Quality Cost Management 2

This Module Includes

2.1 Managing Quality in Competitive Environment

2.2 Cost of Quality

2.3 Total Quality Management

2.4 Lean Accounting

2.5 Six Sigma

Quality Cost Management

SLOB Mapped against the Module

1. **Possessing fair knowledge on Total Quality Management, Lean Accounting and Six Sigma.**
2. **Effective Management and Control of Quality Costs.**

Module Learning Objectives:

After studying this module, the students will be able to –

- Possessing fair knowledge on Total Quality Management, Lean Accounting and Six Sigma.
- Effective Management and Control of Quality Costs.

Managing Quality in Competitive Environment

2.1

Quality

Quality is that characteristic or a combination of characteristics that distinguishes one article from the other or from one service provider to another service provider or goods of one manufacturer from that of competitors or one grade of product from another when both are the outcome of the same factory.

The main characteristics that determine the quality of an article may include such elements as design, size, materials, chemical composition, mechanical functioning, electrical properties, workmanship, finish and appearance. The quality of a product may, thus, be defined as the sum of a number of related characteristics such as shape, dimension, composition, strength, workmanship, adjustment, finish and colour.

Quality as perception: It will not be wrong when you state that the term quality is a perception which is personal to an individual. In plain terms, quality is "features" or "worth" or "value". You will realise how this is true when you read the following phrases picked-up from literature on quality.

(i) "Quality is not an act. It is a habit"- Aristotle. This is true and applicable to any act of a human being.

(ii) "Quality is conformance to requirements": This is in line with the concept that quality is decided by the customer.

(iii) "Quality is zero defects": No customer wants defects in the products or services he or she pays for. This is a totally different idea on quality and is true when you make quality a habit.

(iv) "Quality is free" - Phil Crosby. This is a unique theory when there are no defects, then there is no wastage and Boosted Sales, thus quality becomes free.

(v) "Quality is the degree to which a set of inherent characteristics fulfils requirements"- ISO 9000. This is an attempt to give universality to the term quality.

Today, there is no single universal definition of quality. Some people view quality as "performance to standards." Others view it as "meeting the customer's needs" or "satisfying the customer." Let's look at some of the more common definitions of quality.

- **Conformance to Specifications:** Conformance to specifications measures how well the product or service meets the targets and tolerances determined by its designers. For example, the dimensions of a machine part may be specified by its design engineers as 3 + 0.05 inches. This would mean that the target dimension is 3 inches but the dimensions can vary between 2.95 and 3.05 inches. Similarly, the wait for hotel room service may be specified as 20 minutes, but there may be an acceptable delay of an additional 10 minutes. Also, consider the amount of light delivered by a 60-watt light bulb. If the bulb delivers 50 watts it does not conform to specifications. As these examples illustrate, conformance to specification is directly measurable, though it may not be directly related to the consumer's idea of quality.

- **Fitness for Use:** Fitness for use focuses on how well the product performs its intended function or use. For example, a Mercedes Benz and a Jeep Cherokee both meet a fitness for use definition if one considers transportation as the intended function. However, if the definition becomes more specific and assumes that the intended use is for transportation on mountain roads and carrying fishing gear, the Jeep Cherokee has a greater fitness for use. You can also see that fitness for use is a user-based definition in that it is intended to meet the needs of a specific user group.
- **Value for Price Paid:** Value for price paid is a definition of quality that consumers often use for product or service usefulness. This is the only definition that combines economics with consumer criteria; it assumes that the definition of quality is price sensitive. For example, suppose that you wish to sign up for a personal finance seminar and discover that the same class is being taught at two different colleges at significantly different tuition rates. If you take the less expensive seminar, you will feel that you have received greater value for the price.
- **Support Services:** Support services provided are often how the quality of a product or service is judged. Quality does not apply only to the product or service itself; it also applies to the people, processes, and organizational environment associated with it. For example, the quality of a university is judged not only by the quality of staff and course offerings, but also by the efficiency and accuracy of processing paperwork.
- **Psychological Criteria:** Psychological criteria is a subjective definition that focuses on the judgmental evaluation of what constitutes product or service quality. Different factors contribute to the evaluation, such as the atmosphere of the environment or the perceived prestige of the product. For example, a hospital patient may receive average health care, but a very friendly staff may leave the impression of high quality. Similarly, we commonly associate certain products with excellence because of their reputation; Rolex watches and Mercedes-Benz automobiles are examples.

Differences Between Manufacturing and Service Organizations

Defining quality in manufacturing organizations is often different from that of services. Manufacturing organizations produce a tangible product that can be seen, touched, and directly measured. Examples include cars, CD players, clothes, computers, and food items. Therefore, quality definitions in manufacturing usually focus on tangible product features.

The most common quality definition in manufacturing is conformance, which is the degree to which a product characteristic meets preset standards. Other common definitions of quality in manufacturing include performance—such as acceleration of a vehicle; reliability—that the product will function as expected without failure; features—the extras that are included beyond the basic characteristics; durability—expected operational life of the product; and serviceability—how readily a product can be repaired. The relative importance of these definitions is based on the preferences of each individual customer. It is easy to see how different customers can have different definitions in mind when they speak of high product quality.

In contrast to manufacturing, service organizations produces a product that is intangible. Usually, the complete product cannot be seen or touched. Rather, it is experienced. Examples include delivery of health care, experience of staying at a vacation resort, and learning at a university. The intangible nature of the product makes defining quality difficult. Also, since a service is experienced, perceptions can be highly subjective. In addition to tangible factors, quality of services is often defined by perceptual factors. These include responsiveness to customer needs, courtesy and friendliness of staff, promptness in resolving complaints, and atmosphere. Other definitions of quality in services include time—the amount of time a customer has to wait for the service; and consistency—the degree to which the service is the same each time. For these reasons, defining quality in services can be especially challenging. Dimensions of quality for manufacturing versus service organizations are shown in the Table.

Dimensions of Quality for Manufacturing Versus Service Organizations

Manufacturing organizations	Service organizations
Conformance to specifications	Tangible factors
Performance	Consistency
Reliability	Responsiveness to customer needs
Features	Courtesy/friendliness
Durability	Timeliness/ promptness
Serviceability	Atmosphere

Quality Management

Quality management is defined as "coordinated activities to direct and control an organization with regard to quality" (ISO 9000:2000). The activities are normally integrated into a system.

This is known as the systems approach to managing quality and the same approach needs to be adapted to business operations. Starting from early 60s and migrating to the 70s, the practices of quality management have shown an evolution. In the following paragraphs, you will get an overview of the way this evolution started from the activity or process of "Inspection".

Inspection: Inspection is defined as "Activities such as measuring, testing and gauging one or more characteristics of a product or service and comparing with specifications as in design to determine its conformity". This approach is the "after the event" approach, meaning the things which have happened and then which you verify by, measuring or testing and screen out those which do not meet specifications. Organisation is said to be working in a "detection" mode, having things or events which have happened. The result is that the nonconforming products are part of cost as they are a waste of material and as well as that of efforts or needing some rework or being sold as "seconds" at a lower price, all resulting into a dent in profits. This also creates the culture of "somebody else will check my outcome and it is that somebody's responsibility to give the conforming product". This approach had several limitations and had to be replaced by another effective way of attaining quality and the concept of Quality Control was the result.

Quality Control: Quality Control may be defined as "Operational techniques and activities that are used to fulfill requirements for quality". Organisations realized that "Inspection" alone was a costly affair as all that was segregated was a waste and a cost to the organisation, thus reducing profitability. The result was the idea of "control on operations," as Quality control. This was not necessarily very different from Inspection but had a new look at inspection. Under a system of quality control, there was a need to find controls for an activity, in the form of procedures, intermediate stage inspections and recording of performance of a process for giving feedback. The methods of inspection got sophisticated with addition of tools like sample checks, lot size, etc., for inspections at identified stages. However, the intention and activity of preventing a non-conforming product reaching a customer depended solely on the screening inspection at the final stage of production or service delivery. Application of this concept of course resulted into lesser defects but remained in nature as "detection mode", which we have discussed earlier.

Quality Assurance: From the business point of view, eliminating non-conformance was the key to a better level of quality and assurance of quality. And then the concept of Quality Assurance (QA) was developed. The central idea is to identify the root cause of non-conformity, take steps to eliminate the cause and thus remove recurrence of the non-conformity in future deliveries to the customer. QA is defined as "All those planned and systematic

actions necessary to provide an adequate confidence that a product or service will satisfy the given requirements for quality".

