Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 66

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-1 LG-66**
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LO1: Identify and select theme/problem

ADRA Ethiopia

Instruction Sheet	Learning Guide:-66

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

- Following Safety requirements with safety plans and procedures.
- Listing all possible problems related to the process /Kaizen elements using statistical tools and techniques.
- Identifying and listing all possible problems related to kaizen elements on Visual Management Board/Kaizen Board.
- Classifying Problems based on obviousness of cause and action.
- Selecting Critical factors like the number of customers affected, Potentials for bottlenecks, and number of complaints etc
- Selecting Problems related to priorities of Kaizen Elements given due emphasis.

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:-**

- Identify Safety requirements with safety plans and procedures.
- List all possible problems related to the process /Kaizen elements using statistical tools and techniques.
- Identify and list all possible problems related to kaizen elements on Visual Management Board/Kaizen Board.
- Classify Problems based on obviousness of cause and action.
- Select Critical factors like the number of customers affected, Potentials for bottlenecks, and number of complaints etc
- Select Problems related to priorities of Kaizen Elements given due emphasis.

Learning Instructions:

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

Information Sheet-1	Following Safety requirements with safety plans and procedures.

1.1. Theme Selection:

At the first stage, members select a theme from among the problems in the workplace—a theme concerning problems for which they think solutions would be most beneficial. This is to provide clear vision on the objectives for the activity. Members ask themselves, —What kinds of problems do we have and how do we improve them?

1.2. To applying a problem shall be accountable for the following safety program activities:

- Visibly demonstrate and communicate their commitment to safety as a top priority of the department.
- Abide by safety policies/procedures.
- Establish expectations for employees to conduct Work Activity Safety Planning before work begins, during the actual work as conditions change, shifting to other work, and when emergent work is encountered.
- Review, approve, and communicate the safety and health policies and procedures as a foundation for the overall Safety Program.
- Establish annual agency injury/accident reduction goals.
- Use data to monitor the performance of the overall safety program and report program performance to stakeholders.
- Prioritize and advocate for the needed resources to meet the department's injury reduction goals and to support the safety program.
- Set direction that employee safety is a performance expectation of all positions Conduct periodic inspections of field and facility operations to ensure consistency with safety program policies and procedures.
- and safety performance will be evaluated for all personnel.
- Recognize agency safety achievements.
- Use all appropriate personal protective equipment.

Self-Check-1	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. To identify a problem the 1st step is

   A. Problem identify B. theme selection C. problem analysis D. problem organize

2. To select theme/problem the safety consider:-

   A. Abide by safety policies B. Recognize agency safety achievements.

   C. Use all appropriate personal protective equipment D. all

3. Review, approve, and communicate the safety and health policies and procedures as a foundation for the overall Safety Program. A. True B. False

4. Safety plans and procedures to help

   A. to get the right problem B. to flow steps of gathering data

   C. accident reduction D. All

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet-2	Listing all possible problems related to the process /Kaizen elements using statistical tools and techniques.

2.1 The concept of qc story/ pdca cycle

QC Circles were organized in Japan as a way of getting operators to participate in quality control activities. In order to be efficient and effective in their problem-solving activities, members follow the **Plan-Do Check-Act (PDCA**) cycle, in which they plan for improvement, implement what is planned, check and analyze what has been implemented, and act based on the results of the checks.

2.2 What is a QC Story?

The problem-solving processes of QCC activities will be often presented in the form of a QC Story. Initially this method was used to report Circles' activities after they had solved their problems.

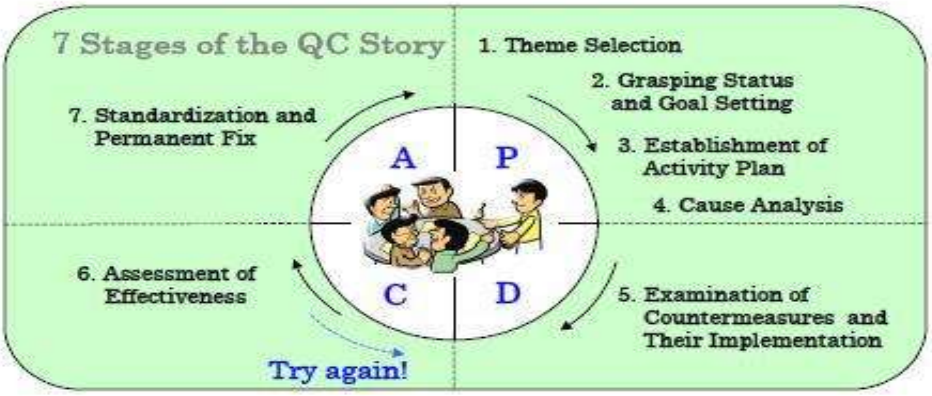


Figure 1:7stage of the QC story

2.3 Why do we use the QC Story?

QC Circles follow a problem-solving process that provides guidelines for processes to be taken in order to run QCC activities. But why do we need to follow a process? Why not follow our own ideas and procedures? Why are guidelines so important? The reason is that in problem-solving procedures, it is very important to analyze the data and provide appropriate judgment according to scientific evidence.

2.4 Statistical Tools And Techniques:

QC Circles need a well-defined process for collecting facts and data that help them to understand situations in real time and develop countermeasures (implemented through the following PDCA management cycle or the QC Story) to address problems and prevent them from recurring. QC tools and QCC techniques, weapons to help QC Circles make decisions that allow them to properly follow the QC Story, are not only powerful but also imperative. In other words, it is impossible for QCC members to follow the QC Story without proper QC tools. This chapter describes the **seven QC tools** and **QCC technique**s that QC Circles all over the world use in their problem solving.

Self-Check- 2	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. QC circles a way of getting to participate in quality control activity

A. False B. True

2. The order/step from start-to-end of problem solving activity.

A. Do- Plan Check-Act B. Do -Check Plan- -Act

C. Plan-Do Check-Act D. Check -Plan Do –Act

3. QCC is not problem solving process activity.

A. True B. False

4. One of the following is statistical tools and techniques of problem solving:

A. Seven QC tools B. QCC techniques C. A and B D. none

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet-3	Identifying and listing all possible problems related to kaizen elements on Visual Management Board /Kaizen Board/.

3.1 Signboard strategy

The signboard strategy uses signboards to identify what, where, and how many. The three main types of signboards are:

- Location indicators that show where items go.
- Item indicators that show what specific items go in those places.
- Amount indicators that show how many of these items belong there.

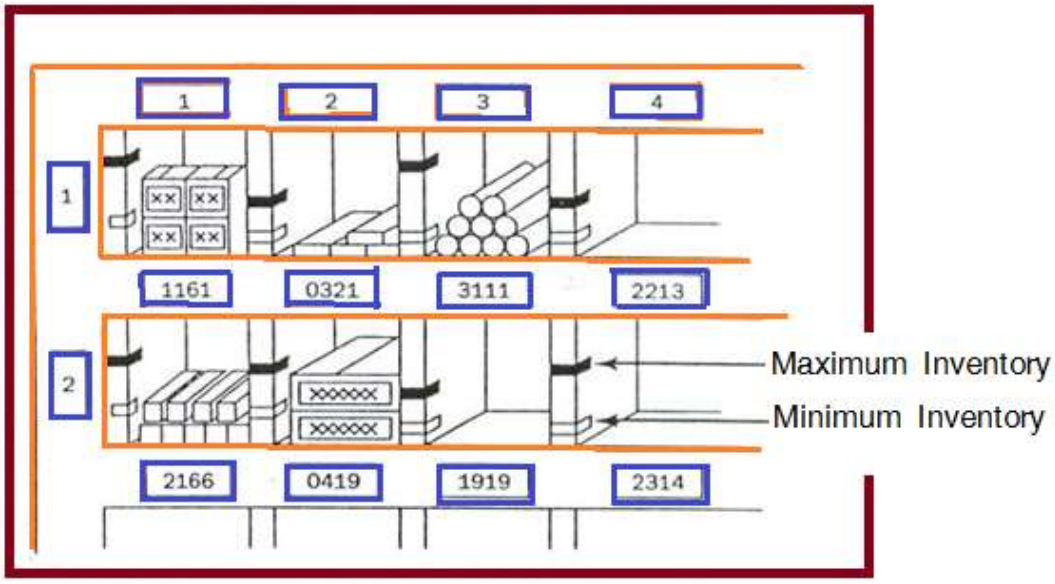


Figure 2: Kaizen Board

- Names of work areas
  - ✓ Inventory locations
  - ✓ Equipment storage locations
  - ✓ Standard procedures
  - ✓ Machine layout

For example, in order to identify inventory stored on shelves in a warehouse, a whole system of signboards may be used. Every section of shelving may have a signboard identifying the section. Within that section, vertical and horizontal addresses on shelves can be identified with

additional signboard. Each item stored on the shelve may also have a signboard showing the “return address” for that item. The “return address” allows the item to be put back in the proper location once it has been removed.

