Ethiopian TVET-System

MEDICAL LABORATORY

Level -III

Based on Apr.2018G.C. Occupational Standard

Module Title:	**Preventing and Eliminating MUDA**
TTLM Code:	**HLT MLT3 TTLM 1019v1**

This module includes the following Learning Guides

LG30: Prepare for work

LG31: Identify MUDA.

LG32: Eliminate wastes/MUDA.

LG33: Prevent occurrence of wastes/MUDA.

Instruction Sheet	LG30: Prepare for work

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

- using Work instructions to determine job requirements
- Read and interpret Job specifications following working manual
- Observe ***OHS requirements***
- Selecting of appropriate material for work
- identify and check ***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 to determine job requirements, including method, material and equipment.
- Read and interpret Job specifications following working manual.
- Observe OHS requirements, including dust and fume collection, breathing apparatus and eye and ear personal protection needs throughout the work.
- Select appropriate material for work.
- Identify and check Safety equipment and tools for safe and effective operation.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4,---”**in page ---, ---, --- and ---** respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” ,---”**in page ---, ---, --- and ---** respectively
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ”**in page ---.**
6. Do the “LAP test” **in page – ---**

Information Sheet-1	using Work instructions to determine job requirements

1.1. Introduction to 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.

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

2. Work Instruction

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

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. 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

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is the meaning of job? (2 points)
2. List the requirements of job. (5 points)
3. What is the meaning of work? (2 points)
4. Describe work instruction in your own words. (5 points)
5. Explain the difference between procedure and work instruction? (5 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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.

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

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Define job specification? (3 points)
2. Prepare specification samples. (10 points

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____

   _____

   _____

2. _____

   _____

   _____

Information Sheet-3	Observe *OHS requirements*

3.1. Introduction to 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 include 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.
- **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.

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.

Physical and mechanical hazards

At-risk workers without appropriate safety equipment

- 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

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is OHS represents for (2 point)
2. What is OSH represents for? (1 point)
3. What does WHS represent for? (1 point)
4. What are the goals of OHS? (2 points)
5. List at least two examples of OHS requirements in your work areas. (10 points)
6. List at least four workplace hazards? (4 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-4	Tools and equipment preparation and selection for measuring and identification of Muda

Tools and Equipment used for Waste/Muda measurment and Identification

Tools and Equipment are required to identify and measure Waste/Muda in work stations. The following are some tools and equipment used to identify and measure Waste/Muda:

- Tape (any length measuring device)
- Stop watch
- Photo Camera
- Video Camera
- Calculator
- etc

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. List at least four tools and equipment used to identify and measure Muda. (12 points).

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Operation Sheet 1	Prepare tools and equipment for identification and measuring Muda.

1. Discuss and plan to prepare tools and equipment for Muda identification.
2. Prepare tools and equipment for Muda identification.

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LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1: Identify and prepare tools and equipment for measuring and identification of Muda

Instruction Sheet	LG31: Identify MUDA

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

- Preparing and implement Plan of MUDA identification.
- Causes and effects of MUDA
- Using of ***Tools and techniques*** to draw and analyze current situation of the work place.
- Identifying and measure Wastes/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.
- Discus Causes and effects of MUDA.
- Use Tools and techniques to draw and analyze current situation of the work place.
- 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 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4,---”**in page ---, ---, --- and ---** respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” ,---”**in page ---, ---, --- and ---** respectively
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ”**in page ---.**
6. Do the “LAP test” **in page – ---**

2.1. Targets of Customer

- Customer is the one who buys products/services from manufacturers/service providers. So the customer does not bother how the manufacturer/service provider makes it. Now a days customers have many alternative manufacturers/service providers to buy the same type of product/service from and choose one that fulfills their targets which are listed below:-
  - ✓ Customer needs better quality
  - ✓ On time delivery
  - ✓ Reasonable price

2.2. Targets of Manufacturer/Service provider

- The primary target of Manufacturers/Service providers is to earn profit. So as to meet his/her target, he/she needs to satisfy the targets of customers in such a way by providing better quality product/service on time and at a reasonable price. If he/she is able to do so, he can win customers' targets. Then to get higher profit the Manufacturer/Service provider needs to minimize his/her costs by reducing/eliminating wastes and following effective working procedures.

2.3. The concept of Cost

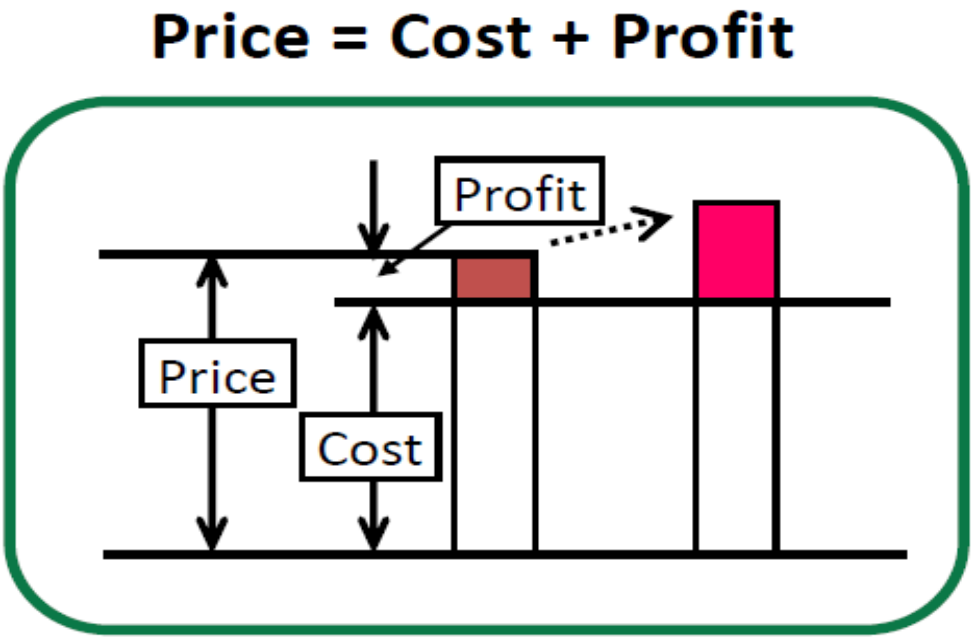
- **Cost :-** is the amount of money that is expended to accomplish a given task/operation.
- Cost can be of Manufacturing or Service Delivering cost=(material + labor + facility + utility + others)cost

  Determination of the sales price of the product/Service

  Sales price=(manufacturing or service delivery)cost + profit

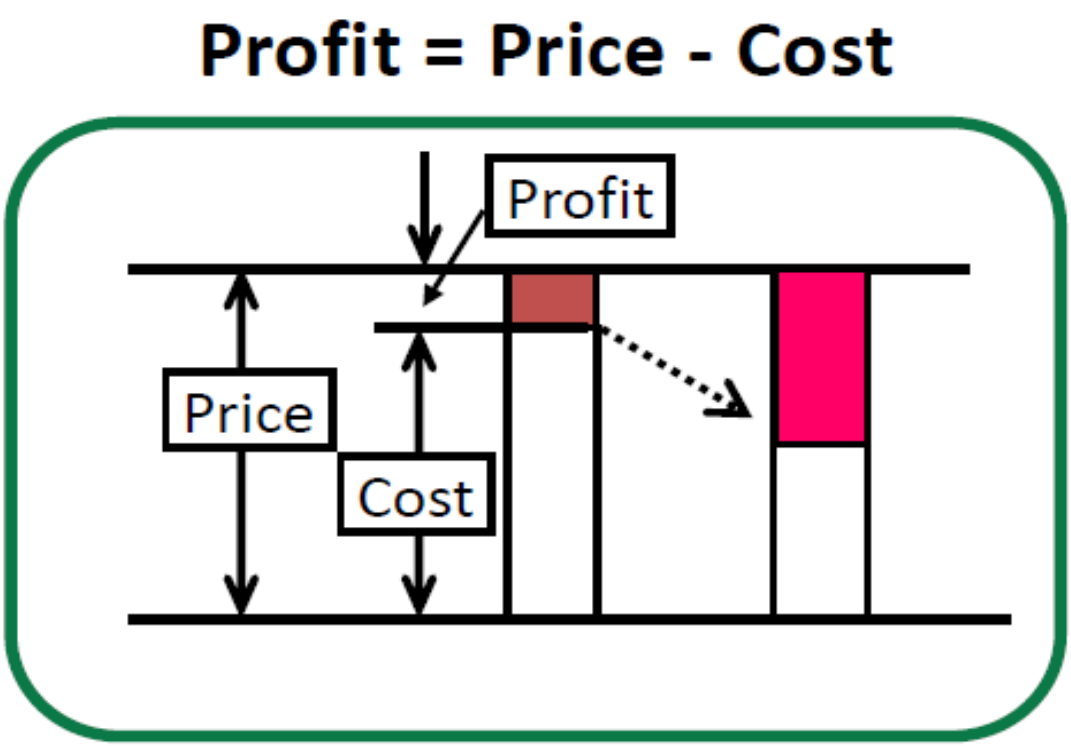
2.4. Traditional Thinking of Price Setting

- In traditional thinking of price setting, price is determined by the manufacturer/service provider rather than the market itself.
- When there is shortage of supply then the manufacturer raises selling price.



2.5. Kaizen Thinking of Price Setting

- In modern time, there are a large number of manufacturers/service providers delivering the same type of product/service offering the customers a great deal of options to buy products/services.Price is determined by the interaction between market demand and supply. Manufacturers/service providers ,who want to set selling price above the market price, customers will not be willing to buy their products/services. Manufacturers/Service providers to be competent in the market they should provide Quality product/service on time and at the market price.Since todays economy is market based, we should focus on minimizing our costs and not maximizing selling price to maximize our profit.



2.6. **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 prevous process and makes his/her own process.
- **External customer:-** is the customer that buys the final out put product/service of the enterprise.

2.7. The three Categories of Operation

1. Net Operation/Value Adding Operation
2. Non-Value Adding Operation
3. "Muda''

- **Net Operation/Value Adding Operation**

- Part of an operation that 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.

  ✓ Examples - Milling, Turning, Grinding, Assembling and Welding.
  - Printing/photocopying a document etc.

2. 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

(3)"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

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

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

No.	Activities	Time taken	Category of the operation	Action to be taken to	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	-	

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%)

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the targets of customers?(9 points)
2. What is the target of manufacturer/service provider? (3 points)
3. What is the difference between traditional and kaizen thinking on price setting, cost and profit? (3 points)
4. What is value? (2 points)
5. List out the three categories of operation. (3 points)
6. Define the three categories of operation. (6 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

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

2.2. 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
- Occurance of defects

2.3. 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 proces

2.4. 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

2.5. Causes of Muda of motion

- Isolated operations
- Low employee morale
- Poor work layout
- Lack of training
- Undeveloped skill

2.6. Effects of Muda of motion

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

2.7. Causes of Muda of Conveyance/Transportation

- Poor layout
- Shish-skilled workers
- Sitting to perform operations
- The need for conveyance systems is assumed

2.8. 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

2.9. Causes of Muda of Waiting/ Idle time

- Obstruction of flow
- Poor equipment layout
- Trouble at the upstream process
- Capacity imbalances
- Large Lot-production

2.10. Effects of Muda of Waiting/ Idle time

- Waste of manpower, time, & machines
- Increase in the in-process inventory
- Failed delivery dates
- Poor workflow continuity

2.11. Causes of Muda of Defect making

- Emphasis on downstream inspection
- No standard for inspection work
- Omission of standard operations
- Material handling and conveyance

2.12. 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

2.13. Causes of Muda of Processing

- Inadequate study of processes

- Inadequate study of operations
- Incomplete standardization
- Materials are not studied

2.14. 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 -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write at least two causes and effects of each type of the seven deadly wastes/Muda. (28 points)

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Using of *Tools and techniques* to draw and analyze current situation of the work place

3.1. 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.

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.