Quality assurance is a prevention-based system. The system improves product and service quality and increases productivity by placing emphasis on the design of product or service and relevant processes. The basis is that the process that makes the product or a service needs to be designed in such a manner that the variation in the process outcome is minimal in reference to design specifications, thus eliminating non-conformance. This is a proactive approach as compared to the reactive one in the "detection mode" discussed above.

In this system of operations, quality is created in the design stage and not in the control stage. The premise is that the design of the products and the processes makes the quality happen and not any verification or inspection as in the detection mode. Changing from "detection mode" to "prevention-based system" requires the use of a set of quality management tools and techniques along with a new operating philosophy and approach –even of thinking, by the top management.

The new philosophy demands a change in the management style to integrate various functions or departments to work together to discover the root cause of non-conformance or variation and to pursue elimination. Quality planning and improvements begin when the top management includes prevention, as opposed to detection, in organizational policies because this philosophy directs the business towards the future.

Integrating various processes of the business into "a whole" was at the basis and thus a true system approach to business. Such thinking resulted into a new practice which came to be known as the "Total Quality Management" (TQM). To get an insight into this concept, you need to understand that no-business process can work in isolation. Interdependence and an interaction between each of the business processes exist, and must be addressed while operating a business. This is the systems approach.

Quality is a key differentiator in a populated marketplace, driven by dynamic customer choices and competitive business offerings. Quality products make an important contribution to long-term revenue and profitability, building your brand value by simply letting your services and products, speak for themselves. So, we must consider the customer, the attributes of the product and the degree to which the product or service meets the needs of all stakeholders. Based on these characteristics we can define the quality of a product as "good", "average", "excellent".

Adherence to a recognized quality standard is essential for dealing with certain customers or complying with legislation. If you sell products in regulated markets, such as health care, food or electrical goods, you must be able to comply with the health and safety compliance standards designed to protect consumer's interests. In today's business environment, organizations face multiple challenges ranging from a global economic slowdown, challenging and agile competition, and technology that's moving at lightning pace and one of the ways in which an organization can build a strong, sustainable competitive advantage for itself, is via implementing Total Quality Management (TQM) practices.

Case 1. A Quality Education

Although it may appear easier to find success with TQM at a boutique-sized endeavour, the philosophy's principles hold true in virtually every sector. Educational institutions, for example, have utilized quality management in much the same way – though to tackle decidedly different problems.

The global financial crisis hit higher education harder than many might have expected, and nowhere have the odds stacked higher than in India. The nation pays home to one of the world's fastest-growing markets for business education. Yet over recent years, the relevance of business education in India has come into question. A report by one recruiter recently asserted just one in four Indian MBAs were adequately prepared for the business world.

At the Ramaiah Institute of Management Studies (RIMS) in Bangalore, recruiters and accreditation bodies specifically called into question the quality of students' educations. Although the relatively small school has always struggled to compete with India's renowned Xavier Labour Research Institute, the faculty finally began to notice clear hindrances in the success of graduates. The RIMS board decided it was time for a serious reassessment of quality management.

The school nominated Chief Academic Advisor Dr Krishnamurthy to head a volunteer team that would audit, analyse and implement process changes that would improve quality throughout (all in a particularly academic fashion). The team was tasked with looking at three key dimensions: assurance of learning, research and productivity, and quality of placements. Each member underwent extensive training to learn about action plans, quality auditing skills and continuous improvement tools – such as the 'plan-do-study-act' cycle.

Once faculty members were trained, the team's first task was to identify the school's key stakeholders, processes and their importance at the institute. Unsurprisingly, the most vital processes were identified as student intake, research, knowledge dissemination, outcomes evaluation and recruiter acceptance. From there, Krishnamurthy's team used a fishbone diagram to help identify potential root causes of the issues plaguing these vital processes. To illustrate just how bad things were at the school, the team selected control groups and administered domain-based knowledge tests.

The deficits were disappointing. A RIMS students' knowledge base was rated at just 36 percent, while students at Harvard rated 95 percent. Likewise, students' critical thinking abilities rated nine percent, versus 93 percent at MIT. Worse yet, the mean salaries of graduating students averaged $36,000, versus $150,000 for students from Kellogg. Krishnamurthy's team had their work cut out.

To tackle these issues, Krishnamurthy created an employability team, developed strategic architecture and designed pilot studies to improve the school's curriculum and make it more competitive. In order to do so, he needed absolutely every employee and student on board – but there was some resistance at the onset. Yet the educator asserted it didn't actually take long to convince the school's stakeholders as the changes were extremely beneficial.

"Once students started seeing the results, buy-in became complete and unconditional," he says. Acceptance was also achieved by maintaining clearer levels of communication with stakeholders. The school actually started to provide shareholders with detailed plans and projections. Then, it proceeded with a variety of new methods, such as incorporating case studies into the curriculum, which increased general test scores by almost 10 percent. Administrators also introduced a mandate saying students must be certified in English by the British Council – increasing scores from 42 percent to 51 percent.

By improving those test scores, the perceived quality of RIMS skyrocketed. The number of top 100 businesses recruiting from the school shot up by 22 percent, while the average salary offers graduates were receiving increased by $20,000. Placement revenue rose by an impressive $50,000, and RIMS has since skyrocketed up domestic and international education tables.

(The case study is taken from the website www.europeanceo.com/business-and-management/total-quality-management-three-case-studies-from-around-the-world on 21.03.2019)

No matter what the business is, total quality management can and will work. Yet this philosophical take on quality control will only impact firms that are in it for the long haul. Every employee must be in tune with the company's ideologies and desires to improve, and customer satisfaction must reign supreme.

Cost of Quality

2.2

The reason quality has gained such prominence is that organizations have gained an understanding of the high cost of poor quality. Quality affects all aspects of the organization and has dramatic cost implications. The most obvious consequence occurs when poor quality creates dissatisfied customers and eventually leads to loss of business. However, quality has many other costs, which can be divided into two categories. The first category consists of costs necessary for achieving high quality, which are called quality control costs. These are of two types: prevention costs and appraisal costs. The second category consists of the cost consequences of poor quality, which are called quality failure costs. These include external failure costs and internal failure costs. The first two costs are incurred in the hope of preventing the second two.

Prevention Costs: Prevention costs are all costs incurred in the process of preventing poor quality from occurring. They include quality planning costs, such as the costs of developing and implementing a quality plan. Also included are the costs of product and process design, from collecting customer information to designing processes that achieve conformance to specifications. Employee training in quality measurement is included as part of this cost, as well as the costs of maintaining records of information and data related to quality.

Appraisal Costs: Appraisal costs are incurred in the process of uncovering defects. They include the cost of quality inspections, product testing, and performing audits to make sure that quality standards are being met. Also included in this category are the costs of worker time spent measuring quality and the cost of equipment used for quality appraisal.

Internal Failure Costs: Internal failure costs are associated with discovering poor product quality before the product reaches the customer site. One type of internal failure cost is rework, which is the cost of correcting the defective item. Sometimes the item is so defective that it cannot be corrected and must be thrown away. This is called scrap, and its costs include all the material, labour, and machine cost spent in producing the defective product.

External Failure Costs: External failure costs are incurred when inferior products are delivered to customers. They include cost of handling customer complaints, warranty replacements, repairs of returned products and cost arising from a damaged company reputation.

We may tabulate the above details with suitable examples as below:

Prevention costs	Ensuring the failures do not happen **Example:** • Quality training • Quality circles • Statistical process control activities • System Development for prevention • Quality improvement

Appraisal costs	Checking for failures **Example:** • Testing and inspecting materials • Final product testing and inspecting • WIP testing and inspecting • Package inspection • Depreciation of testing equipment
Internal failure costs	Keeping defective products from falling into the hands of customers **Example:** • Cost of Scrap (net of realization) • Cost of Spoilage • Cost of Rework • Down time due to defect in quality • Retesting
External failure costs	Costs of defects discovered by the customers **Example:** • Cost of field servicing • Cost of handling complaints • Warranty repairs • Lost sales • Warranty replacements

Total Quality Management

2.3

Total Quality Management is a philosophy of continuously improving the quality of all the products and processes in response to continuous feedback for meeting the customers' requirements. It aims to do things right the first time, rather than need to fix problems after they emerge (A company should avoid defects rather than correct them). Its basic objective is customer satisfaction.

The elements of TQM are:

Total	Quality involves everyone and all activities in the company (Mobilizing the whole organization to achieve quality continuously and economically)
Quality	Understanding and meeting the customers' requirements. (Satisfying the customers first time every time)
Management	Quality can and must be managed (Avoid defects rather than correct them)

TQM is a vision based, customer focused, prevention oriented, continuous improvement strategy based on scientific approach adopted by cost conscious people committed to satisfy the customers first time every time. It aims at Managing an organization so that it excels in areas important to the customer.