Self-Check- 3	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. Signboard strategy indicates
   A. Location indicators that show where items go.
   B. Item indicators that show what specific items
   C. Amount indicators D. All E. none

2. Names of work areas indicators
   A. Inventory locations
   B. Equipment storage locations
   C. Standard procedures
   D. Machine layout E. All

3. Each item stored on the shelve may also have a signboard showing the “return address” for that item
   A. True B. False

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet-4	Classifying Problems based on obviousness of cause and action

4.1 Introduction

Problem exists when there is a gap between what you expect to happen and what actually happens. Problems must be resolved for organizations to function properly.

- **Causal of problems**: cause is a condition or an event that results in an effect (anything that shapes or influences the outcome). This may be anything from noise in an instrument channel, a pipe break, an operator error, or a weakness or deficiency in management or administration. There are seven major causal factor (Causes of Problems) categories.
- **These are:**
  - ✓ Equipments, plant and/or tools Problem
  - ✓ Materials Problem
  - ✓ Methods and Procedures Problem
  - ✓ Policies
  - ✓ People /Personnel Error
  - ✓ Design Problem
  - ✓ Training Deficiency
  - ✓ Management Problem
  - ✓ External Phenomenon/Other external factors

The goal of problem management is to minimize both the number and severity of incidents and potential problems to the business/organization.

Problem management has reactive and proactive aspects:

- **Reactive – problem solving when one or more incidents occur**
- **Proactive** – identifying and solving problems and known errors before incidents occur in the first place

Note: There are often several root causes for one problem

- ✓ Contributing Causes: Contributing causes are causes that taken alone would not cause the problem but can increase the risk of the issue to happen. Analysis for these causes generally require taking small steps (or a finer look) to be identified and fixed.
- ✓ Root Cause Analysis (RCA): The process of identifying all the causes (root causes and contributing causes) that have or may have generated an undesirable condition, situation, nonconformity or failure.
- ✓ Containment -the action to mitigate impact of the problem and protect the operations /customers (stop the problem getting worse). Includes correction, immediate corrective action, immediate communication and verification that problem does not degrade
- ✓ Immediate Correction: Action(s) taken to immediately fix the nonconformity.

- Note: For a product non conformity, correction might be understood as reworking the part, accepting the non-conformance through concession process, or ultimately scrapping it. For a system issue, it may include correcting the paper work or issuing a new purchase order. For a delivery issue, it may include air transportation instead of by truck or by ship, increasing production rate, etc
  - ✓ Immediate Corrective Action: Action(s) taken to eliminate, prevent, or reduce the probability of any additional non-conformances related to the apparent cause from happening again in the short term.

- Note: These actions may be temporary and should remain in place until root cause(s) is(are) identified and permanent root cause corrective action(s) is(are) implemented and verified to be effective.
  - ✓ Root cause corrective action (or permanent corrective action): The corrective action(s) implemented to address the root cause(s) and contributing cause(s) of the undesirable condition, situation, nonconformity or failure and that will permanently prevent recurrence
  - ✓ Root cause (or Permanent) corrective action verification: Actions taken to verify that the planned actions were taken as scheduled.

- ✓ Note: This includes specific actions, milestones, completion dates, and responsibilities.
- ✓ Root cause (or Permanent) corrective action effectiveness: Actions taken to verify that the planned actions have permanently prevented recurrence of the identified root cause(s).

Self-Check- 4	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. What is problem?
   A. is a solution B. is a gap C. is a process D. All
2. What is causal of problem?
   A. is a solution B. is a problem influence the out come
   C. A&B D. All
3. one of the following is not cause of problem?
   A. Policies B. People /Personnel Error C. Design Problem
   D. Training Deficiency E. None

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet-5	Selecting Critical factors like the number of customers affected, Potentials for bottlenecks, and number of complaints

5.1 Data Collecting and Analysis

What is data?

The most critical matter for QC Circles is to understand facts and data. Without correct data collecting and analysis, it is impossible to solve problems in the workshop. Points concerning the treatment of data are described hereinafter. Data is information about a certain event or matter expressed objectively and through both numerical values (numerical data) and language (verbal data). Numerical data has measurement values and discrete values.

- **Measurement values**: fixed data such as length, weight, and profit
- **Discrete values:** Variable data such as the number of defects
  Verbal data has logical expression words and emotional expression words.
- **Logical expression words**: Communicated objectively (instrumental words for reporting.
- **Emotional expression words**: needing translation into logical expression words.

5.2 How is data collected?

How to collect data

Step 1: Clarify the objectives of collecting data.

Step 2: Clarify the items to be understood within the problem.

Step 3: Determine the method of stratification.

Step 4: Make a check sheet.

Step 5: Gather facts from the data using QC tools.

5.3 Seven (7) QC tools

The seven QC tools are used to collect, summarize, and analyze data (quantitative and qualitative). The seven QC tools and QCC techniques described here are the most basic ones. As the Circle matures and the members are able to handle more complex QC tools and techniques, these should be made available to them by the QC Circle Office. The seven tools are usually considered to be

- **Stratification**

The objective of stratification is to grasp a problem or to analyze its causes by looking at possible and understandable factors or items. Collected data of a single population is divided— by time, workforce, machinery, working methods, raw materials, and so on—into a number of stratums (or layers) to find some latent characteristics among the data—be they the same or similar.

- **How to stratify data**
  - ✓ Step 1: Clarify the objectives of stratifying data.
  - ✓ Step 2: Clarify the items to be stratified within the problem.
  - ✓ Step 3: Determine the method of collecting data.
  - ✓ Step 4: Check and compare the stratified data items.
  - ✓ Step 5: Find causes by finding big differences among data items. If a big difference is not found, keep going back to step 2 to add some other stratifying items until obvious peculiarities among the data are discovered.

- **Typical Categories of Stratification**
  - ✓ Time: year, month, week, day, hour, night, afternoon, morning, period,
  - ✓ Workforce: division, section, dayshift, nightshift, group, age, experience,
  - ✓ Machinery: line, equipment, machine number, model, structure, jigs, dies, etc.
  - ✓ Working method: working procedure, manual, speed, etc.
  - ✓ Raw material: place of origin, supplier, lot, charge, etc.
  - ✓ Product: country, unit, order, manufacturer, service provider, etc.
  - ✓ Environment: temperature, humidity, weather, etc.

- **Pareto Diagram**

A Pareto diagram is a form of bar chart with the items arranged in descending order so that you can identify the highest contributing factors to a problem. Pareto diagram shows which defective items should be tackled first.

How to construct Pareto diagram

Step 1: Clarify the objectives of constructing a Pareto diagram.

Step 2: Clarify the stratified items of collected data within the problem.

Step 3: Design a data tally sheet listing the items with their totals.

Step 4: Fill out the tally sheet and calculate the totals.

Step 5: Make a Pareto diagram data sheet listing the items, their individual totals, cumulative totals, percentages of overall total, and cumulative percentages.

Step 6: Arrange the items in terms of number of occurrences and fill out the data sheet. The item—others‖ should be on the last line, no matter how large it is. This is because it is a collection of items for which the largest number of occurrences of any one item is smaller than that for the smallest of the individually listed items.

