

Pearson BTEC Level 4 Higher Nationals in Engineering (RQF)

Unit 17: Quality and Process Improvement

Unit Workbook 2

in a series of 2 for this unit

Learning Outcomes 3 and 4

Industry Standards and Total Quality Management

3.2 Standards for Measurement

3.2.1 Defining Measurement Systems

The two main systems for measurement are imperial and metric, the metric system is the standard adopted by almost the entire globe, the exceptions still using Imperial are Liberia, Myanmar and the United States. The difference in the metric and imperial system can be shown in Table 3.1 below.

Table 3.1: Metric and imperial units of measuring length

Metric	Imperial
12 inches to 1 foot	10mm to 1cm
3 feet to 1 yard	100cm to 1m
1760 yards to 1 mile	1000m to 1km

The use of metrics can make calculations much simpler, hence why it is almost globally adopted. With this in mind, but it's also important to define the units of measurement in technical drawings, technical drawings have four different unit lists:

- Inch, pound, second (IPS)
- Millimetre, gram, second (MMGS)
- Centimetre, gram, second (CGS)
- Meter, kilogram, second (MKS)

If these units aren't defined, a manufacturer could make the wrong assumption, and end up with a completely incorrect sized part, which will stall production and be incredibly costly.

3.2.2 Fittings

When considering fittings in an assembly, it is important to think about what kind of fit is required, as this will give different operations. ISO defines three different types of fits, which can then be sub-categorised:

- Clearance fit
- Transition (location) fit
- Interference

Clearance fit is a case where the hole is larger than the shaft, meaning that the two parts will be able to free to slide and rotate. Table 3.2 shows the possible subcategories for clearance fits.

Table 3.2: Clearance fits

Type	Description	Example
Loose running	Large clearance, accuracy is not essential	Pivots, latches,
Free running	Large clearance, high running speeds	Journal Bearings
Easy running	Moderate clearances for high running speeds	Long shafts, pump or fan bearings
Close running	Small clearances for moderate running speeds	Shafts, spindles, sliding rods
Sliding	Minimal clearance for high accuracy	Guiding shafts, sliding gears
Location	Close clearances for precision accuracy	Precision guiding

Transition fit is a case where the hole is fractionally smaller than the shaft, and a mild force will be required to assemble or disassemble the system. Table 3.3 shows different classifications of transition fits.

Table 3.3: Transition fits

Type	Description	Example
Tight	Assembled or disassembled by hand	Hubs, gears
Similar	Assembled or disassembled by rubber mallet	Pulleys, bearings
Fixed	Assembled or disassembled with a light pressing force	Plugs

Interference fit will have a smaller hole than the shaft and will need a high force or heat to assemble or disassemble the system, Table 3.4 shows the different types of interference fits.

Table 3.4: Interference fits

Type	Description	Example
Press	Light interference using cold pressing	Retainers
Driving	Medium interference with hot pressing or high force cold pressing	Permanent mounting onto a shaft
Forced	High interference shrink fit with large temperature difference	

These fits are normally given a label for shorthand in technical drawings (in the case for a loose-running shaft, H11 for the hole, e11 for the shaft). Table 3.5 shows the tolerances in the fitting for a three types of clearance fits. **(These tolerances may vary as the shaft increases in size).**

Table 3.5: Clearance fit tolerances

	Loose-Running			Free-Running			Sliding		
	Hole H11	Shaft e11	Fit	Hole H9	Shaft d9	Fit	Hole H8	Shaft f7	Fit
Max	+0.060	-0.060	+0.180	+0.025	-0.020	+0.070	+0.010	-0.002	+0.018
Min	+0.000	-0.120	-0.060	+0.000	-0.045	-0.020	+0.000	-0.008	-0.002

3.2.3 Threads

The thread is the turn that is seen on a screw or bolt, that helps anchor it into the assembly. The thread of a nut and bolt are always designed to match, if it doesn't match it can create a lot of stresses in the system, or just jam it. When choosing the appropriate thread size, there are a few things that need to be considered, such as the pitch, clearance hole and tapping diameter.