Principles of TQM

Underlying Principles of TQM

1. **Customer Focus:** The first of the Total Quality Management principles puts the focus back on the people buying your product or service. Your customers determine the quality of your product. If your product fulfills a need and lasts as long or longer than expected, customers know that they have spent their money on a quality product. When you understand what your customer wants or needs, you have a better chance of figuring out how to get the right materials, people, and processes in place to meet and exceed their expectations.
2. **Total Employee Commitment:** You can't increase productivity, processes, or sales without the total commitment of all employees. They need to understand the vision and goals that have been communicated. They must be sufficiently trained and given the proper resources to complete tasks in order to be committed to reaching goals on time.

3. **Process Approach:** Adhering to processes is critical in quality management. Processes ensure that the proper steps are taken at the right time to ensure consistency and speed up production.
4. **Integrated System:** Typically, a business has many different departments, each with their own specific functions and purposes. These departments and functions should be interconnected with horizontal processes that should be the focus of Total Quality Management. But sometimes these departments and functions operate in isolated silos. In an integrated system, everybody in every department should have a thorough understanding of policies, standards, objectives, and processes. Integrated systems help the company to look for continual improvement in order to achieve an edge over the competition.
5. **Strategic and Systematic Approach:** The International Organization for Standardization (ISO) describes this principle as: "Identifying, understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its objectives." Multiple processes within a development or production cycle are managed as a system of processes in an effort to increase efficiency.
6. **Continual Improvement:** Optimal efficiency and complete customer satisfaction do not happen in a day– your business should continually find ways to improve processes and adapt your products and services as customer needs shift.
7. **Fact-based Decision-making:** Analysis and data gathering lead to better decisions based on the available information. Making informed decisions leads to a better understanding of customers and your market.
8. **Communications:** Everybody in your organization needs to be aware of plans, strategies and methods that will be used to achieve goals. There is a greater risk of failure if you don't have a good communication plan.

Steps in Total Quality Management

- **Step 1: Identification of customers/customer groups:** Through a team approach (a technique called Multi-Voting), the firm should identify major customer groups. This helps in generating priorities in the identification of customers and critical issues in the provision of decision-support information.
- **Step 2: Identifying customer expectations:** Once the major customer groups are identified, their expectations are listed. The question to be answered is - What does the customer expect from the firm?
- **Step 3: Identifying customer decision-making requirements and product utilities:** By identifying the need to stay close to the customers and following their suggestions, a decision- support system can be developed, incorporating both financial and non-financial information, which seeks to satisfy user requirements. This way, the firm finds out the answer to - What are the customer's decision-making requirements and product utilities? The answer is sought by listing out managerial perceptions and not by actual interaction with the customers.
- **Step 4: Identifying perceived problems in decision-making process and product utilities:** Using participative processes such as brainstorming and multi-voting, the firm seeks to list out its perception of problem areas and shortcomings in meeting customer requirements. This will list out areas of weakness where the greatest impact could be achieved through the implementation of improvements. Here, the firm identifies the answer to the question - What problem areas do we perceive in the decision-making process?
- **Step 5: Comparison with other firms and benchmarking:** Detailed and systematic internal deliberations allow the firm to develop a clear idea of their own strengths and weaknesses and of the areas of most significant deficiency. Benchmarking exercise allows the firm to see how other companies are coping with similar problems and opportunities.
- **Step 6: Customer Feedback:** Steps 1 to 5 provide a information base developed without reference to the customer. This is rectified at Steps 6 with a survey of representative customers, which embraces their views on perceived problem areas. Interaction with the customers and obtaining their views helps the firm in correcting its own perceptions and refining its processes.

- **Steps 7 & 8: Identification of improvement opportunities and implementation of Quality Improvement Process:** The outcomes of the customer survey, benchmarking and internal analysis, provides the inputs for Steps 7 and 8, i.e., the identification of improvement opportunities and the implementation of a formal improvement process. This is done through a six-step process called PRAISE, in short.

6C's and 4P's

The essential requirements for successful implementation are described as the six C's of TQM as tabulated below:

The 6C's

Commitment	If a TQM culture is to be developed, total commitment must come from top management. It is not sufficient to delegate 'quality' issues to a single person. Quality expectations must be made clear by the top management, together with the support and training required for its achievement.
Culture	Training lies at the centre of effecting a change in culture and attitudes. Negative perceptions must be changed to encourage individual contributions and to make 'quality' a normal part of everyone's job.
Continuous Improvement	TQM should be recognised as a 'continuous process'. It is not a 'one-time programme'. There will always be room for improvement, however small it may be.
Co-operation	TQM visualises Total Employee Involvement (TEI). Employee involvement and co-operation should be sought in the development of improvement strategies and associated performance measures.
Customer Focus	The needs of external customers (in receipt of the final product or service) and also the internal customers (colleagues who receive and supply goods, services or information), should be the prime focus.
Control	Documentation, procedures and awareness of current best practice are essential if TQM implementations are to function appropriately. Unless control procedures are in place, improvements cannot be monitored and measured nor deficiencies corrected.

It is possible that the organisation is led to Total Quality Paralysis, instead of improvement, by improper implementation of TQM. To avoid such disruption and paralysis the following principles (called the four P's) of TQM should be followed:

The 4P's

People	To avoid misdirection, TQM teams should consist of team spirited individuals who have a flair for accepting and meeting challenges. Individuals who are not ideally suited to the participatory process of TQM, should not be involved at all, e.g., lack of enthusiasm, non-attendance at TQM meetings, failure to complete delegated work, remaining a "Mute Spectator" at TQM meetings, etc.
Process	It is essential to approach problem-solving practically and to regard the formal process as a system designed to prevent participants from jumping to conclusions. As such, it will provide a means to facilitate the generation of alternatives while ensuring that important discussion stages are not omitted.

Problem	Problems need to be approached in a systematic manner, with teams tackling solvable problems with a direct economic impact, allowing for immediate feedback together with recognition of the contribution made by individual participants.
Preparation	Additional training on creative thinking and statistical processes are needed in order to give participants a greater appreciation of the diversity of the process. This training must quickly be extended beyond the immediate accounting circle to include employees at supervisory levels and also who are involved at the data input stage.

Case 2. The Customer Knows Best (AtlantiCare)

TQM isn't an easy management strategy to introduce into a business; in fact, many attempts tend to fall flat. More often than not, it's because firms maintain natural barriers to full involvement. Middle managers, for example, tend to complain their authority is being challenged when boots on the ground are encouraged to speak up in the early stages of TQM. Yet in a culture of constant quality enhancement, the views of any given workforce are invaluable.

One firm that's proven the merit of TQM is New Jersey-based healthcare provider AtlantiCare. Managing 5,000 employees at 25 locations, AtlantiCare is a serious business that's boasted a respectable turnaround for nearly two decades. Yet, in order to increase that margin further still, managers wanted to implement improvements across the board. Because patient satisfaction is the single-most important aspect of the healthcare industry, engaging in a renewed campaign of TQM proved a natural fit. The firm chose to adopt a 'plan-do-check-act' cycle or (PDCA Cycle), revealing gaps in staff communication – which subsequently meant longer patient waiting times and more complaints. To tackle this, managers explored a sideways method of internal communications. Instead of information trickling down from top-to-bottom, all of the company's employees were given freedom to provide vital feedback at each and every level.

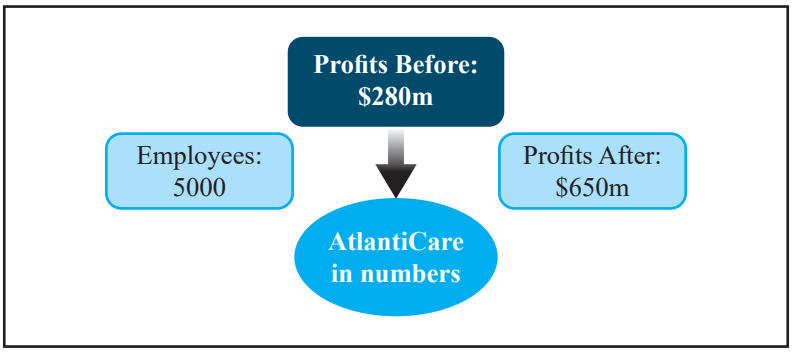

Figure 2.1

AtlantiCare decided to ensure all new employees understood this quality culture from the onset. At orientation, staff now receive a crash course in the company's performance excellence framework – a management system that organises the firm's processes into five key areas: quality, customer service, people and workplace, growth and financial performance. As employees rise through the ranks, this emphasis on improvement follows, so that managers can operate within the company's tight-loose-tight process management style.