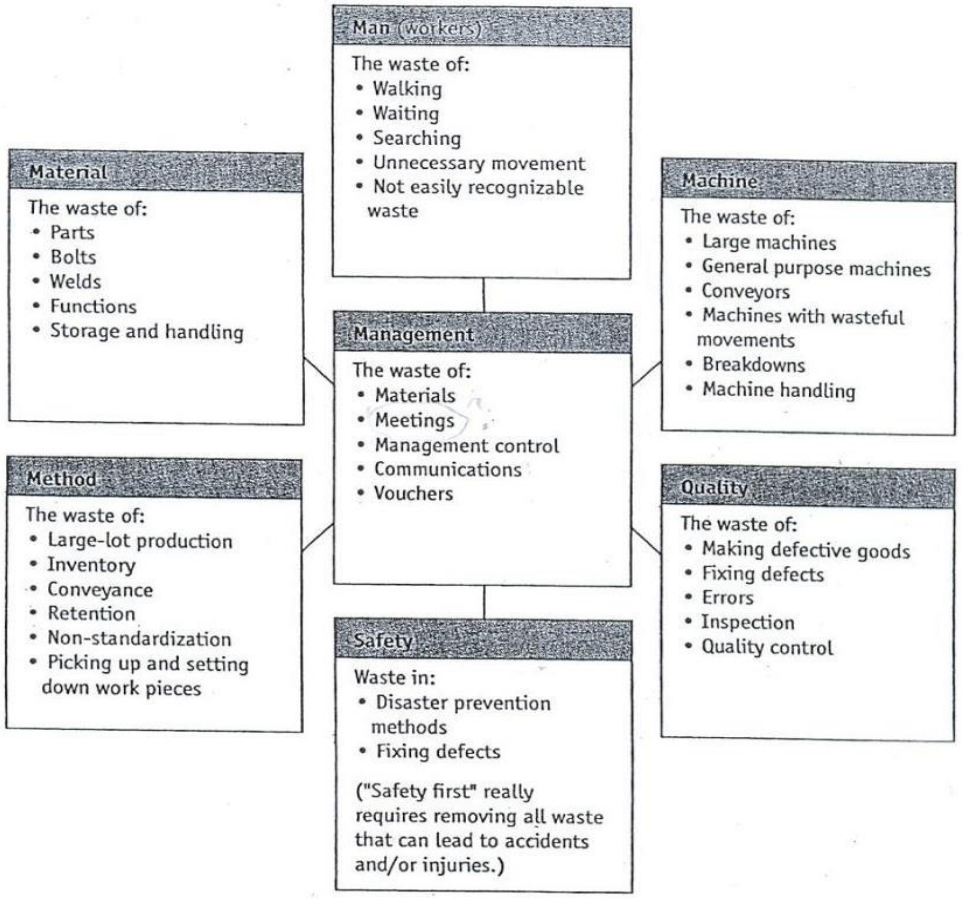


Figure 1-4. The 5M + Q + S Classification of Waste

- 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 ⇨ 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.Retension means stopping the flow of goods without adding any value to them.It is called stockpiling, warehousing,

- temporary storage, and so on. Retension 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.
- Retension 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 retension 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 retension point is often called “conveyance” and movement between a retension 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 fulfil 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 occuring.

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 istinict 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

- **Overproduction:-** To produce things more than necessary in terms of type, time, and volume. It is called “the worst kind of Muda” since it hides all the other wastes. **Inventory :-** The situation where items such as raw materials, work in process and finished goods are stagnant or which are not having value added to them. Some are located in the warehouses, and others are in-process inventory.
- **Motion :-** These are non-value adding movements or more than necessary movements of workers, equipment, and machines, such as looking for goods, bending, stretching, walking, lifting, reaching etc.
- **Conveyance/Transportation :-** It is Unnecessary transportation of parts between processes caused by unnecessary transportation distance, temporary storage, relocations or re-piling up. Transportation does not create any value added except for transportation companies. Transportation is usually difficult to be totally eliminated but reducing is possible.
- **Waiting/ Idle time:-** Refers to both human and machine waiting.

This includes all kinds of waste of time such as workers or parts waiting:

- ✓ -for an upstream process to deliver.
- ✓ -for a machine to finish processing.
- ✓ -for incoming parts or materials.
- ✓ -for process that has a long wait time.

- **Defect making:-** This includes defects, inspections for defects in-process, and claims, rescheduling, and resource loss.
- **Processing:-** This consists of processing and operations primarily unnecessary. It is processing beyond the standard required by the customer.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Describe the 3MU's and their relationships. (9 points)
2. What are the seven deadly wastes/Muda? (7 points)
3. Describe the seven deadly wastes/Muda? (7 points)
4. What are the focus areas of 5M + Q + S ? (7 points)
5. What are the four things going on during the flow of goods? (4 points)
6. Explain the four things going on during the flow of goods in relation to waste? (8 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

3.1 **Some of the benefits of identifying and eliminating waste To the company**

Benefits to the company include:

1. **Cutting the hidden costs of production**-It is estimated that 80 percent of production activities and associated costs are non-value-added, or waste.When factories begin to focus on identifying and eliminating waste, the impact on the bottom line is astronomical.

2. **Increased customer satisfaction-** Customer satisfaction rises as a direct result of implementing lean production. When waste is eliminated from production, deliveries occur on time and product quality goes up.

To Shopfloor workers

Benefits to individuals include:

1.*Increased job satisfaction*- No longer will you spend hours looking for missing tools, waiting for materials to arrive, walking around piles of inventory,lifting and setting down heavy parts or tools, working in unsafe conditions and all the other things you have to do that are not essential to your job. The frustrating non-value-added aspects of your job will disappear and what you are trained to do and enjoy doing will be the major part of how you spend your time.

2.*Contributing to improvement*- Your ideas about how to improve your job will be listened to and you will participate in taking the frustration out of the workplace. Part of your job will be to find root causes and to create solutions that last. You will not have to make short-term fixes or live with someonelse's short-term fixes that no longer solves the problems you face.

- There is no question that when production waste is rooted out everyone is happier. The flow of materials creates a hum in the workplace: a rhythm of the flow of materials from supplier to customer emerges as the value-added processes are freed up to operate at the rate of customer demand.

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:
    1. Make waste visible
    2. Be conscious of the waste
    3. Be accountable for the waste.
    4. Measure the waste.

1.Make waste visible

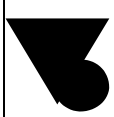
- Waste can be made visible in several ways such as:
    - ✓ Shop layout analysis
    - ✓ Process flow analysis
    - ✓ Take photos/video
    - ✓Etc

Shop layout analysis and Process flow analysis

- There are several tools you can use to analyze current conditions of shop layout and process flow quickly and effectively. We will describe some of them.

The Arrow Diagram

- The Arrow Diagram focuses on the flow of goods to discover waste.(Arrow diagrams have recently been renamed value stream maps.) We include here a simple method for creating an arrow diagram to get a good understanding of your production process and to see where the waste exists in your workplace.
- The factors to be identified in your arrow diagram are retention, conveyance, processing and inspection. There are specific symbols you use to indicate each of these aspects of a production process as indicated below

Analysis factors	Symbols	Description	Amount of waste
Retention		When the work-in-process flow is stopped (for other than conveyance, processing, or inspection)	Large
Conveyance		When the work-in-process is moved from one place to another	Large

Processing		When the work-in-process 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 showing symbols used in Arrow Diagram

There are four steps for creating your arrow diagram.

1. *Understand the purpose*-The purpose is to discover major forms of waste. The arrow diagram will help your improvement team "see" the waste.

2. *Select the product to be analysed*- You can do a product/quantity(PQ) analysis to compare products and quantity. Choose products with a large output and those with many production problems as starting points for your analysis of current conditions using the arrow diagram.

3. *Prepare a factory layout diagram*- Include the entire factory layout, indicating the position of machines, worktables and other equipment. Store the original in a safe place so that you can make a copy of it each time you want to analyze another product line.

4. *Make the arrow diagram*- Do this on the factory floor. Use the symbols below to show the different types of activities that occur. The map will make the waste more obvious to you and your team than when you are simply standing on the factory floor observing standard operations. Connect the symbols with lines that show the direction of the flow and the sequence of product through each operation. Create other symbols as you need to. At all conveyance points, note the conveyance distance and type of conveyance. At all retention points, note average work-in- process inventory.

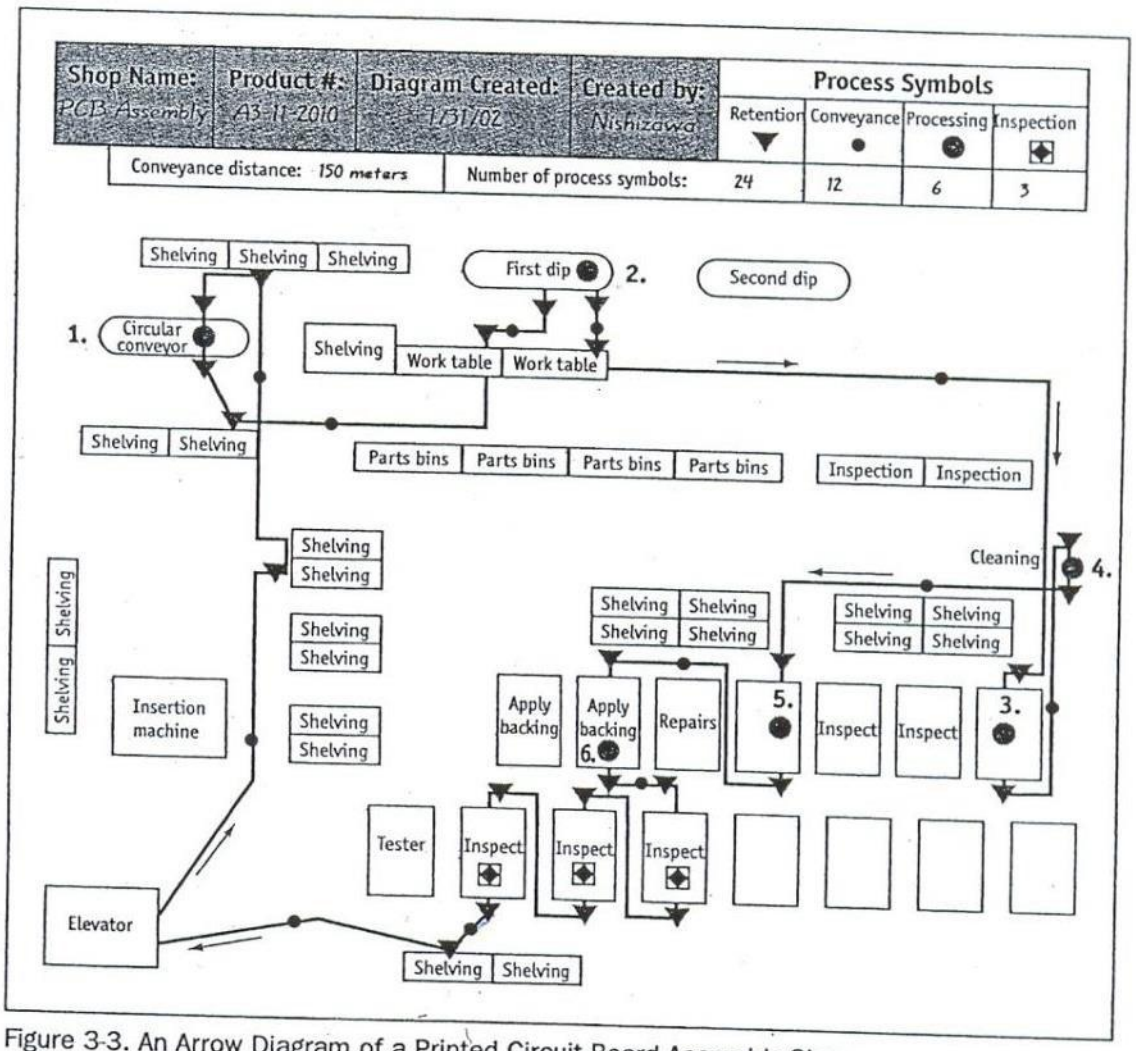


Figure 3-3. An Arrow Diagram of a Printed Circuit Board Assembly Shop

The Summary Chart of Flow Analysis

- Now that you have done an arrow diagram, write up a Summary Chart of Flow Analysis. Count the symbols you used on the arrow diagram to show totals for the number of retention and conveyance and inspection points. Also note the total amount of goods retained and the total conveyance distance. Keep track of changes after improvements are made using the same chart to compare.
- With these tools in hand, brainstorm improvement ideas. In brainstorming, you must let ideas flow freely. One unlikely suggestion may trigger a good idea. Select and further analyze good ideas. The arrow diagram and the flow analysis should not take you too long or keep you away from your observation of the factory floor. Draw the arrow diagram while watching the production of the product on the floor and use it to help you see the waste there. Keep it relevant and keep looking. The whole purpose of using this tool and the others discussed is to help you gain a “sixth sense” for waste. You will start to see the

waste at some point as you do this, and when you do you will never be able to not see it again.