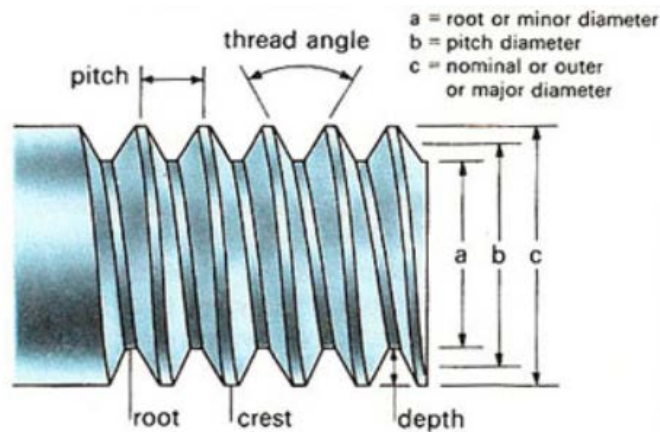


Fig.3.1: A diagram of a screw or bolt thread

Pitch: Width of a thread shown in Fig.3.1

Tapping Diameter: This is the diameter of the hole required to mate with the thread of the screw or bolt.

Clearance Hole: This is the diameter of the hole required to allow the threads to pass through, but not the head of the screw or bolt.

ISO standards split the threading as “coarse” (standard) or “fine”, a table of ISO standard threads are shown in Table 3.2.

Table 3.2: ISO sizes for screw and bolt threads

Size	Pitch (mm)		Tapping Diameter (mm)		Clearance (mm)
	Coarse	Fine	Coarse	Fine	
M1.6	0.35	-	1.25	-	1.8
M2	0.4	-	1.60	-	2.4
M2.5	0.45	-	2.05	-	2.9
M3	0.5	-	2.50	-	3.4
M4	0.7	-	3.30	-	4.5
M5	0.8	-	4.20	-	5.5
M6	1.0	-	5.00	-	6.6
M8	1.25	1.0	6.50	7.0	9.0
M10	1.5	1.25	8.50	8.7	11.0
M12	1.75	1.25	10.50	10.8	14.0
M16	2.0	1.5	14.00	14.5	18.0
M20	2.5	1.5	17.50	18.5	22.0
M30	4.0	2.0	26.50	28.0	33.0

3.3 Standards for Management

While there are thousands of industrial standards set by a variety of organisations, there are also standards that can be implemented to improve the management of a company.

3.3.1 ISO 9000

The ISO 9000 family of publications cover the standards regarding the quality management system and is based on the idea of continual improvement. This standard focuses on specifying the terms and definitions that will be applied to all quality management systems. ISO 9000 is directed for all companies, in all sizes and sectors.

ISO 9000 is applicable to:

- Organisations seeking sustained success through a quality management system
- Customers seeking confidence in an organisations ability
- Organisations seeking confidence in their supply chain and service requirements
- Organisations and interested parties seeking to improve communication through a common understanding
- Providers of training, assessment or advice in quality management

General

The adoption of a quality management system is a strategic decision for an organization that can help to improve its overall performance and provide a sound basis for sustainable development initiatives.

The potential benefits to an organization of implementing a quality management system based on this International Standard are:

- a) the ability to consistently provide products and services that meet customer and applicable statutory and regulatory requirements;
- b) facilitating opportunities to enhance customer satisfaction;
- c) addressing risks and opportunities associated with its context and objectives;
- d) the ability to demonstrate conformity to specified quality management system requirements.

This International Standard can be used by internal and external parties.

It is not the intent of this International Standard to imply the need for:

- uniformity in the structure of different quality management systems;
- alignment of documentation to the clause structure of this International Standard;
- the use of the specific terminology of this International Standard within the organization.

The quality management system requirements specified in this International Standard are complementary to requirements for products and services.