After creating benchmark goals for employees to achieve at all levels – including better engagement at the point of delivery, increasing clinical communication and identifying and prioritising service opportunities – AtlantiCare was able to thrive. The number of repeat customers at the firm tripled, and its market share hit a six-year high. Profits unsurprisingly followed. The firm's revenues shot up from $280m to $650m after implementing the quality improvement strategies, and the number of patients being serviced dwarfed state numbers.

PRAISE

Identification of improvement opportunities and implementation of quality improvement process, of the TQM Process is through a six-step activity sequence, identified by the acronym 'PRAISE'.

Steps	Activity		Elements
1	**Problem Identification**	**P**	• Areas of customer dissatisfaction. • Absence of competitive advantage.
2	**Ranking**	**R**	• Prioritise problems and opportunities by – 1. Perceived importance, and 2. Ease of measurement and solution.
3	**Analysis**	**A**	• Ask "Why?" to identify possible causes. Keep asking 'Why?' beyond to the move symptoms and to avoid jumping to premature conclusion. • Ask 'What?' to consider potential implications. • Ask 'How much?' to quantify cause and effect.
4	**Innovation**	**I**	• Use creative thinking to generate potential solutions. • Operationalise these solutions by identifying: 1. Barriers to implementation, 2. Available enablers, and 3. People whose co-operation must be sought.
5	**Solution**	**S**	• Implement the preferred solution. • Take appropriate action to bring about the required changes. • Reinforce with training and documentation back-up.
6	**Evaluation**	**E**	• Monitor the effectiveness of actions. • Establish and interpret performance indicators to track progress towards objectives • Identify the potential for further improvements and return to Step 1.

Difficulties in PRAISE Analysis

Step	Activity	Difficulties	Remedies
1	**Problem Identification**	• Effects of a problem are apparent, but the problems themselves are difficult to be identified. • Problem may be identifiable, but it is difficult to identify a measurable improvement opportunity. • Some problems are too vague to define e.g., morale, communication, productivity etc.	• Participative approaches like brainstorming, multi-voting, panel discussion. • Quantification and precise definition of problems.

Step	Activity	Difficulties	Remedies
2	**Ranking**	• Difference in perception of individuals in ranking • Difference in preferences based on functions, e.g., production, finance, marketing etc. • Lack of consensus between individuals.	• Participative Approach. • Subordination of individual to group interest.
3	**Analysis**	• Adoption of adhoc approaches and quick-fix solutions.	• Lateral Thinking. • Brainstorming.
4	**Innovation**	• Lack of creativity or expertise. • Inability to operationalise ideas, i.e., convert thoughts into action points.	• Systematic evaluation of all aspects of each strategy.
5	**Solution**	• Resistance from middle managers.	• Effective internal communication. • Training of personnel and managers. • Participative approach.
6	**Evaluation**	• Problems in implementation. • Lack of measurable data for comparison of expectations with actuals.	• Effective Control System to track actuals. • Feedback system.

Central to the PRAISE system are - (a) Quality Control - the search for continuous improvements in quality -and (b) Total Employee Involvement - the co-operation and commitment of employees. This dual approach provides a single focus - the customer - whose increased satisfaction remains the primary goal of the procedure.

Implementation of PRAISE Process

A three-point action plan for implementation of the process is -

1. **Small to Big Issues:** Big improvement opportunities are generally complex and require extensive interdepartmental co-operation. The choice of a relatively small problem in the first instance provides a greater chance of success. Therefore, the TQM team has to proceed from small to big issues gradually.
2. **Solvable Problem:** The problem selected should not be trivial, but it should be one with a potential impact and a clear improvement opportunity. Measurable progress towards implementation should be accomplished within a reasonable time in order to maintain the motivation of participants and advertise the success of the improvement itself.
3. **Recognition of Participants:** The successful projects and team members should receive appropriate recognition. Prominent individuals should be rewarded for their efforts through monetary / non-monetary prices as a measure of personal recognition and as encouragement to others.

Pareto Analysis

Pareto Analysis is a rule that recommends focus on the most important aspects of the decision making in order to simplify the process of decision making. It is based on the 80:20 rule that was a phenomenon first observed by Vilfredo Pareto, a nineteenth century Italian economist. He noticed that 80% of the wealth of Milan was owned

by 20% of its citizens. This phenomenon, or some kind of approximation of it say, (70: 30 etc.) can be observed in many different business situations. The management can use it in a number of different circumstances (including TQM) to direct management attention to the key control mechanism or planning aspects. It helps to clearly establish top priorities and to identify both profitable and unprofitable targets.

Usefulness of Pareto Analysis: It provides the mechanism to control and direct effort by fact and not by emotions. It helps to clearly establish top priorities and to identify both profitable and unprofitable targets. Pareto analysis is useful to:

1. Prioritize problems, goals, and objectives to Identify root causes.
2. Select and define key quality improvement programs.
3. Select key customer relations and service programs.
4. Select key employee relations improvement programs.
5. Select and define key performance improvement programs.
6. Maximize research and product development time.
7. Verify operating procedures and manufacturing processes.
8. Boosts / Assists Product or services sales and distribution.
9. Allocate physical, financial and human resources.

Application of Analysis: Pareto analysis may be applicable in the presentation of Performance Indicators data through selection of representative process characteristics that truly determine, directly or indirectly influence or conform the desired quality or performance result or outcome. The Pareto Analysis is generally applicable to the following business situations:

(i) **Pricing of a Product:** In the case of a firm dealing with multi products, it would not be possible for it to analyse cost-profit-price–volume relationships for all of them. In practice, in case of such firm, approximately 20% of products may account for about 80% of total sales revenue. Pareto Analysis is used for analysing the firm's estimated sales revenues from various products and it might indicate that approximately 80% of its total sales revenue is earned from about 20% of its products. Such analysis helps the top management to delegate the pricing decision for approximately 80% of its products to the lower levels of management, thus RELIEVING themselves to concentrate on the pricing decisions for products approximately 20%, which are essential for the company's survival. Thus, a firm can adopt more sophisticated pricing methods for small proportion of products that jointly accounts for approximately 80% of total sales revenue. For the remaining 80% of the products which accounts for 20% of total sales revenue the firm may use cost based pricing method.

(ii) **Customer Profitability Analysis:** Instead of analyzing products, customers can be analysed for their relative profitability to the organisation. Again, it is often found that approximately 20% of customers generate 80% of the profit. There will always be some customers who are less profitable than others, just as some products are less profitable than others. Such an analysis is useful for evaluation of the portfolio of customer profile and decision making such as whether to continue serving a same customer group, what is the extent of promotion expenses to be incurred.

(iii) **ABC analysis – Stock Control:** Another application of Pareto analysis is in stock control where it may be found that only a few of the goods in stock makeup most of the value. In practice approximately 20% of the total quantity of stock may account for about 80% of its value. The outcome of such analysis is that by concentrating on small proportion of stock items that jointly accounts for 80% of the total value, a firm may well be able to control most of monetary investment in stocks.

(iv) **Application in Activity Based Costing:** In Activity Based Costing it is often said that 20% of an organization-cost-drivers are responsible for 80% of the total cost. By analysing, monitoring and controlling those cost drivers that cause most cost, a better control and understanding of overheads will be obtained.

(v) **Quality Control:** Pareto analysis seeks to discover from an analysis of defect report or customer complaints which "vital few" causes are responsible for most of the reported problems. Often, 80% of reported problems can usually be traced to 20% of the various underlying causes. By concentrating one's efforts on rectifying the vital 20%, one can have the greatest immediate impact on product quality. The Pareto Analysis indicates how frequently each type of failure (defect) occurs. The purpose of the analysis is to direct management attention to the area where the best returns can be achieved by solving most of quality problems, perhaps just with a single action.

Example 1

A Toy company performs a Pareto analysis, given a set of 'defect types' and frequencies of their occurrence. The sample data consists of information about 84 defective items. The items have been classified by their 'defect types' as follows:

Defect Type	No. of Items
Cracks (due to mishandling of raw material)	10
Improper shapes	8
Incomplete	8
Surface scratches	53
Others (due to bad quality raw material)	5

Frequency table indicating the frequency of occurrence of defects in decreasing order of their occurrence will be as follows:

Defect Type	No. of items	(%)	Cumulative %
Surface scratches	53	63.10	63.10
Cracks	10	11.90	75.00
Improper shape	8	9.52	84.52
Incomplete	8	9.53	94.05
Others	5	5.95	100.00

The purpose of Pareto analysis in this example, is to direct attention to the area where best returns can be achieved by solving most of the quality problems, perhaps just with a single action. In this case, use of good quality raw material say plastic may solve 63% of problem and if raw material is handled properly at least 75% the problems may be overcome.