Summary Chart of Flow Analysis

Date:

	Shop name PCB Assembly	Before Improvement								After Improvement							
		Retention			Conveyance		Processing		Inspection	Retention			Conveyance		Processing		Inspection	
	Part name/number	# of times	# of units	Time	# of times	Distance	# of times	Lots	# of times	Lots	# of times	# of units	Time	# of times	Distance	# of times	Lots	# of times	Lots
1	PCB1 (A3-11-2010)	24			12	150	6		3										

Figure 3-4. A Summary Chart of Flow Analysis

The Operations Analysis Table

- The Operations Analysis Table focuses on people's actions. As discussed in the previous topic, not everything you do adds value. Operations analysis tables help you identify the waste in your own operations. See the table below. Either have your supervisor fill in the table or do it as a team, filling it in for each other. It is hard to do it for yourself because you can't watch yourself the same way someone else can.
- Eventually, you will develop an awareness of your own motion and be able to identify, ever more precisely, when you are not adding value. But in the beginning someone else must observe you and fill in the table.

Operations Analysis Table

Section: *Aluminum casting* Operation: *Deburring* Processes: *Press/drill*

Part number: *A11-21-301* Author: *(name)*

Before Improvement Date:				After Improvement Date:			
Processing Mat. Hdlng. Conveyance Idle Time Inspection	Description of operation	Time	Distance	Processing Mat. Hdlng. Conveyance Idle Time Inspection	Description of operation	Time	Distance
	Load castings onto cart	10'			Develop small shotblaster; install in U-cell		
	Transfer to press		300		Transfer to press (via cart)		300
	Unload work pieces to be pressed	10'			Press		
	Transfer to drill press		200		Drill		
	Unload with work pieces to be drilled	10'			Shotblast		
	Drill work pieces (lot size: 100 units)				Inspect		
	Load drilled work pieces onto cart	10'					
	Transfer to shotblaster		200				
	Wait until shotblaster is empty	10'					
	Suspend work pieces in shotblaster w/crane						
	Shotblast work pieces (lot size—100 units)	3'					
	Load shotblasted work pieces onto cart	5'					
	Transfer to inspection station		500				
	Inspection (lot size: 100 units)	10'					

Figure 3-5. Operations Analysis Table for an Aluminum Casting Deburring Operation

1. *Fill in the table on the factory floor*- It is important to look at the real situation as you fill in the table, even if you know the situation by heart. As you fill in the form, you will see things differently.

2. *Look for detail* – Write everything down that you possibly can.

3. *Now identify the waste* – Analyze as critically as you can to distinguish work from wastefull movement. Everything that is not value-added must be counted as waste.

4. *Set an improvement goal* – Review all the data from your observation and decide what would be best to improve and how much improvement you expect.

5. *Eliminate waste*- Eliminate waste from everything except the real work operations. Write down the results of your improvement efforts on the “After Improvement” side of the table.

The Standard Operation Combination Chart

- Standard operations are a critical aspect of lean production. In order to create standard operations, current conditions must be understood and waste must be eliminated from all aspects of the process. A Standard Operation Combination Chart focuses on the relationship of people, goods and machines. By plotting the cycle time of all activities in the process you can discover where the waste is and design the process to create a more efficient combination and reduce overall cycle time. See the figure below for an example of a combination chart

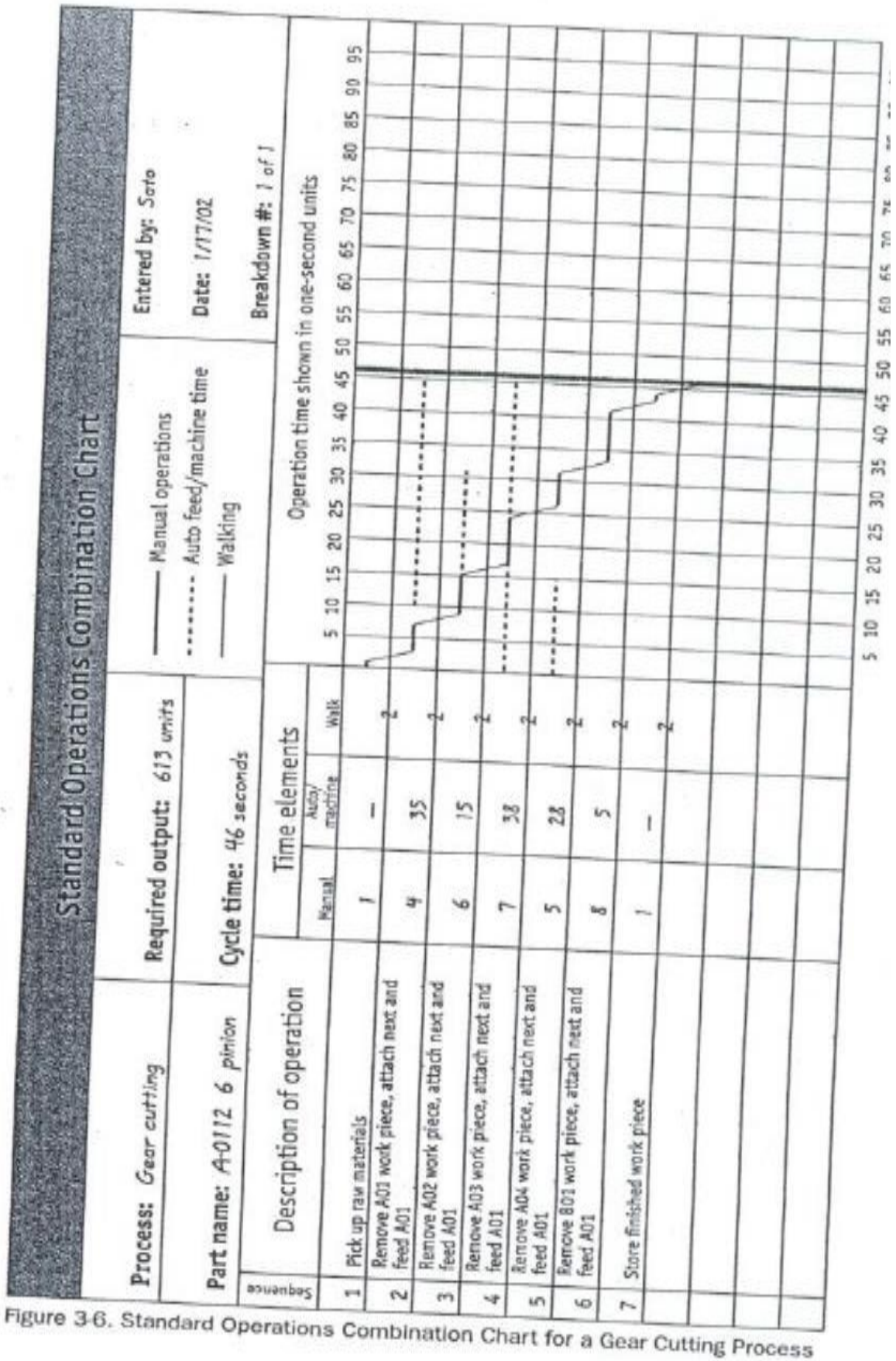


Figure 3.6. Standard Operations Combination Chart for a Gear Cutting Process

The Workshop Checklist for Major Waste Finding

- In the previous portions you have seen detailed checklists for identifying specific instances of each one of the seven deadly wastes. The Workshop Checklist for Major Waste Finding allows you to identify – in a more general way – the seven types of waste in a work area. See the figure below. You might want to use this checklist before using the detailed checklists. Checklists are good tools for identifying waste and recording improvement ideas.

Workshop Checklist for Major Waste Finding

Workshop Name: **Date:**

#	Process Name	1 Overproduction waste	2 Inventory waste	3 Conveyance waste	4 Defect waste	5 Processing waste	6 Operation waste	7 Idle time waste	Waste Magnitude Total	Improvement Ranking	Improvement Ideas and Comments

Use these four steps to follow to discover and remove waste

1. Choose several processes or work areas and look for waste.
   - Using the above figure find the major forms of waste at each process.
   - Note the magnitude of each waste (Using the figure below).
2. Rank the improvements that are needed. Focus improvements on the process with the greatest total when you add up the magnitude columns.
3. Choose the first process to be improved from the workshop checklist.
   - Using the more detailed waste-finding checklists provided, find more specific instances of waste.
   - Observe the types and magnitude of the detailed waste.
4. Brainstorm improvement ideas and then carry out them.

Taking photoes/Video :- Taking photoes and videos and analyzing are also valuable techniques to find waste.

2.Be conscious of the waste

When something is denied as waste, it also cannot be stopped.

3.Be accountable for the waste

When one refuses to accept responsibility for the waste, then he/she will not eliminate it.

4.Measure the magnitude of 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.

- ✓ Do time study by work element
- ✓ Measure Travel distance
- ✓ Measure Total steps
- ✓ Make list of items/products, who produces them and who uses them & those in warehouses, storages etc.

Tools and Equipment for Waste/Muda Identification

- ✓ Tape/Meter
- ✓ Stop watch
- ✓ Photo Camera
- ✓ Video Camera
- ✓ Calculator

Use of Tools and Equipment

Tape/Meter - is used to measure distances or lengths.

Stop watch – is used to measure operation/processing or waiting/idling times.

Photo Camera – may be necessary to take pictures ,such as shop layout, for analysis.

Video Camera – may be necessary to record video of each work element to study and identify wastes ,such as motion, processing, waiting,etc.

Calculator – required to make arithemetic calculations.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the benefits of identifying and eliminating wastes/Muda to a company? (4 points)
2. What are the benefits of identifying and eliminating wastes/Muda to the workers of a company? (4 points)
3. Write down the steps to identify wastes/Muda. (4 points)
4. List out at least three ways to make waste visible. (3 points)
5. What are the four factors to be identified in arrow diagram? (4 points)
6. What is the focus of Operation Analysis Table? (2 points)
7. What is the focus of a Standard Operation Combination Chart? (2 points

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	Report Identified and measured wastes to relevant personnel.