This International Standard promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system, to enhance customer satisfaction by meeting customer requirements.

Understanding and managing interrelated processes as a system contributes to the organization's effectiveness and efficiency in achieving its intended results. This approach enables the organization to control the interrelationships and interdependencies among the processes of the system, so that the overall performance of the organization can be enhanced.

The process approach involves the systematic definition and management of processes, and their interactions, so as to achieve the intended results in accordance with the quality policy and strategic direction of the organization. Management of the processes and the system as a whole can be achieved using the PDCA cycle with an overall focus on risk-based thinking aimed at taking advantage of opportunities and preventing undesirable results.

The application of the process approach in a quality management system enables:

- a) understanding and consistency in meeting requirements;
- b) the consideration of processes in terms of added value;
- c) the achievement of effective process performance;
- d) improvement of processes based on evaluation of data and information.

Figure 1 gives a schematic representation of any process and shows the interaction of its elements. The monitoring and measuring check points, which are necessary for control, are specific to each process and will vary depending on the related risks.

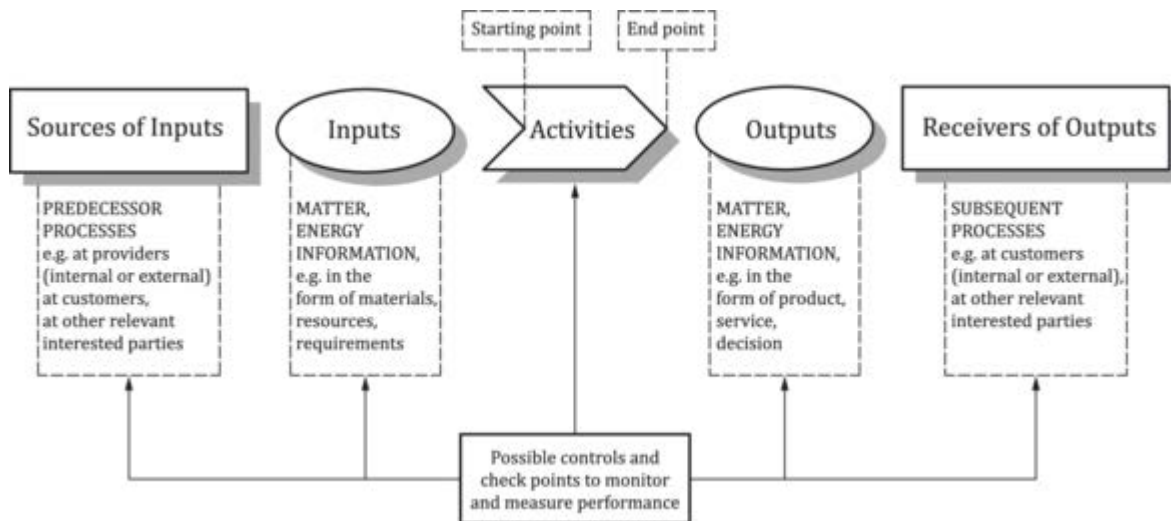


Figure 1 — Schematic representation of the elements of a single process

Plan-Do-Check-Act cycle

The PDCA cycle can be applied to all processes and to the quality management system as a whole. Figure 2 illustrates how Clauses 4 to 10 can be grouped in relation to the PDCA cycle.

