Industrial Electrical/Electronic Control Technology Level III

Based on October, 2023, Curriculum Version II



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Acronym

QCD	Quality, Cost and Delivery
3MU’s	Muda, Mura and Muri
5M+Q+S	Man, Machine, Materials, Methods, And Measurement
5W and 1H Sheet	What, Who, When, Where, Why, and How.
SOP	Standard operating procedures
TPM	Total Productive Maintenance

Introduction to Module

Maintaining and Repairing Instrumentation and Control Devices operations, preventing and eliminating MUDA is necessary to perform the job specification in freight transport and logistic. This module covers identifying, eliminating and prevention of Muda.

This module covers the units:

- Identifying MUDA
- Eliminating Muda
- Muda Prevention

Learning Objective of the Module

- Identify Muda
- Eliminate Muda
- Muda Prevention

Module Instruction

For effective use these modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit.
2. Accomplish the Self-checks at the end of each unit.
3. Perform Operation Sheets which were provided at the end of units.
4. Do the “LAP test” giver at the end of each unit and
5. Read the identified reference book for Examples and exercise.

Unit One: Introduction to MUDA

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Elements of Satisfying Customer
- Methods for categorizing MUDA
- Cause and effect of MUDA

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Understand the Elements of Satisfying Customer
- Identify Methods for categorizing MUDA
- Realize the Cause and effect of MUDA

1.1 Elements of Satisfying Customer Requirement

If this three targets can be achieved then success of the organization and customer satisfaction are confirmed. QCD refers to the three elements of satisfying customer requirements: Quality, Cost and Delivery

Quality means degree of fulfillment of requirements. In a market economy or where competition is prevalent, these requirements are ultimately what the customers' demand of products or services they want to purchase. In most cases, companies providing the products or services determine the requirements based on their best attempt to meet the customer needs.

In other words, quality refers to conformance to specifications and customer requirements. For instance, Product quality requirements relate to the product's shape, appearance, performance, reliability, durability, and so forth. These product requirements are ultimately what the customers want.

In a broader sense, quality refers to the quality of process or work in designing, producing, delivering, and after-servicing the products or services. The foremost concern is with the quality of people. The three building blocks of a business are hardware, software, and "human ware." Only after human ware is squarely in place should the hardware and software aspects of a business be considered. Building quality into people means helping them become Kaizen conscious.

Cost: is monetary value of all the inputs to produce a product. In accounting terms, cost includes cost of labor, cost of materials, and other expenses. The cost items that can be directly attributable to a product manufacturing process is called direct expense, while others are called indirect expense. Total manufacturing cost, or product cost, is the sum of the two.

Unit manufacturing cost (unit product cost) is used in the factory level or workplace level cost management, therefore, used often times in KAIZEN activities as well. Cost is one of the three primary targets of improvement in KAIZEN activities along with quality and deliver.

Manufacturing/Service Cost = (Material + Labor + Facility + Utility + Others Cost)

The word cost usually refers to cost management, and not cost cutting. Cost management refers to managing various resources properly, and eliminating all sorts of wastes/Muda in such a way that the overall cost goes down.

Delivery time refers to the timely delivery of the volume of products or services to meet the customer's needs. On-time product delivery to the customer or adhering to the due date is critical to achieve customer satisfaction together with quality and cost in a competitive market environment

1.2 Methods for Categorizing Wastes

A number of methods for classification of waste have emerged. Here are some of them:

- The 3MU's
- 5M+Q+S
- The flow of goods
- The forms of wastes

1.2.1 The 3MU's



A. MUDA

Muda in lean management (lean management is a method of production management that focuses on making the least amount of waste possible, we find at first this method within Japanese companies like Toyota) is any activity that doesn't add value to the business. This Japanese word translates to "wasteful" in English, the opposite of value-added work and productivity. It's a best practice in manufacturing to reduce and eliminate wastefulness in order to improve efficiency and increase profitability. From an end-customer's point of view, value-added work is any activity that produces goods or provides a service for which a customer is willing to pay; **MUDA** is any constraint or impediment that causes waste to occur.

Types of MUDA

- **MUDA Type I:** non value-adding, but necessary for end-customers. These are usually harder to eliminate because while classified as non-value adding, they may still be necessary.
- **MUDA Type II:** non value-adding and unnecessary for end-customers. These contribute to waste, incur hidden costs and should be eliminated.

B. Muri

Muri means overburden, beyond one's power, excessiveness, impossible or unreasonableness. Muri can result from Mura and in some cases be caused by excessive removal of Muda (waste) from the process. Muri also exists when machines or operators are utilized for more than 100% capability to complete a task or in an unsustainable way. Muri over a period of time can result in employee absenteeism, illness, and breakdowns of machines. Standardize work can help avoid Muri by designing the work processes to evenly distribute the workload and not overburden any particular employee or equipment.

C. Mura

Mura means unevenness, non-uniformity, and irregularity. Mura is the reason for the existence of any of the seven wastes. In other words, Mura drives and leads to Muda. For example, in a manufacturing line, products need to pass through several workstations during the assembly process. When the capacity of one station is greater than the other stations, you will see an accumulation of waste in the form of overproduction, waiting, etc. The goal of a Lean production system is to level out the workload so that there is no unevenness or waste accumulation.

Relationship between Muda, Mura and Muri

Muda, Mura, and Muri are interrelated. Eliminating one of them will affect the other two. For example, a firm that needs to transport 6 tons of materials to a customer has several options.

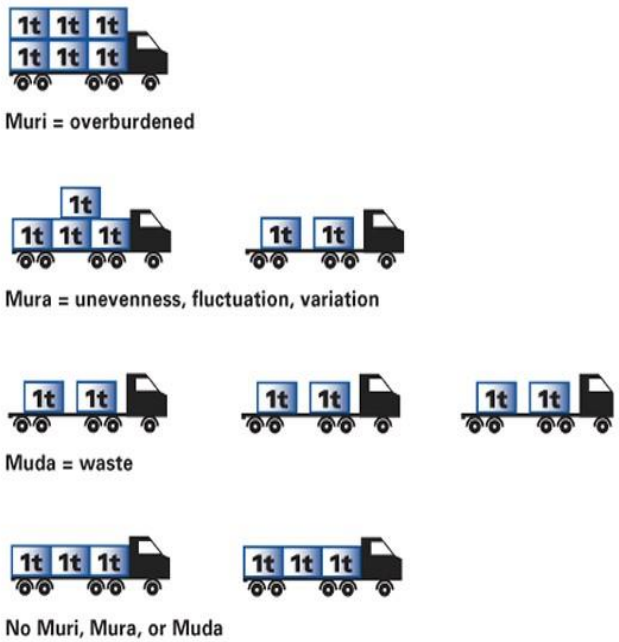


Figure 1-2Relationship between Muda, Mura and Muri

The first option is to load one truck with all 6 tons and make a single trip. However in this example, it would be considered Muri due to the overburden of the truck. This excess load can lead to a breakdown.

The second option is to divide the transportation into two trips. One with two tons and the other with four tons. This would be considered Mura since the unevenness of the arrival of materials to the customer can lead to problems at the receiving dock. In the first trip, the delivery may be too little for the production necessary on-site. In the second trip, the amount of delivered material may be too much for on-site storage and material handling. This leads to Muri since one of the truck is overburden and the receiver is also overburden for that delivery. Additionally, Muda can be seen from the uneven workload. This can cause employees who receive the materials to wait around. ***The third option*** is to load two tons on each truck and make three trips. Even though this option has no Mura and Muri, it has Muda since the truck would not be fully loaded on each trip. Each truck can carry up to 3 tons of material and this option makes one unnecessary trip.

The fourth option is to deliver the materials with two trucks each with 3 tons. In this example, this would be the optimal level that minimizes Muda, Mura, and Muri. Muda does not exist because the trucks are carrying the loads at their maximum capacity. There is no excess capacity nor unnecessary trips with this strategy. Mura does not exist because the workload between the two deliveries are uniform. As a result, there is no unevenness. And finally, Muri is absent from this option because both the truck and the operators are not working beyond their capacity.

In real world applications of Lean, it is not always easy or possible to find an optimal solution. Reducing Muda can lead to Muri. The existence of Mura can be seen as a waste in Muda. And finally Muri can lead to a breakdown in the system that will result in a large amount of Muda and Mura. Since real world problems are dynamic and the needs of customers are always changing, our work processes must also change as well. As we design our processes and standardize our work, we must look at the resulting system from the lens of these three concepts. Only by considering the impacts of Muda, Mura, and Muri and optimizing our production strategy can we develop an efficient Lean system.

1.2.2 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.