Overproduction Waste-finding Checklist Process: Date:					
Description of waste		Yes	No	Magnitude	Causes and/or Improvement plans
1	No production schedule of control boards.				
2	No leveling of production schedule.				
3	Productions not in synchronize with production schedule.				
4	Items missing				
5	Defective goods produced.				
6	Equipment breakdowns.				
7	Too much manual assistance required.				
8	Machines have too much capacity.				
9	Lots are grouped in to batches.				
10	Using “Push” production.				
11	Caravan style operations.				
12	Not balanced with tne next process.				
		Total			

Inventory Waste-finding Checklist **Process:** **Date:**					
Description of waste		**Yes**	**No**	**Magnitude**	**Causes and/or Improvement plans**
1	Lots of inventory on shelves and floors.				
2	Shelf and floor storage takes up lots of space.				
3	Inventory stacks block walkways.				
4	In-process inventory accumulates within individual operation.				
5	In-process inventory is stacked up between operators.				
6	In-process inventory is stacked up between processes.				
7	Impossible to visually determine quantities of in-process inventory.				
		Total			

Motion Waste-finding Checklist **Process:** **Date:**					
Description of waste		**Yes**	**No**	**Magnitude**	**Causes and/or Improvement plans**
1	Walking				
2	Turning around				
3	Leaning sideways				
4	Bending over				
5	Too wide arm movements.				
6	Unnecessary wrist movements.				
7	Left or right hand is idle.				
8	Poorly utilized idle time.				
9	Wasteful work piece set up/removal.				
10	Non-standardized repetition of operations.				
11	Worker operates using different motions each time.				
12	Operations divided into too many little segments.				
		Total			

Conveyance/Transportation Waste-finding Checklist Process: Date:					
Description of waste		Yes	No	Magnitude	Causes and/or Improvement plans
1	Pile up during conveyance.				
2	Change of conveyance devices in mid transfer.				
3	Previous and/or next process is on another floor.				
4	Conveyance requires manual assistance.				
5	Conveyance distance is too long.				
		Total			

Waiting/Idle Time Waste-finding Checklist Process: Date:					
Description of waste		Yes	No	Magnitude	Causes and/or Improvement plans
1	Work piece delay from previous process.				
2	Machine busy status.				
3	Missing item(s).				
4	Lack of balance with previous process.				
5	Lack of planning				
6	Lack of standard operations.				
7	Worker absence.				
8	Too many workers(more than two).				

		Total			
Defect Waste-finding Checklist **Process:** **Date:**					
Description of waste		**Yes**	**No**	**Magnitude**	**Causes and/or Improvement plans**
1	Complaints from next process.				
2	Defects within the process.				
3	Human errors.				
4	Defects due to missing part(s).				
5	Defects due to wrong part(s).				
6	Omission(s) in processing.				
7	Defect(s) in processing.				
8	No human automation.				
9	No mistake-proofing.				
10	No inspection within process.				
11	Defects not addressed by improvement activities.				
		Total			

Processing Waste-finding Checklist **Process:** **Date:**					
Description of waste		**Yes**	**No**	**Magnitude**	**Causes and/or Improvement plans**
1	Process is not required for product function.				
2	Process includes unnecessary operations.				
3	Process can be replaced by something less wasteful.				
4	Part of process can be eliminated without detracting from product.				
		Total			

Operation Sheet 1	Procedures for identifying categories of operation.

1. Select one operation.
2. Identify and write your customer.
3. Identify/Define what your customer needs.
4. Observe and list out the contents of the operation.
5. Categorize the contents of the operation as Net operation/Value adding operation, Non-value adding operation and Muda.
6. Measure the three categories of the operation (Time).
7. Compare them.
8. Write the action needed to be taken for the three categories of the operation.

.

Operation Sheet 2	Procedure for analyzing the existence of Mura, Muri and Muda

Procedures

1. Select a workplace.
2. Write the work load on each machine/worker in process.
3. Recognize the actual capacity of each worker/machine in the process.
4. Compare capacity against work load of workers/machines.
5. Explain the existence of Mura, Muri and Muda on each machine/worker.
6. Write their causes.

Operation Sheet-3	Ways of effective Waste/Muda identification

Method Using Arrow Diagram

1. *Select the product to be analysed*- Choose products with a large output and those with many production problems as starting points for your analysis of current conditions using the arrow diagram.
2. *Prepare a factory layout diagram*- Include the entire factory layout, indicating the position of machines, worktables and other equipment. Store the original in a safe place so that you can make a copy of it each time you want to analyze another product line.
3. *Make the arrow diagram*- Do this on the factory floor. Use the symbols below to show the different types of activities that occur. The map will make the waste more obvious to you and your team than when you are simply standing on the factory floor observing standard operations. Connect the symbols with lines that show the direction of the flow and the sequence of product through each operation. Create other symbols as you need to. At all conveyance points, note the conveyance distance and type of conveyance. At all retention points, note average work-in-process inventory.

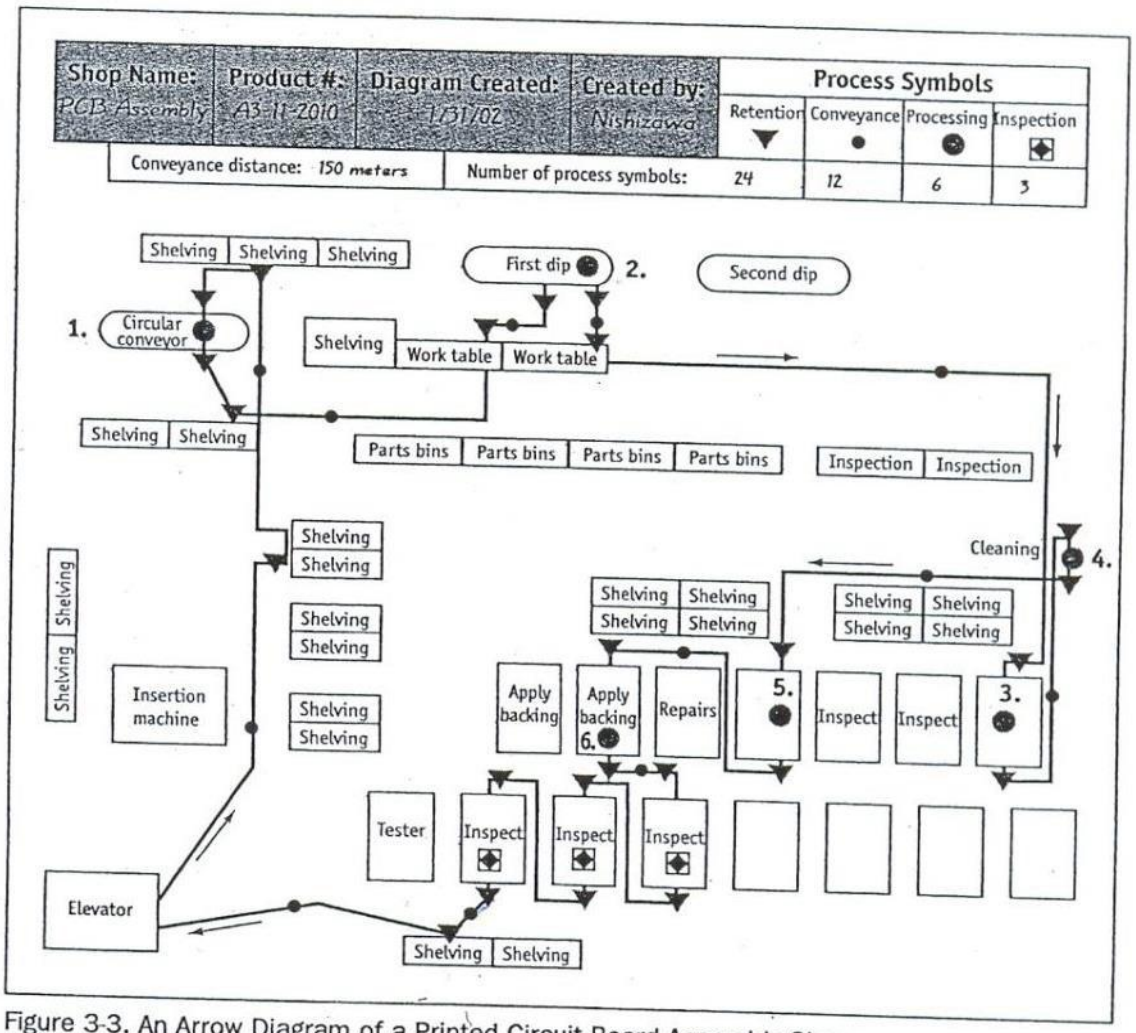


Figure 3-3. An Arrow Diagram of a Printed Circuit Board Assembly Shop

After preparing Arrow Diagram we continue to prepare a Summary Chart of Flow Analysis to show totals for the number of retention, conveyance and inspection points as follows:

Summary Chart of Flow Analysis

Summary Chart of Flow Analysis

Date:

	Shop name PCB Assembly	Before Improvement								After Improvement							
		Retention			Conveyance		Processing		Inspection	Retention			Conveyance		Processing		Inspection	
	Part name/number	# of times	# of units	Time	# of times	Distance	# of times	Lots	# of times	Lots	# of times	# of units	Time	# of times	Distance	# of times	Lots	# of times	Lots
1	PCB1 (A3-11-2010)	24			12	150	6		3										

Figure 3-4. A Summary Chart of Flow Analysis

The Operations Analysis Table

Since it is hard to do it for yourself because you can't watch yourself the same way someone else can, either have your supervisor fill in the table or do it as a team filling it in for each other

Operations Analysis Table

Section: *Aluminum casting* Operation: *Deburring* Processes: *Press/drill*

Part number: *A11-21-301* Author: *(name)*

Before Improvement Date:				After Improvement Date:			
Processing Mat. Hdlng. Conveyance Idle Time Inspection	Description of operation	Time	Distance	Processing Mat. Hdlng. Conveyance Idle Time Inspection	Description of operation	Time	Distance
	Load castings onto cart	10'			Develop small shotblaster; install in U-cell		
	Transfer to press		300		Transfer to press (via cart)		300
	Unload work pieces to be pressed	10'			Press		
	Transfer to drill press		200		Drill		
	Unload with work pieces to be drilled	10'			Shotblast		
	Drill work pieces (lot size: 100 units)				Inspect		
	Load drilled work pieces onto cart	10'					
	Transfer to shotblaster		200				
	Wait until shotblaster is empty	10'					
	Suspend work pieces in shotblaster w/crane						
	Shotblast work pieces (lot size—100 units)	3'					
	Load shotblasted work pieces onto cart	5'					
	Transfer to inspection station		500				
	Inspection (lot size: 100 units)	10'					

Figure 3-5. Operations Analysis Table for an Aluminum Casting Deburring Operation

1. *Fill in the table on the factory floor*- It is important to look at the real situation as you fill in the table, even if you know the situation by heart. As you fill in the form, you will see things differently.
2. *Look for detail* – Write everything down that you possibly can.
3. *Now identify the waste* – Analyze as critically as you can to distinguish work from wastefull movement. Everything that is not value-added must be counted as waste.
4. *Set an improvement goal* – Review all the data from your observation and decide what would be best to improve and how much improvement you expect.
5. *Eliminate waste*- Eliminate waste from everything except the real work operations. Write down the results of your improvement efforts on the “After Improvement” side of the table.

The Standard Operation Combination Chart

Plot the cycle time of all activities in the process to discover where the waste is and design the process to create a more efficient combination and reduce overall cycle time. See the figure below for an example of a combination chart.