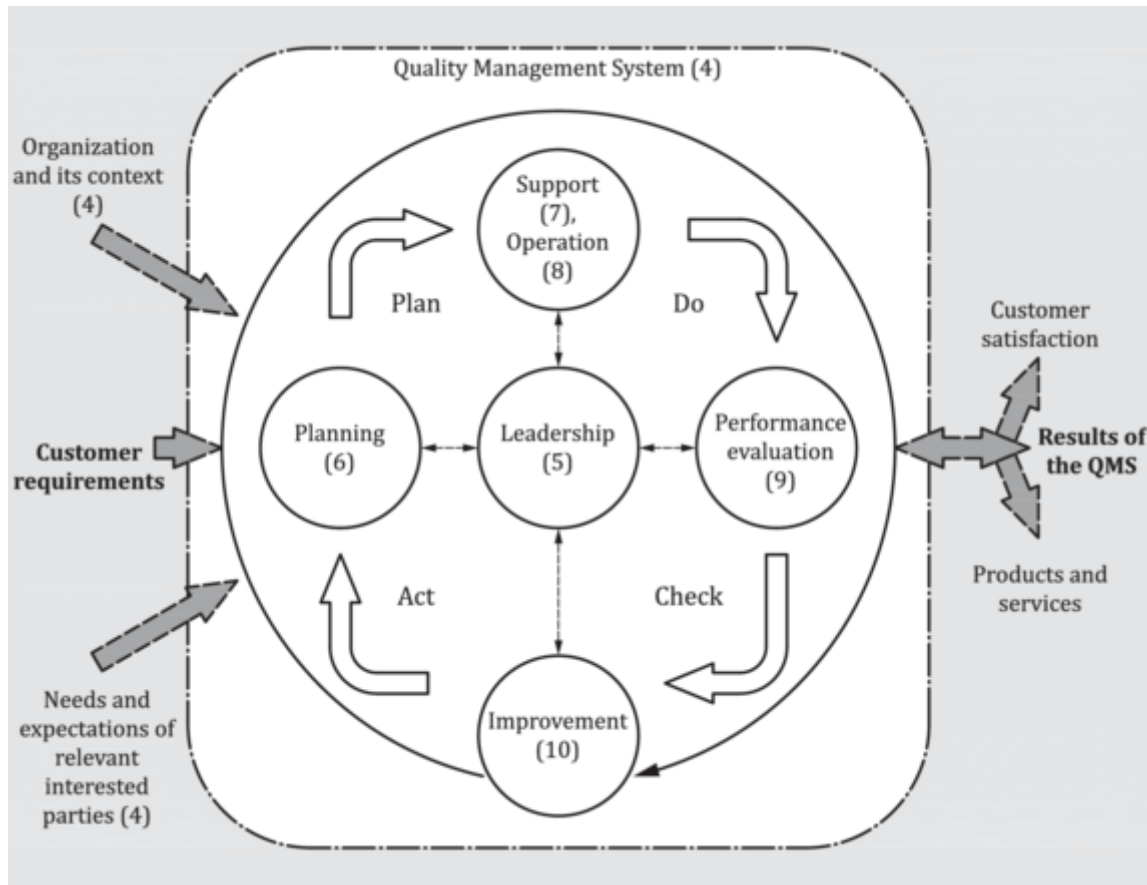


Figure 2 — Representation of the structure of this International Standard in the PDCA cycle

NOTE Numbers in brackets refer to the clauses in the International Standard.

The PDCA cycle can be briefly described as follows:

- Plan: establish the objectives of the system and its processes, and the resources needed to deliver results in accordance with customers' requirements and the organization's policies, and identify and address risks and opportunities;
- Do: implement what was planned;
- Check: monitor and (where applicable) measure processes and the resulting products and services against policies, objectives, requirements and planned activities, and report the results;
- Act: take actions to improve performance, as necessary.

Risk-based thinking

Risk-based thinking (see Clause A.4) is essential for achieving an effective quality management system. The concept of risk-based thinking has been implicit in previous editions of this International Standard including, for example, carrying out preventive action to eliminate potential nonconformities, analysing any nonconformities that do occur, and taking action to prevent recurrence that is appropriate for the effects of the nonconformity.

All the requirements of this International Standard are generic and are intended to be applicable to any organization, regardless of its type or size, or the products and services it provides.

NOTE 1 The terms “product” or “service” only apply to products and services intended for, or required by, a customer.

NOTE 2 Statutory and regulatory requirements can be expressed as legal requirements.