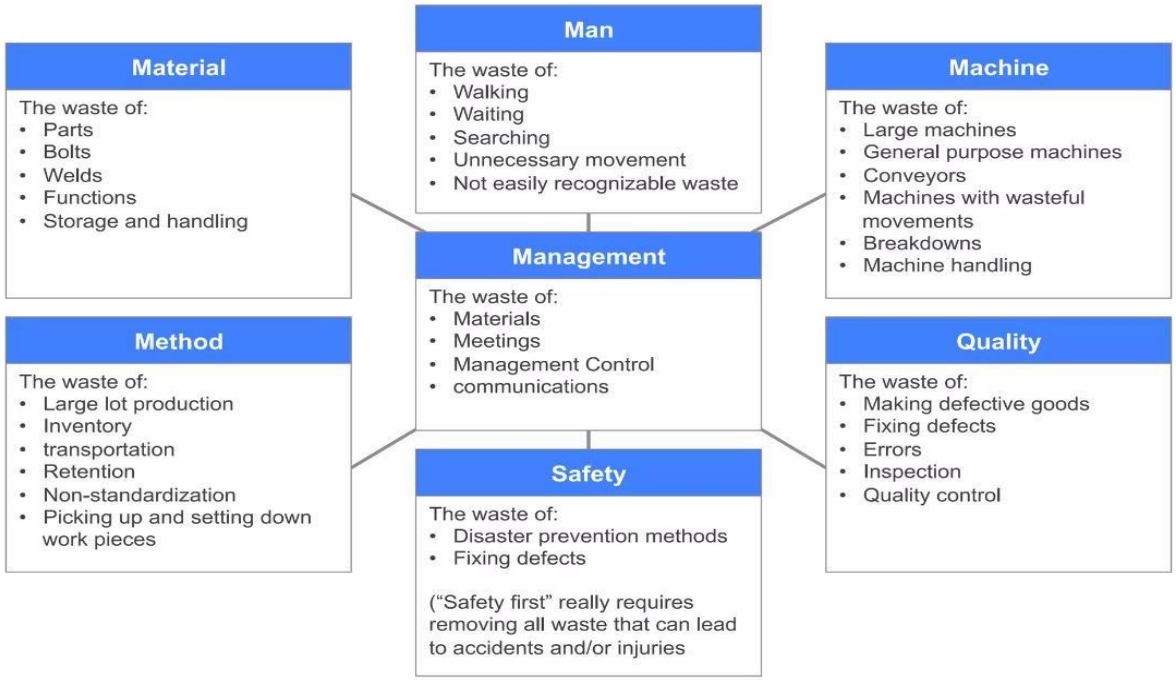


Figure 1-3: 5M+Q+S

1.1.1 The flow of goods

A third way of thinking about waste is to focus on the flow of goods in production

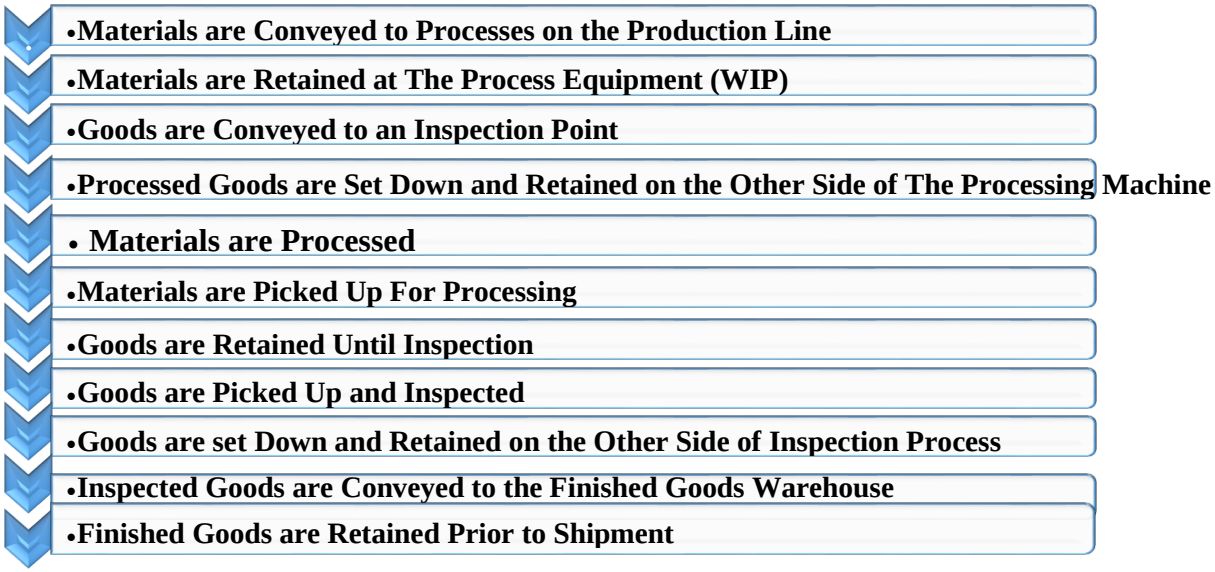


Figure 1.4 Flow Goods in Production

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

- **Retention** means stopping the flow of goods without adding any value to them. It is called stockpiling, warehousing, temporary storage, and so on. Retention produces inventory:

materials inventory before processing, work-in process inventory, or finished goods inventory. Inventory occurs for variety of reasons:

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

Retention adds cost without adding value. It is easy to think that inventory solves production flow problems but in fact it just hides them. When you eliminate retention points the real problems in the production flow must be addressed directly. This is the only path to wastefree production flow, or lean production.

- **Conveyance** refers to transporting goods without adding value. Movement between a retention points is often called "conveyance" and movement between a retention point and a process is often called "material handling."
- **Processing** means adding value. We either alter the raw materials or parts or when 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 occurring.

1.1.2 Forms of Waste

In lean manufacturing, the value stream is the sequence of steps that create value, for example, cutting, stamping, and painting. Any work that is not absolutely required to produce that value is Muda. Notice that it is not a waste reduction plan, focus group, or meeting agenda. Rather, it is the relentless pursuit of absolute elimination. When Muda is discovered the patient is sick and dying, it is an emergency that requires swift, decisive action, usually by the production floor personnel.

A. Overproduction

This waste refers to producing too much product. The overproduced volume must be transported, stored, inspected, and probably has some product you cannot sell. When you cannot sell the product the entire manufacturing process has been wasted. When product is overproduced, costs are incurred to store the product and the sales staff must work to produce discount campaigns to move it.

In a traditional non-lean factory, large batches of raw materials are ordered and processed into large batches of finished goods prior to being sold. This allows for a large inventory that is available for unexpected orders. In lean, however, there are multiple assembly lines working in parallel that move the product from raw materials to finished goods rapidly, thereby allowing for the production of rush orders.

Example

A computer hardware manufacturing plant produces thousands of units prior to being sold, in order to beat the competition to market. The product turns out to be slightly different than the market wants and must be discounted resulting in a loss on the product.



Figure 1-5Factory Overproduction



B. Waiting

This refers to workers that are not working, for any reason. Anything that is waiting for something is wasting a component of the process. Whether it's the products being produced, the people producing them, or the machines on the factory floor, the process is improved by

eliminating the act of waiting. In a lean plant, each production station is designed so that the product spends no time waiting for the next or previous step.

Example

In a vehicle assembly plant, the paint department is located in a centralized location and applies paint to the vehicles. They are shipped to the department, at which time the main assembly line workers and machines are idle as they wait for the product to return from the paint station.

C. Transportation

This is the waste of moving parts around. It can occur between processing steps, between processing lines, and also when product is shipped to the customer. In a lean facility, the product moves from station to station on one continuous line of flow, which minimizes the transportation of raw materials as well as the product itself. Inventories between production stations are minimized and the movement of goods is not a significant part of the production process.

Example

A furniture production facility accepts bolts, nuts, and steel hardware at its receiving bay. This material is sent to the parts department where it is sorted and stocked in bins. From there, the parts department supplies the assembly line as necessary.



Figure 1-7 Transportation Waste

D. Over processing

This refers to the waste of processing a product beyond what the customer wants. For example, engineers that make specifications greater than the customer is willing to pay for. Also, choosing poor or inefficient processing equipment also creates this type of waste. In a lean manufacturing plant, the value being provided to the customer is carefully assessed and the value stream mapped. That way it is clear to everyone what creates value and what is considered unnecessary, wasteful, or gold plating.

Example

In a textile mill, the thread spacing is adjusted higher than the customer's quality requirements to minimize the amount of rejected material. The mill should consider upgrading, retrofitting, or replacing its looms to minimize the over processing of its product.



Figure 1-7 Over Processing Waste

E. Movement

This is the unnecessary movement of people, such as operator and mechanics moving around looking for tools and equipment. It is very easy to overlook this type of waste because people are moving and active, but make no mistake it hurts the bottom line like any other Muda does. Lean production facilities have highly standardized assembly stations. The workers at each station perform standardized work and all of their raw materials, tools and equipment are available when they need them.

Example

A bicycle assembly plant requires workers to get their tools from the tool shed at the beginning of each shift. Most workers take between 5 and 10 trips to the tool shed throughout their shift. To eliminate this waste, more tools are purchased and placed at each station.