Lean Accounting

2.4

Lean Manufacturing

Idle resources have always remained the fiercest enemy of every cost manager. It could be idle labour, idle machines, idle facilities, idle stocks; anything and everything remaining idle tantamounts to an undue fixed burden which diminishes the impact of value chain.

Lean management is one fascinating concept that supports the efforts of the Cost Manager in the elimination of waste of any kind. It advocates the fundamental that 'Process, next in line, is the most important customer; Process, just before in line, is the most important vendor'.

Benjamin Franklin contributed greatly to waste reduction Philosophy / Techniques. Henry Ford cited Franklin as a major influence on his business practices. They believed that a penny saved is a penny gained. They reinvented the writing on the wall, "Costs do not exist to be Calculated; Costs do exist to be Reduced". There started a number of right initiatives relating to Modern Lean Management.

Taiichi Ohno (1912-1990) is more a symbol of Japan's manufacturing resurgence after the Second World War. Born in Dalian, in eastern China, he joined Toyota Automatic Loom Works between the wars. Ohno felt that there was no reason other than inefficiency and wastefulness why Toyota's productivity should be any lower than that of Detroit. Hence, he set out to eradicate inefficiency and eliminate waste in that part of the production process that he was responsible for. This became the core of the so-called Toyota Production System (TPS) that he and others subsequently developed between the mid-1940s and the mid-1970s. Several elements of this system have become familiar in the West; for example, **muda** (the elimination of waste), **jidoka** (the injection of quality) and **kanban** (the tags used as part of a system of just-in-time stock control).

Lean was evolved from the manufacturing philosophy of the Toyota Production System. The cornerstone of lean is the elimination of waste from processes with a mindset of continuous improvement. In its most basic form, Lean Manufacturing is the systematic elimination of waste by focusing on production costs, product quality and delivery, and worker involvement. It is said that the famed Toyota Production system was inspired by what the Toyota executives learned during their visits to the Ford Motor Company in the 1920s and developed by Toyota leaders such as Taiichi Ohno and consultant Shigeo Shingo after World War II.

Broadly speaking, Lean Manufacturing represents a fundamental paradigm shift from traditional "batch and queue" mass production to production systems based on product aligned "single-piece flow, pull production." Whereas "batch and queue" involves mass-production of large inventories of products in advance based on potential or predicted customer demands, a "single-piece flow" system rearranges production activities in a way that processing steps of different types are conducted immediately adjacent to each other in a continuous and single piece flow. If implemented properly, a shift in demand can be accommodated immediately, without the loss of inventory stockpiles associated with traditional batch-and-queue manufacturing.

While Japanese manufacturers embraced Lean as their biggest hope in recovering effectively from a war-torn economy in the 1950's, today companies embrace Lean Manufacturing for three fundamental reasons:

(i) First, the highly competitive, globalized market of today requires that companies lower costs to increase margins and/or decrease prices through the elimination of all non-value added aspects of the enterprise.

(ii) Second, meeting rapidly changing customer "Just-In-Time" demands through rapid product mix changes and increases in manufacturing velocity in this manufacturing age is the key for survival.

(iii) Finally, goods must be of high and consistent quality. Lean manufacturing facilitates these three goals.

Lean is centered on preserving value with less work. Lean manufacturing is a variation on the theme of efficiency based on optimizing flow; it is a present-day instance of the recurring theme in human history towards increasing efficiency, decreasing waste, and using empirical methods to decide what matters, rather than uncritically accepting pre-existing ideas. As such, it is a chapter in the larger narrative that also includes such ideas as the folk wisdom of Thrift, Time and Motion Study, Taylorism, the Efficiency Movement, and Fordism. Lean manufacturing is often seen as a more refined version of earlier efficiency efforts, building upon the work of earlier leaders such as Taylor or Ford, and learning from their mistakes.

Major elements of lean are derived from the Toyota Product System (TPS), which is Toyota's unique approach to manufacturing. Lean methods and other improvement techniques, such as Six Sigma, Total Quality Management, and Theory of Constraints, have dominated manufacturing trends in the United States since the 1980s. Lean is the most commonly used approach. Many of these practices have now expanded beyond manufacturing into other business functions to create lean enterprises.

Lean is a process, a continuous journey, with renewable goals; it is not a destination. Once you achieve your current targets, it begins all over again with new ones. It never ends because you can always make it better. The journey to achieve higher efficiency, greater waste reduction, and ongoing continuous improvement is, however, daunting. Lean is doing more with less. That means achieving more by using fewer resources-people, machine, material, capital, etc. and doing only those activities that are essential to satisfy customer orders, and doing them well.

Lean is the pursuit of greater operational performance by elimination of waste throughout the organization. The benefits include:

- Reduced lead times
- Improved delivery performance
- Shorter order-to-cash cycle
- Increased sales revenue
- Increased profits
- Lower operating costs
- Reduction in inventory (greater inventory turnover)
- Improved customer satisfaction
- Enhanced supplier relationships
- Greater employee morale and retention
- Improved product and service quality
- Reduced physical space requirement
- Availability of additional working capital

Despite its origin in manufacturing, lean principles apply to the whole enterprise. Often along the way, when lean is implemented properly, most organizations change their thinking about their business practices. It brings the whole business into the focus from customer order to receiving payment.

Lean Accounting

Lean Accounting is the application of lean thinking to all accounting and finance processes and systems. It is an essential component of a successful lean transformation for any organization.

Lean accounting uses a method that categorizes costs by value stream rather than by department. This approach "provides the basis for sound management decisions". The researchers define value stream accounting as "tracking revenue and the associated variable costs required to generate those sales." It is experienced that value stream costing includes a simpler cost collection method and reduces the number of cost centers. They also list features of value stream accounting as:

- Costs calculated weekly
- No distinction made between direct or indirect costs – all costs of the value stream are considered direct costs
- Value stream costs include labour, materials, production support, machines and equipment, operation support, facilities and maintenance
- Value stream costing provides a more accurate picture by elimination of unnecessary costs outside control of value stream managers

Lean accounting groups together costs that fall outside of the value stream as "business sustaining costs" that do not get included in value stream costs. This, in turn, helps the businesses to find better price points for products and do further research into high-cost areas. The bottom line is that Lean accounting can help business leaders quickly know if they are heading in the right direction or need to make a change.

Three principles guide Lean Accounting and form the foundation for all of accounting's work and interaction with the organization:

i. **Customer value:** Delivering the relevant and reliable information in a timely manner to all users of the information inside the organization.

ii. **Continuous improvement:** Improving accounting processes, cross-functional business processes and the information used inside the business for analysis and decision making.

iii. **Respect for people:** Adopting a learning attitude by seeking to understand root causes of business problems and issues in a cross-functional, collaborative manner.

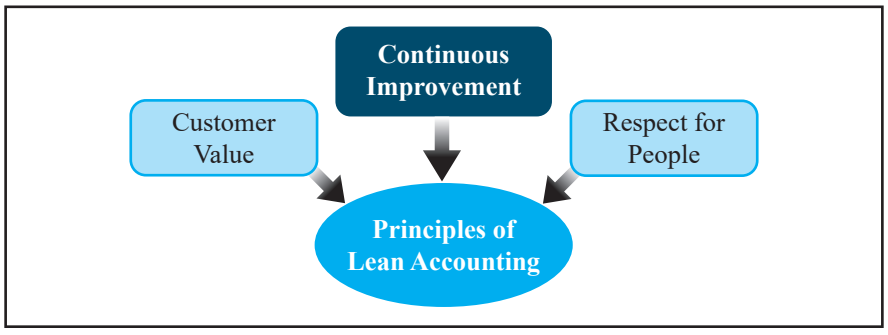

Figure 2.2: Principles of Lean Accounting

Lean Accounting facilitates the changes that are required to a company's accounting, control, measurement, and management processes to support lean manufacturing and lean thinking.

Most of the companies embarking on lean manufacturing may soon find that their accounting processes and management methods are at odds with the lean changes they are making. The reason for this is that traditional accounting and management methods were designed to support traditional manufacturing; they are based upon mass production concept. Lean manufacturing breaks the rules of mass production, and so the traditional accounting and management methods warrant due modifications in tune with the lean changes that the company is embarking.

