Solar PV System Installation and Maintenance

Level-III

Learning Guide -01

Unit of Competence	**Prevent and Eliminate MUDA**
Module Title	**Preventing and Eliminating MUDA**
LG Code	**EIS PIM3 M01 LO1 LG-01**
TTLM Code	**EIS PIM3 TTLM 0920v1**

LO1:-Prepare for work

ADRA ETHIOPIA

Instruction Sheet	Learning Guide:-01

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics

- Using work instructions
- Reading and interpreting Job specification
- Observing OHS requirements
- Selecting appropriate material
- Safety equipment and tools

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to:-**

- Use work instructions
- Read and interpret Job specification
- Observe OHS requirements
- Select appropriate material
- Safety equipment and tools

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 1,
4. Accomplish the Self-checks

Information Sheet-1	Using Work Instruction

1.1. Information about the work

- Describe what workers need to be able to do on the job
- Work functions
- Key activities of each work function
- Performance indicators
- Describe what task to be done or work roles in a certain occupation

1.2. Work instruction

Work instruction is a description of the specific tasks and activities within an organization. A work instruction in a business will generally outline all of the different jobs needed for the operation of the firm in great detail and is a key element to running a business smoothly. In other words it is a document containing detailed instructions that specify exactly what steps to follow to carry out an activity. It contains much more detail than a Procedure and is only created if very detailed instructions are needed. For example, describing precisely how a Request for Change record is created in the Change Management software support tool.

1.3. Procedures vs. Work Instructions

Many people confuse “procedures” with “work instructions”. In fact, most people write work instructions and call them procedures. Knowing the differences of procedures vs work instructions can help you understand the documentation process much better and, therefore, procedure documentation. Procedures describe a process, while a work instruction describes how to perform the conversion itself. Process descriptions include details about the inputs, what conversion takes place (of inputs into outputs), the outputs, and the feedback necessary to ensure consistent results. The PDCA process approach (Plan, Do, Check, Act) is used to capture the relevant information. Questions that need to be answered in a procedure include:

- Where do the inputs come from (suppliers)?
- Where do the outputs go (customers)?

- Who performs what action when (responsibilities)?
- How do you know when you have done it right (effectiveness criteria)?
- What feedback should be captured (metrics)?
- How do we communicate results (charts, graphs and reports)?
- What laws (regulations) or standards apply (e.g., ISO 9001, 8th EU Directive, IFRS, Sarbanes-Oxley)?

Self-Check -1	Written Test

Say true or false

1. Work instruction is a description of the specific tasks and activities within an organization.
2. A work instruction in a business is a key element to running a business smoothly.
3. Procedures and work instruction do have exactly the same meaning.
4. Procedures describe a process, while a work instruction describes how to perform the conversion itself

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score :_____

Rating: _____

Score:_____
Rating:_____

Information Sheet- 2	Reading and interpreting Job specification

2.1. Job Requirements

a Job can be defined as:

- A piece of work, especially a specific task done as part of the routine of one's occupation or for an agreed price.
- A post of employment; full-time or part-time position
- Anything a person is expected or obliged to do; duty; responsibility
- An affair, matter, occurrence, or state of affairs.
- The material, project, assignment, etc., being worked upon.
- The process or requirements, details, etc., of working.
- The execution or performance of a task.

The requirements for a job vary according to the nature of the job itself. However, a certain work ethic must be cultivated to succeed in any job and this is fundamental to an individual's sense of himself as a worker, as part of production relations and a fundamental economic being. The basic requirements for a job remain the same no matter what the job is, where it is located or what professional and educational qualifications are required for it. These are as follows:

- Discipline: Nothing is possible without discipline. Any job requires a fundamental core of discipline from the worker or the employee and this is a quality which is independent of age, post, stature, job and so on. Discipline is absolutely indispensable and provides the impetus for work that can be strenuous, repetitive, boring and even unsatisfactory at times.
- Enthusiasm: Enthusiasm for work is also a pre-requisite for any job. An innate love for the job, which in modern parlance is known as job satisfaction, is a core requirement for any job. The drive to succeed, to innovate, to do well and to make one's profession into one's livelihood is a critical drive which needs to be present in the employee or cultivated as soon as possible. No job, however perfectly carried out, can evoke the feeling of satisfaction of a job well done without the instinct for success.

- Qualifications: This is a more material, tactile need for a job which can be conveyed through degrees and certificates. However education is not limited to what is taught in colleges or vocational training courses. It is the burning desire to learn more, to reach the depths of knowledge about a particular field of interest, to complete the job and learn from it that marks the true enthusiast and the truly learned.
- Soft Skills: Soft skills include those skills which ensure that a job is executed well, and the employee can carry himself in the proper manner too. For example, good and smooth communication, computer skills, proficiency in language if needed, presentable appearance, the ability to manage crises are all soft skills which are fundamentally important in any job and which must be cultivated consciously. Learning Guide for Eliminate and Prevent Muda Level III Version: 1 Revision: 0 Date: July 2015 Page 5 of 23 Author: EKI/MoE – TVET Outcome Based Training Core Process

Thus, the requirements of a job, though specific to it, cover also a general spectrum. These make for better employees and better individuals.

2.2. Job Specification

A statement of employee/workers characteristics and qualifications required for satisfactory performance of defined duties and tasks comprising a specific job or function.

Table 2.1 Specification Sample

Technical parameters	Gigabyte 3D Rocket II (GH-PCU23-VE)
Heatsink and fan dimensions (L x W x H)	112mm x 112mm x 160mm 92mm x 92mm x 25mm
Heatsink material	aluminum plates on a copper base and four copper heatpipes 6mm in diameter
Fan rotation speed	~1500-3000rpm
Airflow	no data
Noise level	16.0 ~ 33.5 dBA
Nominal voltage	~12V
Fan MTBF	50,000h
Maximum power consumption	~4.6W
Fan bearings	2 frictionless bearings
Full weight	640g
Supported CPU sockets	Socket 478, LGA 775, Socket AM2/754/939/940
Additional	Additional fan in the lower part of the cooler Gigabyte thermal grease Replaceable fluorescent rings
Price, USD	$60

Self-Check -2	Written Test

Say true or false

1. A Job can be defined as a piece of work, especially a specific task done as part of the routine of one's occupation or for an agreed price.
2. The requirements for a job don't vary according to the nature of the job itself.
3. Discipline is absolutely indispensable and provides the impetus for work that can be strenuous, repetitive, boring and even unsatisfactory at times.
4. Enthusiasm for work is also a pre-requisite for any job.
5. Soft skills include those skills which ensure that a job is executed well, and the employee can carry himself in the proper manner too.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score :_____

Rating: _____

Score:_____
Rating:_____

Information Sheet-3	Observing OHS requirements

3.1. OHS Requirements

OHS requirements are legislation/regulations/codes of practice and enterprise safety policies and procedures. This may include protective clothing and equipment, use of tooling and equipment, workplace environment and safety, handling of material, use of fire-fighting equipment, enterprise first aid, hazard control and hazardous materials and substances.

Personal protective equipment includes those prescribed under legislation/ regulations/codes of practice and workplace policies and practices. Safe operating procedures include the conduct of operational risk assessment and treatments associated with workplace organization. Emergency procedures include emergency shutdown and stopping of equipment, extinguishing fires, enterprise first aid requirements and site evacuation.

Occupational safety and health (OSH) also commonly referred to as occupational health and safety (OHS) or workplace health and safety (WHS) is an area concerned with the safety, health and welfare of people engaged in work or employment. The goals of occupational safety and health programs include fostering a safe and healthy work environment. OSH may also protect co-workers, family members, employers, customers, and many others who might be affected by the workplace environment. In the United States the term occupational health and safety is referred to as occupational health and occupational and non-occupational safety and includes safety for activities outside work. Occupational safety and health can be important for moral, legal, and financial reasons. In common-law jurisdictions, employers have a common law duty (reflecting an underlying moral obligation) to take reasonable care for the safety of their employees. Statute law may build upon this to impose additional general duties, introduce specific duties and create government bodies with powers to regulate workplace safety issues: details of this will vary from jurisdiction to jurisdiction. Good OSH practices can also reduce employee injury and illness related costs, including

medical care, sick leave and disability benefit costs. As defined by the World Health Organization (WHO) "occupational health deals with all aspects of health and safety in the workplace and has a strong focus on primary prevention of hazards." Health has been defined as "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. Occupational health is a multidisciplinary field of healthcare concerned with enabling an individual to undertake their occupation, in the way that causes least harm to their health. It contrasts, for example, with the promotion of health and safety at work, which is concerned with preventing harm from any incidental hazards, arising in the workplace.

Since 1950, the International Labour Organization (ILO) and the World Health Organization (WHO) have shared a common definition of occupational health. It was adopted by the Joint ILO/WHO Committee on Occupational Health at its first session in 1950 and revised at its twelfth session in 1995. The definition reads: "The main focus in occupational health is on three different objectives: (i) the maintenance and promotion of workers' health and working capacity; (ii) the improvement of working environment and work to become conducive to safety and health and (iii) development of work organizations and working cultures in a direction which supports health and safety at work and in doing so also promotes a positive social climate and smooth operation and may enhance productivity of the undertakings. The concept of working culture is intended in this context to mean a reflection of the essential value systems adopted by the undertaking concerned. Such a culture is reflected in practice in the managerial systems, personnel policy, principles for participation, training policies and quality management of the undertaking."

Joint ILO/WHO Committee on Occupational Health: those in the field of occupational health come from a wide range of disciplines and professions including medicine, psychology, epidemiology, physiotherapy and rehabilitation, occupational, occupational medicine, human factors and ergonomics, and many others. Professionals advise on a broad range of occupational health matters. These include how to avoid particular pre-

existing conditions causing a problem in the occupation, correct posture for the work, frequency of rest breaks, preventative action that can be undertaken, and so forth.

"Occupational health should aim at: the promotion and maintenance of the highest degree of physical, mental and social well-being of workers in all occupations; the prevention amongst workers of departures from health caused by their working conditions; the protection of workers in their employment from risks resulting from factors adverse to health; the placing and maintenance of the worker in an occupational environment adapted to his physiological and psychological capabilities; and, to summarize, the adaptation of work to man and of each man to his job.

3.2. History

Harry McShane, age 16, 1908. Pulled into machinery in a factory in Cincinnati and had his arm ripped off at the shoulder and his leg broken without any compensation. The research and regulation of occupational safety and health are a relatively recent phenomenon. As labor movements arose in response to worker concerns in the wake of the industrial revolution, worker's health entered consideration as a labor-related issue.

In 1833, HM Factory Inspectorate was formed in the United Kingdom with a remit to inspect factories and ensure the prevention of injury to child textile workers. In 1840 a Royal Commission published its findings on the state of conditions for the workers of the mining industry that documented the appallingly dangerous environment that they had to work in and the high frequency of accidents. The commission sparked public outrage which resulted in the Mines Act of 1842. The act set up an inspectorate for mines and collieries which resulted in many prosecutions and safety improvements, and by 1850, inspectors were able to enter and inspect premises at their discretion.

Otto von Bismarck inaugurated the first social insurance legislation in 1883 and the first worker's compensation law in 1884 – the first of their kind in the Western world. Similar acts followed in other countries, partly in response to labor unrest.

3.3. Workplace hazards

Although work provides many economic and other benefits, a wide array of workplace hazards also present risks to the health and safety of people at work. These include "chemicals, biological agents, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks," and a broad range of psychosocial risk factors.

3.4. Physical and mechanical hazards

Physical hazards are a common source of injuries in many industries. They are perhaps unavoidable in certain industries, such as construction and mining, but over time people have developed safety methods and procedures to manage the risks of physical danger in the workplace. Employment of children may pose special problems. Falls are a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance.

An engineering workshop specializing in the fabrication and welding of components has to follow the Personal Protective Equipment (PPE) at work regulations 1992. It is an employer's/workers duty to provide 'all equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work which protects him against one or more risks to his health and safety'. In a fabrication and welding workshop an employer would be required to provide face and eye protection, safety footwear, overalls and other necessary PPE.

Machines are commonplace in many industries, including manufacturing, mining, construction and agriculture, and can be dangerous to workers. Many machines involve moving parts, sharp edges, hot surfaces and other hazards with the potential to crush, burn, cut, shear, stab or otherwise strike or wound workers if used unsafely. Various safety measures exist to minimize these hazards, including lockout-tag out procedures for machine maintenance and roll over protection systems for vehicles.

According to the United States Bureau of Labor Statistics, machine-related injuries were responsible for 64,170 cases that required days away from work in 2008. More than a

quarter of these cases required more than 31 days spent away from work. That same year, machines were the primary or secondary source of over 600 work-related fatalities. Machines are also often involved indirectly in worker deaths and injuries, such as in cases in which a worker slips and falls, possibly upon a sharp or pointed object.
The transportation sector bears many risks for the health of commercial drivers, too, for example from vibration, long periods of sitting, work stress and exhaustion. These problems occur in Europe but in other parts of the world the situation is even worse. More drivers die in accidents due to security defects in vehicles. Long waiting times at borders cause that drivers are away from home and family much longer and even increase the risk of HIV infections.

Confined spaces also present a work hazard. The National Institute of Occupational Safety and Health defines "confined space" as having limited openings for entry and exit and unfavorable natural ventilation, and which is not intended for continuous employee occupancy. Spaces of this kind can include storage tanks, ship compartments, sewers, and pipelines. Confined spaces can pose a hazard not just to workers, but also to people who try to rescue them.

Noise also presents a fairly common workplace hazard: occupational hearing loss is the most common work-related injury in the United States, with 22 million workers exposed to hazardous noise levels at work and an estimated $242 million spent annually on worker's compensation for hearing loss disability. Noise is not the only source of occupational hearing loss; exposure to chemicals such as aromatic solvents and metals including lead, arsenic, and mercury can also cause hearing loss.

Temperature extremes can also pose a danger to workers. Heat stress can cause heat stroke, exhaustion, cramps, and rashes. Heat can also fog up safety glasses or cause sweaty palms or dizziness, all of which increase the risk of other injuries. Workers near hot surfaces or steam also are at risk for burns. Dehydration may also result from overexposure to heat. Cold stress also poses a danger to many workers. Over-exposure to cold conditions or extreme cold can lead to hypothermia, frostbite, trench

foot, or chilblains. Electricity poses a danger to many workers. Electrical injuries can be divided into four types: fatal electrocution, electric shock, burns, and falls caused by contact with electric energy. Vibrating machinery, lighting, and air pressure (high or low) can also cause work-related illness and injury. Asphyxiation is another potential work hazard in certain situations. Musculoskeletal are avoided by the employment of good ergonomic design and the reduction of repeated strenuous movements or lifts. Ionizing (alpha, beta, gamma, X, neutron), and non-ionizing radiation (microwave, intense IR, RF, UV, laser at visible and non-visible wavelengths), can also be a potent hazard In Victoria, workplace health and safety is governed by a system of laws, regulations and compliance codes which set out the responsibilities of employers and workers to ensure that safety is maintained at work.

- **The Act**

The Occupational Health and Safety Act 2004 (the Act) is the cornerstone of legislative and administrative measures to improve occupational health and safety in Victoria. The Act sets out the key principles, duties and rights in relation to occupational health and safety. The general nature of the duties imposed by the Act means that they cover a very wide variety of circumstances, do not readily date and provide considerable flexibility for a duty holder to determine what needs to be done to comply.