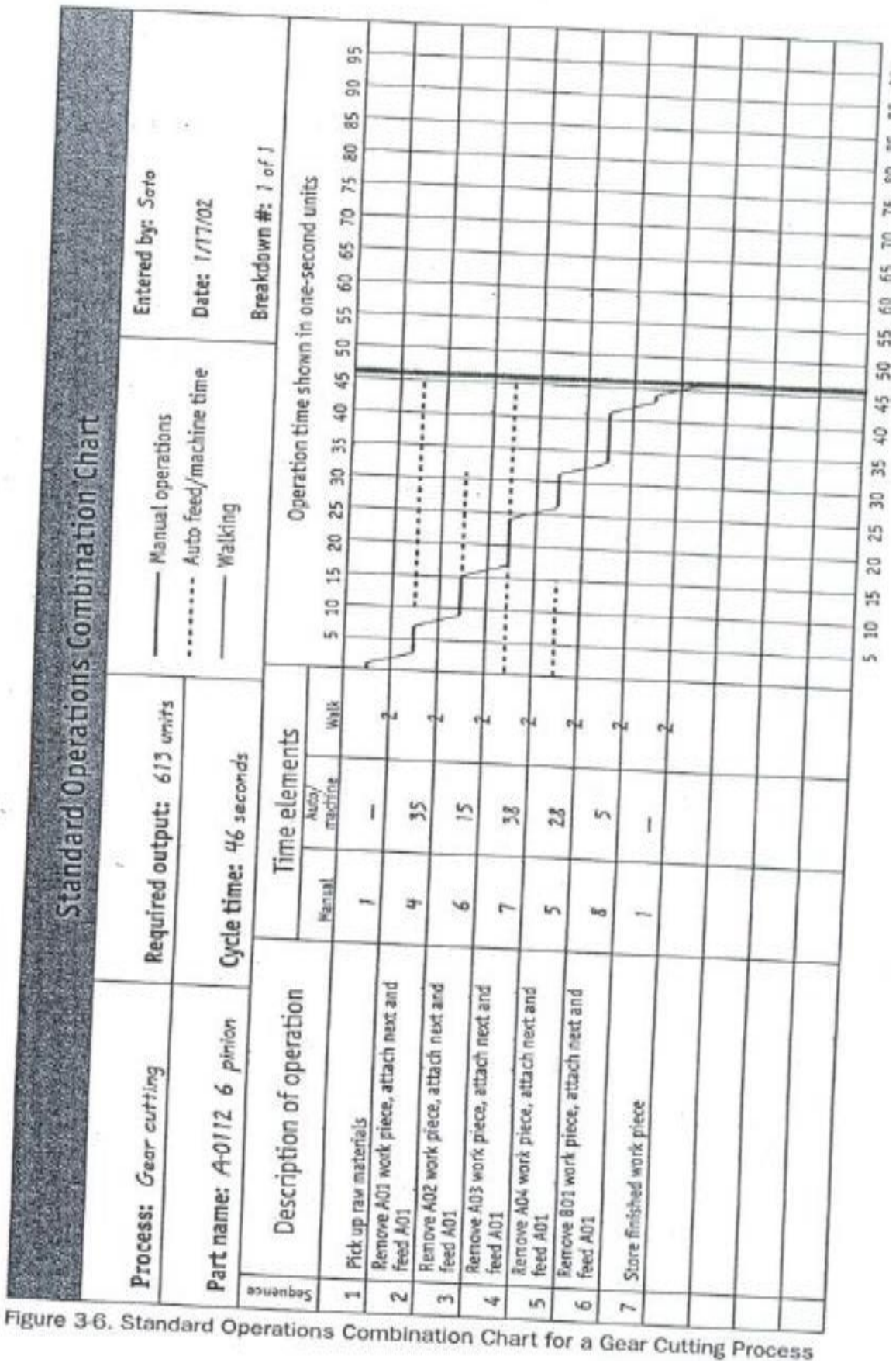


Figure 3-6. Standard Operations Combination Chart for a Gear Cutting Process

The Workshop Checklist for Major Waste Finding

The Workshop Checklist for Major Waste Finding allows you to identify – in a more general way – the seven types of waste in a work area. You might want to use this checklist before

using the detailed checklists.

Workshop Checklist for Major Waste Finding

Workshop Name: **Date:**

#	Process Name	1 Overproduction waste	2 Inventory waste	3 Conveyance waste	4 Defect waste	5 Processing waste	6 Operation waste	7 Idle time waste	Waste Magnitude Total	Improvement Ranking	Improvement Ideas and Comments

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1: In the given operation, identify the three categories of operation, measure their magnitude interms of time and compare them.

Task 2: In the given workplace and check the existence of Mura, Muri and Muda in each process and list out them.

Task 3: Using appropriate method identify the Seven types of Muda in the workplace.

Task 4: Using the given template list out the types of Muda identified and analyze their causes and measure their magnitude.

Instruction Sheet	LG32: Eliminate wastes/MUDA

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

- Preparing and implementing Plan of MUDA elimination.
- Necessary attitude and ***the ten basic principles for improvement***
- Tools and techniques to eliminate wastes/MUDA
- Reducing and eliminate Wastes/MUDA in accordance with OHS and organizational requirements.
- Reporting Improvements gained by elimination of waste/MUDA.

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 and OHS.
- 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 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2, Sheet 3 and Sheet 4,---”**in page ---, ---, --- and ---** respectively.
4. Accomplish the “Self-check 1, Self-check t 2, Self-check 3 and Self-check 4” ,---”**in page ---, ---, --- and ---** respectively
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1, Operation Sheet 2 and Operation Sheet 3 ”**in page ---.**
6. Do the “LAP test” **in page – ---**

2.8. 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 -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What kind of negative attitude for identifying and elimination of waste is mostly observed? Write at least three.(6 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	Necessary attitude and *the ten basic principles for improvement*

The Ten Basic Principles for Improvement

1. Throw out all of your fixed ideas about how to do things.
2. Think of how the new method will work-not how it will not.
3. Don’t accept excuses. Totally deny the status quo.
4. Don’t seek perfection. A 50 percent implementation rate is fine as long as it is done on the spot.
5. Correct mistakes the moment they are found.
6. Don’t spend a lot of money on improvements.
7. Problems give you a chance to use your brain.
8. Ask “Why?” at least five times until you find the ultimate cause.
9. Ten people’s ideas are better than one person’. 10.Improvement knows no limit.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write at least four out of the ten basic principles of improvement.(8 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-3	Tools and techniques to eliminate wastes/MUDA

Some 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.

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

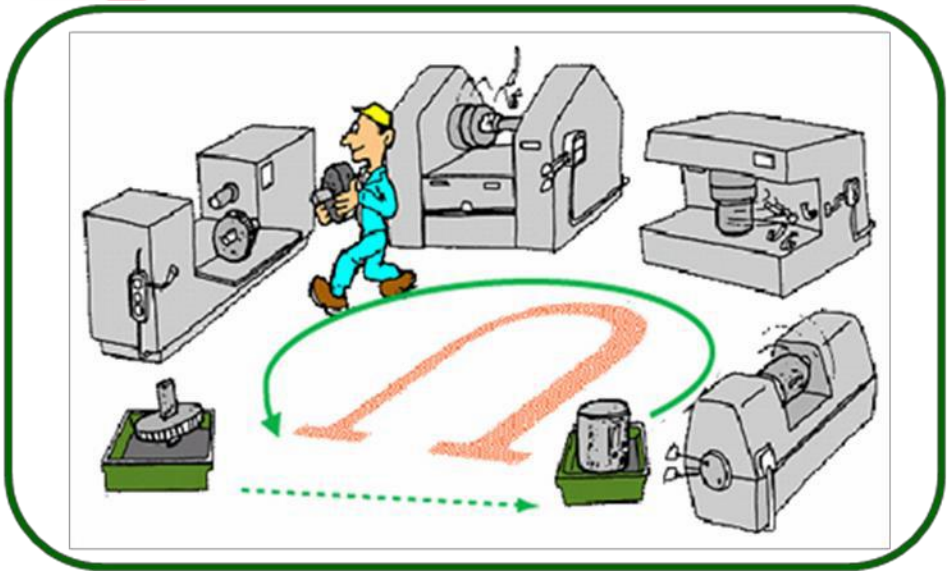
be used to list down all the problems faced by an organization, their causes and the potential effects if a certain suggestion is implemented. To ensure the success of the brainstorming process, it is important for the KPT to follow the following rules:

- 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.

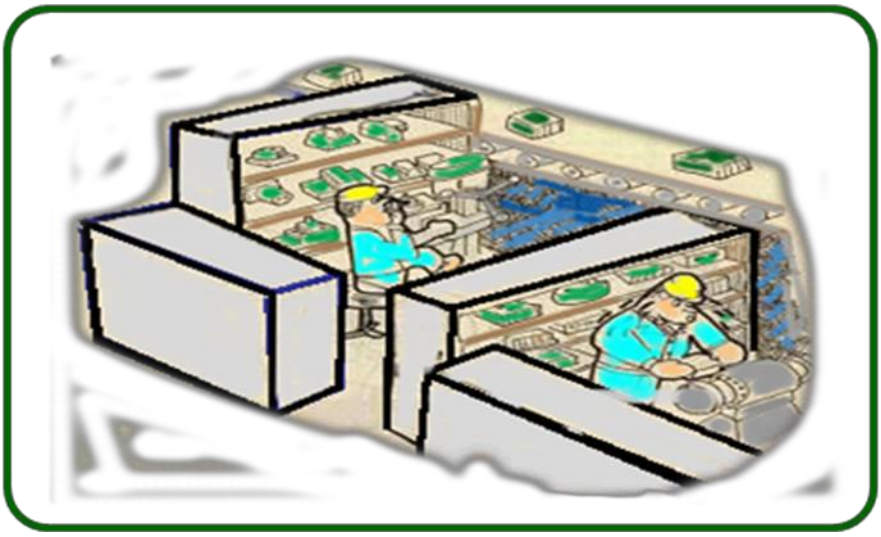
Andon: Is an indicator informing team leaders and supervisors of the current workshop situation with color boards, flash lights, and automated announcement. Types of Andon

- 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 Takt Time.

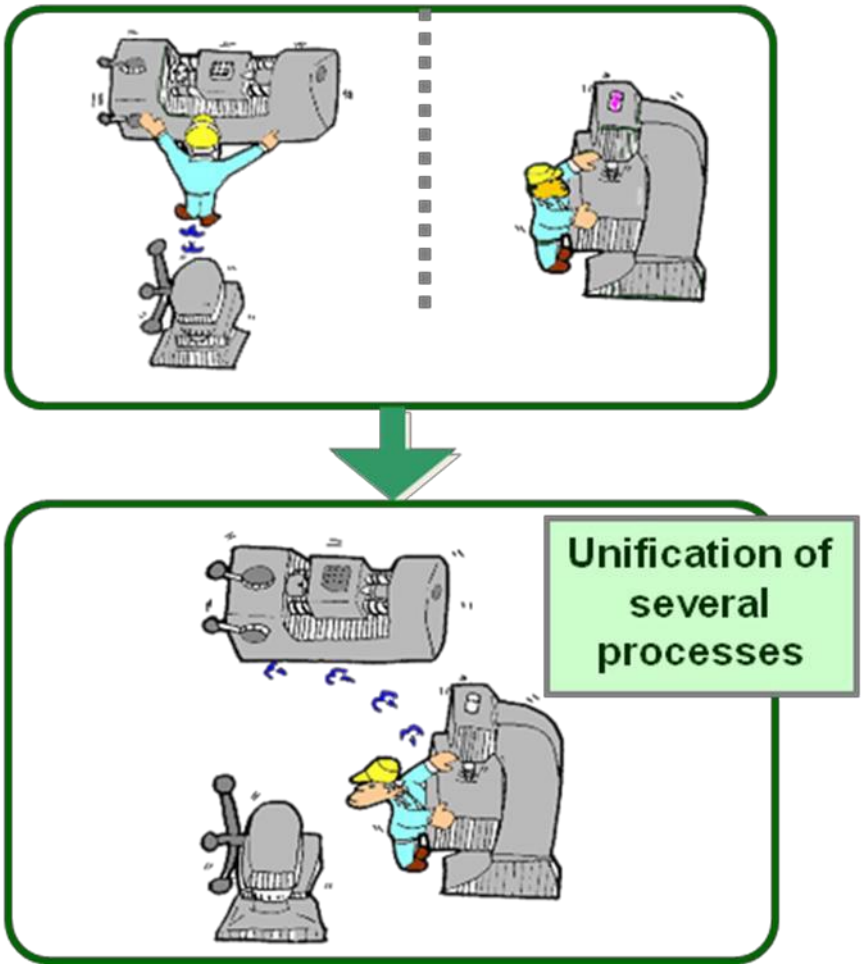
U-line: Is a layout in which the inlet and outlet are positioned in the same direction to avoid walking back for a single operator.