Step 7: Construct a Pareto diagram from the Pareto diagram data sheet.

- Draw two vertical axes, marking the left-hand vertical axis with a scale from 0 to the overall total and the right-hand with a scale from 0% to 100%.
- Draw a horizontal axis. Construct a bar diagrams, dividing the horizontal axis according to the numbers of items.
- Draw the cumulative curve (Pareto curve)

Step 8: Add necessary information regarding the diagram: title, significant quantities, units, sampling period, subject and place of data collected, total number of data, etc.

Example: Data tally sheet of kitchen ware breakage

Table 1: Pareto diagram data

No	Breakage items Tally	Total
	Teacups	10
	Glasses for water	150
	Saucers	20
	Oval plates	30
	Square plates	70
	Others	50
	Total	**330**

Table 2: Pareto diagram data sheet

Pareto Diagram Data Sheet of Kitchen-Ware Breakage

Theme: Cost reduction of kitchen-ware breakage

Total Sample: 300

Period: April 1-7, 2003

Date: May 01, 2003

Name: N. Kaneko

No.	Breakage items	Total	cumulative sum	Per	cum. per
	Glasses for water	150	150	45.5%	45.5%
	Square plates	70	220	21.2%	66.7%
	Oval plates	30	250	9.1%	75.8%
	Saucers	20	270	6.1%	81.8%
	Teacups	10	280	3.0%	84.8%
	Others	50	330	15.2%	100.0%
	Total	**330**			

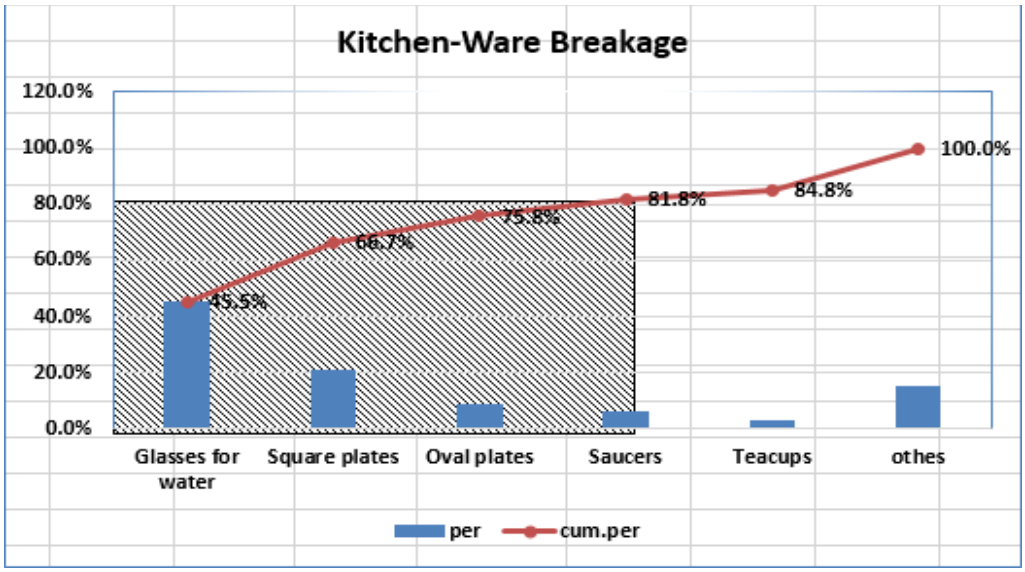


Figure 3:pareto diagram

- **Cause and Effect Diagrams (Ishikawa Diagrams)**

This diagram composed of lines and symbols is designed to represent the relationship between effects and their causes. It is sometimes called an Ishikawa diagram, after Dr. Kaoru Ishikawa who is considered the father of QC Circles. Others call it a fishbone diagram due to its resemblance to a fish skeleton. It is a very effective tool for analyzing the causes of a problem, even household problems like high consumption of electricity.

- **How to construct cause and effect diagrams**

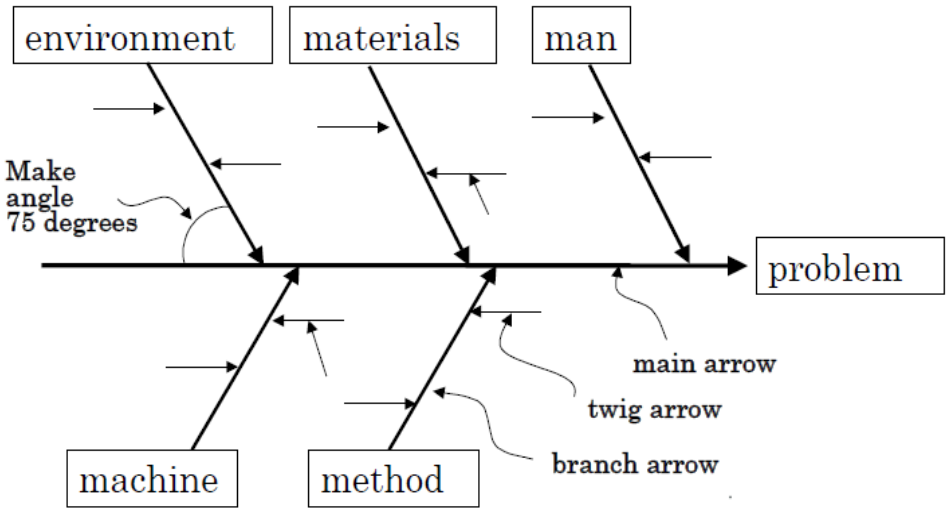
Write the problem on the right side and box it.

Step1: Draw a main arrow from left to right, with the head of the arrow pointing to the problem.

Step 2: Identify all of the main categories of causes of the problem, for example, man, method, materials, machine, and environment. In below figure 4, these factors were grouped as appliances, occupants, household procedures, and household food supplies. Use branch arrows to connect the categories to the main arrow.

Step 3: Using twig arrows, connect the individual main causes identified in step 2 to their respective branch arrows.

Step 4: Identify the detailed causes of each main cause and connect them to the twig arrows, using even smaller twig arrows.



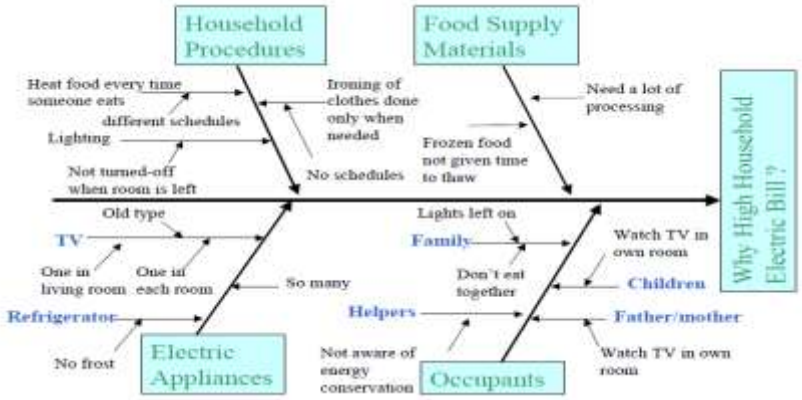


Figure 4: Cause and Effect Diagram

- **Graphs**

A graph is a tool used to present an area of interest in visual form. There are various types of graphs, and the most common are bar graphs, line graphs, and pie charts. People involved in QCC activities are recommended first to decide on the data to be collected and the period in which it will be collected, regardless of the type of graph they will use.

✓ **How to construct a bar graph**

Step 1: Draw the horizontal and vertical axes of the graph, using the horizontal axis for the period and the vertical axis for the value.

Step 2: Divide the horizontal axis into equally spaced vertical columns, each column Representing a period.

Step 3: Divide the vertical axis into as many equally spaced horizontal rows as required, each higher row representing a higher value.

Step 4: Draw the bars.