- **The Regulations**

The Occupational Health and Safety Regulations 2007 are made under the Act. They specify the ways duties imposed by the Act must be performed, or prescribe procedural or administrative matters to support the Act, such as requiring licenses for specific activities, keeping records, or notifying certain matters.

- **Guidance**

Effective OHS regulation requires that Work Safe provides clear, accessible advice and guidance about what constitutes compliance with the Act and Regulations. This can be achieved through Compliance Codes, Work Safe Positions and non-statutory guidance ("the OHS compliance framework"). For a detailed explanation of the OHS compliance framework, see the Victorian Occupational Health and Safety Compliance Framework Handbook.

- **Policy**

Not every term in the legislation is defined or explained in detail. Also, sometimes new circumstances arise (like increases in non-standard forms of employment, such as casual, labour hire and contract work, or completely new industries with new technologies which produce new hazards and risks) which could potentially impact on the reach of the law, or its effective administration by Work Safe. Therefore, from time to time Work Safe must make decisions about how it will interpret something that is referred to in legislation, or act on a particular issue, to ensure clarity. In these circumstances, Work Safe will develop a policy. A policy is a statement of what Work Safe understands something to mean, or what Work Safe will do in certain circumstances.

Self-Check -3	Written Test

Say true false for the statements given below

1. OHS requirements are legislation/regulations/codes of practice and enterprise safety policies and procedures.
2. OHS requirements may include protective clothing and equipment only.
3. One of the main focuses in occupational health is the maintenance and promotion of workers' health and working capacity.
4. Physical hazards are a common source of injuries in many industries.
5. Falls are a common cause of occupational injuries and fatalities, especially in construction, extraction, transportation, healthcare, and building cleaning and maintenance

II. Match column "A" with column "B"

"A"	"B"
_____6.The act	A. a statement of what Work Safe understands something to mean, or what Work Safe will do in certain circumstances
_____7.the regulations	B. specify the ways duties imposed by the Act must be performed, or prescribe procedural or administrative matters to support the Act, such as requiring licenses for specific activities, keeping records, or notifying certain matters.
_____ 8. Policy	C. a detailed explanation of the OHS compliance framework
_____ 9. Guidance	D. sets out the key principles, duties and rights in relation to occupational health and safety

4.1 Material Selection

The basic question is how do we go about selecting a material for a given part? This may seem like a very complicated process until we realize than we are often restrained by choices we have already made. For example, if different parts have to interact then material choice becomes limited. When we talk about choosing materials for a component, we take into account many different factors. These factors can be broken down into the following areas.

- Material Properties
  - ✓ The expected level of performance from the material
  - ✓ Material Cost and Availability
  - ✓ Material must be priced appropriately (not cheap but right)
  - ✓ Material must be available (better to have multiple sources)
- Processing
  - ✓ Must consider how to make the part, for example:
  - ✓ Casting
  - ✓ Machining
  - ✓ Welding
- Environment
  - ✓ The effect that the service environment has on the part
  - ✓ The effect the part has on the environment
  - ✓ The effect that processing has on the environment

Now clearly these issues are inter-linked in some fashion. For example, cost is a direct result of how difficult a material is to obtain and to machine. And the effect of the environment on the material is clearly related to the material properties. So if we really want to use a novel or unusual material, the choice must be made early in the design process. Then we can do the detailed design work using the correct material properties.

Consider the example of wooden airplanes and metal-framed airplanes. If we were to design an airplane of either material we will have to make the choice early. The end

designs are quite different. So, the material choice can radically alter the final design. But the possibility also exists that it may not.

- **Kinds of Materials** (What kind of materials can I use?)
  - ✓ Metals
  - ✓ Iron, Aluminum, Copper, Magnesium, and Composites
  - ✓ Ceramics
  - ✓ Glass
  - ✓ Semi-conductors
  - ✓ Structural ceramics (SiN, SiC)
  - ✓ Refractory Composites
  - ✓ Polymers
  - ✓ Rubber
  - ✓ Plastics
  - ✓ Liquids
  - ✓ Gases

Metal properties tend to be well understood and metals are somewhat forgiving materials. We can make small mistakes (sometimes big ones) and get away with a poor design as a result of metal's forgiving nature. We see ceramics and composites all around us, but they tend to be used in special applications because of fabrication costs. This however, is changing. Plastics are among the most common modern material choices. In large volume production, plastics are inexpensive. In small volume productions, plastics can be an extremely expensive choice due to high tooling costs.

4.2 Material Properties

The following are most concerned characteristics of materials such as:

- Mechanical Properties
  - ✓ Strength
  - ✓ Yield Strength
- Ultimate Tensile Strength

- Shear Strength
  - ✓ Ductility
  - ✓ Young's Modulus
  - ✓ Poisson's ratio
  - ✓ Hardness
  - ✓ Creep
  - ✓ High or low temperature behavior
  - ✓ Density
  - ✓ Anisotropy
- Fatigue strength
- Fracture Toughness
- Thermal Properties
  - ✓ Thermal expansion coefficient Thermal conductivity
  - ✓ Specific heat capacity
- Magnetic Properties
- Fabrication Properties
  - ✓ Ease of machining
  - ✓ Ease of welding, casting, etc
  - ✓ Hardening ability
- Formability
- Availability
- Joining techniques

- Environmental Properties
  - ✓ Corrosion properties
  - ✓ Toxic effects
  - ✓ Out-gassing properties
- Gas and Liquids
  - ✓ Viscosity

However, numerical properties to represent these properties are not easy to find. We would like all this information at our fingers, but it takes some digging. In some cases, objective data does not exist. There is no single, standard place to go and look for all this information. We can however make some recommendations. You can get good information on particular materials from Standards handbooks, such as the ASM's Books on Metals. You can obtain information on gases and liquids from CRC's Handbooks. And the best place to get information on plastics and composites is from the manufacturer. Web sites are also beginning to offer good information. Check the websites on the course web page for material property information and help in the selection process.

The choice of a material is frequently the result of several compromises. For example, the technical appraisal of an alloy will generally be a compromise between corrosion resistance and several other properties such as strength and weld ability. And the final selection may come down to a compromise between technical and economic factors. In identifying a material, approach the task in three stages: List the material requirements for the design. Use the list of characteristics given above to help you in defining ALL the critical requirements. Rank the requirements in importance to the design's success.*
Select and evaluate candidate materials. By researching the various handbooks and resources, attempt to rank your candidate materials as to how well they meet the requirements. Use a decision table to identify the best choices. Choose the most economical material. Research material costs and production costs based upon your anticipated production run. Choose the least expensive of your best choice candidate materials.

We would like to know how to rank and select materials. Consider the airplane problem mentioned earlier. In that case we would like a material that is stiff yet light. What could we do to help arrive at an appropriate material choice? How could we create some numerical standing that would help us compare one material with another? The following procedure is taken from Material Selection in Mechanical Design by Michael Ashby.

Four Basic Steps

- Translation: express design requirements as constraints and objectives
- Screening: eliminate materials that cannot do the job
- Ranking: find materials that best do the job
- Supporting Info: handbooks, expert systems, web, etc.

Self check -4	Selecting appropriate material

Say True or False

1. Cost is a direct result of how difficult a material is to obtain and to machine.
2. Screening is eliminating materials that cannot do the job.
3. Ceramics and composites all around us, but they tend to be used in special applications because of fabrication costs.
4. In small volume productions, plastics can be an extremely expensive choice due to high tooling costs.
5. The effect of the environment on the material is insignificant.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information Sheet-5	Safety equipment and tools

5.1 Safety equipment and tools

Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations. The Occupational Safety and Health Administration (OSHA) require that employers protect their employees from workplace hazards that can cause injury.

Controlling a hazard at its source is the best way to protect employees. Depending on the hazard or workplace conditions, OSHA recommends the use of engineering or work practice controls to manage or eliminate hazards to the greatest extent possible. For example, building a barrier between the hazard and the employees is an engineering control; changing the way in which employees perform their work is a work practice control.

When engineering, work practice and administrative controls are not feasible or do not provide sufficient protection, employers must provide personal protective equipment (PPE) to their employees and ensure its use. Personal protective equipment, commonly referred to as “PPE”, is equipment worn to minimize exposure to a variety of hazards. Examples of PPE include such items as gloves, foot and eye protection, protective hearing devices (earplugs, muffs) hard hats, respirators and full body suits.

5.1.1. Personal Protective Equipment (PPE)

To ensure the greatest possible protection for employees in the workplace, the cooperative efforts of both employers and employees will help in establishing and maintaining a safe and healthful work environment.

In general, employers are responsible for:

- In performing a “hazard assessment” of the workplace to identify and control physical and health hazards.
- Identifying and providing appropriate PPE for employees.
- Training employees in the use and care of the PPE.

- Maintaining PPE, including replacing worn or damaged PPE.
- Periodically reviewing, updating and evaluating the effectiveness of the PPE program.
- In general, employees should:
- Properly wear PPE,
- Attend training sessions on PPE,
- Care for, clean and maintain PPE, and
- Inform a supervisor of the need to repair or replace PPE. That can ca
- Eye and Face Protection

✓ Employees can be exposed to a large number of hazards that pose danger to their eyes and face. OSHA requires employers to ensure that employees have appropriate eye or face protection if they are exposed to eye or face hazards from flying particles, molten metal, liquid chemicals, acids or caustic liquids, chemical gases or vapours, potentially infected material or potentially harmful light radiation. Many occupational eye injuries occur because employees are not wearing any eye protection while others result from wearing improper or poorly fitting eye protection. Employers must be sure that their employees wear appropriate eye and face protection and that the selected form of protection is appropriate to the work being performed and properly fits each employee exposed to the hazard. Some of the most common types of eye and face protection include the following:

✓ **Safety spectacles:** These protective eyeglasses have safety frames constructed of metal or plastic and impact-resistant lenses. Side shields are available on some models.

✓ **Goggles:** These are tight-fitting eye protection that completely cover the eyes, eye sockets and the facial area immediately surrounding the eyes and provide protection from impact, dust and splashes. Some goggles will fit over corrective lenses.

✓ **Welding shields:** Constructed of vulcanized fiber or fiberglass and fitted with a filtered lens, welding shields protect eyes from burns caused by infrared or

intense radiant light; they also protect both the eyes and face from flying sparks, metal spatter and slag chips produced during welding, brazing, soldering and cutting operations. OSHA requires filter lenses to have a shade number appropriate to protect against the specific hazards of the work being performed in order to protect against harmful light radiation.

✓ **Laser safety goggles:** These specialty goggles protect against intense concentrations of light produced by lasers. The type of laser safety goggles an employer chooses will depend upon the equipment and operating conditions in the workplace.

✓ **Face shields.** These transparent sheets of plastic extend from the eyebrows to below the chin and across the entire width of the employee's head. Some are polarized for glare protection. Face shields protect against nuisance dusts and potential splashes or sprays of hazardous liquids but will not provide adequate protection against impact hazards. Face shields used in combination with goggles or safety spectacles will provide additional protection against impact hazards. Each type of protective eyewear is designed to protect against specific hazards. Employers can identify the specific workplace hazards that threaten employees' eyes and faces by completing a hazard assessment as outlined in the earlier section.

✓ **Head Protection**

Protecting employees from potential head injuries is a key element of any safety program. A head injury can impair an employee for life or it can be fatal. Wearing a safety helmet or hard hat is one of the easiest ways to protect an employee's head. Employers must ensure that their employees wear head protection if any of the following apply:

- Objects might fall from above and strike them on the head;
- They might bump their heads against fixed objects, such as exposed pipes or beams; or
- There is a possibility of accidental head contact with electrical hazards.

Some examples of occupations in which employees should be required to wear head protection include construction workers, carpenters, electricians, linemen, plumbers and pipefitters, timber and log cutters, welders, among many others. Whenever there is a danger of objects falling from above, such as working below others who are using tools or working under a conveyor belt, head protection must be worn. Hard hats must be worn with the bill forward to protect employees properly.

In general, protective helmets or hard hats should do the following:

- ✓ Resist penetration by objects.
- ✓ Absorb the shock of a blow.
- ✓ Be water-resistant and slow burning.
- ✓ Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats must have a hard outer shell and a shock-absorbing lining that incorporates a headband and straps that suspend the shell from 1 to 1 1/4 inches (2.54 cm to 3.18 cm) away from the head. This type of design provides shock absorption during an impact and ventilation during normal wear.

Protective headgear must meet ANSI Standard Z89.1-1986 (Protective Headgear for Industrial Workers) or provide an equivalent level of protection. Helmets purchased before July 5, 1994 must comply with the earlier ANSI Standard (Z89.1-1969) or provide equivalent protection. From injury. Hard hats can protect employees from impact and penetration hazards as well as from electrical shock and burn hazards. Employers must ensure that their employees wear head protection if any of the following apply:

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- Be water-resistant and slow burning.
- Have clear instructions explaining proper adjustment and replacement of the suspension and headband.

Hard hats must have a hard outer shell and a shock-absorbing lining that incorporates a headband and straps that suspend the shell from 1 to 1 1/4 inches (2.54 cm to 3.18 cm) away from the head. This type of design provides shock absorption during an impact and ventilation during normal wear.

Protective headgear must meet ANSI Standard Z89.1-1986 (Protective Headgear for Industrial Workers) or provide an equivalent level of protection. Helmets purchased before July 5, 1994 must comply with the earlier ANSI Standard (Z89.1-1969) or provide equivalent protection.

- **Foot and Leg Protection**

Employees who face possible foot or leg injuries from falling or rolling objects or from crushing or penetrating materials should wear protective footwear. Also, employees whose work involves exposure to hot substances or corrosive or poisonous materials must have protective gear to cover exposed body parts, including legs and feet. If an employee's feet may be exposed to electrical hazards, non-conductive footwear should be worn. On the other hand, workplace exposure to static electricity may necessitate the use of conductive footwear.

Examples of situations in which an employee should wear foot and/or leg protection include:

- ✓ When heavy objects such as barrels or tools might roll onto or fall on the employee's feet;
- ✓ Working with sharp objects such as nails or spikes that could pierce the soles or uppers of ordinary shoes;
- ✓ Exposure to molten metal that might splash on feet or legs;
- ✓ Working on or around hot, wet or slippery surfaces; and
- ✓ Working when electrical hazards are present.
- ✓ Safety footwear must meet ANSI minimum compression and impact performance standards in ANSI Z41-1991 (American National Standard for Personal Protection-Protective Footwear) or provide equivalent protection. Footwear purchased before July 5, 1994, must meet or provide equivalent protection to the earlier ANSI Standard (ANSI Z41.1-1967). All ANSI-approved footwear has a protective toe and offers impact and compression protection. But the type and amount of protection is not always the same. Different footwear protects in different ways. Check the product's labeling or consult the manufacturer to make sure the footwear will protect the user from the hazards they face.
- ✓ Foot and leg protection choices include the following:
- ✓ **Leggings** protect the lower legs and feet from heat hazards such as molten metal or welding sparks. Safety snaps allow leggings to be removed quickly.
- ✓ **Metatarsal guards** protect the instep area from impact and compression. Made of aluminum, steel, fiber or plastic, these guards may be strapped to the outside of shoes.
- ✓ **Toe guards** fit over the toes of regular shoes to protect the toes from impact and compression hazards. They may be made of steel, aluminium or plastic.
- ✓ **Combination foot and shin guards** protect the lower legs and feet, and may be used in combination with toe guards when greater protection is needed.
- ✓ **Safety shoes** have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries. The metal insoles of some safety shoes protect against puncture

wounds. Safety shoes may also be designed to be electrically conductive to prevent the buildup of static electricity in areas with the potential for explosive atmospheres or nonconductive to protect employees from workplace electrical hazards.