Lean Accounting enables identification and elimination of non-value adding activities in the accounting and reporting processes; improves visual reporting on product lines; and realigns accounting activities to a consulting role rather than a transaction role. Lean accounting empowers the finance and accounting functions to partner with the evolving lean enterprise. When the finance department revamps its processes in line with the lean methods, the time savings and communication gains are substantial.

The purpose of lean accounting is to tell the managers about the flow through the Value Stream; to tell them about the capacity for extra work in the Value stream; and to tell them about the incremental costs of alternative decisions and actions. Lean accounting provides a stage that enables the accounting team to move from a transaction focus to a new high value role of consulting within other areas of the company.

Enterprises using Lean accounting have better information for decision-making, have simple and timely reports that are clearly understood by everyone in the company. They understand the true financial impact of lean changes; they focus the business around the value created for the customers, and accounting actively drives the lean transformation. This helps the company to grow, to add more value for the customers, and to increase cash flow and value for the stock-holders and owners.

The benefits of Lean Accounting, thus, are:

i. Creating capacity in accounting by eliminating waste in accounting processes.

ii. Accounting fully participating in cross-function continuous improvement.

iii. Flowing relevant and reliable information to all internal stakeholders for effective decision making.

iv. Leveraging accounting's analytical skills as lean financial coaches throughout the organization.

In other words, Lean Accounting provides service excellence to all of accounting's stakeholders. Lean accounting ensures the right people have the right information at the right time to make the right decision in the areas of pricing, production, procuring, inventory management, performance measuring, etc.

Principles, Practices and Tools of Lean Accounting

Sl.	Principles	Practices	Tools of lean accounting
1	Lean & simple business accounting	Continuously eliminates waste from the transactions, processes, reports, and other accounting methods	• Value stream mapping; current & future state • Kaizen (lean continuous improvement). • PDCA (Planning, Doing, Checking and Acting) problem solving
2	Accounting processes that support lean transformation	Management control & continuous improvement	• Performance Measurement Linkage Chart; linking metrics for cell/process, value streams, plant & corporate reporting to the business strategy, target costs, and lean improvement • Value stream performance boards containing break- through and continuous improvement projects • Box scores showing value stream performance

Sl.	Principles	Practices	Tools of lean accounting
		Cost management	• Value stream costing • Value stream income statements
		Customer & supplier value and cost management	• Target costing
3	Clear & timely communication of information	Financial reporting	• "Plain English" financial statements • Simple, largely cash-based accounting
		Visual reporting of financial & non- financial performance measurements	Primary reporting using visual performance boards; division, plant, value stream, cell/ process in production, product design, sales/marketing, administration, etc.
		Decision-making	Incremental cost & profitability analysis using value stream costing and box scores
4	Planning from a lean perspective	Planning & budgeting	• Hoshin policy deployment. (Hosin Kanri (also called Policy Deployment is a method for ensuring that a company's strategic goals drive progress and action at every level within that company. This method eliminates the waste that comes from inconsistent direction and poor communication). • Sales, operations, & financial planning (SOFP)
		Impact of lean improvement	• Value stream cost and capacity analysis • Current state & future state value stream maps • Box scores showing operational, financial, and capacity changes from lean improvement. • Plan for financial benefit from the lean changes
		Capital planning	• Incremental impact of capital expenditure on value stream box-score. Often used with 3P approaches. (Production Preparation Process)
		Invest in people	• Performance measurements tracking continuous improvement participation, employee satisfaction & cross-training • Profit sharing
5	Strengthen internal accounting control	Internal control based on lean operational controls	• Transaction elimination matrix • Process maps showing controls and SOX risks. (A SOX control is a rule that prevents and detects error withih a process cycle of financial reporting. These controls fall under

Sl.	Principles	Practices	Tools of lean accounting
			the Sarbanes-Oxley Act of 2002 (SOX). SOX is a U.S. federal law requiring all public companies doing business in the United States to comply with the regulation).
		Inventory valuation	• Simple methods to value inventory without the requirement for perpetual inventory records and product costs can be used when the inventory is low and under visual control.

While Lean Accounting is still a work-in-process, there is now an agreed body of knowledge that is becoming the standard approach to accounting, control, and measurement. These principles, practices, and tools of Lean Accounting have been implemented in a wide range of companies at various stages on the journey to lean transformation. These methods can be readily adjusted to meet any company's specific needs and they rigorously maintain adherence to GAAP and external reporting requirements and regulations. Lean Accounting is itself lean, low-waste, and visual, and frees up finance and accounting personel time so they can become actively involved in lean change instead of being merely "bean counters."

Six Sigma

2.5

Concept

Six Sigma is a set of practices originally developed by Motorola to systematically improve processes by eliminating defects. A defect is defined as non-conformity of a product or service to its specifications. While the particulars of the methodology were originally formulated by Bill Smith at Motorola in 1986, Six Sigma was heavily inspired by six preceding decades of quality improvement methodologies such as quality control, TQM, and Zero Defects. Like its predecessors, Six Sigma asserts the following:

a. Continuous efforts to reduce variation in process outputs is key to business success

b. Manufacturing and business processes can be measured, analyzed, improved and controlled

c. Succeeding at achieving sustained quality improvement requires commitment from the entire organization, particularly from top-level management.

The term "Six Sigma" refers to the ability of highly capable processes to produce output within specification. In particular, processes that operate with six sigma quality produce at defect levels below 3.4 defects per (one) million opportunities (DPMO). Six Sigma's implicit goal is to improve all processes to that level of quality or better.

A six-sigma process is one in which 99.99966% of all opportunities to produce some features of a part are statistically expected to be free of defects. It 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.

Six Sigma has two key methodologies: DMAIC and DMADV, both inspired by W. Edwards Deming's Plan-Do-Check- Act Cycle: DMAIC is used to improve an existing business process, and DMADV is used to create new product or process designs for predictable, defect-free performance.

Sigma Level	Defects per million of opportunities (DPMO)	Percentage defects
1	691462	69%
2	308538	31%
3	66807	6.7%
4	6210	0.62%
5	233	0.023%
6	3.4	0.00034%

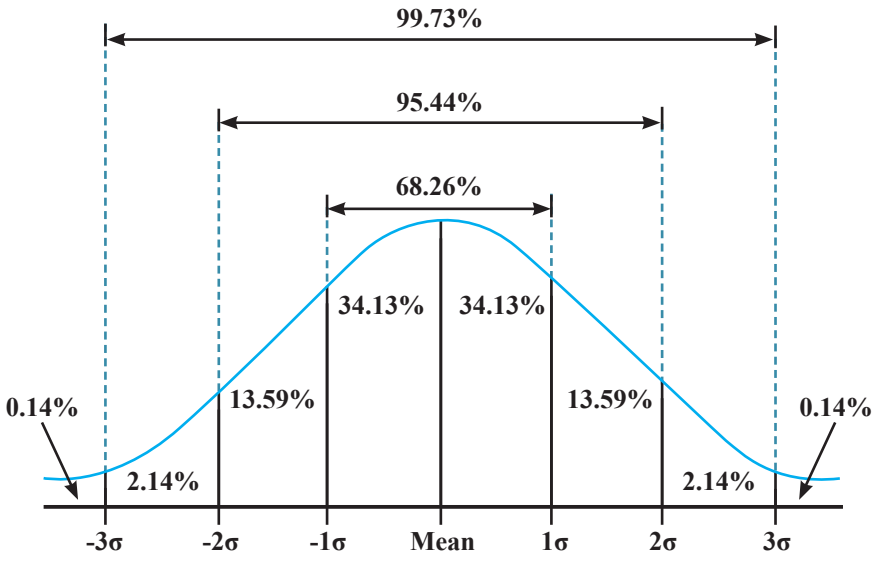

Figure 2.3

DMAIC

Basic methodology consists of the following five (5) steps:

- **D**efine the process improvement goals that are consistent with customer demands and enterprise strategy.
- **M**easure the current process and collect relevant data for future comparison.
- **A**nalyze to verify relationship and causality of factors. Determine what the relationship is, and attempt to ensure that all factors have been considered.
- **I**mprove or optimize the process based upon the analysis using techniques like Design of Experiments.
- **C**ontrol to ensure that any variances are corrected before they result in defects. Set up pilot runs to establish process capability, transition to production and thereafter continuously measure the process and institute control mechanisms.