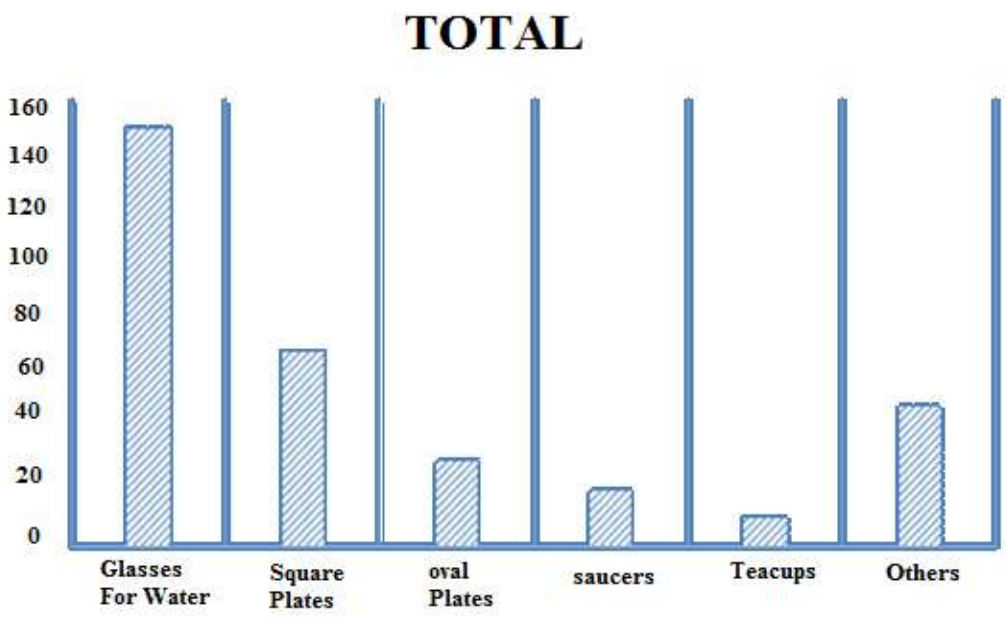


Figure 5: Typical example of bar chart

- ✓ **Line graph**

Line graphs are used to show actual situations at given points in time.

They may also be used to predict future trends. They may be broken lines or straight lines.

Step 1: Draw the horizontal and vertical axes of the graph, using the horizontal axis for the period and the vertical axis for the value.

Step 2: Plot the points corresponding to the values.

Step 3: Connect the points.

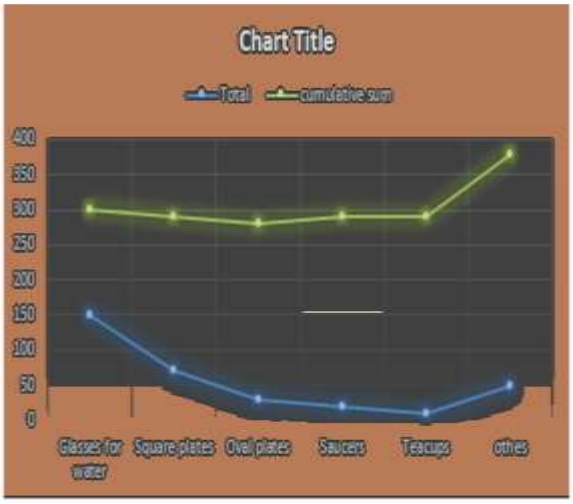


Figure 6: Line Graph

- **Pie chart**

A pie chart is used to denote relative portions of a situation; each slice of pie represents a percentage of the whole.

- ✓ **How to construct a pie chart**

Step 1: Draw a circle.

Step 2: Divide the circle into slices that correspond in size to the relevant percentages. For instance, if you divide the circle into four equal slices, then each is 25 percent of the whole.

Step 3: Moving clockwise from the topmost part of the chart, arrange the items in order of percentage size, unless another order is inherently logical.

Step 4: Indicate the name of the item and its percentage.

Step 5: Consider what color or pattern to use for identification of items.

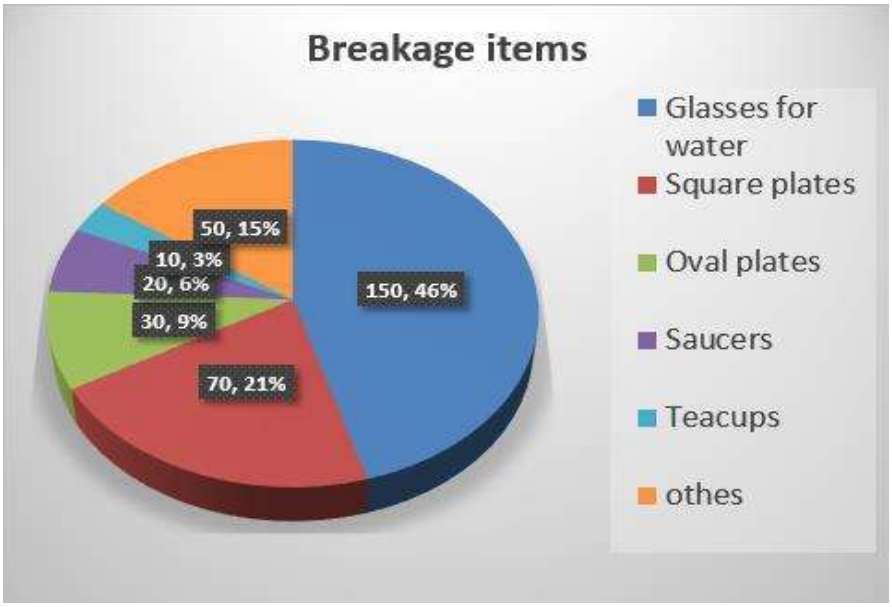


Figure 7: Pie chart

- **Check sheets**

Check sheet are forms used to collect data in an organized manner. They are used to validate problems or causes or to check progress during implementation of solutions. Check sheets can come in different shapes and sizes, and Circle members must be able to design them to suit their needs.

✓ **How to design a check sheet**

Step 1: Include the date on the check sheet. This can be expressed as a single date (e.g., August 11,2002), as a week (e.g., week ending August 19, 2002), or as a month (e.g., month ending August 31, 2002). The date is vital—to show when the data was collected.

Step 2: Include a title: The title should include the location and the type of information being collected—for example; the causes of breakdown of given machine.

Step 3: Indicate the name of the data collector putting the name of the person who collected the data is important, especially in case there is a later need to clarify data gathered.

Step 4: Ensure that everyone is using the same form.

A. Recording check sheet

- Characteristic: Customer Complaints on Refrigerators
- Period of data collection: June 2002
- Source of data: logbook

Table 3: check Sheet

Location	Complaints	Frequency of Occurrence	Subtotal	Percent
A	Paint bubbles	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	45	35.2
B	Dents	𝍸 𝍸 𝍸	15	11.7
C	Scratches	𝍸 𝍸 𝍸 𝍸 𝍸 𝍸	30	23.4
D	Rubber lining of door not fixed	𝍸 𝍸 𝍸	13	10.2
E	Bulb does not light	𝍸	5	3.9
F	Trays for ice cubes not included	𝍸 𝍸 𝍸 𝍸	20	15.6
	TOTAL		128	100

B. Checklist check sheet

Observed results or conditions are recorded by choosing among diametric opposites (e.g., yes or no, on or off, present or not present) for each item on a list. They are sometimes referred to

as inspection checklists. Check sheets simplify data collection, organize information, increase accuracy and facilitate verification of data.

Table 4: Checklist check sheet

	Items to bring for trip abroad	Yes	No	Remarks
1	toothpaste		x	Toothpaste available in airplane
2	toothbrush	x		
3	comb	x		
4	shampoo	x		
5	lotion	x		
6	Rubber shoes	x		No laces
7	Leather shoes	x		2-inch heels
8	Leather jacket	x		Hip length
9	Black hat		x	Bring white hat
10	Red scarf	x		
11	Long black skirt	x		
12	Denim pants (Levi's)		x	Bring Guess denim pants
13	White slacks	x		
14	White long-sleeve blouse	x		
15	Jogging pants	x		
16	Three white T-shirts	x		2 white and 1 off white

- **Histograms**

Processes' outputs naturally vary from one to another. A product may be said to be uniform, but actually no two units are exactly the same. Using precision instruments, these differences will be detected. For example, if we examine the weight of a bottle specified as 50g _ 1g, we may be surprised to find that the bottles vary in weight.