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



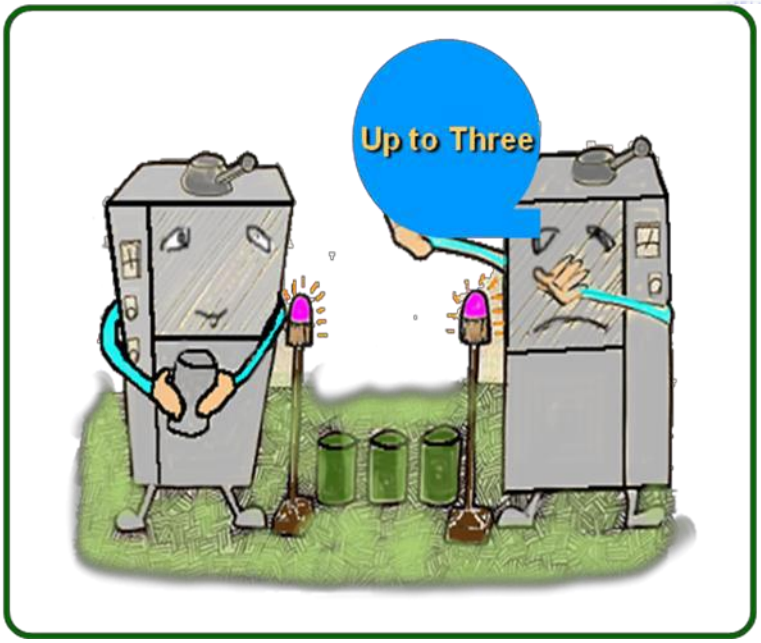
Multi-process handling and Multi-skilled operators

-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.

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.

A.B. control is used as a tool for time control to realize Just in Time(JIT)



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 levelling 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

1. Quality should be built into each process.
2. Guarantee the quality in each process.
    1. Do not make Defect
    2. Do not pass defect
    3. 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.

1. Abnormality will understood simply.
2. “Visual control” visually control the states, ANDON,
3. 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 -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write at least one type of waste/Muda that is eliminated by applying the following tools and techniques. (12 points)
   - 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

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

4.1. Eliminate the seven types of Wastes/Muda.

How to Eliminate Overproduction Wastes

- In order to balance capacity and load without overproducing, you must implement the advanced methods of lean production:
  - ✓ Full work
  - ✓ Line balancing
  - ✓ Pull production using kanban.
  - ✓ Quick-changeover operations.
  - ✓ Level production - small-lot, mixed production.

How to Eliminate Inventory Wastes

- ✓ U-shaped manufacturing cells, layout of equipment by process instead of operation.
- ✓ Production leveling
- ✓ Regulating the flow of production
- ✓ Pull production using kanban
- ✓ Quick changeover operations

How to Eliminate Motion Wastes

- ✓ Gradually switch to flow production
- ✓ Create U-shaped cell layout of equipment
- ✓ Make standardization through
- ✓ Increase training
- ✓ Increase operator awareness about motion during an operation

- Where as many kinds of movement may be unnecessary, work is the movement you do to add value to the product. Movement that does not add value is waste. Find ways to

reduce the amount of movement to do your value added work. Start by looking at the movement of your feet, then your hips, shoulders, arms, hands and fingers.

How to Eliminate Conveyance/Transportation Wastes

- Basically, conveyance waste is corrected by redesigning equipment layout to create a flow between operations. Then you will be able to take out much of the complexity in the conveyance system and decrease material handling to a minimum. Some of the lean production methods that address conveyance flow:

✓ U-shaped manufacturing cells

✓ Flow production

✓ Multi skill workers

✓ Standing to perform operations

✓ Higher utilization rate

✓ Water beetles (material handlers in the kanban system of pull production)

How to Eliminate Waiting/Idle Time Wastes

✓ Production leveling

✓ Product-specific layout

✓ Mistake-proofing

✓ Human automation

✓ Quick changeover

✓ Autonomous maintenance

✓ Line balancing

How to Eliminate Defect Wastes

✓ Standard operations

✓ Mistake-proofing devices

✓ Full-lot inspection

✓ Building quality in at each process

✓ Flow production

- ✓ Elimination of the need to pick up and set down work pieces
- ✓ Improvement of jigs using human automation
- ✓ Promotion of value analysis and value engineering

- To reduce defects, their root cause must be found. Inspection that only sorts out the defective parts is not a solution to defective waste; it is actually one of the major defect-related wastes. Until you initiate back-to-the-source inspection and build quality into every process through standardization, the effects of defects will continue to disrupt the flow of goods and decrease productivity.

How to Eliminate Processing Wastes

- ✓ More appropriate process design
- ✓ Review of operations
- ✓ Improvement of jigs using automation
- ✓ Thorough standardization
- ✓ Promotion of value analysis(VA) and value engineering(VE) techniques

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. Write at least two methods how to eliminate each of the seven deadly wastes.(14 points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-5	Reporting Improvements gained by elimination of waste/MUDA.

Kaizen Effect Evaluation Sheet

Name of the process:_____

Work Place:_____

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

3. 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 ፡_____

Operation Sheet 1	Planning and procedures for elimination of Muda.

1. The documents of the already identified wastes in several processes or work areas are analyzed.
2. Rank the improvements that are needed. Focus on improvements on the process with the greatest total when you add up the magnitude of its wastes.
3. Choose the first process to be improved from the workshop checklist.
    a. Using the more detailed waste-finding checklists provided, find more specific instances of waste.
    b. Observe the types and magnitude of the detailed waste.
4. Set target

   What? Decrease/Eliminate the amount of the waste specified.

   When? By the End of ----

   How many? Minimize the problem from –to –
5. Prepare Activity Plan

	Why?	**What?**	**Where?**	**Who?**	**When?**	**How?**
	Objectives	**Items to be implemented**	**Location**	**Person(s) charge**	**Time/Duration**	**Method**
P						
D						
C						

6. Examine causes of the waste.
7. Brainstorm improvement ideas.
8. Implement the countermeasure.
9. Check / confirm the result against the target set and if it is ok establish new operational standard if not revise your plan.

.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1: Choose the first process to be improved, set target and prepare action plan.

Task 2: Set countermeasure to eliminate/reduce the wastes, implement them and check the result.

Task 3: Prepare a report by using the Appropriate Format.

Instruction Sheet	LG33: Prevent occurrence of wastes/MUDA

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

- Methods for waste prevention
- TPM concept and its pillars
- Reporting method and formats/checklists for improvement gained by waste elimination

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 prevention.
- Discus and prepare Standards required for machines, operations, defining normal and abnormal conditions, clerical procedures and procurement.
- Prevent Occurrences of wastes/MUDA by using visual and auditory control methods.
- Create Waste-free workplace by using 5W and 1Hsheet.
- Complete the required operation in accordance with standard procedures and practices.
- Facilitate the updating of standard procedures and practices.
- Align the capability of the work team with the requirements of the procedure.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below 3 to 6.
3. Read the information written in the information “Sheet 1, Sheet 2 and Sheet 3 **in page 3, 9 and 22** respectively.
4. Accomplish the “Self-check 1and Self-check 2”**in page 8 and 19** respectively
5. If you earned a satisfactory evaluation from the “Self-check” proceed to “Operation Sheet 1”**in page 24.**
6. Do the “LAP test” **in page 25**

Information Sheet-1	Methods for waste prevention

2.9. 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

2.9.1. **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, adehered to, and regularly re-assessed.
- Standards are required for:

✓ Machines

✓ Operations

✓ Defining normal and abnormal conditions

✓ Clerical procedures

✓ Procurement

2.9.2. **Visual and Auditory Controls**

- 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 peocess.
- ***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 quanities 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.
- ***Andons***- 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.

2.9.3. **The 5W and 1H Sheet**

The 5W and 1H (five “whys” and one “how”) is a powerfull 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.

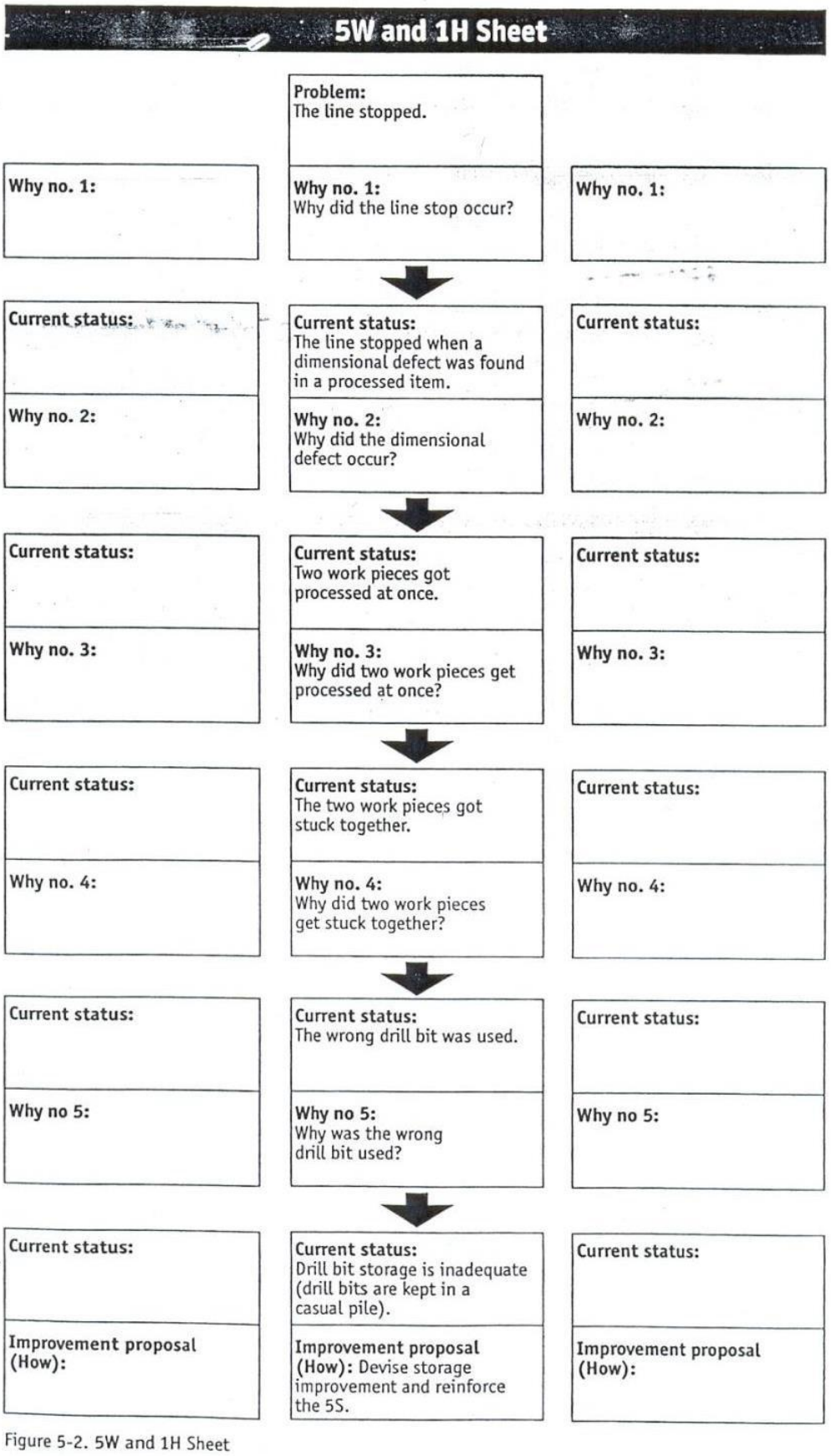


Figure 5-2. 5W and 1H Sheet

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).