Figure 1-8 Movement Waste

F. Inventory

Lean manufacturing is famous for the concept of just-in-time production, whereby the raw materials are supplied to the assembly plant with a minimal amount of storage time prior to being processed. In fact, all storage is considered Muda, as it incurs costs to purchase it, store it, and potentially scrap it when business needs change. But how do you ensure that you don't run out of raw material and thereby shut down the entire factory's production?

Since production volume in a lean manufacturing plant is achieved via multiple, parallel assembly lines, a delay in any one assembly line does not render the entire plant in operational. If a critical raw material is obtained from an external supplier, however, that supplier must become lean as well, using multiple, parallel assembly lines to ensure there are no critical hiccups

Example

A manufacturer of light bulbs uses two separate assembly lines, one for the glass exteriors and one for the filament, which are then combined into a final assembly line. Because the glass exteriors have greater risk of problems and are quicker to produce, large volumes are stored in preparation for final assembly. To eliminate the excessive storage of this inventory, the glass assembly line is broken into 4 parallel assembly lines which can produce at exactly the rate of the filament assembly line. If any one of these parallel assembly lines breaks down, the plant still maintains 75% of its production. A onetime gain of the value of the stored product is achieved.



Figure 1-9 Inventory Waste

G. Making Defective Parts

Every manufacturing plant produces some scrap. Whether it's the excess pieces from a cutting operation or the destruction of finished goods, the material that cannot be used represents a waste that must be minimized.

In a lean plant, every assembly station uses standardized work and the product is not moved to the next station until the work has been completed to specifications in a process called jidoka. Compared to a non-lean plant where large batches of one type of work are performed followed by a machine changeover to another product, the gains in quality have been demonstrably large.

Example

A manufacturer of steel pipe takes large steel plates and puts them through a hot rolling process. The hot-rolling machines are large and expensive, and must be kept at maximum uptime. Hence, the raw material (steel plates) are often cut with 40% or more of the material wasted. The plant converts to lean manufacturing and implements several smaller hot rolling machines, allowing them to produce smaller and bigger pipe quickly, thereby using the material that would otherwise be scrapped.



1.3 Causes and Effects of MUDA

In this section we will discuss about the Causes and Effects of MUDA in accordance with the seven forms of wastes.

Table 1-1 1 Causes and Effects of MUDA

	Causes of Muda	Effects of Muda
Overproduction	• Large-lot production • Anticipatory production • 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	• Anticipatory buying of parts and materials • Blocked flow of goods • Increased inventory • No flexibility in planning • Occurrence of defects

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	• 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
Motion	• Isolated operations • Low employee morale • Poor work layout • Lack of training	• Increase in manpower and processing • Unstable operation • Increases production time • Can cause injury
Transportation	• Poor layout • Shish-skilled workers • Sitting to perform operations • The need for conveyance systems is assumed	• Waste of space • Production deterioration • Expansion of transportation facilities • Occurrence of scratches
Waiting	• Obstruction of flow • Poor equipment layout • Trouble at the upstream process • Capacity imbalances	• Waste of manpower, time, & machines • Increase in the in-process inventory • Failed delivery dates • Poor workflow continuity
Defect Making	• Emphasis on downstream inspection • No standard for inspection work • Omission of standard operations • Material handling and conveyance	• Increase in material cost • Productivity deterioration • Increase in personnel & processes for inspection
Processing	• Inadequate study of processes • Inadequate study of operations • Incomplete standardization • Materials are not studied	• Unnecessary processes or operation • Increase in manpower and man-hour • Lower workability • Increase in defects • Can reduce life of components

1.4 MUDA's Identification Tools and techniques

Under Kaizen umbrella, in the workplace uses different tools and techniques to draw and analyses current situation of the work place and to eliminate Muda.

A) Andon

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



Figure 1-10 Examples of Andon indicator light

Types of "Andon":

1. **Calling "Andon"**-Used for requesting parts.
2. **Warning "Andon"** -Used to inform occurrence of irregularities on the lines.
3. **Progress "Andon"** -Used to identify the progress of operation on the lines with a short Takt Time.

B) U-line

A 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.

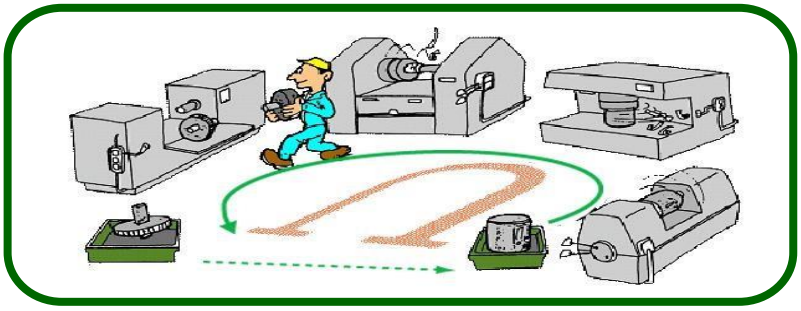


Figure 1-11 U-Line walking sample

C) In-lining

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**.**

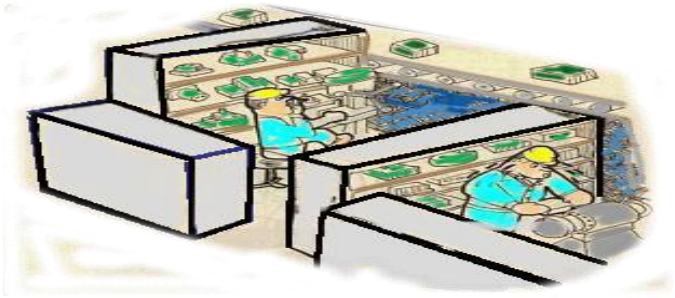


Figure 1-12 Integrating the Parts Processing Into the Main Line

D) Unification

Even if a flowing line cannot be formed, odd operations can be combined together in a place into an operator's work.

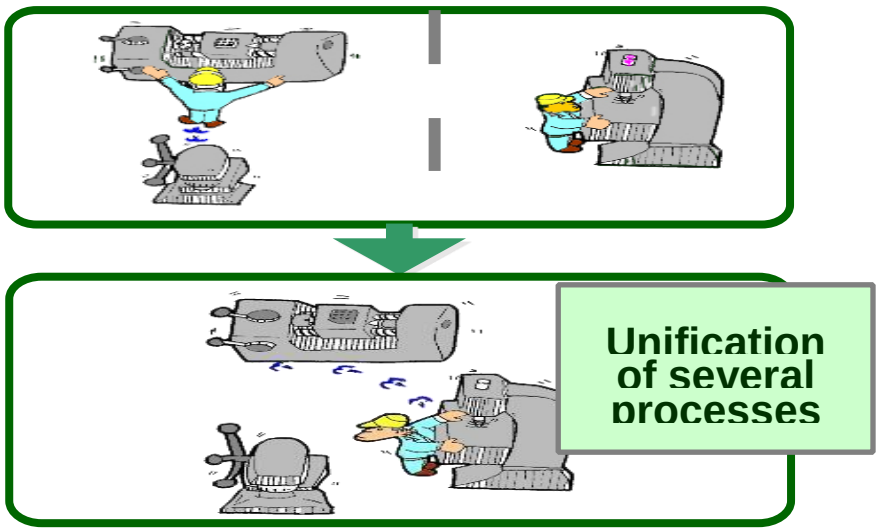


Figure 1-13 Unification Several Processes Sample

E) Multi-process handling & 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 worker 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.

F) A.B. Control (Two-Point Control)

A.B. control is a devised/Created automatic control function. It controls the machine movement when they come to start or stop working depending upon the number of work pieces piled/loaded up between the preceding process and the following process.

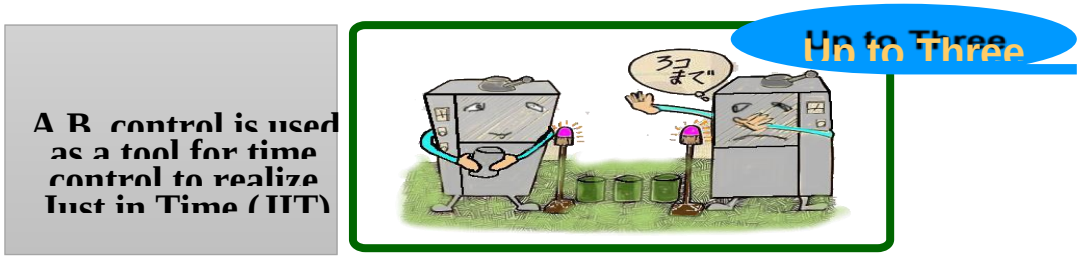


Figure1-14 A Devised automatic control function.

G) Cell Production Line

This is a production line that a single operator manages all the machining or assembly operations in unit production.