✓ **How to construct a Histogram**

- Characteristics being measured: weight of 100 coffee bottles
- Data collection period: produced in august 11,2002; taken after svery 10 bottles
- Data collector: Naomi IsabelAquino

Table 5: Histograms

	1	2	3	4	5	6	7	8	9	10	Low	High
1	50	55	49	46	49	48	50	50	51	52	46	55
2	56	54	52	50	51	52	55	47	49	54	47	56
3	45	53	54	52	51	50	53	50	51	52	45	54
4	49	47	48	50	51	52	54	53	52	50	47	54
5	48	48	49	51	52	49	48	50	49	48	48	52
6	50	48	45	49	50	51	52	51	53	52	45	53
7	51	49	48	50	51	52	50	52	51	52	48	52
8	52	50	51	55	46	51	53	50	51	50	46	55
9	49	49	51	50	54	52	52	51	54	55	49	55
10	49	49	48	50	51	53	50	53	50	51	48	53

- **Scatter Diagrams**

A scatter diagram examines the relationship between paired data. This tool is usually used by the QC Circle when it wants to establish the relationship between cause and effect, the relationship between one cause and another or a relationship between one cause and two causes.

Examples include the relationship between an ingredient and the hardness of a product, the relationship between the speed of cutting and the variation in the length of parts cut, the relationship between the level of illumination in a room and mistakes in validating a bank transaction slip. The scatter diagram is used when a number of people or procedures are producing widely varying results. The scatter diagram may show that two variables have positive correlation, have negative correlation, or have no correlation at all.

- ✓ **How to construct a scatter diagram:**

Step 1: Collect data samples of pairs whose relationship is to be studied. Enter these data in a data sheet.

Step 2: Draw a vertical axis (effect); calibrate it from smallest to largest value (from top to bottom).

Step 3: Draw a horizontal axis (cause); calibrate it from smallest to largest value (from left to

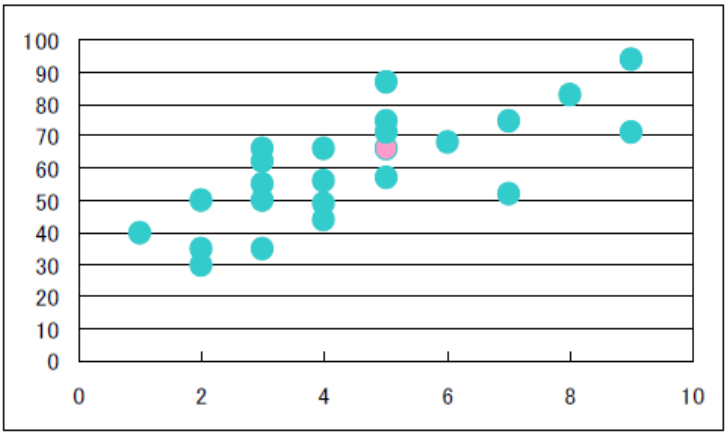
right).

Step 4: Plot the paired values. If values are repeated, make concentric circles (in the graph indicated as pink).

Step5: Plot data in a graph, with material content as the horizontal axis and elongation as the vertical axis.

Table 6: Scatter diagram

Number of paired data	Material Content (%) x	Elongation (%) y
1	9	94
2	4	66
3	1	40
4	2	30
5	7	52
6	3	66
7	4	44
8	6	68
9	2	35
10	3	55
11	3	50
12	3	62
13	5	66
14	5	66
15	4	56
16	2	50
17	3	35
18	9	71
19	5	87
20	4	49
21	5	57
22	8	83
23	5	71
24	7	75
25	5	75



The circle ● is a double counted value.

Self-Check- 5	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. The method data collection is
   A. clarify the objective B. by determining the method
   C. by make check list D. all
2. one of the following is not typical categories of stratification
   A. Time B. working method C. raw material D. product E. none
3. . 7QC tools are used to collect and analyze data.
   A. False B. True
4. The most critical matter for QC Circles is to understand facts and data.
   A. True B False

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet-6	Selecting Problems related to priorities of Kaizen Elements given due emphasis

6.1 QCC Techniques

QC Circles are strongly recommended to use other problem-solving and idea generation techniques such as brainstorming, the why-why approach, affinity diagrams, 5S, 3Mu, 5W1H, and 4M1E to aid them in their QCC implementation. They are also encouraged to experiment with how they conduct their meetings. QC Circles are not expected to use all of these techniques during their problem solving activities; only the appropriate ones. In summary, there are specific tools and techniques for each step of the QC Story.

6.2 The following are techniques for QCC activities

- **Brainstorming**

Brainstorming is used extensively by QC Circles at various stages in their problem-solving activities. This technique was developed in 1930 by Alex Osborne as a way of encouraging groups to be more creative with their ideas.

Rules to follow in brainstorming:

- ✓ Establish a relaxed atmosphere.
- ✓ Ensure participation by all members.
- ✓ Go for a large number of ideas.

- **Why-Why approach**

Curiosity is a marvelous part of the human mind. Our curiosity causes us to analyze and isolate critical root-causes and corrective actions via the Why-Why approach as follows. General why analysis on problem solving When a problem is observed, remedial actions such as stopping operation, hitting the cut-off switch, notifying the supervisor, and waiting for instruction for the next action are taken in workshops. Then, some action to prevent recurrence of the problem will be presented by supervisors who thought about why the problem occurred. But such solutions are apt to not be so effective or long-lasting. It is difficult to give proper countermeasures and isolate root-causes of problems unless we have a proper analytic.

- **Search problems**
  - ✓ **Root of theme selection**

The key to selecting a good theme is to collect specific problems that all the members understand and then to go through this collection for the best problem (which means the one that will have the most impact but that is still within the circle's capabilities if everyone stretches a little).

- Find a way to record problems as they occur in day-to-day operations.
- Listen carefully to each person.
- Consult with management and ask them to point out problems.
- Discuss the candidate problems thoroughly until every one agrees on which problem tackle.
- Do not be in to much of a hurry to be off and running.
- Take the time you need to make sure you know where you are going.

6.3 Looking problems

A "problem" is the difference between what you want to be and what you are-the difference between the ideal or target status and the actual current status. Because people tend to accept the current status as a given, you need close observation and critical analysis to identify such problems.

- Focus on the problems all around you, such as those in the daily routine, the inconveniences you suffer, and the things that give you a hard time.
- Look at how company policies apply to your workplace and identify the problems that your QC circle can handle.
- Ask the people involved in the next (downstream) process for their ideas. What would they like to see you do differently?
- What complaints do they have? How could you make life easier for them?
- Review the list of problems remaining from previous QC circle activities.

6.4 Identify and record problems

It is important that you record problems when they occur or as soon as they are identified. Letting them go until later will mean they are forgotten. At least problems that are not recorded right away have less immediacy and tend to get slighted later on.

- **Identify problems through brainstorming**

All the members of the QC circle should try to ferret out problems in a brainstorming session. This is more than a free-form discussion. Indeed, the basic brainstorming rules mandate four behaviors.

i. Avoiding value judgment one way or the other
ii. Welcoming spontaneous, even wild, ideas
iii. Encouraging as many ideas as possible to come out
iv. Building on other people's ideas

- ✓ Describe any problem you submit thoroughly, so that other people can understand both the phenomenon and why it is a problem.
- ✓ Collect problems by using a theme bank, problem notebooks, cause –and –effect diagrams, and the WBA board.
- ✓ Use check sheets for problem identification.

6.5 Describe the problem in specific terms

Do not use abstract statements to describe the problem. Make the description as specific as possible. Use data and other means to avoid generalizing.

