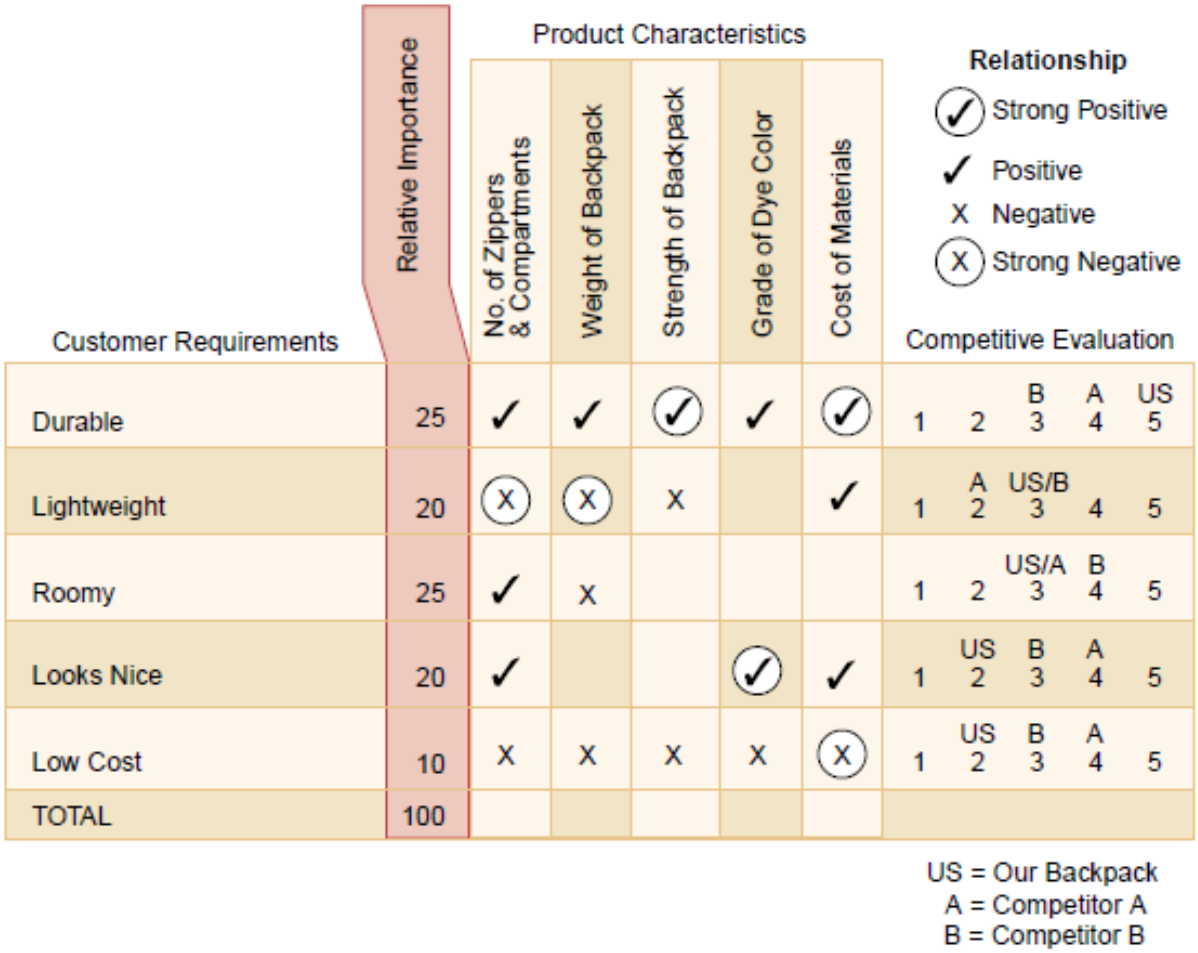

Figure 5.1Relationship matrix

• *Customer Requirements* Remember that our goal is to make a product that the customer wants. Therefore, the first thing we need to do is survey our customers to find out specifically what they would be looking for in a product—in this case, a backpack for students. To find out precisely what features students would like in a backpack, the marketing department might send representatives to talk to students on campus, conduct telephone interviews, and maybe conduct focus groups. Let's say that students have identified five desirable features: the backpack should be durable, lightweight and roomy, look nice, and not cost very much. These are shown in Figure 5.2. The importance customers attach to each of these requirements is also determined and shown in the figure. This part of the figure looks like the chimney of

the "house." You can see that durability and roominess are given the greatest importance.