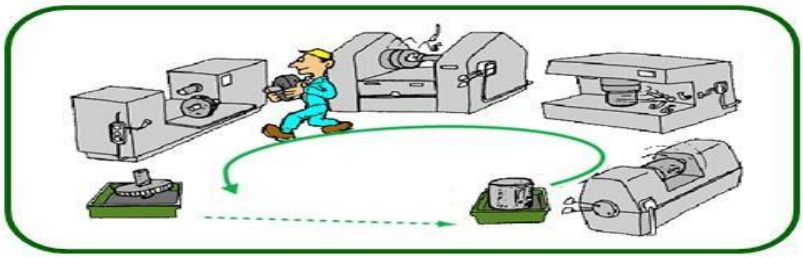


Figure 1-15 A Single Operator Manages All the Machining or Assembly Operations in Unit Production.

H) Shop Layout Analysis and Process Flow Analysis:

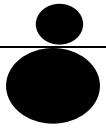
There are several tools you can use to analyze current conditions of shop layout and process flow quickly and effectively. We will describe some of them.

a) 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:

Table 1-2 Symbols Used In Arrow Diagram

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

To create arrow diagram, consider the following.

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

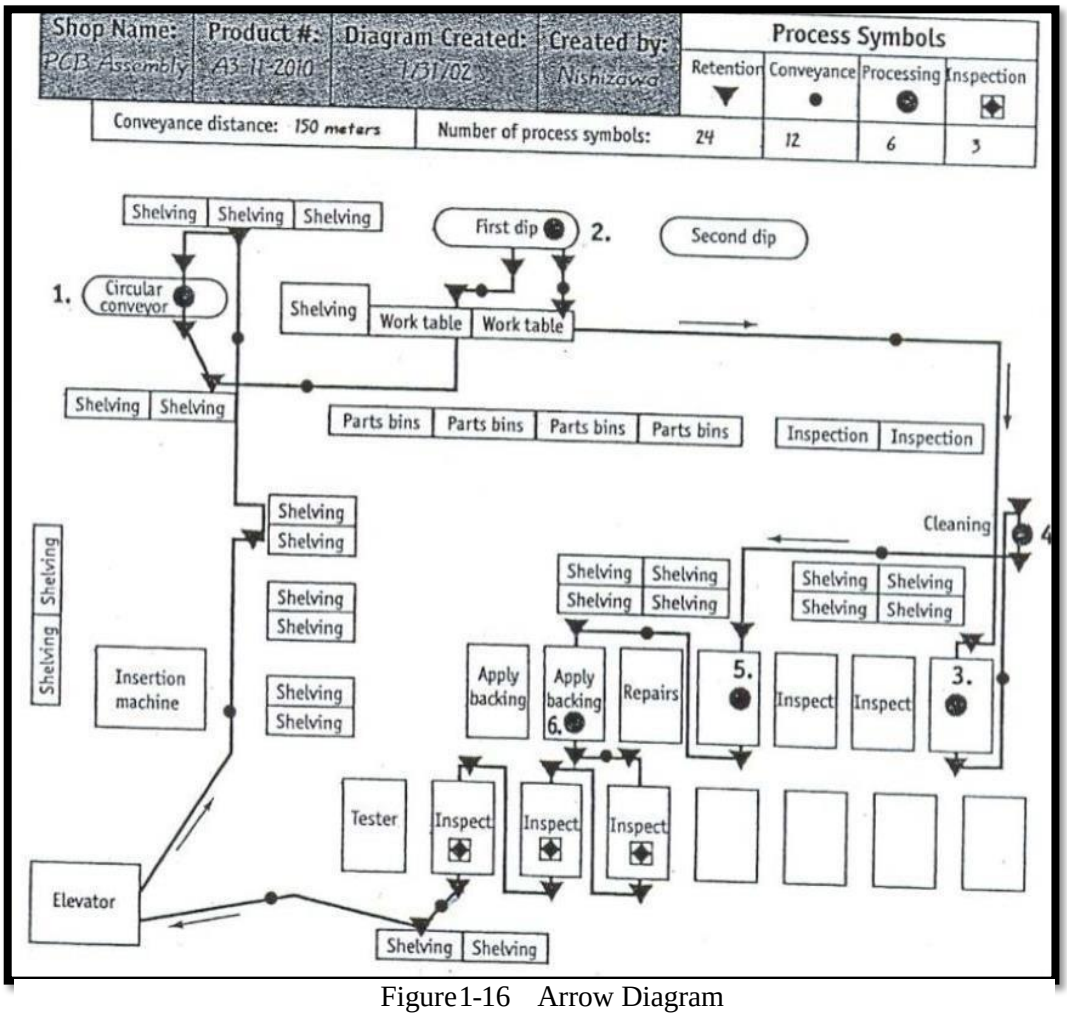


Figure1-16 Arrow Diagram

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.

b) 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.

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 1-17 Summary of chart flow analysis sample

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.

c) 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.

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'					

To prepare and use operation analysis table, consider the followings.

 Fill in the table on the factory floor

Figure 1-18Operations Analysis Table

- **Look For Detail** – write everything down that you possibly can.
- **Identify The Waste** – analyze as critically as you can to distinguish work from waste full movement. Everything that is not value-added must be counted as waste.
- **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.
- **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.

d) 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.

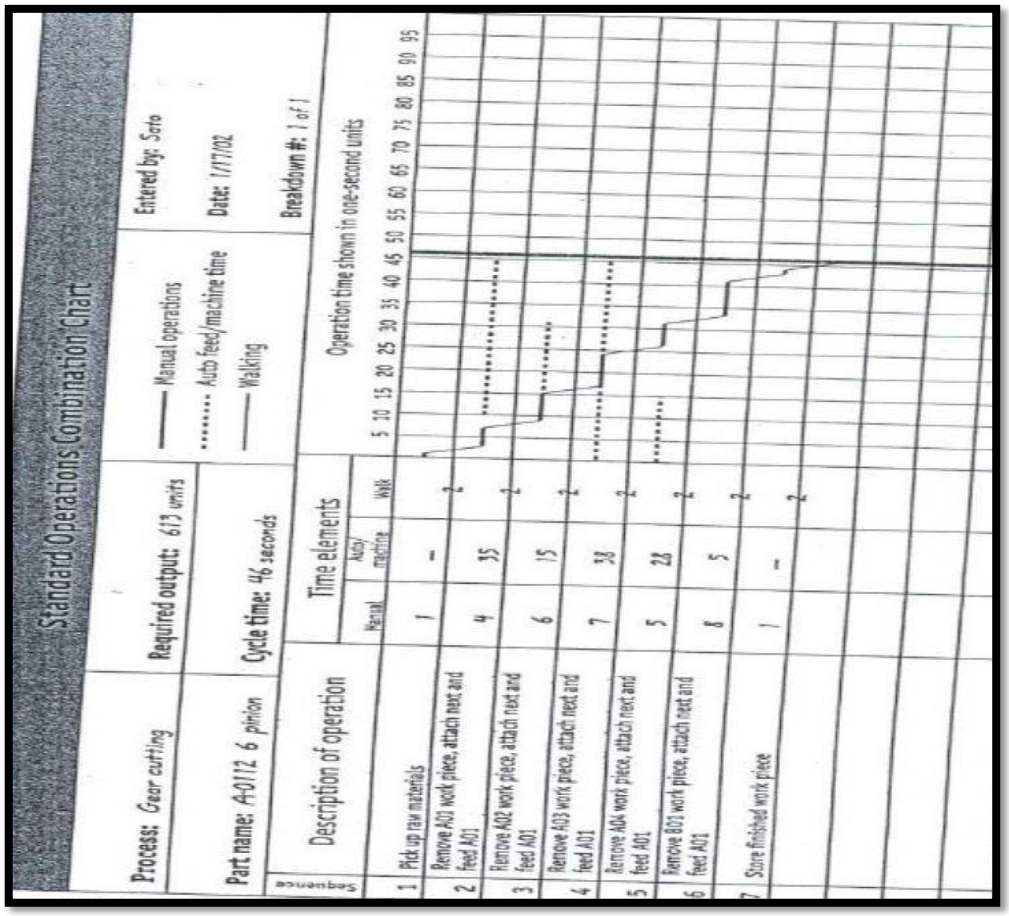


Figure 1-19 Standard Operation Combination Chart

e) 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.

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	Imporvement Ranking	Improvement Ideas and Comments

Figure 1-20 3Workshop Checklist for Major Wastes Findings To

use the workshop checklist for major waste finding, consider these points.

- Choose several processes or work areas and look for waste.
- Rank the improvements that are needed. Focus improvements on the process with the greatest total when you add up the magnitude columns
- Choose the first process to be improved from the workshop checklist.
- Brainstorm improvement ideas and then carry out them.

Magnitude of Waste	0----------No waste found 1---------Very little waste 2--------Some waste 3--------A lot of waste

Table 1-3Four Level of Magnitude

f) Layout improvement

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.

g) 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.

h) Line balancing

It 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.
    - Do not make Defect
    - 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.

4. Abnormality will understood simply.
5. “Visual control” visually control the states, ANDON,
6. Production analysis board, Standardized work chart etc

i) 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 1.1

Directions: Answer all the questions listed below.