- State specifically how bad things are. Rather than "problem with expenses," you might say "too-high office supply expenses negatively impact the operating budget."
- Express the problem in numbers. “Many defects” thus becomes “A 100 ppm defect rate was observed.”
- Do not confuse corrective actions actions or means with problems. "Writing an operating manual" is not a problem. Rather, it is how you might solve the problem of "insufficient operational standardization due to the lack of an operating manual."

6.6 Organize and focus on problems Prioritize

Use a theme selection matrix and other means to prioritize. Select a high-impact theme that is important to your work--one where you will see results when it is solved.

- What impact does this problem how in your work or on your workplace? How important is it?
- Does this problem is requaire immidiate attention? How argent is it?
- How much impact will kaizen have? How cost-effective is it?
- How much will the kaizen cost in terms of time and money? How cost-effective is it?

6.7 Evaluate problems in terms of durability

- Does working on this problem allow all the members of the QC circle to participate
- Is the cause of this problem with in the QC circle's area of competence? Is this something where the circle has responsibility?
- Can this problem be solved everyone work to the fullest? Will it give everyone chances do his/her best, to stretch a bit, and to see results?

Self-Check- six	Written Test

Directions: For each of the following question choose the best answer and circle the letter of Your choice.**:**

1. Brainstorming is used problem-solving activities and the Rules to follow in brainstorming are:

   A. Establish a relaxed atmosphere. B. Ensure participation by all members.

   C. Go for a large number of ideas D. All E. none

2. What is QC story?

   A. data collection method B. is problem C. end solution D,All

3. QC Story is specific tools and techniques for each step of the problem solving.

   A. True B. False

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 67

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-2 LG-67**
TTLM Code	**EIS PIM4 0920 V1**

LO2: Grasp current status and set goal.

Instruction Sheet-2	Learning Guide:-67

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

- .Defining the extent of the problem
- Setting appropriate and achievable goal.

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:-**

- Define the extent of the problem
- Set appropriate and achievable goal

Learning Instructions:

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

Information Sheet-1	Defining the extent of the problem

1.1 Introduction

After a theme is selected, members try to understand the current situation of the problem. They list all of the possible problems related to the process, use data to validate that the —problems are indeed problems, select the priority problem, and again use data to define the extent of this problem. The main objective of these steps is to gather information and grasp the status of the problem so that members can establish a detailed set of goals.

1.2 Methods To Grasp The Current Status Of The Problem

In fact analysis you clarify the impact of the problem (the difference between the current status and the target status) and use stratification to identify variability.

- **Quantify the current status**

Problem-solving starts with accurate fact analysis to determine how bad the current status is.

1.2.1 Identify the problem

- All of the QC circle members discussed the problem thoroughly, to get the essence and to identify what is essentially amiss. Use a process flow chart, the 4Ms, and other means to look at the problem in its broader context.
- Get a systematic understanding of the problem with cause and-effect diagrams, affinity diagrams, and other tools that enable you to see the whole picture.

1.2.2 Narrow down the facts of the problem

- Get the facts based on the three actualities (the actual reality of the actual situation at the actual site).
- Personally conduct an on- site examination of the part, tool, or equipment that seems to be causing the problem so that you can make an objective statement of the problem. Investigate and confirm to get all of the facts that you need.
- You need to do more than just to look. You need to conduct a close, hand-on examination of the problem.

1.2.3 Facts should be expressed quantitatively

- Have the QC circle members discuss how to quantify the facts, including using sample surveys, doing experiments and tests, and completing questionnaires.
- All of the circle members think about how the relevant data can be expressed numerically.
- 1.2.4 Collect data and prepare graphs Work quantitatively and objectively
- Key points
- Collect the necessary data in sufficient quantity, knowing clearly what is to be measured so that it is easy to stratify the data.
- Remember that data are most current immediately up on collection and start getting stale immediately.
- Do not collect just the convenient data. Be sure to get everything you need, including the data that make your job harder by forcing you to get at the underlying causes.
- It is imperative that the QC circle use objective.

1.2.4 Identify variability

Identify variability by using the results of the stratification.

Select problems whose solution will make a major contribution to better results.

- Continue to stratify until variance is identified.
- If you cannot get enough examples, one effective way to fined difference is to compare good products and defective products.
- Do not concentrate only on mean values to identify problems. Also pay attention to variability.
- Select high –impact problem.

Self-Check - 1	Written Test

Directions: Answer the following question.

1. How to identify and narrow down them current status of the problems?

   A. Use a process flow chart, B. Use the 4Ms

   C. with cause and-effect diagrams D. all

2. The key identify variability of problems are?

   A. Continue to stratify B. Select high –impact problem

   C. set the target D. all

3. Select workplace and apply methods to grasp the current status of the problem.

   A. Continue to stratify B. Select high –impact problem

   C. Do not collect just the convenient data D. A&C E. A&B

4. One of them methods to grasp the current status of the problem are not include?

   A. Quantify the past status B. Quantify the current status

   C. Identify variability D. all

5. What are three elements of targets?

   A. target item B. target cost C. target value D. target date

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

Information Sheet-2	Setting appropriate and achievable goal

2.1 Set the Target (Set the Goal)

A target is critical, because it serves as a yardstick against which to measure the results of the corrective action in specific terms and makes your activities more challenging and more rewarding.

- Clarify the three elements of your target
  - ✓ Determine the three elements of the target
    - What (target item) should be fixed?
    - To what extent (target value) it should be fixed, and
    - By when (target date) it should be fixed.
  - ✓ Quantify the target value so it is expressed numerically.
  - ✓ Numeric values help clarify and quantify your accomplishment.

- **The target must be high enough to motivate people**
  - ✓ State the need for the target and its appropriateness. The target should not be to easy. It is better to have a challenging target to motivate people to exert themselves. A target that is too easy may well be meaningless, both for the company and for the individuals involved.

2.2 Use a substitute characteristic (value) when necessary

If the target is not directly quantifiable, use a substitute characteristic that can be quantified.

- ✓ Organize the factors in a cause-and-effect diagram to help you choose a suitable substitute characteristic.
- ✓ Select the substitutes characteristic with the highest contribution rate (the most impact on the effect This is usually the item on the extreme left in your Pareto chart.

Self-Check - 2	Written Test

Directions: For the following questions Say true or false

1. In problem identification Numeric values help clarify and quantify your accomplishment.
2. All of the QC circle members discussed the problem thoroughly, to get the essence and to identify what is essentially amiss.
3. The main objective of grasp the status of the problem is to analyze the data collected.
4. Grasp the status of the problem are consider to help high motivation of people.
5. Select methods to set goal for the selected problem.

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

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 68

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-3 LG-68**
TTLM Code	**EIS PIM4 0920 V1**

LO3: Establish activity plan.

Instruction Sheet-3	Learning Guide:-68

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

- Confirming the problem
- selecting high priority problem
- defining the extent of the problem
- Establishing activity plan as per 5W1H.

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:-**

- Confirm the problem
- select high priority problem
- Identify the extent of the problem
- Establish activity plan as per 5W1H.

Learning Instructions:

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

Information Sheet – 1	Problem confirmation

1.1 Introduction

QC circle practitioners have long realized that "no activity is possible without a plan, no examination is possible without activity, and no growth is possible without examination." The action plan is an important growth tool. It may not be possible to devise a perfect action plan from the very beginning, but you will be able to make better action plans as you become more experienced.

How to establish an activity plan

Brainstorming is based on opinion, so the ideas classified as problems must be confirmed with data. The need to speak with facts rather than opinions has to be stressed because we all have opinions and very often they are all different. This makes it very difficult for the Circle to arrive at a decision and may lead to frustration. Check sheets and other forms are used for easy collection, summarization, and analysis of data.

1.2 Brainstorming

Brainstorming is a technique, generally used in a group setting, to quickly generate a large number of ideas about a specific problem or topic. The most frequently used technique for group decision-making is Brainstorming. It is the foundation for many other techniques and the basis for creative problem-solving. It is a group idea generation method which works best for groups of three to nine members. The key ingredient is to provide an environment free of criticism for creative and unrestricted exploration of options or solutions.