- **Hand and Arm Protection**

  If a workplace hazard assessment reveals that employees face potential injury to hands and arms that cannot be eliminated through engineering and work practice controls, employers must ensure that employees wear appropriate protection. Potential hazards include skin absorption of harmful substances, chemical or thermal burns, electrical dangers, bruises, abrasions, cuts, punctures, fractures and amputations. Protective equipment includes gloves, finger guards and arm coverings or elbow-length gloves.

  ✓ Employers should explore all possible engineering and work practice controls to eliminate hazards and use PPE to provide additional protection against hazards that cannot be completely eliminated through other means. For example, machine guards may eliminate a hazard. Installing a barrier to prevent employees from placing their hands at the point of contact between a table saw blade and the item being cut is another method.

- **Types of Protective Gloves**

There are many types of gloves available today to protect against a wide variety of hazards. The nature of the hazard and the operation involved will affect the selection of gloves. The variety of potential occupational hand injuries makes selecting the right pair of gloves challenging. It is essential that employees use gloves specifically designed for the hazards and tasks found in their workplace because gloves designed for one function may not protect against a different function even though they may appear to be an appropriate protective device. The following are examples of some factors that may influence the selection of protective gloves for a workplace.

- ✓ Type of chemicals handled.
- ✓ Nature of contact (total immersion, splash, etc.).
- ✓ Duration of contact.
- ✓ Area requiring protection (hand only, forearm, arm).
- ✓ Grip requirements (dry, wet, oily).
- ✓ Thermal protection.
- ✓ Size and comfort.
- ✓ Abrasion/resistance requirements.

Gloves made from a wide variety of materials are designed for many types of workplace hazards. In general, gloves fall into four groups:

- ✓ Gloves made of leather, canvas or metal mesh;
- ✓ Fabric and coated fabric gloves;
- ✓ Chemical- and liquid-resistant gloves;
- ✓ Insulating rubber gloves (See 29 CFR 1910.137 and the following section on electrical protective equipment for detailed requirements on the selection, use and care of insulating rubber gloves).

Self check -5	Written test

Say true or False

1. Hazards exist in every workplace in many different forms: sharp edges, falling objects, flying sparks, chemicals, noise and a myriad of other potentially dangerous situations.
2. It is essential that employees use gloves specifically designed for the hazards and tasks found in their workplace
3. Safety shoes have impact-resistant toes and heat-resistant soles that protect the feet against hot work surfaces common in roofing, paving and hot metal industries.
4. A head injury can impair an employee for life or it can be fatal.
5. Welding shields protect eyes from burns caused by infrared or intense radiant light

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

List of Reference Materials

1. Reference Book: Identifying Waste on the Shop floor (1996)
2. Journals/publications/magazines
3. Other Reference Books
4. Job specifications
5. Safety Manual and Guide
6. U.S. Department of Labor Occupational Safety and Health Administration OSHA 3151-12R 2004

Solar PV System Installation and Maintenance

Level-III

Learning Guide -02

Unit of Competence	**Prevent and Eliminate MUDA**
Module Title	**Preventing and Eliminating MUDA**
LG Code	**EIS PIM3 M01 LO2 LG-02**
TTLM Code	**EIS PIM3 TTLM 0920v1**

LO2:-Identify MUDA

Instruction Sheet	Learning Guide:-01

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics

- Preparing and implementing Plan of MUDA.
- Causes and effects of MUDA.
- Tools and techniques to draw &analyze current situation.
- Identifying and measuring waste/Muda.
- Relevant procedures of identifying &measuring MUDA.
- Reporting Identified and measured wastes

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to:-**

- Prepare and implement Plan of MUDA identification.
- Discuss causes and effects of MUDA.
- Use tools &techniques to draw &analyze current situation of the workplace.
- Identify and measure Wastes/MUDA based on relevant procedures.
- Report Identified and measured wastes to relevant personnel.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 1,
4. Accomplish the Self-checks

Information Sheet- 1	Preparing and implementing Plan of MUDA

1.1. Waste/Muda

Waste/Muda is any activity which consumes resources, such as money, time ,energy, materials, etc, that does not create value and can be eliminated

- **Value**

Value is defined by the next customer (Know your Customer's Need). The next process is your customer. The activity/effect exactly what the next customer needs is value adding activity. There are two types of customers:-

- ✓ Internal customer
- ✓ External customer

- **Internal customer:-**is the customer within a production line/service delivering sequence that is next to the previous process and makes his/her own process.
- **External customer:-**is the customer that buys the final out put product/service of the enterprise.
- **The three Categories of Operation**
  - ✓ Net Operation/Value Adding Operation
  - ✓ Non-Value Adding Operation
  - ✓ "Muda''
- **Net Operation/Value Adding Operation**

  Part of an operation adds value to make parts and products or deliver service. In other words, it is part of the operation that the customer exactly needs / willing to pay for. Learning
- **Non-Value Adding Operation**

  Part of operation that adds no value but cannot be avoided rather it can be reduced. Example Setting up / adjustments, Loading paper to a photo copy machine/ printer, etc

- **”Muda’’**

  Muda is a Japanese word meaning Wasteful Activity which use resources, time or cost without adding value. In other words, it is anything unnecessary in operation that affects the quality of the product/service, productivity, delivery time and also production cost. Muda can be eliminated immediately. Example:- Unnecessary motion/searching for tools, unnecessary transportation of materials, over production, Inventory, Waiting /idle time, making defects and over processing, etc.

Example

Use Very simple drill to elaborate the three Categories of Operation.

Operation:-To staple two papers using a stapler where the work place is disorganized.

Needed materials and tools for the activity

- Two pieces of paper
- Stapler
- Staples

Table1: The result in the disorganized sample work place is summarized below.

No.	Activities	Time taken	Category of the operation	Action to be taken to eliminate/reduce	How
1	Searching for Stapler	35 Sec	Muda	Eliminate	5S(Set-in-order)
2	Searching for Staples	30 Sec	Muda	Eliminate	5S(Set-in-order
3	Putting the Staples into the stapler	8 Sec	Non-Value adding	Minimize	Load staples ahead

4	Putting the two papers together	3 Sec	Non-Value adding	-	
5	Staple the papers	2 Sec	Net Operation (Value Adding)	-	

- **Lessons from the drill**

Total time of operation=78 Sec

- ✓ Net Operation(Value adding)=2 Sec(2.6%)
- ✓ Non-Value adding operation=11 Sec(14.1%)
- ✓ Muda(Unnecessary operation)=65Sec(83.3%)

Can you imagine by how much the total time of the operation can be improved if we try to eliminate the Muda and minimize non value adding operations by applying 5S?

Self check -1	Written test

Say True or False

- Waste/Muda is any activity which consumes resources, such as money, time, energy, materials, etc, that does not create value and can be eliminated.
- Value is defined by the next customer.
- External customer is the customer that buys the final out put product/service of the enterprise.
- Muda is a Japanese word meaning Wasteful Activity which use resources, time or cost without adding value.
- Non-Value Adding Operation **is** part of operation that adds no value but cannot be avoided rather it can be reduced

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information Sheet- 2	Causes and effects of MUDA.

2.1. Causes of Muda of Overproduction

- Large-lot production
- Anticipatory production (producing product in advance of demand)
- Inability to achieve short changeover times with the large equipment used in mass production systems
- Creating enough stock to replace the number of defective parts produced
- Overstaffing or too much equipment
- Machines that turn out parts too quickly

Figure 2.1 Causes of Muda of Overproduction

- **Effects of Muda of Overproduction**

Companies often have overproduction as a result of large-lot manufacturing methods or mass production. There are several unfortunate effects of over production:

- ✓ Anticipatory buying of parts and materials
- ✓ Blocked flow of goods
- ✓ Increased inventory
- ✓ No flexibility in planning
- ✓ Occurrence of defects

- **Causes of Muda of Inventory**
  - ✓ Acceptance of inventory as normal or as a “necessary evil”
  - ✓ Poor equipment lay out
  - ✓ Long changeover times
  - ✓ Shish-kabob or large lot production
  - ✓ Obstructed flow of goods
  - ✓ Anticipatory production
  - ✓ Defective parts
  - ✓ Upstream process is too fast for the downstream process

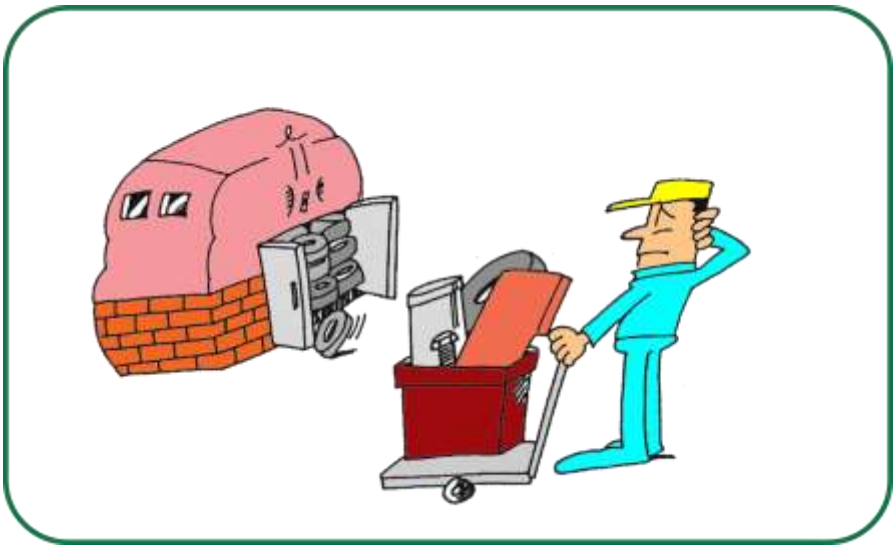


Figure 2.2 Causes of Muda of Inventory

- **Effects of Muda of Inventory**
  - ✓ Waste of space
  - ✓ Needs for inspection, and transportation
  - ✓ Expansion of working fund
  - ✓ Shelf life may expire
  - ✓ It ties up cash
  - ✓ Makes FIFO inventory management more difficult


Figure 2.3 Effects of Muda of Inventory

- **Causes of Muda of motion**
  - ✓ Isolated operations
  - ✓ Low employee morale
  - ✓ Poor work layout
  - ✓ Lack of training
  - ✓ Undeveloped skill

Figure 2.4 Causes of Muda of motion

- **Effects of Muda of motion**

- ✓ Increase in manpower and processing
- ✓ Unstable operation
- ✓ Increases production time
- ✓ Can cause injury

- **Causes of Muda of Conveyance/Transportation**
  - ✓ Poor layout
  - ✓ Shish-skilled workers
  - ✓ Sitting to perform operations
  - ✓ The need for conveyance systems is assumed

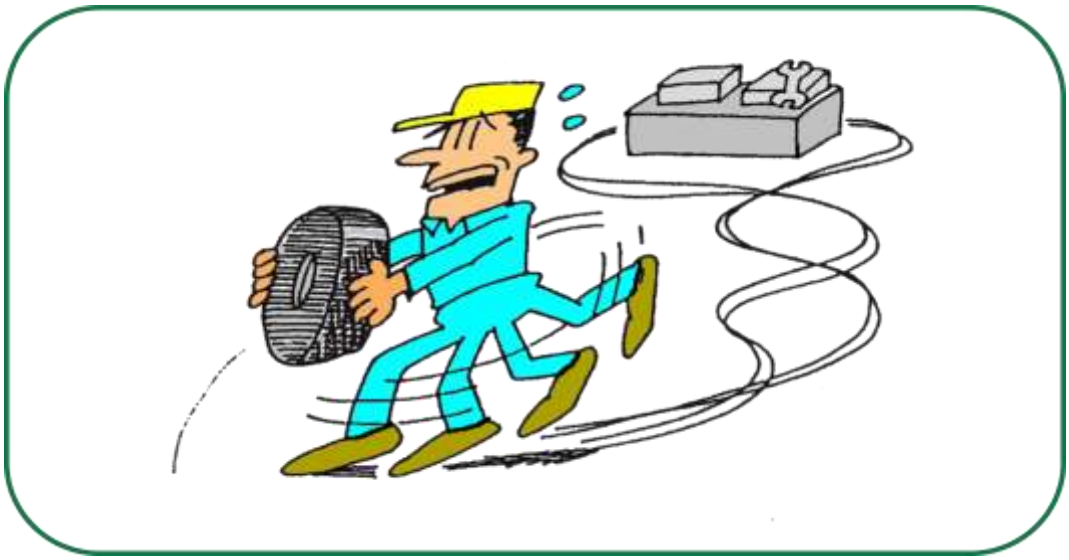


Figure 2.5 Causes of Muda of Conveyance/Transportation

- **Effects of Muda of Conveyance/Transportation**
  - ✓ Waste of space
  - ✓ Production deterioration
  - ✓ Expansion of transportation
  - ✓ facilities
  - ✓ Occurrence of scratches
  - ✓ Increase production time and cost
  - ✓ wastes time and energy

- **Causes of Muda of Waiting/ Idle time**
  - ✓ Obstruction of flow
  - ✓ Poor equipment layout
  - ✓ Trouble at the upstream process
  - ✓ Capacity imbalances
  - ✓ Large Lot-production

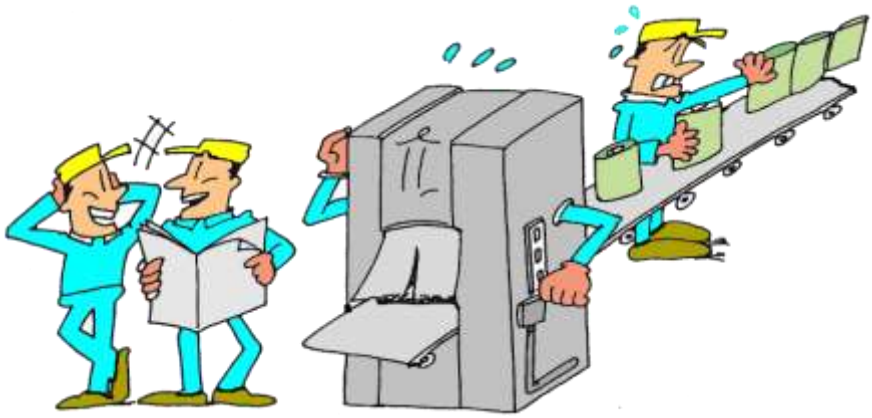


Figure2.6 Causes of Muda of Waiting/ Idle time

- **Effects of Muda of Waiting/ Idle time**
  - ✓ Waste of manpower, time, & machines
  - ✓ Increase in the in-process inventory
  - ✓ Failed delivery dates
  - ✓ Poor workflow continuity