• *Competitive Evaluation* On the far right of our relationship matrix is an evaluation of how our product compares to those of competitors. In this example there are two competitors, A and B. The evaluation scale is from one to five—the higher the rating, the better. The important thing here is to identify which customer requirements we should pursue and how we fare relative to our competitors. For example, you can see that our product excels in durability relative to competitors, yet it does not look as nice. This means that in designing our product, we could gain a competitive advantage by focusing our design efforts on a more appealing product.

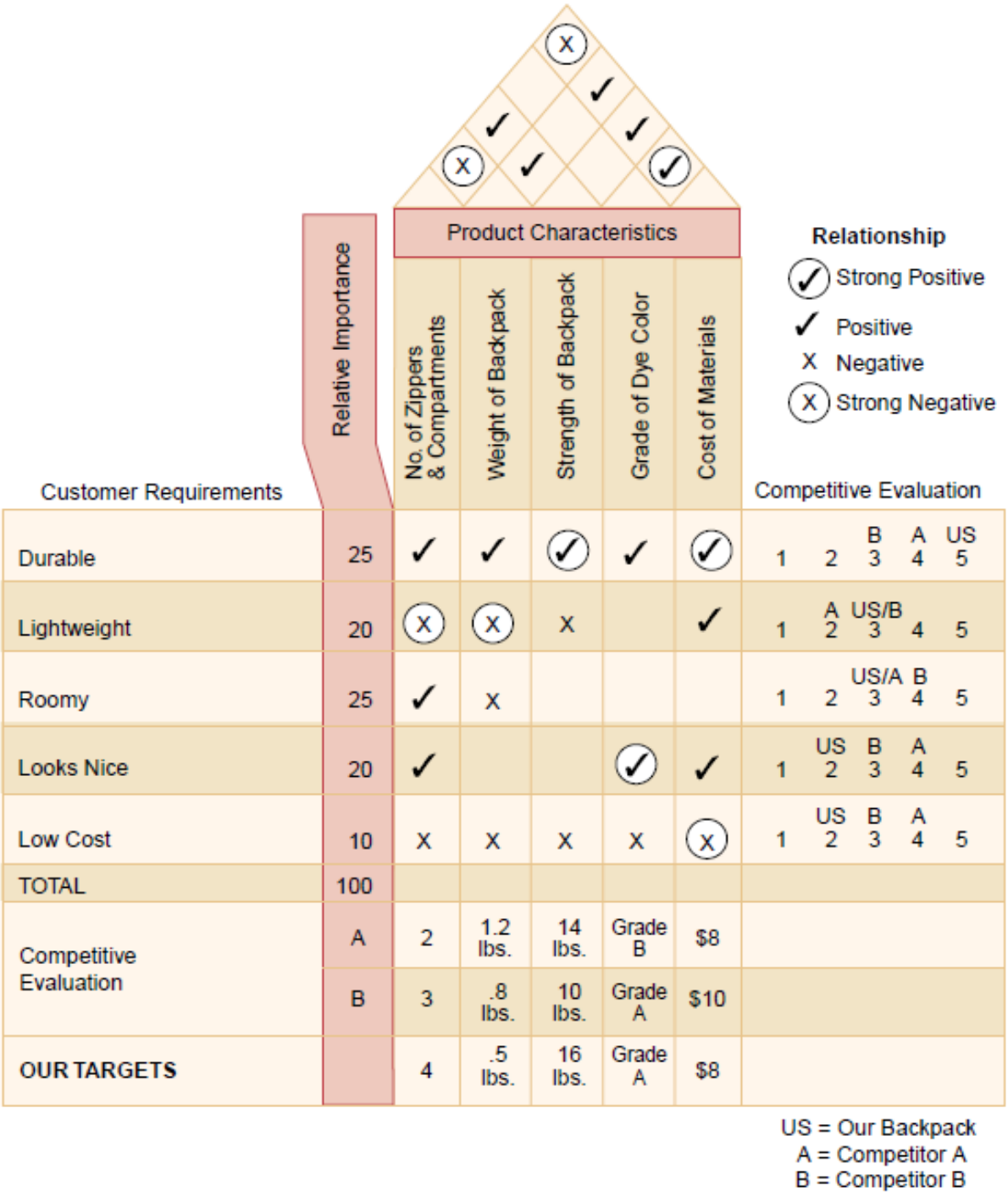

Figure 5.2. House of quality

• *Product Characteristics* Specific product characteristics are on top of the relationship matrix. These are technical measures. In our example these include the number of zippers and compartments, the weight of the backpack, strength of the backpack, grade of the dye color, and the cost of materials.