3.3.2 ISO 14000

The ISO 14000 standards covers the standards related to the environmental management system (EMS), the systematic approach discussed in this ISO family of standards include:

- Reduced cost of waste management
- Saving in consumption of energy and materials
- Lower distribution costs
- Improving the company image to regulators, customers and the public
- Framework for continuous improvement

Background

Achieving a balance between the environment, society and the economy is considered essential to meet the needs of the present without compromising the ability of future generations to meet their needs. Sustainable development as a goal is achieved by balancing the three pillars of sustainability.

Societal expectations for sustainable development, transparency and accountability have evolved with increasingly stringent legislation, growing pressures on the environment from pollution, inefficient use of resources, improper waste management, climate change, degradation of ecosystems and loss of biodiversity.

This has led organizations to adopt a systematic approach to environmental management by implementing environmental management systems with the aim of contributing to the environmental pillar of sustainability.

Aim of an environmental management system

The purpose of this International Standard is to provide organizations with a framework to protect the environment and respond to changing environmental conditions in balance with socio-economic needs. It specifies requirements that enable an organization to achieve the intended outcomes it sets for its environmental management system.

A systematic approach to environmental management can provide top management with information to build success over the long term and create options for contributing to sustainable development by:

- protecting the environment by preventing or mitigating adverse environmental impacts;
- mitigating the potential adverse effect of environmental conditions on the organization;
- assisting the organization in the fulfilment of compliance obligations;

- enhancing environmental performance;
- controlling or influencing the way the organization's products and services are designed, manufactured, distributed, consumed and disposed by using a life cycle perspective that can prevent environmental impacts from being unintentionally shifted elsewhere within the life cycle;
- achieving financial and operational benefits that can result from implementing environmentally sound alternatives that strengthen the organization's market position;
- communicating environmental information to relevant interested parties.

This International Standard, like other International Standards, is not intended to increase or change an organization's legal requirements.

Success factors

The success of an environmental management system depends on commitment from all levels and functions of the organization, led by top management. Organizations can leverage opportunities to prevent or mitigate adverse environmental impacts and enhance beneficial environmental impacts, particularly those with strategic and competitive implications. Top management can effectively address its risks and opportunities by integrating environmental management into the organization's business processes, strategic direction and decision making, aligning them with other business priorities, and incorporating environmental governance into its overall management system. Demonstration of successful implementation of this International Standard can be used to assure interested parties that an effective environmental management system is in place.

Adoption of this International Standard, however, will not in itself guarantee optimal environmental outcomes. Application of this International Standard can differ from one organization to another due to the context of the organization. Two organizations can carry out similar activities but can have different compliance obligations, commitments in their environmental policy, environmental technologies and environmental performance goals, yet both can conform to the requirements of this International Standard.

The level of detail and complexity of the environmental management system will vary depending on the context of the organization, the scope of its environmental management system, its compliance obligations, and the nature of its activities, products and services, including its environmental aspects and associated environmental impacts.

Plan-Do-Check-Act model

The basis for the approach underlying an environmental management system is founded on the concept of Plan-Do-Check-Act (PDCA). The PDCA model provides an iterative process used by organizations to achieve continual improvement. It can be applied to an environmental management system and to each of its individual elements. It can be briefly described as follows.

- Plan: establish environmental objectives and processes necessary to deliver results in accordance with the organization's environmental policy.
- Do: implement the processes as planned.

- Check: monitor and measure processes against the environmental policy, including its commitments, environmental objectives and operating criteria, and report the results.
- Act: take actions to continually improve.

Figure 1 shows how the framework introduced in this International Standard could be integrated into a PDCA model, which can help new and existing users to understand the importance of a systems approach.



Figure 1 — Relationship between PDCA and the framework in this International Standard

Contents of this International Standard

This International Standard conforms to ISO's requirements for management system standards. These requirements include a high-level structure, identical core text, and common terms with core definitions, designed to benefit users implementing multiple ISO management system standards.