- **Causes of Muda of Defect making**
  - ✓ Emphasis on downstream inspection
  - ✓ No standard for inspection work
  - ✓ Omission of standard operations
  - ✓ Material handling and conveyance

Figure 2.7 Causes of Muda of Defect making

- **Effects of Muda of Defect making**
  - ✓ Increase in material cost
  - ✓ Productivity deterioration
  - ✓ Increase in personnel & processes for inspection
  - ✓ Increase in defects and claims
  - ✓ Invite reworking costs

- **Causes of Muda of Processing**
  - ✓ Inadequate study of processes
  - ✓ Inadequate study of operations
  - ✓ Incomplete standardization
  - ✓ Materials are not studied

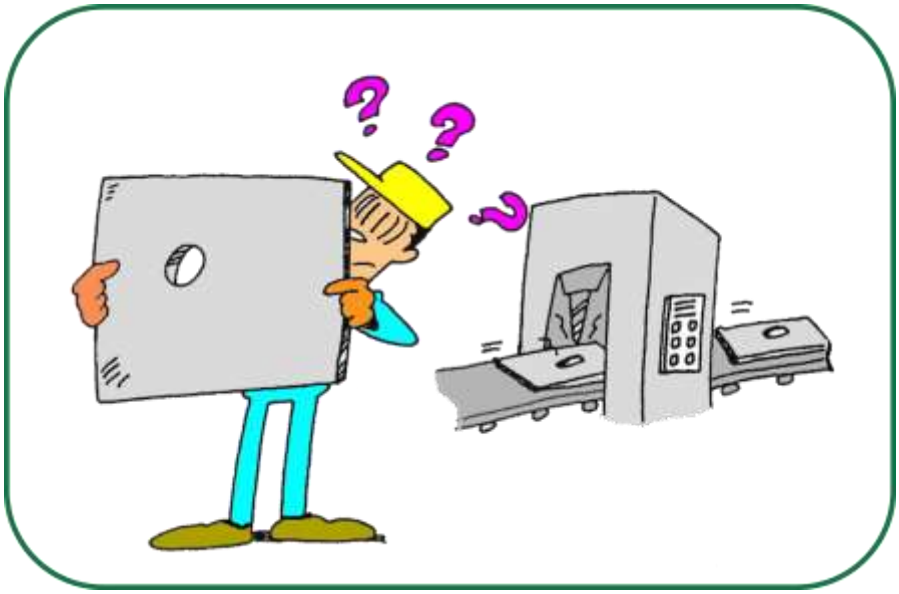


Figure 2.8 Causes of Muda of Processing

- **Effects of Muda of Processing**
  - ✓ Unnecessary processes or operation
  - ✓ Increase in manpower and man-hour
  - ✓ Lower workability
  - ✓ Increase in defects
  - ✓ Can reduce life of components

Self-Check -2	Causes and effects of Muda

Match column “A” with column “B”

“A”	“B”
1. Causes of Muda of Processing	A. Inadequate study of operations
2. Effects of Muda of Defect making	B. Invite reworking costs
3. Effects of Muda of Waiting/ Idle time	C. Waste of manpower, time, & machines
4. Effects of Muda of Conveyance/Transportation	D. Production deterioration
5. Effects of Muda of Overproduction	E. Blocked flow of goods

Information Sheet- 3	Using tools &techniques to draw &analyze current situation of the workplace

4.1. Tools and techniques

Some of the tools and techniques that can be used in program and project management are outlined below. SWOT - strengths, weaknesses, opportunities, threats

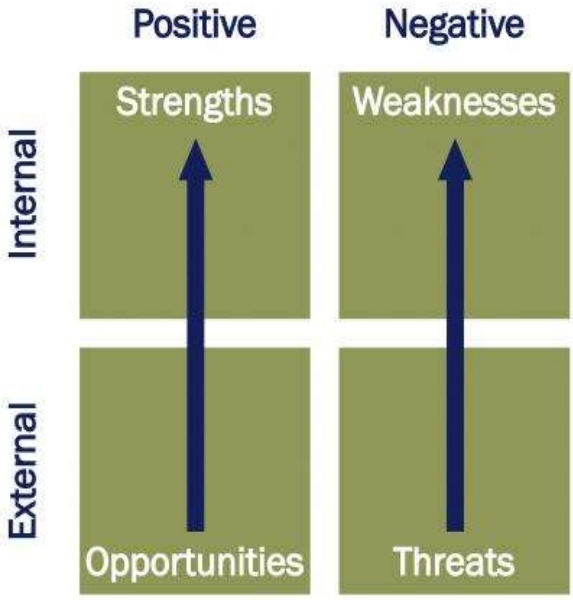


Figure 2.9SWOT analysis diagram

- **SWOT analysis diagram**

A SWOT analysis can be used to draw out the threats and opportunities facing a programme or project. It has the advantage of being quick to implement and is readily understood. Analysis of the strengths, weaknesses, opportunities and threats brings together the results of internal business analysis and external environmental analysis. Common and beneficial applications of SWOT are gaining a greater understanding and insight into competitors and market position. A similar and related form of analysis is known as PEST, examining political, economic, social and technological factors.

RACI - responsible, accountable, consulted, informed

Table comparing tasks with roles to show those responsible, accountable, consulted and informed

	Role 1	Role 2	Role 3	Role 4	Role 5	Role 6
Task A	C	C	I			A, R
Task B	A		C	I	R	
Task C			A	R		I
Task D	R	C			A	
Task E			R	A		
Task F	A	R			C	I

A RACI diagram is used to describe the roles and responsibilities of the participants in a business or project activity in terms of producing predetermined deliverables. RACI is an acronym formed from the four participatory roles which are:

- responsible; those who undertake the activity or the resources
- accountable; those who take the credit for success or accountability for failure or the activity manager; and there must be at least one for each activity
- consulted; those whose opinions are sought
- informed; those who are kept advised of progress

An expanded version, RACI-VS, can also be used, adding the roles of:

- ✓ verifies; the party who checks whether the product meets the quality criteria set out in the product description
- ✓ signs off; the party who approves the verification decision and authorises the product handover

Figure 3 level of interest

- **Stakeholder matrix**

A stakeholder matrix is used to map stakeholders in terms of their importance and potential impact on programme or project activity. Stakeholders are the individuals or groups who will be affected by an activity, programme or project. They could include:

- ✓ senior managers whose business areas are directly or indirectly involved
- ✓ end-users including customers outside the organisation
- ✓ suppliers and partners

Effective management of the stakeholders' interests includes the resolution of conflicting objectives and representation of end-users who may not be directly involved in the activity. Stakeholders' interests can be managed through stakeholder meetings and specific user panels providing input to a requirement specification. The key objective is to capture, align, record, sign off and deliver stakeholder objectives. One way of prioritizing this activity is to use a stakeholder matrix.

Cause and effect diagram

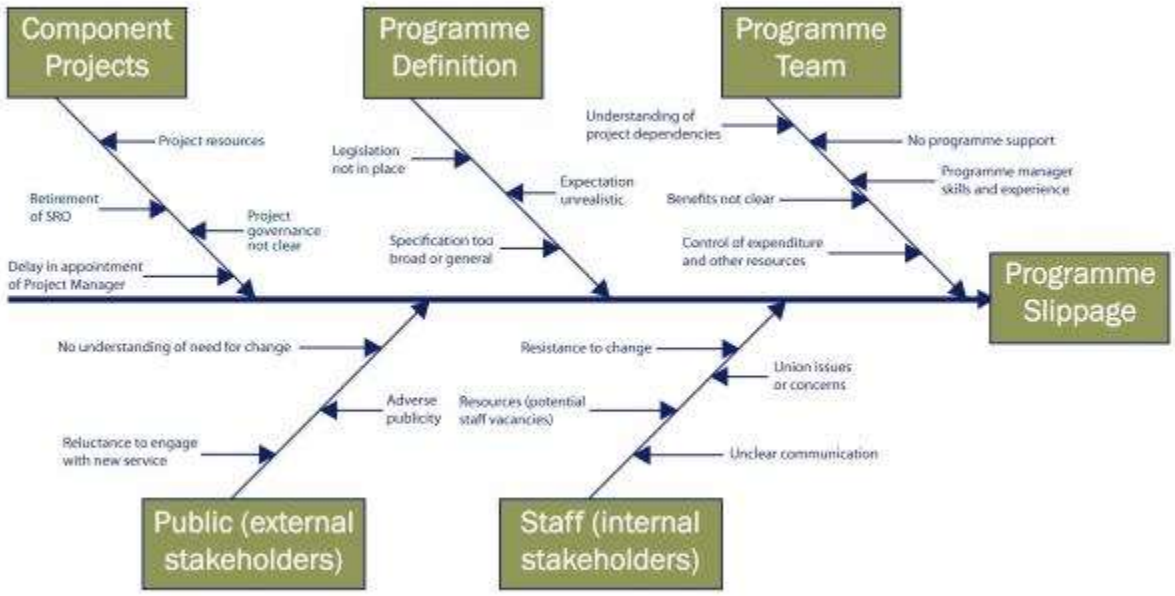


Figure 3.1Cause and effect diagram

- **Cause and effect diagram**

Also known as fish-bone diagram, a cause and effect diagram can be used to represent event causes and potential impacts. It is a graphical representation of the causes of various events that lead to one or more impacts. Each diagram may possess several start points (A points) and one or more end points (B points). Construction of the diagram may begin from an A point and work towards a B point or extrapolate backwards from a B point. This is largely a matter of preference.

Risk map

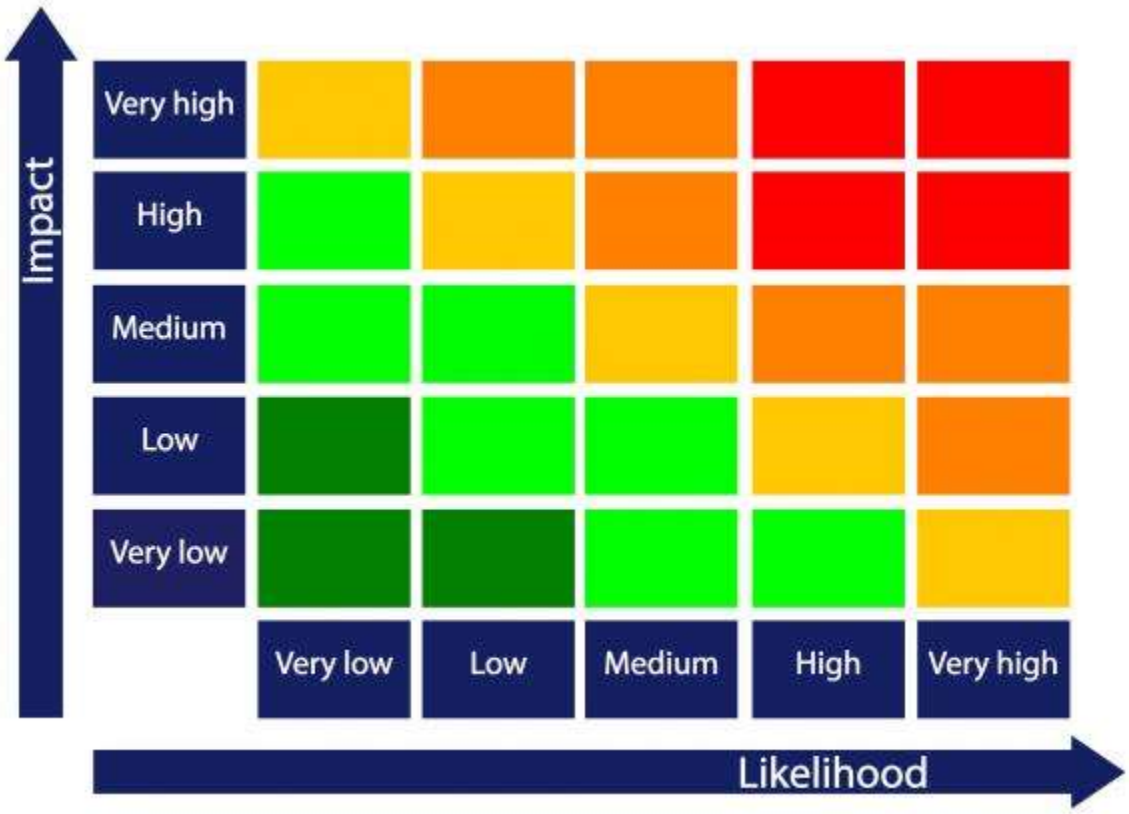


Figure 3.2 risk map

- Risk map with RAG status

This is a simple representation of risk in terms of likelihood and impact. It requires that the probability of a risk occurring is classified as low, medium or high, with a similar classification for the impact if the risk materializes. A combined risk classification of high probability and high impact if the risk occurs is clearly an important risk. The classification can be extended to include very low and very high.

- **Summary risk profile**

A summary risk profile is a simple mechanism to increase the visibility of risks. It is a graphical representation of information normally found on an existing risk register. In some industry sectors it is referred to as a risk map.

The project manager or risk manager needs to update the risk register on a regular basis and then regenerate the graph, showing risks in terms of probability and impact with the effects of mitigating action taken into account. It is essential for the graph to reflect current information as documented in the risk register. The profile must be used with extreme care and should not mislead the reader. If an activity has over 200 risks it will be impractical to illustrate all of the risks. It will be more appropriate to illustrate the top 20 risks, for example, making it clear what is and is not illustrated.

A key feature is the risk tolerance line. It shows the overall level of risk that the organization is prepared to tolerate in a given situation. If exposure to risk is above this line, managers can see that they must take prompt action. Setting the risk tolerance line is a task for experienced risk managers. It reflects the organization's attitudes to risk in general and to a specific set of risks within a particular project. The parameters of the risk tolerance line should be agreed at the outset of an activity and regularly reviewed.
The use of RAGB(red, amber, green, blue) status can be useful for incorporating the status reporting from risk registers into risk profiles, and can provide a quick and effective means of monitoring.
Decision tree

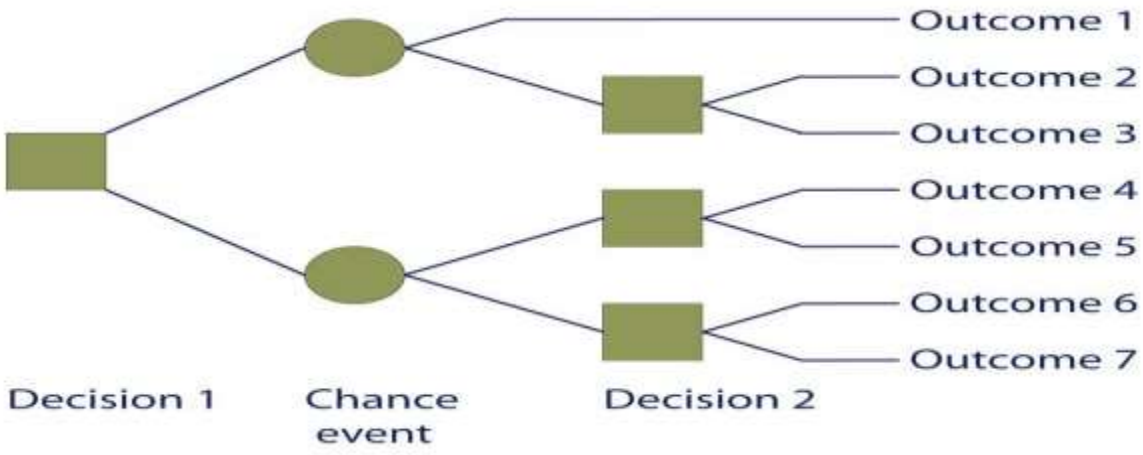


Figure 3.3decision tree

- Example of a simple decision tree

A decision tree is a useful tool for enabling choice between several courses of action. It provides a highly effective structure within which options can be explored and possible outcomes can be investigated. It also helps to form a balanced picture of the risks and rewards associated with each possible course of action. A decision tree is particularly useful when choosing between different strategies, projects or investment opportunities, particularly when resources are scarce.