• *The Relationship Matrix* The strength of the relationship between customer requirements and product characteristics is shown in the relationship matrix. For example, you can see that the number of zippers and compartments is negatively related to the weight of the backpack. A negative relationship means that as we increase the desirability of one variable we decrease the desirability of the other. At the same time, roominess is positively related to the number of zippers and compartments, as is appearance. A positive relationship means that an increase in desirability of one variable is related to an increase in the desirability of another. This type of information is very important in coordinating the product design.

• *The Trade-off Matrix* You can see how the relationship matrix is beginning to look like a house. The complete house of quality is shown in Figure 5-10. The next step in our building process is to put the "roof" on the house. This is done through a trade-off matrix, which shows how each product characteristic is related to the others and thus allows us to see what tradeoffs we need to make. For example, the number of zippers is negatively related to the weight of the backpack.

• *Setting Targets* The last step in constructing the house of quality is to evaluate competitors' products relative to the specific product characteristics and to set targets for our own product. The bottom row of the house is the *output* of quality function deployment. These are specific, measurable product characteristics that have been formulated from general customer requirements.

Once you have prioritized the attributes and qualities, QFD deploys them to the appropriate organizational function for action, as shown in Figure 5.3. Thus, QFD is the deployment of customer-driven qualities to the responsible functions of an organization.

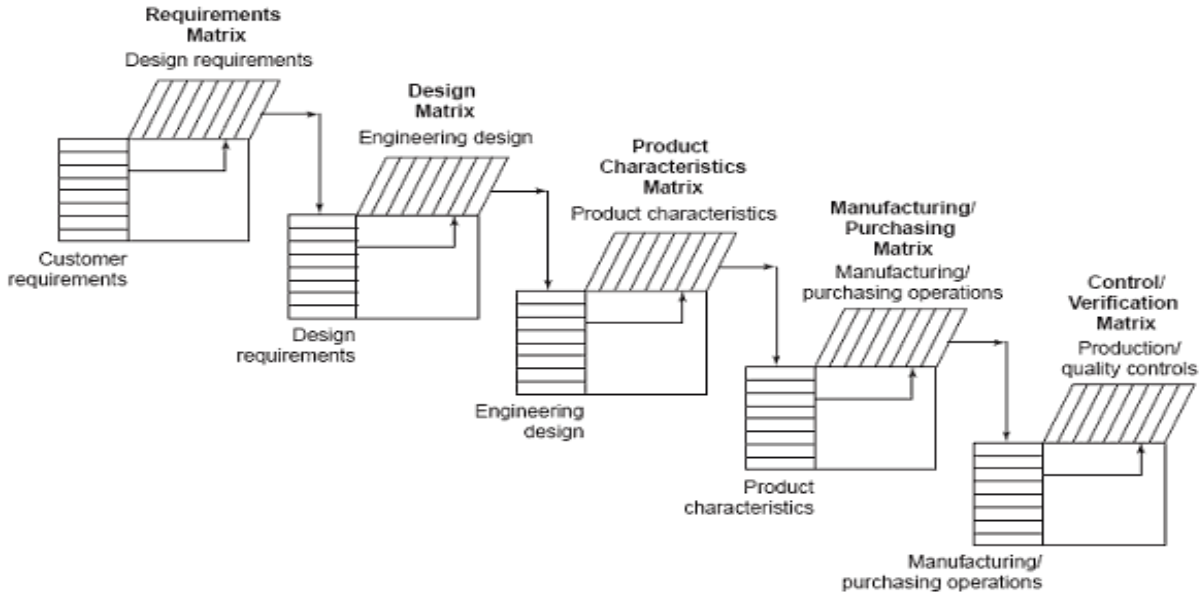

Figure 5.3 — Waterfall relationship of QFD matrices

Summary

The house of quality has been found to be very useful. You can see how it translates everyday terms like “lightweight,” “roominess,” and “nice looking,” into specific product characteristics that can be used in manufacturing the product. Note also how the house of quality can help in the communication between marketing, operations, and design engineering.

Many QFD practitioners claim that using QFD has enabled them to reduce their product and service development cycle times by as much as 75 percent with equally impressive improvements in measured customer satisfaction.

Review & Discussion Questions:

1. What is quality function deployment (QFD)?
2. What is the QFD designed to do?
3. What does QFD enable us?
4. What does QFD begin by?
5. Describe the Relationship matrix.
6. Write short notes on the following:
   d) Customer Requirements
   e) Competitive Evaluation
7. Describe the House of quality. What are the components of it.
8. What is a Trade-off Matrix?
9. What is the Setting Targets?
10. Explain the Waterfall relationship of QFD matrices.

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