How to do it:

The goal of brainstorming is to generate ideas. Before you start, make sure everyone in your group understands the importance of postponing judgments until after the brainstorming session is completed. . Write the problem or topic on a blackboard or flipchart where all participants can see it . Write all ideas on the board and do as little editing as possible . Number each idea for future reference There are several brainstorming techniques:

- structured brainstorming,
- free-form brainstorming, In unstructured (or Open-door) brainstorming or
- silent brainstorming

1.2.1 Points to remember about Brainstorming:

- Never judge ideas as they are generated. The goal of brainstorming is to generate a lot of ideas in a short time. Analysis of these ideas is a separate process, to be done later.
- Don't quit at the first lull. All brainstorming sessions reach lulls, which are uncomfortable for the participants. Research indicates that most of the best ideas occur during the last part of a session. Try to encourage the group to push through at least two or three lulls.
- Try to write down all of the ideas exactly as they were presented. When you condense an idea to one or two words for ease of recording, you are doing analysis. Analysis should be done later.
- Encourage outrageous ideas. While these ideas may not be practical, they may start a flow of creative ideas that can be used. This can help you break through a lull.
- Try to have a diverse group. Involve process owners, customers, and suppliers to obtain a diverse set of ideas from several perspectives.

1.2.2 After Brainstorming:

- Reduce your list to the most important items
- Combine items that are similar
- Discuss each item - in turn - on its own merits
- Eliminate items that may not apply to original issue or topic
- Give each person one final chance to add items

1.2.3 Why should a team do Brainstorming?

Brainstorming helps a team break free of old, ineffective ideas. This free-wheeling technique for generating ideas may produce some that seem half-baked, but it can lead to new and original solutions to problems. Some of the specific benefits of Brainstorming are that it

- Encourages creativity. It expands your thinking to include all aspects of a problem or a solution. You can identify a wide range of options.

- Rapidly produces a large number of ideas. By encouraging people to offer whatever ideas come to mind, it helps groups develop many ideas quickly.
- Equalizes involvement by all team members. It provides a nonjudgmental environment that encourages everyone to offer ideas. All ideas are recorded.
- Fosters a sense of ownership in decisions. Having all members actively participate in the Brainstorming process fosters a sense of ownership in the topic discussed and in the resulting activities. When the people on a team contribute personally to the direction of a decision, they are more likely to support it.
- Provides input to other tools. You may want to affinitize the brainstormed ideas. And, if appropriate, you can work with the team to reduce the number of ideas by Multi voting.
- Brainstorming is useful when you want to generate a large number of ideas about issues to tackle, possible causes of problems, approaches to use, or actions to take.

1.2.4 What are the ground rules for Brainstorming?

For all participants to enjoy a creative and productive Brainstorming experience, the facilitator needs to review and get team members' buy-in on the ground rules for the session. These are the rules:

- Active participation by all team members. Everyone expresses his or her ideas, even if they seem silly or far out.
- No discussion—criticisms, compliments, or other comments—during the brainstorm.
- Build on ideas generated by other team members.
- All ideas written exactly as presented and displayed where everyone can see them.
- Set a time limit.
- Clarify ideas. After the brainstorm, go over the list to make sure that all team members understand the ideas. Remember that you are only clarifying the ideas, not making judgments about them.
- Combine ideas. See whether two or more ideas that appear to be the same can be combined.
- Collect everyone's ideas. After allowing a few minutes for the participants to think about the question, ask them to give their ideas. Establish either a structured or unstructured format for calling out ideas:

- Record ideas on a chart pack as they are called out, or collect ideas written by team members on post its TM. Display the ideas where everyone can see them. Having the words visible to everyone at the same time avoids misinterpretation and duplication and helps stimulate creative thinking by other team members.
- Clarify each idea after all ideas have been presented, to ensure that all members have the same understanding of it. Pointing to each idea on the chart pack in turn, ask the participants whether they have any questions about its meaning. You may have to ask the contributor to explain the idea in a different way.
- Eliminate duplications. If two or more ideas appear to mean the same thing, you should try to combine them or eliminate the duplicates. Before you can wrap the like ideas into a single item or eliminate any items on the list, all of those who contributed the similar ideas must agree that they mean the same thing. Otherwise, they remain as separate items.

Self Check - 1	Written Test

Directions: for the following questions Say true or False

1. Brainstorming is a technique, generally used to quickly generate a large number of ideas about a specific problem or topic.
2. The goal of brainstorming is to generate ideas.
3. In brainstorming is not needs active participation idea Everyone expresses his or her ideas.

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

Information Sheet – 2	Selecting a high priority problem

2.1 Introduction

The choice of a high priority problem is based on the data collected. If data is not readily available, the QC Circle can use a matrix diagram to arrive at a high priority problem. Confirm the problem. Once the problem has been selected and confirmed, the Circle states it from the customer's point of view like was done in the restaurant example: —Wrong order was served. When analyzing problems there is always a tension between the 'current situation' and the 'desired situation'. By explicitly mentioning these different situations you are able to discuss their relevance with other people involved in your project.

- **The priority setting process**
  - ✓ In undertaking a prioritization exercise it is important to recognize that no single intervention is likely to be able to prevent obesity.
  - ✓ Potential areas of action must be carefully analyzed and local, regional or country-specific factors considered.
  - ✓ Selecting the most appropriate approach needs to always be adapted to the specific needs to the country, region or area.

- Consider all sectors and settings
  - ✓ Upstream
  - ✓ Midstream
  - ✓ Downstream

- Identify key stakeholders
  - ✓ Government
  - ✓ International and regional organizations
  - ✓ Private Sectors
  - ✓ Civil society and NGOs
  - ✓ Employees

- **Priority-setting criteria**
  - ✓ Population impact or effectiveness
  - ✓ Costs (affordability)
  - ✓ Cost-effectiveness
  - ✓ Feasibility
  - ✓ Relevance
  - ✓ Strength of evidence base
  - ✓ Effects on equity
  - ✓ Sustainability
  - ✓ Acceptability to stakeholders
  - ✓ Other positive or negative effects of the intervention

Self-Check – 2	Written Test

Directions: For the following questions matching From **“B” column to “A” column.**

“A” column.	**“B” column**
____ 1. The priority setting process	A. International and regional organizations
____2. Priority-setting criteria	B. Selecting the most appropriate approach needs
____3. Identify key stakeholders	C. Strength of evidence base

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

Information Sheet – 3	Defining the extent of the problem

3.1 Extent of the problem

This is a very important step because it establishes the baseline data and it will be used later as a reference in measuring improvement generated by the Circle. A mere statement to the effect that there was reduction in incorrect orders served is insufficient; the reduction has to be backed up by data. Therefore, if historical data is not available, the QC Circle must collect data as the process is being done (e.g., by tallying how many orders are correctly served and how many are not).

3.2 How to use the method?

Designers often underestimate the work required to find and define problems. As a young and ambitious designer you are probably keen to design an innovative water kettle, car or chair. It takes some experience and courage to discuss with your client that the real problem might be something completely different. Possible procedure answering the following questions will help to create a Problem Definition:

- What is the problem?
- Who has the problem?
- What are relevant context factors?
- What are the goals?
- What are the side effects to be avoided?
- Which actions are admissible?

The outcome is a structured description of the design problem, with a clear description of the desired end situation (goals) and possibly the direction of idea generation. A well-written Problem Definition provides a shared understanding between you, your client and possible stakeholders.

- **Limitations of the method**

Defining the problem does not solve the problem. It is some extent of the problem is decrease.

Self-Check – 3	Written Test

Directions: For the following questions say **True** or **False.**

1. The outcome is not a structured description of the design problem, with a clear description of the desired end situation.
2. Limitations of defining the problem do not solve the problem.

Note: Satisfactory rating - 1 points **Unsatisfactory - below 1 point**

Information Sheet – 4	Establishing activity plan as per 5W1H.

4.1 Definition the activity 5W1H

For each of the main ideas that you have identifies in a reading, ask yourself questions starting with the **5 W's** and **1 h** question words. **5 W1H** the question developed to establish the plan: Who, What, Where, When, Why, How?