Project	Number of risks
Project A	20
Project B	32
Project C	98
Project D	49
Project E	10
Project F	27

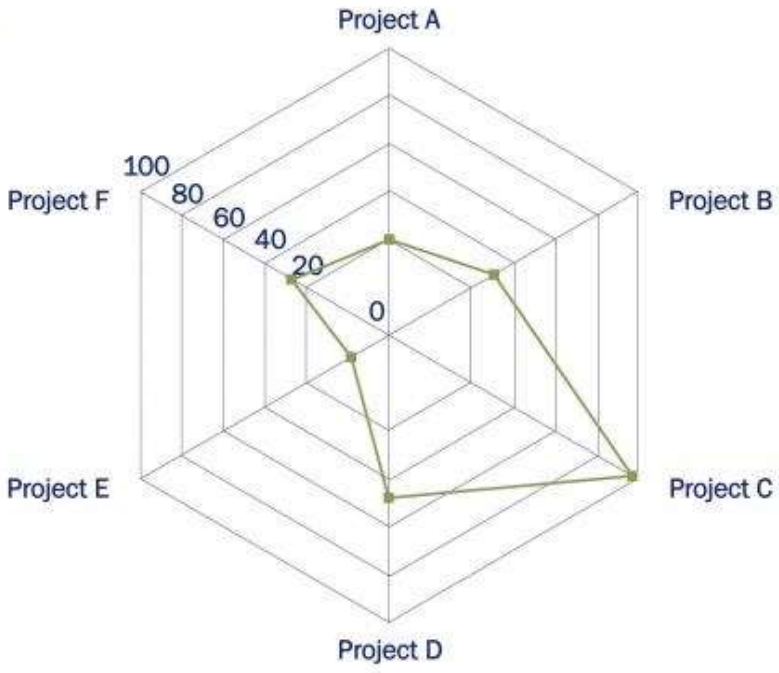


Figure 3.4radar chart

- **An example of a radar chart**

Also known as a spider chart, a radar chart is a diagram that is used to show the number of risks that different projects are exposed to. Initially, the data is placed in a table that is subsequently converted into a chart. In a radar chart, a point close to the centre on any axis indicates a low value and a point near the edge is a high value.

Self-Check -3	Written Test

I Say true or false

1. A SWOT analysis can be used to draw out the threats and opportunities facing a programme or project.
2. A RACI diagram is used to describe the roles and responsibilities of the participants in a business or project activity in terms of producing predetermined deliverables.
3. A decision tree is a useful tool for enabling choice between several courses of action.
4. Risk map with RAG status requires that the probability of a risk occurring is classified as low, medium or high, with a similar classification for the impact if the risk materializes.
5. A stakeholder matrix is used to map stakeholders in terms of their importance and potential impact on programme or project activity.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet -4	Identifying and measuring waste/Muda.

4.1. Identifying and measuring waste/Muda.

- **Classification of Waste**

A number of methods for categorizing types of waste have emerged. We will review some of these models to get a deeper understanding of what waste is and how to find it and eliminate it.

- ✓ The three Mus
- ✓ The 5M + Q + S
- ✓ The flow of goods
- ✓ The seven deadly wastes

- **The Three MUs**

In this way of thinking about waste, the goal is to achieve a condition where capacity and load are about equal. In other words, there are just the right amount of workers, materials and machines to make just the right amount of product that is being ordered and deliver it on time to the customer. In Japanese this is expressed with the terms muda, mura and muri.

- ✓ Muda(waste) = Capacity exceeds load.
- ✓ Mura (inconsistency or variation) = capacity sometimes exceeds the load and the load sometimes exceeds capacity.
- ✓ Muri(irrationality/physical or mental overburden) = load exceeds capacity.

By focusing improvement activities on eliminating the non-value added activities throughout the production/service delivering process, and establishing production flow, a balance is naturally achieved between capacity and load.

- **Muda**

Production factors that increase cost, in other words, all **unnecessary** things

- **Muri**

Mental and physical overburden on operators, and overburden on production machinery

- **Muri**

We should not force hard work on Employees in the name of productivity improvement

Value added work

Working density = Actual work

Muri : overburden

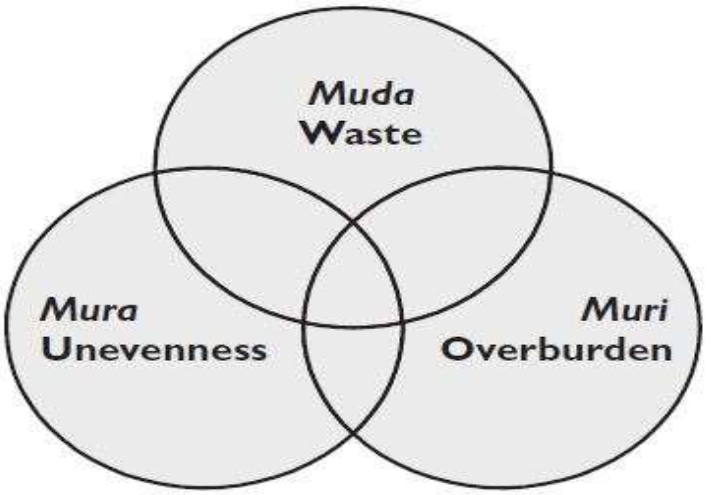
Figure 3.5muri

- **Mura**

Variation in work distribution, production capacity of machinery, and material specifications

- **Relationship between the 3 M's**

Usually Mura creates Muri which in turn lead to generation of Muda



- **The 5M + Q + S**

Another way of thinking about waste is to focus on the areas where waste may occur: the 5M (man, material, machine, method and management), plus quality and safety. See the next figure. Some of the main forms of waste that you will uncover by focusing on these aspects of production include, walking, waiting, searching, material storage and handling, large machines, conveyers, wasteful production methods, inventory, defective goods, errors, inspection, etc.

- **The Flow of Goods**

A third way of thinking about waste is to focus on the flow of goods in production. The flow of goods typically looks like this: Materials are procured Materials are retained in the warehouse Materials are conveyed to processes on the production line Materials are retained at the process equipment(WIP) Materials are picked up for processing Materials are processed goods are set down and retained on the other side of the processing machine(WIP) Goods are conveyed to an inspection point Goods are retained until inspection Goods are picked up and inspected Goods are set down and retained on the other side of inspection process Inspected goods are conveyed to the finished goods warehouse Finished goods are retained prior to shipment Finished goods are delivered to the customer.

If you look carefully at this you will notice there are really only four things going on: retention conveyance, processing and inspection. Retention means stopping the flow of

goods without adding any value to them. It is called stockpiling, warehousing, temporary storage, and so on. Retention produces inventory: materials inventory before processing, work-in process inventory, or finished goods inventory. Inventory occurs for variety of reasons:

- The upstream process moves faster than the downstream process.
- Goods flowing from several lines to one process or goods waiting to go from one process to several different lines tend to pile up.
- There is waiting for machine changeover.
- Materials are purchased and processed for expected end-of-the month rushes.
- Materials are purchased in advance of orders.
- Spare parts are purchased in advance for after-sales service.

Retention adds cost without adding value. It is easy to think that inventory solves production flow problems but in fact it just hides them. When you eliminate retention points the real problems in the production flow must be addressed directly. This is the only path to waste-free production flow, or lean production. Conveyance refers to transporting goods without adding value. Movement between a retention point is often called “conveyance” and movement between a retention point and a process is often called “material handling.” Processing means adding value. We either alter the raw materials or parts or we assemble parts to add value. Improvement of processes includes identifying how a process can best fulfill its purpose or identifying how a process can be done more efficiently. You will ask, Why are we drilling holes? Why are we putting in screws? You may discover many operations that can be replaced by better solutions or even eliminated. Inspection identifies and eliminates defects from the production flow. It does not add value because it does not eliminate the source of the defect but only its result.

Once you change your focus from “finding” defects to “reducing” defects you are on your way to eliminating waste. Ultimately, lean production aims to prevent all defects from occurring. The Seven Deadly Wastes The most well-known category of wastes is the “seven deadly wastes,” which captures the essence of all the ideas discussed above and simplifies them to help you root out waste throughout your production process. You will need strongly motivated people with an instinct for seeing and removing waste. Identifying and eliminating these seven types of waste will forge the path to lean production.

- Overproduction
- Inventory
- Motion
- Conveyance/Transportation
- Waiting/ Idle time
- Defect making
- Processing

Self-Check -4	Written Test

Match column "A" with column "B"

"A"	**"B"**
1. Muda	A. overburden
2. Muri	B. unevenness
3. Mura	C. Waste
4. 5M	D. man, material, machine, method and management
5. Inspection identifies and eliminates defects from the production flow.	E. Identifies and eliminates defects from the production flow.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information Sheet-5	Relevant procedures of identifying &measuring MUDA.

5.1. Relevant procedures of identifying &measuring MUDA

Steps to effective Muda identification

- Making waste visible
- Be conscious of the waste
- Be accountable for the waste
- Measure the waste

✓ **Making waste visible**

Shop layout/process flow analysis using :-

- Arrow Diagram
- Summary chart of flow analysis
- Operation analysis Table
- The standard operation combination chart
- Workshop checklist for major waste finding

- **The Arrow Diagram**
  - ❖ It focuses on the flow of goods to discover waste
  - ❖ Factors to be identified in arrow diagram are:- Retention, Conveyance, Processing & Inspection.
  - ❖ Helps to get a good understanding of production processes and to see where the waste exists.

Arrow Diagram symbols

Arrow Diagram symbols

Analysis Factors	Symbols	Description	Amount of waste
Retention		When the WIP flow is stopped (for other than Conveyance, Processing or Inspection)	Large
Conveyance		When the WIP flow is moved from one place to another.	Large
Processing		When the WIP is changed physically or chemically for added value.	There may be some waste in the process
Inspection		When goods are inspected for conformance to Quality and dimensional standards.	Large

Figure 5.1arrow diagram

- **Four steps to create arrow diagram**
  - Understand the purpose:- To discover waste.
  - Select the product to be analyzed:-
    - You can do product quantity analysis to compare product and quantity.
    - Choose products with a large out put and with many production problems as a starting point.
  - Prepare a factory layout diagram:- Include the entire factory layout with position of machines, work tables, etc.
  - Make the Arrow Diagram:-
    - Do this on the shop floor and use the symbols.
    - Connect the symbols with lines to show the direction of flow.
  - At all conveyance points note:-

- Conveyance distance, and
- Type of conveyance

- **At all retention points - note average WIP inventory.**
- **Operations Analysis Table**
  - Helps you identify the waste in your own operations.
  - Focuses on people's action.
  - Not everything you do adds value.
  - Someone else fills the table for you while you are working as it is hard to fill for yourself while working.
- **Standard Operation Combination Chart:**Focuses on the relationship of people, goods and machines.

Discover where waste is by plotting the cycle time of all activities and design the process to create a more efficient combination and reduce overall cycle time.

The steps to effective waste elimination are

- Make waste visible
- be conscious of the waste
- be accountable for the waste.
- Measure the waste.
- Eliminate or **reduce** the waste

- **Make waste visible**
  - Draw and analyze the current facility layout.
  - Prepare **a process flow chart to see the number and movement of workers, order of processing, type of processing and so on**
    Prepare standard operation sheet.

- **be conscious of the waste**
  - When something is denied as waste, it also cannot be stopped.
- **be accountable for the waste**
  - When one refuses to accept responsibility for the waste, then he will not eliminate it.

- **Measure the waste**
  - ❖ When the waste is not measured, people may think it is small or insignificant and therefore will not be motivated to stop it.
  - ❖ “What is not measured is not improved”.
  - ❖ Appreciate its size and magnitude.
- **Eliminate or reduce the waste**
  - ❖ When the great Italian sculptor Michelangelo was asked what he was sculpting, he responded he was not sculpting but releasing the figure inside by removing the unnecessary rocks (wastes). Like Michelangelo, we should eliminate all forms of wastes in any process or product until only what is valuable remains.

Self-Check -5	Written Test

I. Say true or false

1. The first step to effective waste elimination is to make waste visible.
2. Eliminate all forms of wastes in any process or product until only what are valuable remains.
3. When the waste is not measured, people may think it is small or insignificant and therefore will not be motivated to stop it.
4. When something is denied as waste, it also cannot be stopped.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information Sheet-6	Reporting Identified and measured wastes

6.1 Documenting and reporting reports to personnel and stakeholders.

It is important to maintain proper document management of all the identified and measured wastes activities. This will ensure that a full record of the system's performance is kept and deviations to be detected timely.

6.2 Reporting results

As soon as a scheduled identified and measured wastes activity was performed, the results should be sent to the system manager. Include with the reports also the following:

- filled in forms including date and conditions;
- Photos of any potential problems;
- Descriptions of operational indicators, meters, and error messages;
- Any areas of concern relating to the system.

6.3 Document Management

The managers should maintain proper document management of the O&M operation including:

- Send the system owner reminders to do scheduled identification and measurement of wastes;
- Receive the scheduled maintenance forms, photos and other information;
- Interpret the results to identify any potential issues;
- Notify the owner of any issues detected with possible remedies;
- File all documents together with system documentation for easy access when needed.

6.4 Analyzing data

The received data can only be useful if it is regularly examined and interpreted by a qualified person.

Self-Check -6	Written Test

True or False: (1 point each)

1. It is important to maintain proper document management of all the identified and measured wastes activities.
2. The received data can only be useful if it is regularly examined and interpreted by a qualified person.
3. The managers should maintain proper document management to notify the owner of any issues detected with possible remedies
4. Photos of any potential problems cannot be included in report result.

Note: Satisfactory rating - 2 points and above Unsatisfactory - below 2 points

Answer Sheet

Score = _____

Rating: _____

List of Reference Materials

1. By Prof. Rene T. Domingo Asian Institute of Management
rtd@aim.eduwww.rtdonline.com

Solar PV System Installation and Maintenance

Level-III

Learning Guide -03

Unit of Competence	**Prevent and Eliminate MUDA**
Module Title	**Preventing and Eliminating MUDA**
LG Code	**EIS PIM3 M01 LO3 LG-03**
TTLM Code	**EIS PIM3 TTLM 0920v1**

LO3:-Eliminate wastes/MUDA

Instruction Sheet	Learning Guide:-01

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics

- Preparing and implementing elimination plan of MUDA
- Necessary attitude to eliminate MUDA
- The ten basic principles to eliminate MUDA
- Tools and techniques to eliminate wastes/Muda.
- Reducing and eliminating Wastes/MUDA.
- Reporting Improvements.