This International Standard does not include requirements specific to other management systems, such as those for quality, occupational health and safety, energy or financial management. However, this International Standard enables an organization to use a common approach and risk-based thinking to integrate its environmental management system with the requirements of other management systems.

This International Standard contains the requirements used to assess conformity. An organization that wishes to demonstrate conformity with this International Standard can do so by:

- making a self-determination and self-declaration, or
- seeking confirmation of its conformance by parties having an interest in the organization, such as customers, or
- seeking confirmation of its self-declaration by a party external to the organization, or

— seeking certification/registration of its environmental management system by an external organization.

Annex A provides explanatory information to prevent misinterpretation of the requirements of this International Standard. Annex B shows broad technical correspondence between the previous edition of this International Standard and this edition. Implementation guidance on environmental management systems is included in ISO 14004.

In this International Standard, the following verbal forms are used:

- “shall” indicates a requirement;
- “should” indicates a recommendation;
- “may” indicates a permission;
- “can” indicates a possibility or a capability.

Information marked as “NOTE” is intended to assist the understanding or use of the document. “Notes to entry” used in Clause 3 provide additional information that supplements the terminological data and can contain provisions relating to the use of a term.

3.3.3 European Foundation for Quality Management

The European Foundation for Quality Management (EFQM) is a not-for-profit organisation that, for the past 25 years, has guided many organisations in public and private sectors to improve the productivity and efficiency. The EFQM has worked with some of the largest counties in Europe, such as TNT, Renault, Volvo, Fiat, BMW, EDF and Siemens to name a few.

Companies work for their shareholders to make a return on their investments; but in order to develop a sustainable growth and return the customers need to be satisfied. In order to keep the customers satisfied, the company needs to develop and deliver products and services that add value to them. To ensure the customer retention and loyalty, and to build the company’s reputation there needs to be an excellent service delivered.