Part I: Say True or False

1. Creating enough stock to replace the number of defective parts produced is a cause of Overproduction waste
2. Mura means unevenness, non-uniformity, and irregularity.
3. Long changeover times is an effect of Inventory waste
4. Increase in manpower and processing is a Motion waste
5. Muri means overburden, beyond one's power, excessiveness, impossible or unreasonableness

Part-II: Fill in the blank Space

1. ……. means degree of fulfillment of requirements
2. ……. is monetary value of all the inputs to produce a product
3. ……. in lean management is any activity that doesn't add value to the business.
4. ……non value-adding, but necessary for end-customers
5. ……non value-adding and unnecessary for end-customers

Part-III: Answer the following questions accordingly.

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

Operation Sheet 1.1

Operation Title: Identification of the seven types of MUDA

Instruction:

- Keep safe your working area
- Properly operated manual handling equipment

Purpose: To identify the identification of the seven types of MUDA. **Required**

Tools and Equipment: Stationary material and warehouse tags

Safety Equipment and Tools:

- Dust masks / goggles First aid Kit
- Glove Safety shoes
- Working cloth **Precautions:**
- Wearing appropriate cloth
- Make working area hazard free.

Quality Criteria: - Identification of the seven types of MUDA meet Kaizen Standard

Procedures:

The steps in the process are noted below. It may be useful to evaluate this procedure after every count, to see if the procedure should be altered to compensate for any counting issues experienced.

Step 1: Select one working operation area

Step 2: Identify and write wastes

Step 3: Identify/Define what your customer needs.

Step 4: Observe and list out the contents of the operation.

Step 5: Measure the severity of waste

Step 6: Compare the result between wastes

Waste-finding Checklist

Overproduction					
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 ten next process.				
Total					

Inventory					
Description of waste		**YNo**		**Magnitude**	**Causes**
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				**Date:**	
Description of waste		**Yes**	**No**	**Magnitude**	**Causes**
1.	Walking				
2.	Turning around				
3.	Leaning sideways				
4.	Bending over				
5.	Too wide arm movements.				
6.	Unnecessary wrist movements.				
7.	Wasteful work piece set up/removal.				
8.	Non-standardized repetition of operations.				
9.	Using different motions each time.				
10.	Operations divided into many little segments.				
Total					

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

Defect Waste				**Date:**	
Description of waste		**Ye**	**No**	**Magnitudee**	**Causes**
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				
Total					
Processing					
Description of waste		**Yes**	**No**	**Magnitude**	**Causes**
1.	Process is not required for product				
2.	Process includes unnecessary				
3.	Process can be replaced by				
4.	Part of process can be eliminated				
Total					
Result					

Unit Two: MUDA Elimination

This unit is developed to provide you the necessary information regarding the following content coverage and topics

- Necessity of MUDA Elimination
- Ways of Muda Elimination
- Eliminating and Reducing Waste

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Understand the Necessity of Muda Elimination
- Identify Ways of MUDA Elimination
- Elimination and Reduction of Waste

2.1 Necessity of Muda Elimination

Muda translates roughly as waste, and refers to the inefficiencies within processes which you can seek to reduce or eliminate entirely. In effect, lean declares war on waste – any waste. Waste or Muda is anything that does not have value or does not add value. Waste is something the customer will not pay for. The elimination of Muda intervenes in the processes of continuous improvement because it prevents the use of disproportionate means for the realization of an operation (Muri), the deviations of realization in particular with the instability of the processes (Mura) and finally it limits the waste (Muda).

2.2 Ways of Muda Elimination

The 7 forms of waste is a concept that is an integral part of Lean management. Learn what costs you money and resources as well as how to eliminate waste from your work processes.

A. Identify the Key Areas of Waste

Anything that provides no value to the customer and contributes nothing to your bottom line but has a cost can be classified as waste. It may exist in every department of your company. Thus it's critical for you to find out the most common areas of waste in your business.

Have you been producing too many goods that your customers do not even need? Or is there too much delay in your production process, so you need more time and costs to spend on machines and workers?

B. Manage Inventory Efficiently

Efficient inventory management means keeping the proper inventory (including raw materials, WIP, and finished goods), thereby reducing the risk of loss, decay, and damage. So, how do you control the procurement of goods at a manufacturing plant?

First of all, you must be able to forecast your inventory needs. Then, you need to make sure that the amounts and types of materials you keep are adequate for your production. Also, the goods you will produce follow your customer demands. This step aims to make sure that there will be no more unnecessary purchases.

C. Reduce Packaging Materials Usage

Product packaging is one of the significant contributors to waste. Good packaging designs are sometimes needed to highlight the uniqueness of your product, but that does not mean you have to sacrifice a lot of money for them.

Redesign your product if that's possible. For example, replace your product packaging with reusable and recyclable materials for starting a zero-waste lifestyle. Also, consider making a new product out of the cardboard boxes or leftover plastics that you use to pack your current products.

D. Establish Routine Maintenance Schedules

Check the condition of your machines and equipment regularly. Equipment damage or failures lead to unplanned downtime in the production process and other activities on the shop floor, which then cause order fulfilment delays. Furthermore, you will end up spending more on new machines and equipment. Therefore, it's important to schedule regular preventive maintenance.

Hash Micro's Manufacturing System can make it easy for you to record conditions and schedule routine maintenance for all manufacturing assets. The system also allows you to monitor fuel consumption and track your truck's location to identify problems early.

E. Leverage Automation for Your Business

You may be thinking that investing in software is not the right solution to reduce waste since you will still need to spend quite a lot of money to implement it. However, the cost you will spend on software is much cheaper than the costs you have to pay regularly on your workers, new machines, reparations, and other unnecessary tools.

2.2.1 Adopting the Necessary Attitude

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

It is very important that you understand that one purpose of discovering waste is to take the frustration out of your work.

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

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

2.2.2 Basic Principles for Improvement

There are ten basic principles for improvement in workplace by reducing wastes.

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.
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.

2.3 Eliminating and Reducing Waste

2.3.1 Eliminating seven Forms Waste

A. Waste Resulting From Overproduction

Maintaining this principle is also a means for shrinking markets to maintain margins since it is easy to improve productivity by increasing the quantities produced, but it is difficult to do so in a context of declining production volumes. Eliminating overproduction means paying great attention to planning but also agreeing not to seek the full use of resources. It can also involve losing stored objects in a hurry, no longer finding them in an emergency context. This wastes time, energy and even money if the product is not reusable. 5S allow organizes to arrange the storage area, production and teams.

B. Wastage From Waiting Times

An unoccupied resource is not necessarily a waste, because full employment must be distinguished from the activation of a resource. Pending parts can be assimilated to stocks. The halt of labor resulting from a lack of balancing or hazards affecting the production flow is minimized by operators being authorized to provide mutual assistance. Downtime due to equipment failure or series changes are drastically reduced using Total Productive Maintenance (TPM).

But this isn't the only instance affecting profits. When overproduction is stored in an unorganized manner, time is lost locating the product when needed. To avoid searching time, it is possible to set up visual management to locate products quickly and efficiently.

C. Waste Caused By Transport

Transporting a part from one machine to another gives it no added value. Having the various machines in flow-shop, i.e. in specialized workshops, is a good way of reducing internal logistics. In the flow-shop, all the necessary resources are available to carry out the various operations so that production flows smoothly. The job-shop or specialized workshop groups together resources of the same type, turning workshop, drilling unit, milling workshop, etc.

Carrying out the different operations on the same part requires constant transport and waiting times between workshops. It is generally accepted by all manufacturers that the availability of resources in specialized workshops leads to a real logistical nightmare. The pieces cross circuits and spend time waiting in the inter-stocks. Placing different resources very close to each other reduces transportation needs and physically prohibits large inter-stocks. If transport is being identified as waste and transport cannot be eliminated or further reduced, improvements can be sought.

D. Waste Due To Unnecessary Stocks

The definition of stocks must be understood in a broad sense; pending parts are a stock, parts on the way are a stock, perhaps in movement, but still a stock. The distinction between transfer batch and production batch leads to the principle of just-in-time flow. It is certainly the best indicator and means of destroying hidden stocks. The limited space available prevents storage. The layout of the various flow-shop resources considerably reduces transport requirements and allows little or no storage. Ideally, we try to put the resources in direct contact with each other and we try to work with transfer lots of one size. Automatic stores have the same characteristics as transitic means; they improve the storage operation but do not suppress it. The objective is to

eliminate waste due to unnecessary stocks, which implies the existence of "useful" stocks; which are vital.

To seek zero stock is nonsense.

E. Waste In Manufacturing Processes

It is hard to believe there can be unnecessary operations in manufacturing. However, trade and technological evolutions require less operations for a product. A critical analysis of each operation can uncover this kind of waste.