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to:-**

- Prepare and implement .Plan of MUDA elimination
- Adopt necessary attitude and the ten basic principles for improvement to eliminate waste/MUDA.
- Use tools and techniques to eliminate wastes/MUDA based on the procedures
- Reduce and eliminate wastes/MUDA in accordance with OHS and organizational requirements.
- Report improvements gained by elimination of waste/MUDA to relevant bodies.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 1,
4. Accomplish the Self-checks

Information Sheet-1	Preparing and implementing elimination plan of MUDA

1.1. Plan and procedure for Waste/Muda Identification

It is not easy to find waste when you look at the production line or the warehouse or an operation. If you have never been involved in improvement activities you will find it even harder to discover waste that may be right in front of you. Waste is everywhere, in every operation; it is so common and you are so used to it that it is hard to see.

The steps to effective waste identification are:

- Make waste visible
- Be conscious of the waste
- Be accountable for the waste.
- Measure the waste.
- **Make waste visible**

Waste can be made visible in several ways such as:

- ✓ Shop layout analysis
- ✓ Process flow analysis
- ✓ Take photoes/video
- ✓ Etc

The primary goal of pre-incident waste management planning is to prepare a community to effectively manage waste, debris and materials generated by a homeland security incident, including reducing the potential amount of waste generated at the outset.

- **Benefits of Pre-incident Waste Management Planning**

Nearly all incidents generate waste, debris and materials. While the amount of waste varies between incidents, the generated waste is often greater than the amount of waste many communities handle each year. Additionally, homeland security incidents may generate waste streams, such as chemical, biological and radiological-

contaminated wastes, which typically are not handled by communities or waste management facilities. In addition to helping the whole community prepare for these potential wastes, pre-incident planning encompasses source reduction and hazard mitigation activities aimed at reducing the total amount of waste generated by an incident, especially for a large-scale natural disaster. While this pre-incident planning should be documented in a Waste Management Plan (WMP), the community's preparation provides the most benefits, such as:

- ✓ Saves valuable time and resources during an incident
- ✓ Allows more efficient and effective waste management decision-making during an incident
- ✓ Encourages stakeholders (e.g., state, local, tribal and territorial governments; owners of private storage, treatment and disposal facilities; residents) to work together before an incident occurs
- ✓ Boosts the community's resiliency, resulting in a quicker and less costly recovery to its pre-incident state
- ✓ Enhances communities' adaptation to the waste-related impacts of climate change
- ✓ Minimally detracts from, or otherwise impacts, the broader response and recovery efforts due to the efficient implementation of waste management activities

- **Planning with Limited Time and Resources**

Pre-incident planning can be done in stages. Below is a list of waste management planning activities that may provide the greatest benefit for a community that has limited resources and time to devote to planning. Small but significant steps taken prior to an incident can have a big impact on the efficiency and effectiveness of post-incident waste management decision-making.

For example, few facilities are able to accept radiological-contaminated waste. Knowing where radiological-contaminated waste can be taken and if it will be accepted by the facility before a radiological incident occurs means that the site can be cleaned up faster

(e.g., contaminated waste immediately can begin to be transported off-site to a permitted facility), limiting the possible spread of contamination (e.g., minimizes opportunities for radiation to spread into the surrounding environment due to weather and other factors).Even if a radiological incident is unlikely to occur in a particular community, planning for radiological contaminated waste has value beyond radiological incidents. For example, a large-scale natural disaster may damage hospitals and generate mixed waste (i.e., waste containing both radioactive and hazardous waste components) that would need to be managed at an appropriate facility. Further ideas on planning activities can be found in the Pre-incident All-Hazards Four Step Waste Management (WM) Planning Process section.

- **Possible waste streams**
  - ✓ Ammunition and Explosives
  - ✓ Animal Carcasses
  - ✓ Asbestos-containing Waste
  - ✓ Biological-contaminated Waste
  - ✓ CCA-treated Wood
  - ✓ Chemically-contaminated Waste
  - ✓ Construction and Demolition Debris
  - ✓ Cylinders and Tanks
  - ✓ Electronic Waste
  - ✓ Food
  - ✓ Household Hazardous Waste
  - ✓ Oil-contaminated Waste
  - ✓ PCB-contaminated Waste
  - ✓ Radiological-contaminated Waste
  - ✓ Soils, Sediments and Sandbags
  - ✓ Treated Biological-contaminated Waste
  - ✓ Treated Chemically-contaminated Waste
  - ✓ Treated Radiological-contaminated Waste
  - ✓ Vegetative Debris
  - ✓ Vehicles and Vessels

- ✓ White Goods (i.e., household appliances)

Self-Check -1	Written Test

I. Say true or False

1. The primary goal of pre-incident waste management planning is to prepare a community to effectively manage waste, debris and materials generated by a homeland security.
2. Waste is everywhere, in every operation; it is so common and you are so used to it that it is hard to see.
3. Nearly all incidents generate waste, debris and materials
4. The amount of waste varies between incidents; the generated waste is often greater than the amount of waste many communities handle each year.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

2.1 Adopting the Necessary Attitude

First you must adopt an attitude that supports your ability to see waste. Waste is hard enough to find when you want to find it; if you don't want to find it, or if your response to find it is denial or resistance, then it will never be possible for you to root out waste and make your work environment stress free. It is very important that you understand that one purpose of discovering waste is to take the frustration out of your work.

Many people will resist seeing the waste in their work. Just don't let it be you. You may hear yourself or others saying things like: "Let's not fix what is not broken." "Can't we live well enough alone?" "This is just another attempt to make us work harder for the same amount of money." "It looks good on paper, but it will never work on the floor." "We tried that twenty years ago. It didn't work then; it won't work now." "That is not my job." And so on.

You know the lines. You have probably said one or two of them at one time or another. We all have. Resistance is normal. Just don't let it keep you from learning to see the waste in your work. In the end, you are the one who suffers most from the results of waste.

Self-Check -2	Written Test

I. say true or false

1. First you must adopt an attitude that supports your ability to see waste.
2. Waste is hard enough to find when you want to find it; if your response to find it is denial or resistance
3. It is very important that you understand that one purpose of discovering waste is to take the frustration out of your work.
4. “That is not my job.” Is a good say that shows necessary attitude.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-3	The ten basic principles to eliminate MUDA

3.1.The ten basic principles to eliminate MUDA

- Throw out all of your fixed ideas about how to do things.
- Think of how the new method will work-not how it will not.
- Don't accept excuses. Totally deny the status quo.
- Don't seek perfection. A 50 percent implementation rate is fine as long as it is done on the spot.
- Correct mistakes the moment they are found.
- Don't spend a lot of money on improvements.
- Problems give you a chance to use your brain.
- Ask "Why?" at least five times until you find the ultimate cause.
- Ten people's ideas are better than one person'.
- Improvement knows no limit.

3.2. Lean manufacturing

The following are principles that constitute lean manufacturing. Due to the practicality and applicability of these concepts, most companies (even in office settings) try to replicate them. To help you gain a comprehensive understanding of lean manufacturing, here are 10 things you should know:

- **Leveled Production**

Leveled production is simply smoothing out the quantity or type of production over a period of time. In Japanese, it's known as "heijunka." The idea of leveling is to optimize manufacturing capacity, allowing production that meets demands while at the same time avoiding inventory accumulation. It helps maintain minimum production lead time, manpower, capital costs, and inventories.

- Continuous Improvement

Known as “kaizen” in Japanese, continuous improvement goes hand in hand with documenting procedures. Managers and employees work together to achieve regular, incremental improvements within processes, diligently documenting each change to achieve best practices. The ultimate goal of kaizen is to build a company culture that promotes proactive employees who are always looking to improve inefficiencies. Learn more about kaizen.

- Efficiency through a Customer-First Approach

Finding efficiency that helps cut waste, a manufacturer has to step into their customer’s shoes and learn about their needs and expectations. This way, the manufacturer can devise ways to cut out wastes such as slow transportation, overproduction, and defective products. Deeply understanding the customer’s needs not only improves customer service, but reduces waste and ultimately increases the product’s value.

- **Total Productive Maintenance (TPM)**

TPM is a management philosophy stressing the importance of equipment maintenance in the manufacturing process. The idea of the program is to eliminate any loses tied to maintenance of equipment, keeping the process flawless without any unplanned downtime. Training, safety, and office efficiency all have a role in TPM. Employee participation in improvement proposals and maintenance is critical, as multidisciplinary teams work together to improve machine reliability. Learn more about the 7 pillars of TPM.

- **Streamlining Processes**

One main idea in lean manufacturing is creating a streamlined process, and this means delivering products on time. This does not only entail the end product, but also includes raw materials from vendors. Keeping the sales, production, and engineering departments in fluid communication is fundamental for streamlining. They must be in sync to spot buying trends, choose reliable vendors, and determine forecasts.

- **Develop Error-Proof Processes**

Poka-yoke in Japanese means “mistake-proofing.” This principle stresses error-proof processes, which should be developed to prevent unintended errors. The goal is to immediately reveal any errors so they can be addressed quickly. By doing this, workers are able to focus their energy on other important factors, rather than back-tracking to fix mistakes. Error-proof processes come in many forms, from double-checking work quality to inventing mechanisms that activate in the event of an error. Learn more about poka-yoke.

- **Focus on Quality**

Lean manufacturing encourages its adherents to focus on quality as they try to eliminate waste. Companies have to develop a system whereby quality is maintained, whether in the accounting process or the product itself. After all, the goal of lean is to deliver the maximum customer value in the shortest amount of time with the highest possible quality.

- **One-Piece Flow**

This principle is pretty simple. In a production line that has several workstations, one-piece flow means that one item is moved to a work station where any pending work is completed before it moves on to the next station. The idea is to ensure that the product spends as little time as possible at each station and travel time from one station to another is minimal. This process also increases quality assurance, as it is easier to trace product errors back to a single station. Here are7 advantages to the one-piece flow system.

- **Mapping the Value System**

Value Stream Mapping (VSM) creates a visual representation of all the steps in a process. It puts on display every element required, from start to finish. In manufacturing, it’s common to find one or two steps in the process that don’t create or add value. Mapping the value system involves finding these steps and eliminating them completely. Check out this article for a step-by-step guide.

- **Respect for Humanity**

To keep things working efficiently, a company has to have high respect standards for employees, and this means not overworking them, aligning the company's purpose with individual and team goals, and maintaining high accountability for both failure and success. If an organization wants to implement lean, they need support and participation from everyone in the company.

These 10 principles of lean manufacturing are all geared to eliminating waste and helping a company gain value while delivering quality. Big manufacturers such as Toyota have employed these principles for ages, promoting lean as a global trend. But these practices are not just for huge corporations, even small businesses can adopt the over-arching mindset of what it means to be lean.

Self-Check -3	Written Test

Say true or false

1. Levelled production is simply smoothing out the quantity or type of production over a period of time.
2. Value Stream Mapping (VSM) creates a visual representation of all the steps in a process.
3. In a production line that has several workstations, one-piece flow means that one item is moved to a work station where any pending work is completed before it moves on to the next station.
4. TPM is a management philosophy stressing the importance of equipment maintenance in the manufacturing process.
5. Lean manufacturing encourages its adherents to focus on quality as they try to eliminate waste.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information Sheet-4	Tools and techniques to eliminate wastes/Muda.

4.1 Tools and Techniques to eliminate Wastes/Muda.

- 5S
- Layout improvement
- Brainstorming
- Andon
- U-line
- In-lining
- Unification
- Multi-process handling & Multi-skilled operators
- A.B. control (Two point control)
- Cell production line
- Line balancing
- Build in quality at each process
- Etc.

- **5S (Five S):** Implementing 5S/workplace organization to eliminate Wastes/Muda.

4.2. Layout improvement: Is to plan the placement of machineries, raw materials, workers, etc. in order to produce raw materials, parts or products economically. When the layout of a shop floor is decided, it is necessary to plan considering production conditions and environmental conditions appropriately. Layout improvement is important technique to avoid ”Muda, Mura and Muri” due to placement in production activities.

- **Brainstorming**

Brainstorming can be defined as the methodology used to encourage every individual in the KPT to express freely their opinions or give ideas in an open discussion. Brainstorming can be used to list down all the problems faced by an organization, their causes and the potential effects if a certain suggestion is implemented. To ensure the

success of the brainstorming process, it is important for the KPT to follow the following rules:

I. The subject for brainstorming should be clear and accurate. For example, members may brainstorm to identify the causes and reasons why a certain task cannot be completed on schedule.

- Each member will give only one opinion / idea at each turn regardless of the number of ideas he / she may have.
- A tension-free atmosphere must be maintained to encourage free expression of ideas.
- Every idea expressed should be written on the black / white board, flip chart or noted down by a secretary.
- At the end of the brainstorming session, all the ideas expressed should be evaluated one by one and short-listed.
- Voting is used to list the ideas according to priority. The prioritization is based on the number of votes received for each idea.
- **Andon:** Is an indicator informing team leaders and supervisors of the current workshop situation with color boards, flash lights, and automated announcement.
  Types of Andon
  - ✓ Calling “Andon” -Used for requesting parts.
  - ✓ Warning “Andon” -Used to inform occurrence of irregularities on the lines.
  - ✓ Progress “Andon” -Used to identify the progress of operation on the lines with a short Take Time.
- **U-line:** Is a layout in which the inlet and outlet are positioned in the same direction to avoid walking back for a single operator.
- **In-lining:** Is a way to make the production lines simple and effective by integrating the parts processing into the main line in the unit production**.**
- **Unification:** Even if a flowing line cannot be formed, odd operations can be combined together in a place into an operator’s work.
- **Multi-process handling and Multi-skilled operators**

Multi-process handling- means that a single operator manages multiple machines and processes in product processing and assembling. This is the primary factor for constructing lines by a small number of operators. A multi-skilled Operator- can deal with several machines or processes as described above. The supervisor can make a flexible placement of operators when someone within the same team or section is absent.

- **A.B. control (Two point control):**Is a devised automatic control function. It controls the machine movement when they come to start or stop working depending upon the number of work pieces piled up between the preceding process and the following process.
- **Cell production line:** This is a production line that a single operator manages all the machining or assembly operations in unit production.
- **Advantages**
  - ✓ Quality assurance can be ensured.
  - ✓ The production output or efficiency of each operator can be clarified.
  - ✓ Operators can obtain a feeling of work achievement.
  - ✓ **Line balancing:** Refers to the state where there is a difference in time required for each process of a production line. It is determined that the line balance is good if this difference is small (usually smaller than 15%), but in a bad case the line balance should be improved by leveling out the work time through shortening that of a very time-consuming process and increasing loads of processes consuming less time.

  - ✓ **Build in quality at each process**
    - Quality should be built into each process.
    - Guarantee the quality in each process.
    - Do not make Defect
    - Do not pass defect
    - Work to standard
- The machine stops, if abnormality is caused.

- ✓ Worker stops operation, if he/she finds abnormality.
- ✓ Don’t send the next process the defects.
- ✓ Abnormality will understood simply.
- ✓ “Visual control” visually control the states, ANDON,
- ✓ Production analysis board, Standardized work chart etc.