DMIADV

Basic methodology consists of the following five steps:

- **D**efine the goals of the design activity that are consistent with customer demands and enterprise strategy.
- **M**easure and **I**dentify CTQs (critical to qualities), product capabilities, production process capability, and risk assessments.
- **A**nalyze to develop and design alternatives, create high-level design and evaluate design capability to select the best design.
- **D**esign details, optimize the design, and plan for design verification. This phase may require simulations.
- **V**erify the design, set up pilot runs, implement production process and handover to process owners.

Key roles required for successful implementation of Six Sigma

Six Sigma identifies several key roles for its successful implementation:

1. **Executive Leadership** includes CEO and other key top management team members. 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.
2. **Champions** are responsible for the Six Sigma implementation across the organization in an integrated manner. The Executive Leadership draws them from the upper management. Champions also act as mentors to Black Belts. At GE, this level of certification is now called "Quality Leader".
3. **Master Black Belts**, identified by champions, act as in-house expert coaches for the organization on Six Sigma. They devote 100% of their time to Six Sigma. They assist champions and guide Black Belts and Green Belts. Apart from the usual rigour of statistics, their time is spent on ensuring integrated deployment of Six Sigma across various functions and departments.
4. **Experts** this level of skill is used primarily within Aerospace and Defense Business Sectors. Experts work across company boundaries, improving services, processes, and products for their suppliers, their entire campuses, and for their customers. Raytheon Incorporated was one of the first companies to introduce Experts to their organizations. At Raytheon, Experts work not only across multiple sites, but across business divisions, incorporating lessons learned throughout the company.
5. **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.
6. **Green Belts** are the employees who take up Six Sigma implementation along with their other job responsibilities. They operate under the guidance of Black Belts and support them in achieving the overall results.
7. **Yellow Belts** are employees who have been trained in Six Sigma techniques as part of a corporate-wide initiative, but have not completed a Six Sigma project and are not expected to actively engage in quality improvement activities.

Case 3:

Case Study: Six Sigma Reduces Costs & Improve Environmental Impact (Ford Motors)

The Red Flag: Ford's balanced scorecard system provides reporting tools that offer monthly values versus target figures, year-to-date/year-end values against target, and a prioritization system using red/green/yellow evaluations to pinpoint where improvement is needed. Using this evaluation system, the auto-maker classifies data as:

- **Green:** measures are on or over target.
- **Yellow:** metrics are under target, but better than last year.
- **Red:** results are under target.

In the fall of 2009, data for body paint consumption for the Focus and Kuga were classified as red, thus capturing the attention of plant officials. A quick review of historical data showed basecoat paint consumption stood at 3.74 kg/unit in 2007, while current consumption was 4.18 kg/unit. Sensing an opportunity, Ford officials selected this improvement as a Six Sigma Black Belt project, offering an ideal fit with the One Ford strategy that focuses on "working together effectively as one team."

Six Sigma Black Belt Project: The project began in October 2009 with team member selection. Of the plant's

7,000 employees, more than 50 are Six Sigma Black Belts and another 400 are trained as Green Belts, thus providing a pool of qualified team members to assist with the project. Team leader and Six Sigma Black Belt Martin Fischer based his selections on a candidate's responsibilities, subject- matter expertise and process ownership, and on relative need throughout project development, planning, implementation, and follow up. Other factors included communication skills and the candidate's ability to interact in a team-based structure.

Applying the define, measure, analyze, improve, and control (DMAIC) approach, the team began by defining project stakeholders using a SIPOC (Suppliers, Inputs, Process, Outputs, Customers) analysis. This analysis led to three groups— internal, external, and a mixed group that contained both internal and external customers. The mixed group included not only customers who purchase the cars, but also internal customers such as the process owners, in this case the paint shop and the quality control group.

Define: The goals of the project were threefold:

1. Reduce costs: Reduce paint consumption to lower production costs.

2. Improve customer satisfaction: Improve process capability to better meet customer needs.

3. Lower environmental impact: Reduce solvent consumption to achieve a better VOC[1] balance.

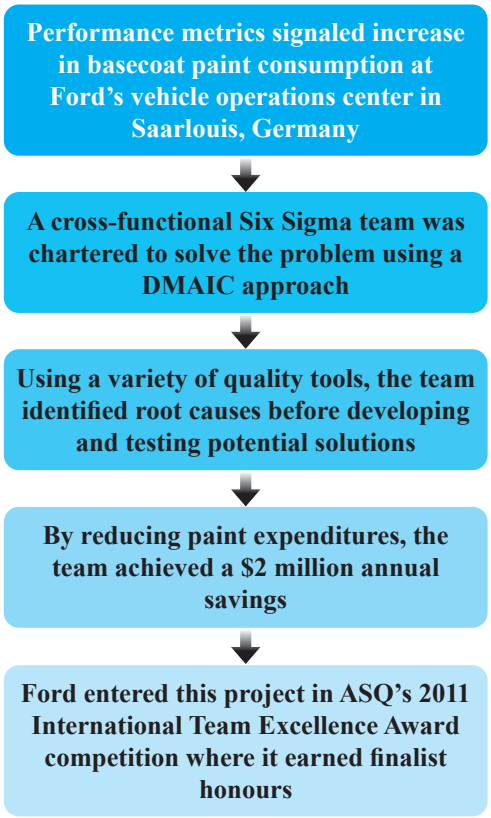

Figure 2.4

The team predicted the degree of impact for each goal by measuring anticipated benefits against organizational goals and measures.

They determined:

- The degree of impact for cost reduction was high, as $1.5 million could be saved annually.
- Customer satisfaction impact was medium with a target of 127.000 ppm (defective parts per million) reduction.
- Environmental impacts were also medium with a projected 50,000 kg annually in VOC[1] savings.

Measure: Several tools were used early in the measurement phase. For example, value-stream mapping served as a visual tool to help the team understand the flow of material and the paint application process. Statistical measures helped them filter, evaluate, and obtain strong data for the project. Cause-and effect diagrams were useful for identifying the root causes of consumption and performance issues, and brainstorming sessions were used to rate all potential causes. The next step was creating a data collection plan to help narrow the list of potential root causes by focusing on the following factors or critical Xs:

1. Daily basecoat consumption : Is there any dependency based on day or shift?
2. Paint film thickness check : Is there an increase, and if so, why?
3. Consumption per robot (automated painter) : Are there differences, and if so, why?

1 VOCs are organic chemicals that have a high vapor pressure at room temperature (around 72 degrees).

4. Consumption per manual painter : Monitor consumption to check the process capability.
5. First-time through rate versus consumption : A low rate means more repairs, which translates to higher basecoat use.
6. Application equipment : Check for damages or technical problems.

Analyze: The Six Sigma team conducted a '5 Why analysis', as well as test trials on the six potential root causes. The results showed that factors one, two, four, and five were not significant. Factor three, consumption per robot, showed an increase for the liftgate robot. Through testing of factor six—application equipment—the team discovered a damaged solvent recovery valve that warranted further investigation. Additional testing uncovered that a defective solvent recovery valve was causing a direct paint flow from the color changer to the recycling tank, thus increasing consumption. Normally, the solvent recovery valve opens only for the cleaning program to bring the cleaning solvent back to a recycling tank.

Improve: The team used a variety of tools to develop solutions/improvement actions to address the two likely root causes. Value-stream mapping and benchmarking activities proved useful in the search for a manual solution to monitor the valve. On the other hand, while zeroing in on the robot issue, the team reviewed the value-stream map and discovered they could change the automatic process to a manual one for painting the liftgates. Also, through research and discussions with suppliers, they realized the plant could apply paint more efficiently by upgrading to an electrostatic paint application process.

Based on the outcome of the analyze phase, four potential improvement actions were identified for the defective solvent recovery valve factor:

1. Replace plastic valves with stainless steel valves.
2. Create an automatic recovery valve check system.
3. Check the valves weekly.
4. Eliminate the solvent recovery process.

The team used four primary methods to select the final improvement actions: test trials to evaluate stainless steel valves against plastic valves, technical research to develop an automatic recovery valve check system, brainstorming and value-stream mapping to determine the effectiveness of a weekly valve check, and the elimination of the solvent recovery process.

The test results revealed that a quick, inexpensive change from plastic to stainless steel valves would result in a 45 percent performance improvement. Testing also demonstrated that an automatic recovery valve check system would be cost effective and could offer an effective error-proofing device.

For the liftgate robot factor, three potential solutions were identified:

1. Develop a new cleaning program.
2. Change the robot process to a manual paint application.
3. Upgrade to an electrostatic paint application.