F. Unnecessary Movements

The notion of unnecessary movements is well known to all. The most obvious unnecessary movements are usually easily eliminated. It's understandable that bad habits spontaneously develop may go unnoticed. These habits can easily escape observation, either because these actions stop when an observer arrives, or because the observer is deceived by the ease of performers. It is sometimes surprising to note the efficiency with which the operators manage to carry out complicated and unnatural gestures.

G. Waste Due To Defective Parts

The abundant literature on quality management and the dissemination of the quality spirit in companies have raised awareness of the costs of non-quality. This cost exceeds that of the defective part and its reprocessing or replacement, because with just-in-time flows, the incidence of non-quality spreads downstream, creating delays, missing parts, loss of opportunity, etc. The important thing is to remove the cause of non-quality, not to treat the symptoms.

2.3.2 Reducing Waste

There are seven Strategies used for reducing the forms of Muda

S.No	Type of MUDA	Strategies to reduce
1	Transportation	• Store materials as close to the point of use as possible • Avoid transportation over long distance • Avoid overproduction
2	Inventory	• Dispose of obsolete material to save space and avoid confusion • Do not produce items ahead of customers delivery
3	Motion	• Motion economy principal • Effective supervision
4	Waiting	□ Time management
5	Over Processing	□ Improve work allocation and identify more effective methods
6	Overproduction	• Strong production planning and control • Production according to customer schedule • Firm delivery requirements
7	Defects	• Conduct design review; reduce defective materials and train employees • Maintain machines and equipment regularly

Self-check 2.1

Directions: Answer all the questions listed below.

Part I: Say True or False

1. The halt of labor resulting from a lack of balancing or hazards affecting the production flow is minimized by operators being authorized to provide mutual assistance
2. Transporting a part from one machine to another gives it no added value.
3. An unoccupied resource is not necessarily a waste, because full employment must be distinguished from the activation of a resource.
4. The notion of necessary movements is well known to all.
5. This cost not exceeds that of the defective part and its reprocessing or replacement,

Part-II: Fill in the blank Space

1. _____it's critical for you to find out the most common areas of waste in your business.
2. _____in Efficient inventory management means keeping the proper inventory
3. _____is one of the significant contributors to waste
4. _____check the condition of your machines and equipment regularly
5. _____is not the right solution to reduce waste since you will still need to spend quite a lot of money to implement it.

Part III: Answer the following question accordingly

1. How do we eliminating the seven Forms Waste?
2. How do we reduce waste
3. What is the importance of adopting the Necessary Attitude
4. Mention the ten Basic Principles for Improvement

Unit Two: MUDA Prevention

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- Methods of MUDA Prevention
- Practicing Standard Operating Procedures
- Total Productive Maintenance
- Improvements Gained by elimination

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identify the Methods of MUDA Prevention
- Perform Standard Operating Procedures
- Understand Total Productive Maintenance
- Recognize Improvements Gained by elimination

3.1 Methods of MUDA Prevention

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.

3.1.1 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, wellcommunicated, adhered to, and regularly re-assessed.

Standards are required for:

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

3.1.2 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.

a) **Red-tagging** – You probably did this at the beginning of your improvement activities when you implemented 5S. If not, do it now: put a red tag on everything in the factory that is not necessary to the current operations of the production process. After everyone

has had time to notice red-tagged items and claim any that are needed in their area, remove the remaining red-tagged items from the environment. Management can decide what to do with them: they can be sold, thrown out, or moved to a location where they are needed. Always keep the production floor free of any thing that is not directly part of the production process.

b) **Signboards**- The purpose of workstations and the names of the workers who operate them should be displayed at every processing point. Signboards can also identify equipment and processes so that everyone knows what things are and what they are used for. Standard quantities should be included on supply bins or carts. The products produced on each line or in each cell can be displayed, and so on.

c) **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.

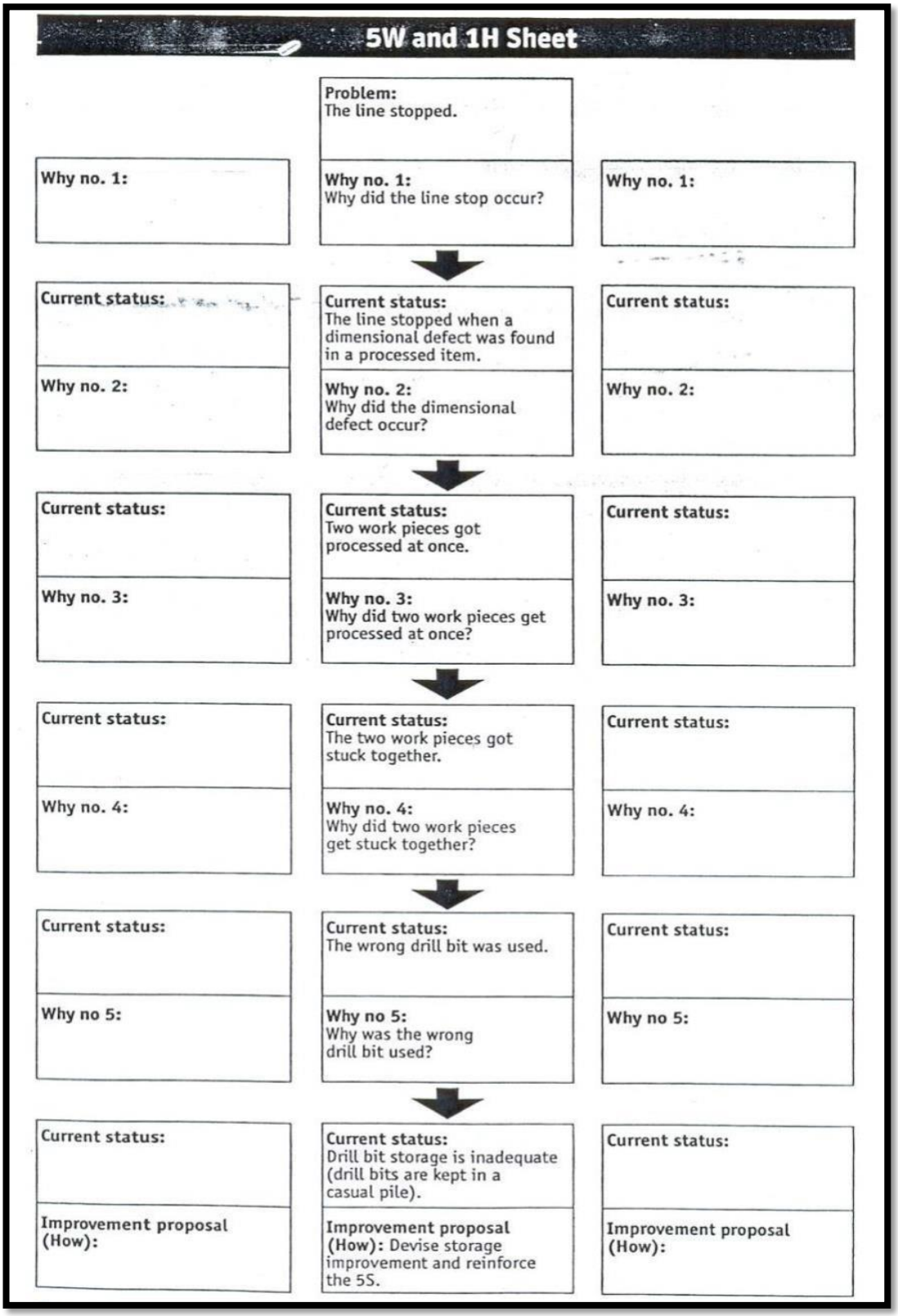
d) **Andon**- Different colored lights can report the status and needs of a system and signal when defects or abnormal conditions occur so that problems can be solved immediately.

e) **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.

f) **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.

3.1.3 5W and 1H Sheet

The 5W and 1H (five “whys” and one “how”) is a powerful method and one that never stops being wasteful in sustaining a waste-free production environment. The 5W and 1H sheet is a tool that will help you systematically apply this method.