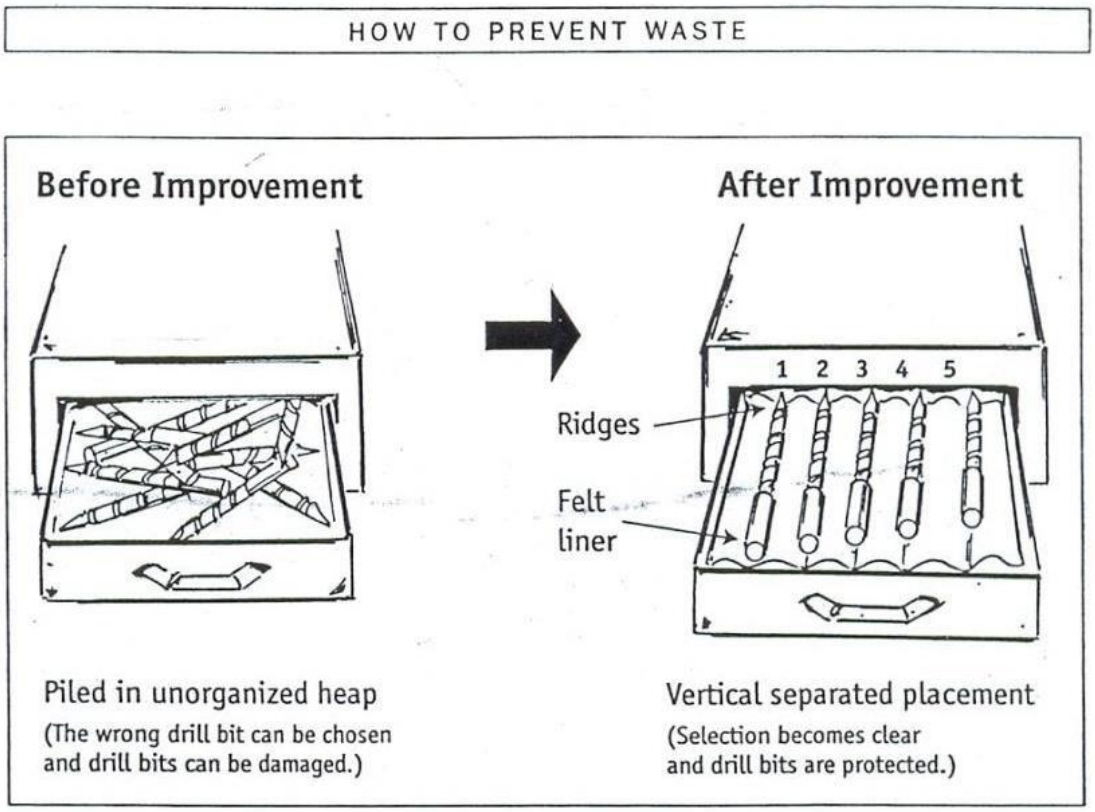


Figure 5-3. Improvement in Drill Bit Storage

Figure 2 shows an example of an improvement idea that resulted from the use of the 5W1H Sheet in figure 1.

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 wait. Put your ideas into practice immediately!

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What are the four methods for maintaining a waste free production environment? (4 Points)

3. How does standardization maintains a waste free environment? (4 Points)
4. How does visual and auditory controls maintains a waste free environment? (4 Points)
5. How does 5W and 1H sheet maintains a waste free environment? (3 Points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Information Sheet-2	TPM concept and its pillars

2.1 Introduction to Total Productive Maintenance (TPM)

- **Total** means All individuals in the organization working together. **Productive** means Production of goods that meet or exceed customer's expectations.
- **Maintenance** means Keeping equipment and plant in good condition at all times**. What is Total Productive Maintenance (TPM) ?**
- *It can be considered as the medical science of machines.* Total Productive Maintenance (TPM) is a maintenance program which involves a newly defined concept for maintaining plants and equipment. The goal of the TPM program is to markedly increase production while, at the same time, increasing employee morale and job satisfaction.
- TPM brings maintenance into focus as a necessary and vitally important part of the business. It is no longer regarded as a non-profit activity. Down time for maintenance is scheduled as a part of the manufacturing day and, in some cases, as an integral part of the manufacturing process. The goal is to hold emergency and unscheduled maintenance to a minimum.

Why TPM ?

- TPM was introduced to achieve the following objectives. The important ones are listed below.
  - ✓ Avoid wastage in a quickly changing economic environment.
  - ✓ Producing goods without reducing product quality.
  - ✓ Reduce cost.
  - ✓ Produce a low batch quantity at the earliest possible time.
  - ✓ Goods send to the customers must be non defective.

Types of maintenance

- **Breakdown maintenance**

- This refers to the maintenance strategy, where repair is done after the equipment failure/stoppage or upon occurrence of severe performance decline. This concept has the disadvantage of unplanned stoppages, excessive damage, spare parts problems, high repair costs, excessive waiting and maintenance time and high trouble shooting problems.

- **Preventive maintenance**

- PM comprises of maintenance activities that are undertaken after a specified period of time or amount of machine use. This type of maintenance relies on the estimated probability that the equipment will breakdown or experience deterioration in performance in the specified interval. The preventive work undertaken may include equipment lubrication, cleaning, parts replacement, tightening, and adjustment. The production equipment may also be inspected for signs of deterioration during preventive maintenance work.
- It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.
  - **Periodic maintenance (Time based maintenance - TBM)**

    Time based maintenance consists of periodically inspecting, servicing and cleaning equipment and replacing parts to prevent sudden failure and process problems.
  - **Predictive maintenance**

    This is a method in which the service life of important part is predicted based on inspection or diagnosis, in order to use the parts to the limit of their service life. Compared to periodic maintenance, predictive maintenance is condition based maintenance. It manages trend values, by measuring and analyzing data about deterioration and employs a surveillance system, designed to monitor conditions through an on-line system.

- **Corrective maintenance**

- This is a system in which the concept to prevent equipment failures is further expanded to be applied to the improvement of equipment so that the equipment failure can be eliminated (improving the reliability) and the equipment can be easily maintained (improving equipment maintainability).
- The primary difference between corrective and preventive maintenance is that a problem must exist before corrective actions are taken.
- The purpose of corrective maintenance is improving equipment reliability, maintainability, and safety; design weaknesses (material, shapes); existing equipment undergoes structural reform; to reduce deterioration and failures, and to aim at maintenance-free equipment.
- Maintenance information, obtained from CM, is useful for maintenance prevention for the next equipment and improvement of existing manufacturing facilities. It is important to form setups to provide the feedback of maintenance information.

- **Maintenance prevention**

- It indicates the design of a new equipment. Weakness of current machines are sufficiently studied (on site information leading to failure prevention, easier maintenance and prevents of defects, safety and ease of manufacturing) and are incorporated before commissioning a new equipment.

History of TPM

- TPM is innovative Japanese concept. The origin of TPM can be traced back to 1951 when preventive maintenance was introduced in Japan. However the concept of preventive maintenance was taken from USA. Nippondenso was the first company to introduce plant wide preventive maintenance in 1960. Preventive maintenance is the concept wherein, operators produced goods using machines and the maintenance group was dedicated with work of maintaining those machines, however with the automation of

Nippondenso, maintenance became a problem as more maintenance personnel were required. So the management decided that the routine maintenance of equipment would be carried out by the operators. (This is Autonomous maintenance, one of the features of TPM). Maintenance group took up only essential maintenance works.

- Thus Nippondenso which already followed preventive maintenance also added Autonomous maintenance done by production operators. The maintenance crew went in the equipment modification for improving reliability. The modifications were made or incorporated in new equipment. This lead to maintenance prevention. Thus *preventive maintenance* along with *Maintenance prevention* and *Maintainability Improvement* gave birth to ***Productive maintenance***. The aim of productive maintenance was to maximize plant and equipment effectiveness to achieve optimum life cycle cost of production equipment.
- By then Nippon Denso had made quality circles, involving the employees participation. Thus all employees took part in implementing Productive maintenance. Based on these developments Nippondenso was awarded the distinguished plant prize for developing and implementing TPM, by the *Japanese Institute of Plant Engineers* (JIPE). Thus Nippondenso of the Toyota group became the first company to obtain the TPM certification.

TPM Targets:

- ✓ Productivity
- ✓ Obtain Minimum 80% OPE (Overall Plant Efficiency)
- ✓ Obtain Minimum 90% OEE (Overall Equipment Effectiveness)
- ✓ Run the machines even during lunch. (Lunch is for operators and not for machines!) Quality - Operate in a manner, so that there are no customer complaints.
- ✓ Cost - Reduce the manufacturing cost by 30%.
- ✓ Delivery time - Achieve 100% success in delivering the goods as required by the customer.
- ✓ Safety - Maintain accident free environment.
- ✓ Moral - Increase the suggestions by 3 times. Develop Multi-skilled and flexible workers.

Motives of TPM	4. Adoption of life cycle approach for improving the overall performance of production equipment. 5. Improving productivity by highly motivated workers which is achieved by job enlargement. 6. The use of voluntary small group activities for identifying the cause of failure, possible plant and equipment modifications.
Uniqueness of TPM	The major difference between TPM and other concepts is that the operators are also made to involve in the maintenance process. The concept of *"I (Production operators) Operate, You (Maintenance department) fix"* is not followed.
TPM Objectives	1. Achieve Zero Defects, Zero Breakdown and Zero accidents in all functional areas of the organization. 2. Involve people in all levels of organization. 3. Form different teams to reduce defects and Self Maintenance.

Direct benefits of TPM	• Increase productivity and OPE (Overall Plant Efficiency) by 1.5 or 2 times. • Rectify customer complaints. • Reducethe manufacturing cost by 30%. • Satisfy the customers needs by 100 % (Delivering the right quantity at the right time, in the required quality.) • Reduce accidents. • Follow pollution control measures.
Indirect benefits of TPM	**3.** Higher confidence level among the employees. **4.** Keep the work place clean, neat and attractive. **5.** Favorablechange in the attitude of the operators. **6.** Achieve goals by working as team. **7.** Horizontaldeployment of a new concept in all areas of the organization. **8.** Share knowledge and experience. **9.** The workers get a feeling of owning the machine.

Factors affecting equipment effectiveness

4. Equipment failure (breakdown)
5. Setup and adjustment downtime
6. Idling and minor stoppages
7. Reduced speed
8. Process defects
9. Reduced yield

Cycle Time and Set-Up Reduction

- The amount of time that elapses between the completion of two parts completed on the same line. Cycle time may also be defined as the amount of time it takes for a single operation to complete a single part. Both working definitions are based on shop floor observation. The general term “Cycle Time” should be specified as “Observed Cycle Time”. It is important to note that with all variations of “Cycle Time” definitions, the starting and ending point of each cycle must be exactly the same point to ensure a complete cycle.
- Shorter runs produce customer orders with less lead time. However, equipment breakdowns, idling and minor stoppages will make it very difficult to reduce cycle times. Hence, cycle time reductions result in shorter and more frequent production runs. Suddenly, set-ups and adjustments become crucial in reducing cycle times. Past OEE (Overall Equipment Efficieny) studies show that set-up and adjustments can consume up to 50% of total production time.
- The Equipment Losses (you can and must measure)

Equipment Availability	Set up and adjustments including: ✓ Changeovers ✓ Programming ✓ Test runs Equipment Failures: ✓ Sporadic breakdowns. ✓ Chronic breakdowns.
Equipment Efficiency	Idling and Minor Stoppages ✓ Jams and other short ✓ stoppages. ✓ No parts, no operator. ✓ "Blocked". Reduced Speed ✓ Equipment worn out. ✓ Lack of accuracy.
Quality	Process defects ✓ Scrap ✓ Rework
Others	Equipment warm up etc. No parts, no operator.

Availability

- ✓ Loading time = Total available time per day (or month) – Planned downtime
- ✓ Planned downtime: amount of downtime officially scheduled in the production plan.

OEE (Overall Equipment Efficiency) :

$$OEE = A \times PE \times Q$$

- Possibly there are three ways that failure may occur

1. *A - Availability of the machine*. Availability is proportion of time machine is actually available out of time it should be available. (t*he equipment can stop working completely* known as a *total failure*),

$$Availability\ (\%) = \frac{total\ time\ available - downtime}{total\ time\ available} * 100\%$$

2. *The equipment can work slower than it is capable of known as the partial failure (throughput rate/Performance), and*

$$Performance\ (\%) = \frac{number\ of\ units\ manufactured}{possible\ number\ of\ manufacturable\ units} * 100\%$$

3. *The equipment or product can lose quality known as* quality failure (Quality)

$$Quality\ (\%) = \frac{number\ of\ units\ produced - number\ of\ defects}{} * 100\%$$

number of units produced

OEE Exercise

- Calculate Availability, Performance, Quality and OEE based on the following information.