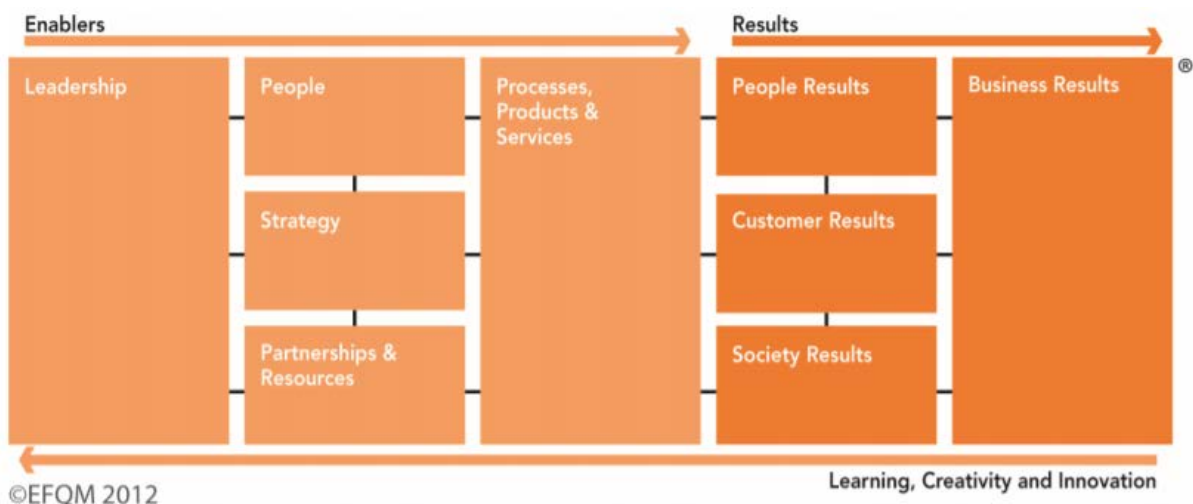


Fig.3.2: EFQM model for a successful company

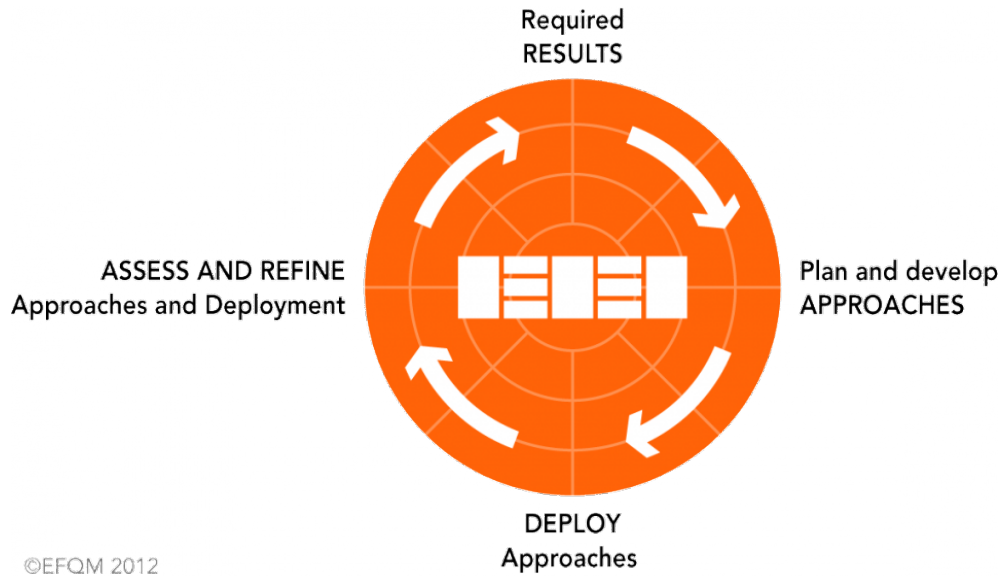


Fig.3.3: EFQM model for "RADAR"

RADAR is broken down into four parts:

- **Results:** Determine the results that the organisation is aiming to achieve as a part of the strategy.
- **Approaches:** Develop the correct approaches to deliver the required results for now and in the future.
- **Deploy:** Systematically deploy the correct approach to ensure implementation
- **Assess and Refine:** Assess and refine the deployed approaches based on the analysis of the results achieved and the on-going learning activities.

4.3.1 The 5S Philosophy of Kaizen

The 5S Philosophy of Kaizen is a five step guide to discipline and good housekeeping in the workplace. We outline each of the steps here.

What is the 5S Philosophy?

The 5S Philosophy forms part of Kaizen, a renowned continuous improvement method. Focusing on your workplace environment, the philosophy should help you and your team to:

- organise your working environment and ensure it is properly maintained
- increase efficiency
- simplify workplace processes
- adopt effective working practices as standard
- improve safety at work
- highlight areas for improvement

Each 'S' in the Philosophy is based on a Japanese word. (Kaizen originates from Japan. The literal translation of Kaizen is 'continuous improvement'.)

Term	Meaning
Seiri	Sorting Out
Seiton	Set in Order
Seiso	Shine
Seiketsu	Standardising
Shitsuke	Sustaining

1. Seiri (sorting out)

This first step focuses on eliminating unnecessary waste from the workplace. Tools and equipment that are not used frequently should be stored away, and items that are not required at all should be disposed of. All essential items should be kept in the area they are used so that they are always to hand.

Seiri helps to keep the workplace tidy, clears space, and makes for a more productive environment. Care should be adopted when implementing this step, however. While it is fine to discard broken or obsolete equipment and tools, do not get too carried away and throw out items that could be of use in the future.

2. Seiton (set in order)

The second stage in the 5S Philosophy, Seiton highlights the need for efficient storage methods and ensuring that the workplace is organised.

In most cases storage will mean utilising shelves, cupboards and cabinets that are convenient for employees to access. Additionally, if two items are frequently used in tandem, they should be stored in the same location. However, certain items will have their own considerations, e.g. computer hardware needs to be kept away from areas that attract too much light and heat or else there is the risk of it malfunctioning.