5W and 1H Sheet

	Problem: The line stopped.	
Why no. 1:	**Why no. 1:** Why did the line stop occur?	**Why no. 1:**
Current status:	**Current status:** The line stopped when a dimensional defect was found in a processed item.	**Current status:**
Why no. 2:	**Why no. 2:** Why did the dimensional defect occur?	**Why no. 2:**
Current status:	**Current status:** Two work pieces got processed at once.	**Current status:**
Why no. 3:	**Why no. 3:** Why did two work pieces get processed at once?	**Why no. 3:**
Current status:	**Current status:** The two work pieces got stuck together.	**Current status:**
Why no. 4:	**Why no. 4:** Why did two work pieces get stuck together?	**Why no. 4:**
Current status:	**Current status:** The wrong drill bit was used.	**Current status:**
Why no 5:	**Why no 5:** Why was the wrong drill bit used?	**Why no 5:**
Current status:	**Current status:** Drill bit storage is inadequate (drill bits are kept in a casual pile).	**Current status:**
Improvement proposal (How):	**Improvement proposal (How):** Devise storage improvement and reinforce the 5S.	**Improvement proposal (How):**

Figure 3-1 5W and 1H Sheet

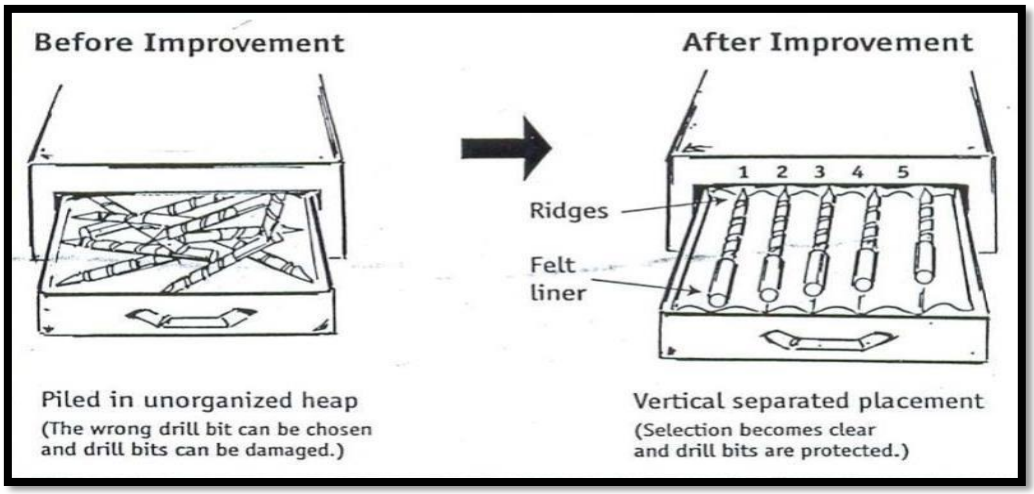


Figure3-2 Improvement in Drill bit Storage

Concepts for Asking "Why" and "How"

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

1. **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.
2. **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.

3. **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.
4. **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.
5. **Do it now-** Don't wait. Put your ideas into practice immediately

3.2 Practicing Standard Operating Procedures

Standard operating procedures (SOPs) are step-by-step instructions that act as guidelines for employee work processes. Whether written up in numbered steps or formatted as flow charts, effective SOPs are complete, clearly written, and based on input from the workers who do the job. When employees follow the SOP for a particular job, they produce a product that is consistent and predictable.

The following are some benefits of standard procedures and practices in completion of operation.

- Readiness for Future Growth
- Standard Operating Procedures Simplify Performance Management
- Control the Quality and Consistency of Your Product
- Protect Yourself from Knowledge Loss
- Save on Training Costs
- Greater efficiency

3.2.1 Types of SOPs

A. **Safety and Quality**: Since safety and quality are the most critical things to manage in any factory, you might want to focus on general or role-specific, work instructions that have an impact on these two areas. These SOPs ensure that workers follow internal controls and comply with industry and government regulations with regards to safety and quality.

B. **Line Performance**: If you are experiencing issues on a specific line, or need to create new lines due to expansion, you might want to focus on your line performance SOPs. These standard operating procedures would outline the most efficient and effective methods for setting up a line, switching between different products on the line, and operating and troubleshooting equipment on the line.

C. **Worker Performance**: If, on the other hand, you are experiencing performance gaps between shifts, teams or individual workers, or you need to quickly train new workers, you might want to make work instruction SOPs a priority. SOPs geared towards replacing a retiring worker would focus on the specific role and troubleshooting Procedures, while standard work instructions aimed at training many employees due to high turnover, would focus on entry-level workstations.

D. **Workplace Safety Procedures** The most important concept to remember is that you are responsible for your own safety and the safety of others. Most safety practices are

common sense. Unfortunately, they can be forgotten or overlooked unless you make safe practices a habit or an instinct.

E. **Lock-out procedures**: All powered machinery or equipment shut down for maintenance or repair must be secured against the possibility of the equipment being accidentally turned on while being worked on. To safeguard the person working on such equipment, lock-out procedures must be posted near the equipment, and the procedures listed must be followed before repairs or maintenance can start.

F. **Equipment Safety:** Extreme care should be taken when operating equipment. Before you attempt to operate any tool or piece of equipment, you must be fully trained by an experienced operator. Make sure that all guards are in place and function properly and that all electrical connections are properly made.

G. **Electrical safety:** Even though you may normally deal with low voltages and current, the values are never far away from lethal levels. You can receive a shock or burn from any common electrical circuit.

3.2.2 Checking the existing SOPs

Here are some questions to ask as you consider whether your existing SOPs are in use throughout your organization and are still working as you intended them to.

A. Staff awareness

- Where are the SOPs kept? Is the "centralized" copy really still available?
- Does everyone have a copy? Does new staff get a copy right away? Is there someone responsible for assuring this?
- Do all of the staff know—more than vaguely—what you are talking about when you ask about policies?

B. Usefulness of current SOPS

- Do you hear consistent grumbling from staff regarding any particular procedures
- Is the manual truly comprehensive? Have you noticed any gaps?
- Are the SOPs still realistic? Efficient? Effective? Is there now a better way
- When did you last really read them

C. Integration with Operations

- Are staffs still involved in conversations that arise about needed updates
- Are you open to changes and improvements, even though you worked so hard to get what you have now

- Is your training still linked to procedures, and successful at helping staff understand what it is they need to accomplish

3.2.3 Needs for Change

The following are the kinds of changes needed most of the time For example:

- If awareness is the issue, you may need to produce and distribute the procedures and ask supervisors to remind staff about them.
- If the information is out of date, you can use the process outlined in Part I to identify and make necessary changes to the SOPs.
- If there's a lack of acceptance of the SOPs, do some digging to find out why:
- Is the use of the SOPs included in job descriptions, employment policies, performance objectives, and training?
- Are the SOPs too cumbersome to use? Are they unnecessarily complicated or too far removed from day-to-day reality?
- Do your supervisors believe in their value and insist on their use? If not, why?
- Do line staff resist following the SOPs? If so, why?
- Identifying where the gaps between the procedures and their acceptance occur means that you can focus on a response that addresses the real issues and involves the right people.

3.2.4 Ways of Making Changes

Designate only one person to actually enter changes in the master document. This person could be your director of operations, manager, and executive director—based on what's best for your agency. Here is a suggested process for identifying and implementing changes to your SOPs:

- Include SOPs on the agenda of regular department staff meetings if there are any suggestions for change, deletions, or additions that need to be discussed.
- After discussion with the entire department, the department supervisor advises the director of operations of his/her team's suggestions or needed clarification.
- The director of operations evaluates the requested change and if necessary discusses it with the executive director or leader.
- If the Director of Operations and the ED agree to make the change, that section of the master SOP manual (both electronic and physical copy) is updated with the new wording and instruction.

- A memo then goes out to the entire staff with a summary of the update, and the page and section number that was updated. Each staff person also receives a printed copy of the new revised section for the staff member to update their own manual.

3.2.5 Updating SOPs

This is where most organizations get it wrong. So many of them keep the exact same operating procedures for years at a time–even though their business continues to evolve. Not good. There's no set rule here, but our recommendation is that you aim to update your SOPs every 6 months, or at least re-evaluate them on that timeline. If you find that some procedures are good to stay as they are, that's fine. But odds are that you'll notice significant areas for improvement. For example, your SOP for on boarding new clients might be razor sharp, but the one for sales calls is missing key steps–resulting in low conversions. Or vice versa.

At the 6 month mark, a few guiding questions to ask yourself about the SOPs are as follows:

- **Are they still relevant?**

Businesses can change a lot in 6 months so you want to make sure that your operating procedures reflect all the shifts you've experienced.

- **Are they producing the results that you want?**

You might notice that one area of your business is thriving while another is lagging. A reason for this could be expectations set by the SOPs. For any part of your business that's underperforming, a good first step is to look at where your SOPs could be improved.

- **Is there a 100% adoption rate from employees?**

This one is critical. If you're getting consistent feedback from employees that they're confused about certain steps in the SOPs, then you need to immediately address those concerns. This will help you improve productivity and compliance.

3.2.6 Improving Compliance with New SOPs

If we are updating existing SOP's it is a way to ensuring even more productivity and growth in your business. The final step of the SOP process, then, is to improve compliance from your employees. Because SOPs are useless unless they are followed correctly.

- Asking for feedback during the collaboration process was an excellent way to start–good thinking on your part!

- By including your employees from the beginning, you immediately let them know that they're valued members of the team. They feel that their voice is heard and the result is that they're more likely to stick to the new SOPs.

Another benefit of making the SOP updating process collaborative is that you improve team communication and cohesion. No one wants to feel like everything is an overbearing top-down process. Therefore, approaching this important aspect of the business as a team was another smart decision. There are additional ways to improve compliance, too. Detailed trainings and check-ins go a long way towards helping all employees get behind the new SOPs. This provides yet another reason why you should put just one person in charge of each SOP: you minimize confusion. Having one person check-in about the effectiveness of a certain procedure is efficient and clear. Any more than that and you run the risk of having "too many cooks in the kitchen."