Testing focused on improving the existing cleaning program and then comparing the consumption data from the robot process to a manual process. The team also created a cost-benefit analysis for an upgrade to an electrostatic paint application. Tests showed there was no significant difference between the old and the new cleaning program but, by simply changing to manual only painting processes for interior painting, it was estimated that Ford could save 0.28 kg/unit. Finally, the team also determined that upgrading to an electrostatic paint application system would not be cost effective.

Once the solutions were finalized, the team created a three-step implementation plan that included the following steps:

- **Think**: Plan all necessary implementation activities.
- **Act:** Implement the solutions.
- **Control:** Check if solutions were correctly implemented.

Yet another critical element in the project was overcoming stakeholder resistance to the solutions. This was accomplished through effective relationship building as well as providing data, training, and opportunities to discuss the project solutions.

Once the solutions were implemented, the team achieved every project goal and even exceeded the expected cost reduction by a half million dollars annually. More specifically, in meeting these goals, the basecoat paint consumption dropped from 4.18 kg/unit to a mean consumption of 3.3 kg/unit.

Control: The new monitoring system and standard operating procedures are vital to helping the Saarlouis plant sustain the results gained in this project. This system provides a real-time view of paint consumption in detail for each of the four paint booths. All of the plant's standard operating procedures are part of the plant's ISO 9001 compliant quality management system and are therefore included in routine audits. This helps assure that paint consumption will remain within specifications.

Honours

Because of the project's results, Ford's global Six Sigma organization nominated the team to compete in ASQ's International Team Excellence Awards (ITEA) process. The project earned finalist honours, and team members had the opportunity to present their project at the 2011 World Conference on Quality and Improvement. This project was a strong candidate for the competition because it was a cross-functional team that included members from production, maintenance, quality, manufacturing engineering, and the supplier: "They worked together as a team in an excellent way, proving the power of a team and the sum of competencies in a team."

Terms to Master

Quality: Quality is that characteristic or a combination of characteristics that distinguishes one article from the other or goods of one manufacturer from that of competitors or one grade of product or service from another when both are the outcome of the same organisation.

Quality Management: Quality Management is defined as "coordinated activities to direct and control an organization with regard to quality" (ISO 9000:2000).

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

Appraisal costs: Appraisal Costs are incurred in the process of uncovering defects.

Internal Failure Costs: Internal Failure Costs are associated with discovering poor product quality before the product reaches the customer site.

External Failure Costs: External Failure Costs are incurred when inferior products are delivered to customers.

Total Quality Management: Total Quality Management is a philosophy of continuously improving the quality of all the products and processes in response to continuous feedback for meeting the customers' requirements.

Lean Accounting: Lean Accounting is the application of lean philosophy to all accounting and finance processes and systems.

Six Sigma: Six Sigma is a set of techniques and tools for process improvement.

Exercise

A. Theoretical Questions:

Multiple Choice Questions

1. TQM stands for
   A. Technical Quantitative Management
   B. Total Quality Management
   C. Theory of Queuing Management
   D. None of the Above

2. Four Ps of Total Quality Management
   A. Principles, Project, Problem, & Process
   B. People, Process, Problem & Preparation
   C. Product identification, Product quality, Product utility & Product expectation
   D. None of the above

3. PRAISE stands for
   A. Appreciating someone
   B. Product, Recognition, Adoption, Invention, Solution & Evaporation
   C. Problem Identification, Ranking, Analysis, Innovation, Solution & Evaluation
   D. None of the above

4. Six Sigma is about
   A. Quality systems
   B. Quality control process
   C. Statistical technique
   D. None of the above

5. DMIADV is a methodology associated with
   A. Pareto Analysis
   B. PRAISE
   C. Six Sigma
   D. None of the above

6. Pareto analysis recognizes
   A. 80:20 Rule
   B. 50:50 Rule
   C. 20:80 Rule
   D. None of the above

7. Cost of Rework is a cost related to
   A. Internal failure
   B. Appraisal
   C. Prevention
   D. None of the above

8. The cost incurred to ensure that failures do not happen
   A. External failure cost
   B. Internal failure cost
   C. Prevention cost
   D. None of the above
9. Which of the following is not the quality parameter for service organizations?
   A. Consistency
   B. Friendliness
   C. Durability
   D. Promptness

Answer

1	2	3	4	5	6	7	8	9
B	B	C	A	C	A	A	C	C

⊙ Essay Type Questions

1. Write an elaborative note on managing quality in a competitive environment.
2. Detail and discuss the costs of quality.
3. "Total Quality Management is vital for growth" – Justify.
4. Narrate the steps for implementing the Total Quality Management.
5. What do you understand by 6C's?
6. State the relevance of PRAISE analysis.
7. Comment about the utility of Pareto Analysis.
8. Discuss the significance of lean accounting.
9. Narrate the principles, practices, and tools of lean accounting.
10. Define and discuss DMAIC.
11. Define and discuss DMIADV.

B. Practical Problems:

⊙ Comprehensive Numerical Questions

1. Zebra Limited introduced a quality improvement program and following results are observed -

₹ In lakhs

Particulars	2022-23	2023-24
Sales	10,000	10,000
Scrap	100	50

Particulars	2022-23	2023-24
Rework	650	550
Production inspection	250	325
Product Warranty	500	250
Quality Training	125	250
Materials inspection	120	90

Required:

(a) Classify the quality costs and express each class as a percentage of sales

(b) Compute the increase in the amount of profit due to quality improvement.

2. A Company manufactures a single product, which requires two components. The Company purchases one of the components from two suppliers: X Ltd and Y Ltd. The price quoted by X Ltd is ₹180 per 100 units of the component and it is found that on an average 3% of the total receipt from this supplier is defective. The corresponding quotation from Y Ltd is ₹174 per 100 units, with defect rate of 5%. If the defectives are not detected, they are utilized in production causing a damage of ₹180 per 100 units of the defective component.

The Company intends to introduce a system of inspection for the components on receipt. The Inspection cost is estimated at ₹24 per 100 units of the component. Such an inspection will be able to detect only 90% of the defective components received. No payment will be made for components found to be defective in Inspection.

Required:

(a) Please justify the Inspection at the point of receipt and give your working for the same.

(b) Assuming a total requirement of 10,000 units, ascertain the lowest supplier.

3. Rags Ltd. manufactures and sells premium quality of sports shoes in India. Noted sports clubs and its members are the main customers. Finished products show some rectifiable defects. These problems can be detected and rectified during internal inspection. Inspection cost is ₹30 per unit. Rectification / Re-work cost is ₹18 per unit.

During 2023, 60000 pairs of shoes were manufactured and sold. After inspection defect was detected in respect of 5% of output. After sales, customers reported defects in respect of 6% of output. These shoes were received back from customers at a transportation cost of ₹10 per pair. Due to negative publicity arising out of sale of defective materials, loss in sales is expected in next year to the extent of 5% of external failures.

Required:

a. Analyze the cost of quality showing its elements separately with working.

b. If the selling price per pair of shoes is ₹600 and variable cost is 60% of sales, fixed cost is ₹5,50,000 p.a., prepare the profitability statement for the product during 2023.

Answer:

1. (a)

Cost classification	₹ Lakhs		As % to Sales	
	2022-23	2023-24	2022-23	2023-24
Total Quality Costs	1,745	1,515	17.45%	15.15%

(b) Increase in profits during 2023-24 due to quality improvement = ₹ 230 lakhs

2. **Recommendation:**

   a. Inspection at the point of receipt is not advantageous, due to additional cost per 100 good components, i.e. (₹ 205.22 – ₹ 191.13) = ₹ 14.09 in case of X Ltd, and (₹ 200.07 - ₹ 192.63) = ₹ 7.44 in case of Y Ltd.

   b. Purchase from X Ltd. without inspection is cheaper, as there is a cost saving of ₹ 1.50, i.e. (192.63 -191.13) per 100 good components.

3. (a)

Particlars	₹
Total Quality Cost	19,98,000

(b)

Particulars	₹
Profit	1,18,52,000

Abbreviations

DMAIC	Define – Measure – Analyse – Improve – Control
DMIADV	Define – Measure - Identify – Analyse – Design – Verify
DPMO	Defects Per Million Opportunities
ISO	International Organization for Standardization
PRAISE	Problem Identification – Ranking – Analysis – Innovation – Solution – Evaluation
PDCA	Plan-Do-Check-Act
PDSA	Plan-Do-Study-Act
QA	Quality Assurance
QC	Quality Control
SIPOC	Suppliers, Inputs, Process, Outputs, Customers
SOFP	Sales Operation and Financial Planning
TEI	Total Employee Involvement
TQM	Total Quality Management
4P's	People-Process-Problem-Preparation