- **Kanban System**

It’s a TOYOTA Production System manufacturing tool. Kanban is not inventory control system rather it is scheduling system.

In production it tells us:

- ✓ What to produce
- ✓ When to produce it
- ✓ How much to produce

Kanban prevents over production and it is used to give instruction for production and conveyance in every process.

Self-Check -4	Written Test

I. Say true or false

1. Layout improvement is to plan the placement of machineries, raw materials, workers.
2. Kanban is not inventory control system rather it is scheduling system.
3. Line balancing refers to the state where there is a difference in time required for each process of a production line.
4. Cell production line is a production line that a single operator manages all the machining or assembly operations in unit production.
5. Andon Is an indicator informing team leaders and supervisors of the current workshop situation with color boards, flash lights, and automated announcement.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-5	Reducing and eliminating Wastes/MUDA

5.1 Reducing and eliminating Wastes/MUDA

The elimination of waste is the primary goal of any lean system. In effect, lean declares war on waste – any waste. Waste or muda is anything that does not have value or does not add value. Waste is something the customer will not pay for. When the great Italian sculptor Michel Angelo was asked what he was sculpting, he responded he was not sculpting but releasing the figure (value) inside by removing the unnecessary rocks (wastes). Like Michelangelo, we should eliminate all forms of wastes in any process or product until only what is valuable remains. The key is to spot waste and then stop waste.

There are two types of wastes: obvious wastes and hidden wastes. It is important to uncover and eliminate the latter since they are usually bigger. Wastes take the shape of an iceberg, the tip consists of the obvious wastes while the seen bulk under the water contain the hidden wastes. Wastes are not necessarily ugly, and most are outside the waste can! Waste can be in the form of unnecessary output, input, or processing. It can be in the form of materials, stocks, equipment, facilities, man-hours, utilities, documents, expenses, motion, and other activities that do not add value.

The steps to effective waste elimination are:

- Make waste visible.
- be conscious of the waste.
- be accountable for the waste.
- Measure the waste.
- Eliminate or reduce the waste

When anything – people, equipment, supplies, tools, documents, or materials – is moved or transported unnecessarily from one location to another, transport waste is generated. Examples are transporting the wrong parts, sending materials to the wrong location or at the wrong time, transporting defects, and sending documents that should

not be sent at all. One way to cut transport waste is co-location, wherein customers are served by nearby suppliers, usually less than one-hour driving distance away. Departments working with each other or serving each other are also put near each other to cut transport waste. For example, materials and tools departments may be moved, relocated, or pre-positioned beside or nearer the user departments or their internal customers.

- **Over-production waste**

Definition

- ✓ producing more than what is needed
- ✓ producing faster than what is needed
- ✓ Causes
- ✓ volume incentives (sales, pay, purchasing)
- ✓ high capacity equipment
- ✓ line imbalance; poor scheduling/shifting
- ✓ poor production planning
- ✓ cost accounting practices that encourage build up of inventory

Over-production waste occurs when more goods are produced than can be sold, resulting in idle finished goods inventory. Over-produced goods are often hidden wastes since many think they are assets with value, when in fact most of them may be obsolete or costing the company unnecessary expenses just to keep them until they can be sold if ever. The just-in-time, pull system, and kanban rules prevent over-production wastes. Also, lean systems favor smaller equipment over large ones to avoid overproduction due to high but unnecessary capacity utilization.

- **Processing waste**

  Definition

  - ✓ non-value added man processing
  - ✓ non-value added machine processing
  - ✓ Causes
  - ✓ unclear customer specifications

- ✓ frequent engineering changes
- ✓ excessive quality (refinements)
- ✓ inadequate value analysis/value engineering
- ✓ unclear work instructions

Processing waste comes from unnecessary processing that does not add value to the item being produced or worked on. Examples are additional steps that do not enhance quality or steps that simply adds excess quality which customers do not require. Unnecessary documentation is also a form of processing waste. Identify value-adding and non-value adding activities in the process using techniques such as value stream analysis and the waterfall diagram.

- **Transport waste**

Definition

- ✓ unnecessary material movement
- ✓ unnecessary tools or equipment movement
- ✓ Causes
- ✓ poor route planning
- ✓ distant suppliers
- ✓ complex material flows
- ✓ poor layout
- ✓ disorganized workplace
- ✓ line imbalance

When anything – people, equipment, supplies, tools, documents, or materials – is moved or transported unnecessarily from one location to another, transport waste is generated. Examples are transporting the wrong parts, sending materials to the wrong location or at the wrong time, transporting defects, and sending documents that should not be sent at all. One way to cut transport waste is co-location, wherein customers are served by nearby suppliers, usually less than one-hour driving distance away. Departments working with each other or serving each other are also put near each other to cut transport waste. For example, materials and tools departments may be moved,

relocated, or pre-positioned beside or nearer the user departments or their internal customers.

- **Waiting time waste**

Definition

- ✓ man idle or waiting time
- ✓ machine idle or waiting time
- ✓ Causes
- ✓ unsynchronized processes; line imbalance
- ✓ inflexible work force
- ✓ over-staffing
- ✓ unscheduled machine downtime
- ✓ long set-up
- ✓ material shortage or delay
- ✓ manpower shortage or delay

When resources like people and equipment are forced to wait unnecessarily because of delays in the arrival or availability of other resources including information, there is waiting time waste.

Waiting for late attendees in a meeting, waiting for tools to start work, waiting for a signature for a process to continue, waiting for a late vehicle to transport workers to a project site are examples of this waste.

- **Inventory Waste**

Definition

- ✓ excessive process (WIP) inventories
- ✓ excessive raw material inventories and supplies
- ✓ Causes
- ✓ over-production

- ✓ imbalanced line

- ✓ big batch sizes
- ✓ long lead times
- ✓ local optimization (turf mentality)
- ✓ large minimum order quantities
- ✓ high rework rate
- ✓ JIT-incapable suppliers
- ✓ lack of material requisition and issuance standards

Inventory wastes come from the purchasing, issuance, storage of excess or excessive supplies, materials, and other resources. This waste can also be caused by overproduction as excess materials and work-in-process are accumulated. Inventory waste is often due to lack of planning and failure to match purchases with the actual consumption or usage rate of a particular resource. Another example is the storing of slow-moving and obsolete stocks like tools and materials.

- **Motion Waste**

Definition

- ✓ unnecessary movement and motions of worker
- ✓ Causes
- ✓ poor lay-out and housekeeping
- ✓ disorganized work place and storage locations
- ✓ unclear, non-standardized work instructions
- ✓ unclear process and materials flow

Motion waste happens when unnecessary body movements are made when performing a task. Examples are searching, reaching, walking, bending, lifting, and other unnecessary bodily movements. Workers commit this form of waste by searching for tools or documents when their workplace is cluttered or disorganized. Motion waste often delays the start of work and disrupts workflow.

- **Defects**

Definition

- ✓ processing due to the production of defects
- ✓ processing due to rework or repair of defects
- ✓ materials used due to defect and rework
- ✓ Causes
- ✓ unclear customer specifications
- ✓ incapable processes
- ✓ lack of process control
- ✓ unskilled personnel
- ✓ departmental rather than total quality
- ✓ incapable suppliers

Quality is doing the right thing right the first time. It is about prevention and planning, not correction and inspection. Bad quality or defects do not only result in customer dissatisfaction and damage to company image, but also in wastes due to additional costs and time to recall, rework, repair, and replace the defective items. Continuous quality improvement and preventive measures are the most effective means to cut defect wastes.

Self-Check -5	Written Test

I. Matching column “A” with column “B”

“A”	“B”
1. Waiting time waste	A. unnecessary material movement
2. Transport waste	B. delays in the arrival or availability
3. Over-production waste	C. Come from the purchasing, issuance, storage of excess or excessive supplies, materials, and other resources.
4. Inventory waste	D. happens when unnecessary body movements are made when performing a task
4.Motion waste	E. producing more than what is needed

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-6	Reporting Improvements

1.1. Process effectiveness and efficiency

- Improve effectiveness –the degree to which something is successful in producing desired results; with better decisions.
- Improve efficiency – by designing a better process to give more output with the same inputs; E.g. If were able to meet our daily production with less energy and fewer operator. A desired result is achieved more efficiently and effectively when related resources and activities are managed as a process.

- Benefits of using Reports

  Organizations and Process Improvement Teams use Reports to:

  - ✓ Provide a logical thinking process
  - ✓ Clearly present known information objectively
  - ✓ Focus on and share critical information
  - ✓ Align efforts with strategy/objectives
  - ✓ Provide a consistent approach throughout the organization
  - ✓ Provide a powerful problem-solving process

- How to Create a Report

Following are the steps to take when creating a Report:

- ✓ Identify the problem or need.
- ✓ Understand the current situation/state.
- ✓ Develop the goal statement or target state.
- ✓ Perform root cause analysis.
- ✓ Brainstorm/determine countermeasures.
- ✓ Create a countermeasures implementation plan.
- ✓ Check results and confirm the effect.
- ✓ Update standard work.

1.2. Kaizen Effect Evaluation Sheet

Name of the process:

Workplace: _____

Problem Solving Title: _____

Part one –Quantitative Results

S.No	Improvement Indicators	Before Kaizen	Target	After Kaizen	Improvement (%)	Remark
1	**Muda Elimination Indicators**					
	1.1 Tools& Equipment					
	1.2 Parts Saving					
	1.3 Raw Material saving					
	1.4 Transportation					
	1.5 Motion in Meter					
	1.6 Transaction Time					
	1.7 Excess Stock/Inventory					
	1.8 Expired material/Stock)					
2	**Productivity indicators**					
	2.1 Lead time					
	2.2 Machine down time					
	2.3 Frequency of Machine failure					
	2.4 Production volume per day					
	2.5 Labor saving					

	2.6 labour productivity)					
	2.7 Delivery Time					
3	**Quality Indicators**					
	3.1 Defect rate					
	3.2 Raw Material damage in %					
	3.3 Number of Customer complaints					
4	**Other Indicators**					
	4.1 Number of New inventions					
	4.2 Minimized Cost of Production					

Part Two –Qualitative Results

1. Describe the Qualitative results and change that are achieved by Muda Elimination/Reduction based on the indicators listed below

S.No	Improvement Indicators	Description of the Result
1	Muda Elimination capacity of workers	
2	New inventions and Improvements by workers	
3	Motivation of workers	
4	Awareness about Safety	
5	Corporate culture of kaizen	
6	Team work	

7	Transaction Time	

Name of Worker: _____

Signature: _____

Date _____

Name of Leader: _____

Signature _____

Date _____

Self-Check -6	Written Test

I. Say true or false

1. Organizations and process improvement teams use reports to provide a logical thinking process.
2. A desired result is achieved more efficiently and effectively when related resources and activities are managed as a process.
3. Identify the problem or need is the first step to create report.
4. Organizations and Process Improvement Teams use Reports to focus on and share critical information

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

List of Reference Materials

- Reference Book: Identifying Waste on the Shop floor (1996).
- Ethiopian Kaizen Manual (2002)
- Journals/publications/magazines

Solar PV System Installation and Maintenance

Level-III

Learning Guide -04

Unit of Competence	**Prevent and Eliminate MUDA**
Module Title	**Preventing and Eliminating MUDA**
LG Code	**EIS PIM3 M01 LO4 LG-04**
TTLM Code	**EIS PIM3 TTLM 0920v1**

LO4:-Prevent occurrence of wastes/MUDA

Instruction Sheet	Learning Guide:-01

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics

- Preparing and implementing prevention plan of MUDA.
- Discussing and preparing standards for
  - ✓ Machines
  - ✓ Operations
  - ✓ Defining normal and abnormal conditions.
  - ✓ Clerical procedures and procurement.
- Visual and auditory control methods.
- Using 5W and 1H sheet for waste-free workplace
- Doing completion of required operation.
- Updating of standard procedures and practices.
- Ensuring capability of the work team

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, upon completion of this Learning Guide, **you will be able to:-**

- Prepare and implement prevention plan of MUDA.
- Discuss and prepare standards for
  - ✓ Machines
  - ✓ Operations
  - ✓ Defining normal and abnormal conditions.
  - ✓ Clerical procedures and procurement.
- Visual and auditory control methods.
- Use 5W and 1H sheet for waste-free workplace
- Do completion of required operation.
- Update of standard procedures and practices.
- Ensure capability of the work team

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the information Sheets 1,
4. Accomplish the Self-checks

Information sheet-1	Preparing and implementing prevention plan of MUDA

1.1. Introduction

Why waste management plans?

Waste management plans have a key role to play in achieving sustainable waste management. Their main purpose is to give an outline of waste streams and treatment options. More specifically they aim to provide a planning framework for the following:

- Compliance with waste policy and target achievement: Waste management plans, national as well as local/regional are important instruments contributing to implementation and achievement of policies and targets set up in the field of waste management at the national and the European Union level.
- Outline of waste characteristics and sufficient capacity for managing waste: Waste management plans give an outline of waste streams and quantities to be managed. Furthermore, they contribute to ensuring the capacity and the nature of collection and treatment systems are in line with the waste to be managed.
- Control of technological measures: An outline of waste ensures identification of areas in which technological measures should be taken to eliminate or minimize certain types of waste.
- Outline of economy and investment requirements: Waste management plans make way for a statement of financial requirements for the operation of collection schemes, treatment of waste etc. On this basis, the needs for future investments in waste treatment plans may be determined.

As the solution to many waste management problems requires the involvement of several participants/authorities, coherent planning helps to avoid unnecessary duplication of effort and thus benefits all participants in their work together.

The increasing complexity of waste issues and the standards set by EU directives entail increased requirements in terms of the suitability of treatment plants. In many cases, this means larger and more complex plants for waste treatment, which involves the co-operation of several regional units on the establishment and operation of the plants. In

order to enjoy the benefits of large-scale operation covering a larger region, the service is often provided by either inter municipal units or by private enterprises. This makes sense, especially for waste streams or waste treatment methods requiring expensive large-scale equipment, e.g. incineration plants. There is no rigid pattern for how to structure a waste management plan or strategy. However, it may be expedient to structure the plan with a status part and a planning part as the key elements of the plan. The Waste Framework Directive sets up a number of requirements for a waste management plan. A national waste management plan will often be of a strategic nature, though often with certain objectives, whereas regional or local plans will be more action-oriented - operational plans with detailed descriptions of current collection systems, treatment plants etc. National waste management strategies/plans or regional/local waste management plans, however, may contain more extensive measures depending on national legislation and the waste policy applying regionally or locally.

1.2. Elements in a waste management plan

Background

- Overall waste problematic
- EU legislation
- National legislation
- Description of national waste policy and prevailing principles
- Description of objectives set up in specific areas
- Inputs from the consultation process

Status part

- Waste amounts, e.g.
- Waste streams
- Waste sources
- Waste management options
- Waste collection and treatment
- Economy and financing

- Assessment of previous objectives
- Planning **part**
  - ✓ Assumptions for planning
  - ✓ Determination of objectives, e.g. for
    - ➢ Waste streams
    - ➢ Waste sources
    - ➢ Waste management options

- Plan of action, including measures for achieving objectives
  - ✓ Collection systems
  - ✓ Waste management facilities
  - ✓ Responsibilities
  - ✓ Economy and financing

- **Planning process and public consultation**

The waste management planning process runs in cycles, i.e. in principle it is a continuous process, where the plan or strategy is revised at regular intervals. The process may be broken down in six phases: general considerations, status part, planning part, consultation process, implementation and plan revision. The planning process is presented in Figure 1.1.