These check-ins offer a great opportunity to receive constant feedback about what's working and what's outdated in your SOPs. For a more advanced compliance tool, you can build out an "accountability scorecard." This way, the check-ins become more of a productive two-way dialogue. Employees give feedback and you can score them (or they can score themselves) on how well they comply with the SOPs. This helps everyone in the business note areas for improvement– all in the spirit of continued growth. Win-win!

3.3 Total Productive Maintenance

Total productive maintenance is a maintenance management philosophy that strives for total perfection—no breakdowns, no defects, no accidents—by positioning maintenance as a core, value-added function rather than a cost center. In other words, TPM reframes maintenance as a business advantage because of its potential to greatly reduce unscheduled downtime and lost revenue.

More importantly, TPM requires machine operators to get involved in maintaining their own equipment—cleaning, regular lubrication, and basic inspection—thereby turning maintenance management into a shared responsibility throughout the entire facility.

Another key characteristic of TPM is plant personnel must take greater ownership of their workspace and the equipment they use. Finally, continuous process improvement is another main tenet of a total productive maintenance program. This means consistently re-evaluating processes and procedures throughout the value chain and eliminating waste (anything that does not provide value to the customer).

Implementing a TPM plan can greatly increase your overall equipment effectiveness (OEE) over time. While TPM allocates jobs normally done by maintenance technicians to all plant personnel, it does not eliminate the need for a dedicated maintenance team.

3.3.1 Benefits of Total Productive Maintenance

Under the TPM philosophy, a reactive approach to maintenance is unacceptable. This means strategies like breakdown maintenance and corrective maintenance—reactive maintenance strategies typically reserved for low-value assets or for cost-cutting purposes—have no place in a TPM-adherent facility.

While a total productive maintenance strategy poses high upfront costs—particularly in labor hours and employee training—its upsides manifest in the long term.

- **Less unplanned maintenance** – Unanticipated breakdowns are avoided by keeping machinery in good working condition through periodic inspections and maintenance.
- **Reduced equipment downtime** – By preemptively inspecting and maintaining equipment before and/or after use, repairs or replacements are likely to be less invasive and take less time.
- **Minimized delays, breakdowns and production stops** – Clean, well-lubricated equipment is less likely to break down unexpectedly. Secondly, making basic maintenance tasks and inspections the responsibility of the entire facility rather than just the maintenance team increases the likelihood that defects will be detected in advance.
- **Lower maintenance costs** – In the long run, reducing unplanned downtime with TPM can save organizations hundreds of thousands of dollars each year.
- **Better employee retention and engagement** – A clean, hazard-free workspace where technicians have access to tools that are in good working condition is key to recruitment and retention in manufacturing plants.

3.3.2 Pillars of Total Productive Maintenance

There are eight pillars of TPM—practices that organizations must put in place on a daily basis as they strive for total perfection. The pillars are based on the Japanese 5-S system below.



Figure 3-3 Pillars of TPM

1. **Autonomous maintenance.** Operators are charged with monitoring the condition of their own equipment and work areas and upholding a "baseline" standard. This means fully training plant personnel on routine maintenance such as cleaning, lubricating, and inspecting. Standardization ensures everyone follows the same processes and procedures.
2. **Focused improvement (kaizen).** Continual process improvement lies at the heart of total productive maintenance. Sometimes, this involves getting small teams together to brainstorm ways to improve maintenance and production processes. Team leaders may also collect information from operators to prioritize preventive maintenance and other process improvements. The end goal is to combine input from across the company.
3. **Planned maintenance.** Planned maintenance is the process of scheduling preventive maintenance in response to observed machine behaviors, such as failure rates and breakdowns. These PM tasks and schedules are shared by operators and maintenance personnel. The point of planned maintenance is to minimize service interruptions by scheduling maintenance when machines are idle or producing very little.
4. **Quality management.** Quality management involves proactively detecting the source of errors or defects to prevent them from moving down the value chain. This approach requires root cause analysis to determine cause and effect rather than using temporary Band-Aid solutions. Preventing defective products from moving down the line eliminates the need for time-consuming rework.

5. **Early equipment management.** Data gathered from previous maintenance activities can be used to ensure new equipment reaches optimal performance as quickly as possible (equipment is especially prone to failure at the beginning and end of its life cycle). Designing equipment with the input of the people who use it most allows suppliers to improve maintainability.

   Factors that equipment manufacturers should consider include:

   - Ease of cleaning and inspection
   - Accessibility of replacement parts
   - Increased safety features
   - Improving machine operability by ensuring they are comfortable to use

6. **Training and education.** Total productive maintenance can't be executed effectively without training operators on basic equipment maintenance and operation. Additionally, maintenance personnel may need to upskill as they switch from routine maintenance tasks to more highvalue functions such as preventive maintenance and analytical skills.
7. **Safety, health and environment.** Implementing facility-wide safety standards is the linchpin of total productive maintenance. Any new initiatives introduced as part of TPM should consider employee health and safety.
8. **TPM in administration.** Supporting production by improving administrative activities like order processing, procurement, and scheduling to ensure they are streamlined and waste-free. **3.4 Improvements Gained by MUDA**

The elimination of Muda intervenes in the processes of continuous improvement because it prevents the use of disproportionate means for the realization of an operation, the deviations of realization in particular with the instability of the processes and finally it limits the waste. Tangible benefits include: reduced lead time for orders, reduced costs, improved quality, inventory reductions, increased productivity, and work space utilization. Some of the intangible benefits include: improved employee morale, better teamwork, improved customer perception, and increased brand awareness.

Muda is one a tool to confirm the effectiveness of kaizen in the workplace. The following chart will serve as a checklist to check this effect.

Kaizen Effect Evaluation Sheet

Part one –Quantitative Results

S.No	Improvement Indicators	Before Kaizen	Target	After Kaizen	Improvement (%)	Remark
1	**Muda Elimination Indicators**					
	Tools& Equipment					
	Parts Saving					
	Raw Material saving					
	Transportation					
	Motion in Meter					
	Transaction Time					
	Excess Stock/Inventory					
	Expired material/Stock					
2	**Productivity indicators**					
	Lead time					
	Machine down time					
	Frequency of Machine failure					
	Production volume per day					
	Labor saving					
	Labor productivity					
	Delivery Time					
3	**Quality Indicators**					
	Defect rate					
	Raw Material damage in %					
	Number of Customer complaints					
4	**Other Indicators**					
	Number of New Inventions					

	Minimized Cost of Production					

Part Two –Qualitative Results

Elimination/Reduction based on the indicators listed below improvement Indicators Description of the Result

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	

Self-check 3.1

Directions: Answer all the questions listed below.

Part I: Say True or False

1. Standardization is to create and sustain a waste-free process
2. The factory is a living thing and must constantly be adjusted to stay responsive to changes in the environment
3. Total productive maintenance is a maintenance management philosophy that strives for total perfection—no breakdown
4. Standard operating procedures (SOPs) are step-by-step instructions that act as guidelines for employee work processes.
5. The 5W and 1H is a powerful method and one that never stops being wasteful in sustaining a waste-free production environment.

Part-II: Fill in the blank Space

1. _____ can also identify equipment and processes so that everyone knows what things are and what they are used for.
2. _____ 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.
3. _____ can report the status and needs of a system and signal when defects or abnormal conditions
4. _____ indicate when operations get out of sync with demand or when defects are around
5. _____ is the process of scheduling preventive maintenance in response to observed machine behaviors

Part III: Answer the following question accordingly

1. What are the Pillars of Total Productive Maintenance
2. Describe the types of SOPs
3. Discuss the benefits of Total Productive Maintenance
4. What kinds of changes needed most of the time for SOP

Operation Sheet 3.1

Operation Title: Planning and procedures for elimination of Muda.

Instruction:

- Keep safe your working area
- Properly operated manual handling equipment

Purpose: To Plan and procedures for elimination of Muda.

Required Tools and Equipment: Stationary material and warehouse tags

Safety Equipment and Tools:

- Dust masks / goggles First aid Kit
- Glove Safety shoes
- Working cloth **Precautions:**
- Wearing appropriate cloth
- Make working area hazard free.

Quality Criteria: - Planning and procedures for elimination of Muda is meet Kaizen standard

Procedures:

The steps in the process are noted below.

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.

- Using the more detailed waste-finding checklists provided, find more specific instances of waste.
- 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
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.

S.No	Why?	What?	Where?	Who?	When?	How?
	Objectives	**Items to be implemented**	**Location**	**Person(s) charge**	**Time/Duration**	**Method**

LAP Test

Practical Demonstration

Name: _____ Date: _____ Time started: _____ Time finished: _____

Instruction I: Perform the following tasks by referring Annexes

Task 1: Identify Wastes in the workplace

Task 2: Eliminating Wastes in the workplace

Task 3: Reducing Wastes in the workplace

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The Experts who developed the TTLM