Item	Data
Shift Length	8 hrs = 480 min
Short Breaks	2@15 min = 30 min
Meal Breaks	1@30min=30min
Down Time	47min
Ideal Run Time	60 pieces per min
Total Pieces	19,271 pieces
Reject Pieces	423 pieces

a. Availability = $\frac{\text{Operating time}}{\text{Planned production time}}$

= 373 minutes / 420 minutes

= **0.8881 = 88.81%**

b. Performance = $\frac{\text{(Total pieces /Operating time)}}{\text{Ideal Run Time}}$

= (19,271 pieces/373 minutes)/60 pieces per minute

= **0.8611 = 86.11%**

c. Quality = $\frac{\text{Good Pieces}}{\text{Total Pieces}}$

= 18,848 / 19,271 pieces

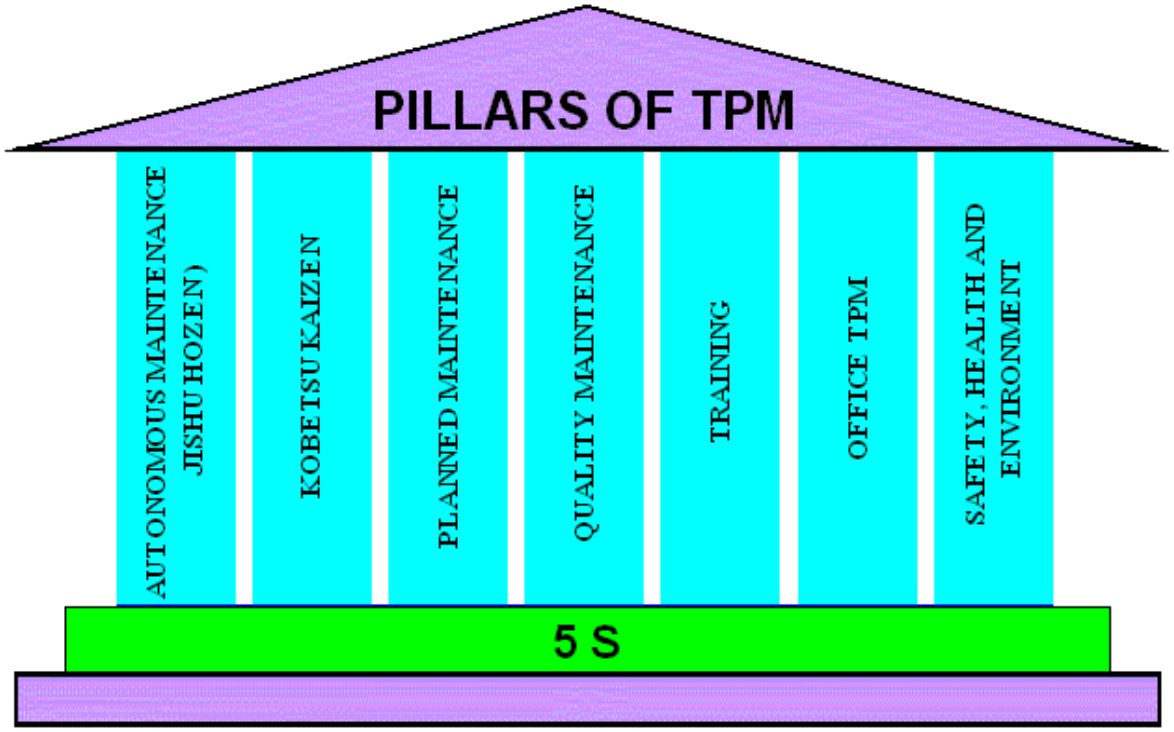
= **0.9780 = 97.80 %**

d. OEE = Availability X Performance X Quality

= 0.8881 X 0.8611 X 0.9780

= 0.7479 = 74.79%

The 8 Pillars of TPM



PILLAR 1 - 5S :

- TPM starts with 5S. Problems cannot be clearly seen when the work place is disorganized. Cleaning and organizing the workplace helps the team to uncover problems. Making problems visible is the first step of improvement.

PILLAR 2 - Autonomous maintenance (JISHU HOZEN)

- This pillar is geared towards developing operators to be able to take care of small maintenance tasks, thus freeing up the skilled maintenance people to spend time on more value added activity and technical repairs. The operators are responsible for upkeep of their equipment to prevent it from deteriorating.

PILLAR 3 - KAIZEN :

- "Kai" means change, and "Zen" means good (for the better). Basically kaizen is for small improvements, but carried out on a continual basis and involve all people in the organization. Kaizen is opposite to big spectacular innovations. Kaizen requires no or little investment. The principle behind is that "a very large number of small improvements are morTPMe effective in an organizational environment than a few improvements of large value. This pillar is aimed at reducing losses in the workplace that affect our efficiencies. By using a detailed and thorough procedure we eliminate losses in a systematic method using various Kaizen tools. These activities are not limited to production areas and can be implemented in administrative areas as well.

The Six Big Loses

Down Time

1. Breakdowns due to equipment failure.
2. Setup and adjustment (e.g. exchange of dies in injection molding machines, etc.)

Speed Losses

3. Idling and minor stoppages (abnormal operation of sensor, etc.).

4. Reduced speed (discrepancies between designed and actual speed of equipment)

Defects

5. Defects in process and rework (scrap and quality defects requiring repair)
6. Reduced yield between machine startup and stable production.

Classification of losses :

Aspect	Sporadic Loss	Chronic Loss
Causation	Causes for this failure can be easily traced. Cause-effect relationship is simple to trace.	This loss cannot be easily identified and solved. Even if various counter measures are applied
Remedy	Easy to establish a remedial measure	This type of losses are caused because of hidden defects in machine, equipment and methods.
Impact / Loss	A single loss can be costly	A single cause is rare - a combination of causes trends to be a rule
Frequency of occurrence	The frequency of occurrence is low and occasional.	The frequency of loss is more.
Corrective action	Usually the line personnel in the production can attend to this problem.	Specialists in process engineering, quality assurance and maintenance people are required.

PILLAR 4 - PLANNED MAINTENANCE :

- It is aimed to have trouble free machines and equipments producing defect free products for total customer satisfaction. This breaks maintenance down into 4 "families" or groups which was defined earlier.
    1. Preventive Maintenance
    2. Breakdown Maintenance
    3. Corrective Maintenance
    4. Maintenance Prevention

- With Planned Maintenance we evolve our efforts from a reactive to a proactive method and use trained maintenance staff to help train the operators to better maintain their equipment.

Target :

6. Zero equipment failure and break down.
7. Improve reliability and maintainability by 50 %
8. Reduce maintenance cost by 20 %
9. Ensure availability of spares all the time.

PILLAR 5 - QUALITY MAINTENANCE :

- It is aimed towards customer delight through highest quality through defect free manufacturing. Focus is on eliminating non-conformances in a systematic manner, much like Focused Improvement. We gain understanding of what parts of the equipment affect product quality and begin to eliminate current quality concerns, then move to potential quality concerns. Transition is from reactive to proactive (Quality Control to Quality Assurance).
- QM activities is to set equipment conditions that preclude quality defects, based on the basic concept of maintaining perfect equipment to maintain perfect quality of products. The condition are checked and measure in time series to very that measure values are within standard values to prevent defects. The transition of measured values is watched to predict possibilities of defects occurring and to take counter measures before hand.

Target :

1. Achieve and sustain customer complaints at zero
2. Reduce in-process defects by 50 %
3. Reduce cost of quality by 50 %.

PILLAR 6 - TRAINING :

- It is aimed to have multi-skilled revitalized employees whose morale is high and who has eager to come to work and perform all required functions effectively and independently. Education is given to operators to upgrade their skill. It is not sufficient know only "Know-How" by they should also learn "Know-why". By experience they gain, "Know-How" to

overcome a problem what to be done. This they do without knowing the root cause of the problem and why they are doing so. Hence it become necessary to train them on knowing "Know-why". The employees should be trained to achieve the four phases of skill. The goal is to create a factory full of experts. The different phase of skills are

Phase 1 : Do not know.

Phase 2 : Know the theory but cannot do.

Phase 3 : Can do but cannot teach

Phase 4 : Can do and also teach.

PILLAR 7 - OFFICE TPM :

- Office TPM should be started after activating four other pillars of TPM (JH, KK, QM, PM). Office TPM must be followed to improve productivity, efficiency in the administrative functions and identify and eliminate losses. This includes analyzing processes and procedures towards increased office automation.

Office TPM and its Benefits :

1. Involvement of all people in support functions for focusing on better plant performance
2. Better utilized work area
3. Reduce repetitive work
4. Reduced inventory levels in all parts of the supply chain
5. Reduced administrative costs
6. Reduced inventory carrying cost
7. Reduction in number of files
8. Reduction of overhead costs (to include cost of non-production/non capital equipment)
9. Productivity of people in support functions
10. Reduction in breakdown of office equipment
11. Reduction of customer complaints due to logistics
12. Reduction in expenses due to emergency dispatches/purchases
13. Reduced manpower
14. Clean and pleasant work environment.

PILLAR 8 - SAFETY, HEALTH AND ENVIRONMENT :

Target :

1. Zero accident,
2. Zero health damage
3. Zero fires.

- In this area focus is on to create a safe workplace and a surrounding area that is not damaged by our process or procedures. This pillar will play an active role in each of the other pillars on a regular basis.
- To create awareness among employees various competitions like safety slogans, Quiz, Drama, Posters, etc. related to safety can be organized at regular intervals.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

1. What is Total Productive Maintenance (TPM)? (3 Points)
2. What are the four types of maintenance? (4 Points)
3. Describe the four types of maintenance. (8 Points)
4. What are the disadvantages of breakdown maintenance?(write at least four)(4 Points)
5. What are the advantages of preventive maintenance over breakdown maintenance? (3 Points)
6. What are the activities carried out on the machine during preventive maintenance? (write at least four) (4 Points)
7. What is the primary difference between corrective and preventive maintenances? (2 Points)
8. What is cycle time? (2 Points)
9. What are the factors affecting Equipment Effectiveness? (At least three) (3 Points)
10. What are the eight pillars of TPM? (8 Points)
11. What are the aims of each pillars of TPM? (8 Points)

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

Answer Sheet

Score = _____

Rating: _____

Name: _____ Date: _____

Short Answer Questions

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____

11. _____

_____

_____

_____

_____

_____

Information Sheet-3	Reporting method and formats/checklists for improvement gained by waste elimination

3.2 Kaizen Effect Evaluation Sheet

Name of the process:_____

Work Place:_____

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 tock/Inventory					
	1.8 expired material/Stock)					
2	Productivity indicators					
	2.1 Lead time					
	2.2 Machine down time					
	2.3 Frequency of					
	2.4 Production volume					
	2.5 Labor saving					
	2.6 labour productivity					
	2.7 Delivery Time					
3	Quality Indicators					
	3.1 Defect rate					
	3.2 Raw Material					
	3.3 Number of					
4	Other Indicators					
	4.1 Number of New					
	4.2 Minimized Cost of					

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 : _____

Operation Sheet 1	Planning and procedure for Preventing Muda

1. After implementing improvement idea and confirming the result establish a new standard procedure.
2. Document the new standard procedure.
3. Train the workers the new standard procedure.
4. Prepare action plan to implement and follow up the standard procedure.

No.	What	When	Where	Who	How	Why	Counter point	Follow up
1		Always		Operator				Team Leader
2		At the time of purchasing		Leader				
3		Always		Leader				
		Once every 6 months		Leader and maintenance head				
4		Every 6 months		Leader & members				
		When necessary		Leader & trainers				
		Once a year		Leader				
5		When necessary		Operators				

Sample action plan.

5. Follow up the workers to correctly apply the standard procedure according to the action plan.
6. Improve the standard procedure when conditions change.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within --- hour.

Task 1. After confirming the result, prepare a new standard procedure that is capable of preventing reccurance of Muda eliminated

Task 2. Prepare action plan to implement and follow up the standard procedure using the given template

List of Reference Materials

- **BOOKS**

1- Identifying Waste on the Shopfloor (1996).

2- □ Ethiopian Kaizen Manual (2011)