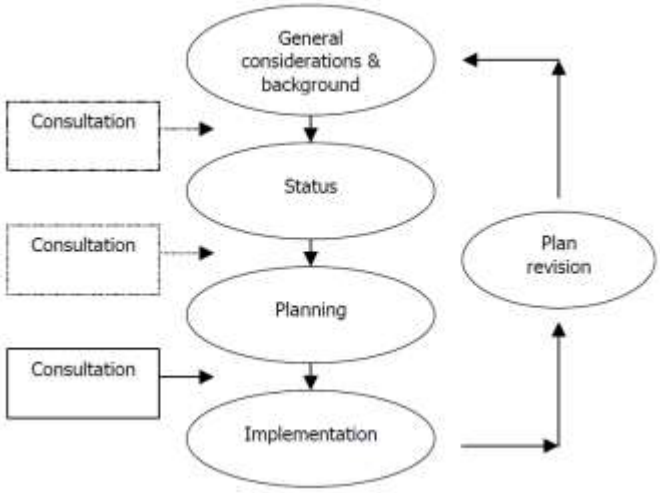


Figure 1.1 planning process

- **General considerations and background**

As a starting point, the initiative is taken to draw up a waste management plan, and all assumptions are gathered. In this phase the planning period is determined, and any other boundaries of the planning scope are clarified. An important issue here is public participation, who should be involved in the planning process and how? Time schedules and work plans for preparing the plan are set up. Moreover, the relationship with other plans, such as spatial and energy planning is considered.

- **Status**

In this phase all data and information on the current situation in the waste management field are gathered and analyzed. Then the current waste management system is evaluated, i.e. problems relating to the current system are identified and also the possible solutions to these problems. Questions to be answered in this phase are: does the current system comply with the objectives that are set and may be expected in the future and if not, how can the system be improved?

- **Planning**

The planning part is prepared on the basis of requirements in national legislation, the status part and relevant assumptions for projecting future developments. A central element is determination of political objectives, e.g. for priority waste streams or waste treatment, and to develop indicators to monitor if the objectives are met. Another central element is to evaluate how these objectives may be met most effectively. For this purpose the choice of measures and instruments for the implementation of the plan or strategy is relevant.

- **Consultation process**

The public should be involved in the determination of the future waste management system and a consultation phase must be included in the planning process before adopting the final waste management plan and its initiatives. Public consultations may take place at various stages in the planning process. Thus, it may take place as a kick-off meeting before the status part, allowing the competent authority to receive ideas and

inputs from selected stakeholders or the general public. Alternatively, consultations may be placed just before the planning part when the problems and possible solutions have been identified.

However, in the preparation of a national waste management plan the public in practice is often involved in a consultation round when the first draft of the plan is available. The consultation round may be very limited – the draft plan is sent for written comments to selected stakeholders (political parties, industrial organizations in the waste management sector, consumer and environmental organizations, NGOs etc.). The preparation of a regional/local waste management plan often includes a more extensive consultation phase, for example with public meetings, distribution of information pamphlets and information about the plan on the Internet.

- **Implementation**

After the adoption of the waste management plan, its orientations are put into practice either via legislation and regulation, negotiations with the industry, or information to the general public. The implementation of the waste management plan/strategy is not dealt with in further detail in these guidelines.

- **Plan revision**

Well ahead of the expiry of the planning period covered, initiatives are taken to revise the plan. At the start of a new planning period the process set out in Figure 1.1 is repeated. Initially, all assumptions are gathered, and the results of the previous plan are analyzed in detail during the conduct of a new status report. Special questions of interest include: which objectives have been met? Which activities were not implemented or did not have the desired effect? and, did any of the initiatives have an unexpected impact on other sectors?

Self-Check -1	Written Test

I. Say true or false

1. Waste management plans have a key role to play in achieving sustainable waste management.
2. Public consultations may take place at various stages in the planning process.
3. The planning part is prepared on the basis of requirements in national legislation, the status part and relevant assumptions for projecting future developments.
4. Waste management plans give an outline of waste streams and quantities to be managed.
5. Waste management plans make way for a statement of financial requirements for the operation of collection schemes, treatment of waste

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-2	Discussing and preparing standards

2.1. Introduction

We have discussed how you discover waste and what to do to remove it; but it doesn't end there. Unfortunately, problems always crop up, and we prevent them from becoming sources of waste we will be right back where we started in no time at all. That is one reason why one of the very first things mentioned about discovering waste adopting the right attitude. If everyone is paying attention to keeping waste from taking hold, then you have a good chance of sustaining production flow. There are four important methods you can use for maintaining a waste-free production environment:

- Standardization
- Visual controls
- Auditory controls
- 5W and 1H Sheet

2.2. Standardization

The primary purpose of standardization is to create and sustain a waste-free process. Standardization means establishing standard procedures for every operation so that anyone can understand and use them – and everyone does. There are many aspects to standardization. Standards must be created, documented, well-communicated, adhered to, and regularly re-assessed. Standards are required for:

- Machines
- Operations
- Defining normal and abnormal conditions
- Clerical procedures
- Procurement

Machines:

Type A standards: Fundamental safety standards which contain basic concepts, principles of design, and general aspects applicable to all machinery.

- **Type b standards:** Group safety standards, each of which focuses on a specific subject applicable to a Range of machinery type."B1 standards" cover a specific safety aspect defined in the fundamental standards. "B2 standards" cover the requirement of specific safety related devices such as two-hand controls, interlocking devices, movable guards , etc...
- **Type c standards:** specific machine safety standards, each of which define protective measures required for hazardous areas of a specific machine or group of machines .
- **Operations:**

A **standard operating** procedure (SOP) Is a set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations**.** SOPs aim to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply with industry regulations.

2.3. Defining normal and abnormal conditions:

The normal condition is that the temperature and pressure are as per the standard reaction conditions; if the temperature and pressure (or one of them) increase (or decrease), then the condition is abnormal.

- **Clerical procedure:**

Clerical work generally involves day-to-day office tasks, such as answering phones and entering data into spread sheets other duties traditionally associated with clerical work include: word processing and typing, sorting and filing, photocopying and collating.

- **Procurement:** is the process of finding and agreeing to terms, and acquiring goods, services, or works from an external source, often via a tendering or competitive bidding process. Procurement generally involves making buying decisions under conditions of scarcity.

Self-Check -2	Written Test

II. Say true or false

1. The primary purpose of standardization is to create and sustain a waste-free process.
2. Procurement is the process of finding and agreeing to terms, and acquiring goods, services, or works from an external source, often via a tendering or competitive bidding process.
3. Clerical work generally involves day-to-day office tasks, such as answering phones and entering data into spreadsheets ....other duties
4. If the temperature and pressure (or one of them) increase (or decrease), then the condition is abnormal.
5. A standard operating procedure (SOP) is a set of step-by-step instructions compiled by an organization to help workers carry out complex routine operations.

Note: Satisfactory rating – 3 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-3	Visual and auditory control methods.

3.1 Visual and auditory control methods

One way waste enters into operations is when standards are not improved to meet changing conditions. Even standardization fails to sustain waste-free production if not systematically updated to take advantage of new materials, new technology, and worker improvement ideas. If the slightest defect occurs, the standard must be reconsidered.

The factory is a living thing and must constantly be adjusted to stay responsive to changes in the environment. Responsiveness must be systematic so that problems are addressed without losing the solid foundation of the waste-removing methods already established. The best way to do this is through visual and auditory controls.

Red-tagging – You probably did this at the beginning of your improvement activities when you implemented 5S. If not, do it now: put a red tag on everything in the factory that is not necessary to the current operations of the production process. After everyone has had time to notice red-tagged items and claim any that are needed in their area, remove the remaining red-tagged items from the environment. Management can decide what to do with them: they can be sold, thrown out, or moved to a location where they are needed. Always keep the production floor free of any thing that is not directly part of the production process.

Signboards- The purpose of workstations and the names of the workers who operate them should be displayed at every processing point. Signboards can also identify equipment and processes so that everyone knows what things are and what they are used for. Standard quantities should be included on supply bins or carts. The products produced on each line or in each cell can be displayed, and so on. Outlining- Boarders around tools and equipment, big and small, help people find and return things. Outlining can also create patterns of work-flow by using the floor to indicate where and where not to place things, where to walk, safety zones and danger zones. Outlining to indicate goods to be processed or parts that have been processed becomes a signal to material handlers for replenishing or for delivery to the next process. And ons - Different colored lights can report the status and needs of a system and signal when defects or abnormal

conditions occur so that problems can be solved immediately. Kanban- These little signs accompany work-in-process. They are the flexible production instructions or work orders that trigger materials supply and production in a pull system, the hallmark of lean manufacturing. Pitch and Inspection Buzzers- These indicate when operations get out of sync with demand or when defects are around. They keep awareness focused on solving problems and keep waste from taking root.

Self-Check -3	Written Test

I. Say true or false

1. One way waste enters into operations is when standards are not improved to meet changing conditions.
2. Pitch and Inspection Buzzers indicate when operations get out of sync with demand or when defects are around.
3. Signboards can also identify equipment and processes so that everyone knows what things are and what they are used for.
4. Put a red tag on everything in the factory that is not necessary to the current operations of the production process.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-4	Using 5W and 1H sheet for waste-free workplace

4.1 The 5W and 1H Sheet

The 5W and 1H (five “whys” and one “how”) is a powerful method and one that never stops being wasteful in sustaining a waste-free production environment. The 5W and 1H sheet is a tool that will help you systematically apply this method. Figure 1 shows one sheet filled out.(Use the side columns when multiple questions or answers arise at any step of solving a single problem). Figure 2 shows an example of an improvement idea that resulted from the use of the 5W1H Sheet in figure

Figure 1.2planning process

Five Key Concepts for Asking “Why” and “How”

Following these principles suggested by Hiroyuki Hirano when you are asking the 5”whys” and 1”how”:

- Look with the eyes of a child- All improvement begins with the first why. Never cease looking and never cease asking that first why. As you practice this, the result will follow.

- Remember three essentials for fact finding- (1) Go to where the problem occurred.(2) See the problem first-hand. (3) Confirm the facts based on your own observations.
- Be a walker and an observer- Supervisors and managers must continually work through the factory to see that standards are being followed and to practice seeing waste. Operators need to continually examine their own operations to stay alert for new problems and new ideas for solving them that may come to mind as they do their jobs.
- Break down fixed thinking- If you ask “why” and “how” often enough you will eventually run out of “known” answers. At this point you may reach internal mental resistance to the discovery of what you don’t know. Get in the habit of asking why and how beyond this point of fixed thinking. That is when you will make the big discoveries about waste and how to solve it.
- **Do it now- Don’t w**ait. Put your ideas into practice immediately!

Self-Check -4	Written Test

I. Say True or False

1. The 5W and 1H (five “whys” and one “how”) is a powerful method and one that never stops being wasteful in sustaining a waste-free production environment.
2. Supervisors and managers must continually work through the factory to see that standards are being followed and to practice seeing waste.
3. All improvement begins with the first why.
4. The 5W and 1H sheet is a tool that will help you systematically apply this method.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet-5	Doing completion of required operation

5.1 Introduction

For proper completion of required operation, it is quite important to ensure that the maintenance schedule is followed and that the maintenance checklists are filled in properly.

5.2 Completing Forms

When completing the required operation forms:

- Keep to the schedule agreed with the SOP;
- Always note down date, time and weather conditions;
- Required operation changes due to these factors so the conditions are needed to interpret the results;
- Take photos of any areas of concern;
- Report the physical condition of the operation.

Self-Check -5	Written Test

I. Say true or false

1. When completing the required operation forms sake photos of any areas of concern
2. For proper completion of required operation, it is quite important to ensure that the maintenance schedule is followed.

Information sheet-6	Updating of standard procedures and practices

6.1. Introduction

SOPs should be reviewed by all staff, department supervisors and the director at least once each year, and suggestions from staff should always be considered for changes of process. The consequences of not having SOPs in good working order are far more serious than the inconvenience of keeping them updated.

Updating of standard procedures and practices

Development of SOPs and keeping them up to date and used must be a priority of **a**n agency. To go through this process to say" yes, we have them" is a waste of time.

- Agencies that are most successful with following SOPs have made it someone's main task to**:**
- Keep the SOPs current,
- Ensure training is taking place based on the SOPs, and
- Prevent SOPs from falling to the bottom of the priority

Many agencies are understaffed, and yours may be one of them. If you are thinking you can't devote staff time to SOPs, think again about all of the aspects of your operation that will run more smoothly, more safely, and more reliably when everyone follows a good set of SOPs. SOPs are the core of your entire operation, and therefore critical to the internal and external success of your program.

Self-Check -6	Written Test

I. Say true or false

1. SOPs should be reviewed by all staff, department supervisors and the director at least once each year, and suggestions from staff should always be considered for changes of process.
2. SOPs are the core of your entire operation, and therefore critical to the internal and external success of your program.
3. The consequences of not having SOPs in good working order are far more serious than the inconvenience of keeping them updated.
4. Development of SOPs and keeping them up to date and used must be a priority of **a**n agency.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

Information sheet 7	Ensuring capability of the work team

7.1. Team capability

Collaboration is a key aspect of team capability. Unlike individual performance where the focus is only on your own work load, working as a key member of a team requires the will to understand what your colleagues offer, and then to adapt, support, challenge, plug gaps and keep a strong focus on what needs to be achieved. It may mean doing something not in your skill set or defined role to ensure the team delivers- that's why flexibility is key. To build and maintain this kind of responsiveness within the team, each member needs to be prepared to step outside rigid role parameters to support the collective accountability of the team. They also need to be working towards common goals and objective. clarity of purpose can be evaluated by observing discussions and decisions about, tasks , priorities, timelines and resources in order to meet those goals. Too often the purpose is poorly defined and the team struggles endlessly to balance priorities. But that is not all. High performing teams understand their team capability but also the expectations of their stakeholders, their suppliers, their customers-the people they interact with. To truly grasp this, they need to see themselves through the eyes of colleagues. Once the team know how they are viewed by people they have key relationships with, they can judge whether to tweak their approach or processes, spend time developing relationships or introduce something new. So, in summary, to maximize their team capability, effective teams need shared commitment to common goals, a good understanding of each other's strengths and an even better understanding of how they are viewed by the people they serve or interact with.

Self-Check -7	Written Test

I. Say true or false

1. High performing teams understand their team capability but also the expectations of their stakeholders, their suppliers, their customers.
2. Collaboration is a key aspect of team capability.
3. Clarity of purpose can be evaluated by observing discussions and decisions about, tasks, priorities, timelines and resources in order to meet those goals.
4. Effective teams need shared commitment to common goals, a good understanding of each other's strengths and an even better understanding of how they are viewed by the people they serve or interact with.

Note: Satisfactory rating – 2 and above points Unsatisfactory - below 2 points

Score:_____

Rating:_____

List of Reference Materials

1. European Topic Centre on Waste and Material Flows May 2003