What	What will be done	action, steps, description
Who	By whom will it be done?	responsibility for action
When	When will it be done?	time, dates, deadlines
Where	Where will it be done?	Location
Why	Why will it be done?	justification, reason
How	How will it be done?	method, process

An action plan is crucial if you are to conduct your activities on your own and to conduct a good examination.

- **Draw up the action schedule**
  - ✓ Schedule completion dates for each of the problem- solving steps in the action plan.
  - ✓ Incorporate items carried over from provirus activities in to the action plan.
  - ✓ The date each step is completed should be filled in on the schedule alongside the scheduled completion side.

- **Assign responsibilities**

Assigning responsibilities is an important part of energizing your QC circle activities. Try to assign the right person to the right job, so that each person's strengths are utilized to best effect and everyone has a chance to grow without being overwhelmed by the task at hand.

- ✓ Determine the responsibilities in the action plans.
- ✓ Assign the QC circle management responsibilities (eg. Theme leader and recording secretary.)
- ✓ Let people take the initiative and volunteer for responsibilities.

- ✓ Look at each person's character strengths and skills. Have people take responsibility for the things they are best suited for.
- ✓ Experience means grow and it is important that activities be organized and conduct so as to help everyone grow.

4.2 Case Study for Preparing Action Plan

QCC Name: Red fox

Case study: customer satisfaction improvement operation –Reduction of low score Items in the Customer Questionnaire survey We established the goal reducing the low score replies by half from 91 replies (12.8%) to improve the level of customer satisfaction. The subsequent action plan was implemented with our slogan Every circle member is the main actor‖ and each member was given a specific role to play.

Self-Check - 4	Written Test

Directions: For the following questions say **True** or **False.**

1. The outcome is not a structured description of the design problem, with a clear description of the desired end situation.
2. Limitations of defining the problem do not solve the problem.

Note: Satisfactory rating - 1 points **Unsatisfactory - below 1 point**

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 69

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-4 LG-69**
TTLM Code	**EIS PIM4 0920 V1**

LO4: Analyze causes of a problem.

Instruction Sheet	Learning Guide:-69

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

- Listing all possible causes of a problem.
- Analyzing cause relationships using4M1E.
- Identifying causes of the problems.
- Selecting root causes.
- Selecting the root cause which is most directly related to the problem.
- Creative idea generating all possible ways are listed using to eliminate the most critical root cause.
- Testing and evaluating the suggested solutions are carefully for potential complications.
- Preparing detailed summaries of the action plan to implement the suggested solution.

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:-**

- List all possible causes of a problem.
- Analyze cause relationships using4M1E.
- Identify causes of the problems.
- Select root causes.
- Select the root cause which is most directly related to the problem.
- Identify all possible ways are listed using to eliminate the most critical root cause.
- Test and suggested solutions are carefully for potential complications.
- Prepare detailed summaries of the action plan to implement the suggested solution. .

Learning Instructions:

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

Information Sheet - 1	Listing all possible causes of a problem.

1.1 Identify and Define the Effect

Step-1: identify and define the effect

- Decide on the effect to examine
- Use operational definition.
- Phrase effect as
- Positive (an objective) or
- Negative (a problem)

1.2 Using a chart pack

Step 2 - Using a chart pack draw the SPINE and create the EFFECT box.

- Draw horizontal arrow pointing to the right. This is the spine.
- To the right of the arrow, write a brief description of the effect or outcome which results from the process. EXAMPLE: The EFFECT is Poor Gas Mileage.
- Draw a box around the description of the effect

1.3 Identify the main causes contributing to the effect being studied

Step 3 - Identify the main causes contributing to the effect being studied.

These are the labels for the major branches of your diagram and become categories under which to list the many causes related to those categories**.**

- Establish the main cause, or categories, under which other possible causes will be listed. You should use category labels that make sense for the diagram you are creating. Here are some commonly used categories:
  - ✓ **3Ms and P** - methods, materials, machinery, and people
  - ✓ 4Ps - policies, procedures, people, and plant
  - ✓ Environment - a potentially significant fifth category

- Write the main categories your team has selected to the left of the effect box, some above the spine and some below it.

- Draw a box around each category label and use a diagonal line to form a branch connecting the box to the spine. **EXAMPLE:** below figure uses the 3Ms and P to start developing the diagram we began in Step 2.

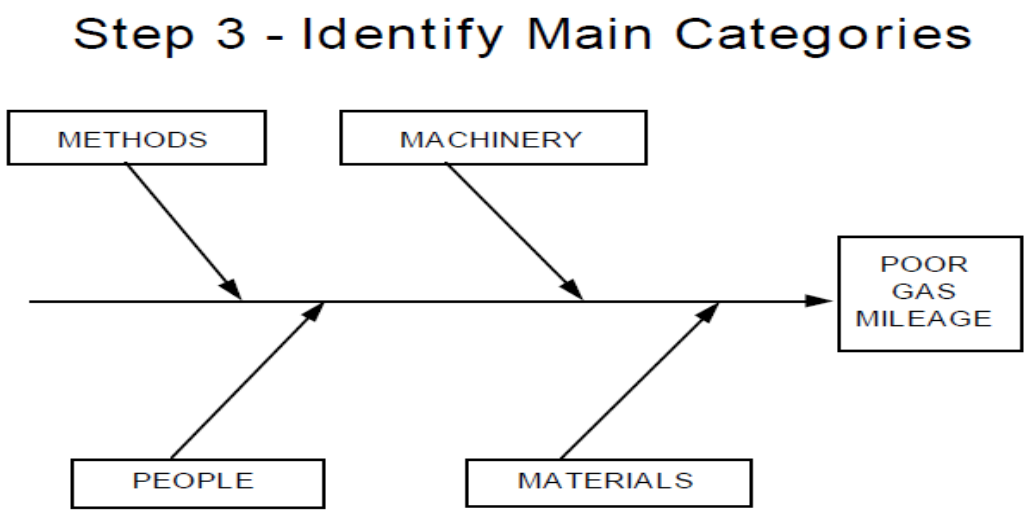


Figure 8: Causes of the effect

1.4 For each major branch, identify other specific factors which may be the causes of the effect

Step 4 - For each major branch, identify other specific factors which may be the CAUSES of the EFFECT

- Identify as many causes or factors as possible and attach them as sub branches of the major branches. example: the possible causes for poor gas mileage are listed under the appropriate categories in figure below:
- fill in detail for each cause. If a minor cause applies to more than one major cause, list it under both.

Self-Check- 1	Written Test

Directions: For each of the following question choose the best answer and circle the letter of your choice.

1. One of the following is not cause of problem?

A. man B. machine C. material D. none

2. One of the following is not the possible cause in method category

A. poor maintenance B. use wrong gears C. drive tool fast D. none

3. One of the following is the possible cause in people category

A. poor driving habits B. use wrong gears C. drive tool fast D. none

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet - 2	Analyzing cause relationships using4M1E.

2.1 Cause Analysis of the Problem Using 4M1E

Cause analysis: means seeking the causes for the variability identified in fact analysis. One common approach is to formulate a hypothesis, narrow the factors down, verify them with facts, and slowly work your way down to the underlying causes.

The main objective of this stage is to confirm which measures can be taken for what kinds of problems. After a theme is selected, the causes and effects of problems are to be identified. This is the most important stage of the process, as it identifies the root causes of the problems and shows what needs to be changed.

2.2 4M group; Man, Machine, Material, Method, Environment

Human: knowledge, skills health conditions, physical conditions etc.

Soft: system, methodologies, mechanism etc.

Hard: material, equipment, furniture, tools etc.

Environment: facility environment (water supply, electricity, smell, humidity etc.), working environment (work space, accessibility of materials, arrangement etc.)

Man	Employs lack attention to process
Machine	size of mixing tank long lifetime of mixing tank
Material	type of raw materials steam for heating
Method	heating time Heating temperature syrup temperature
Environment	Equipment not enough Room temperature

Cause and effect analysis fishbone diagrams for problem solving

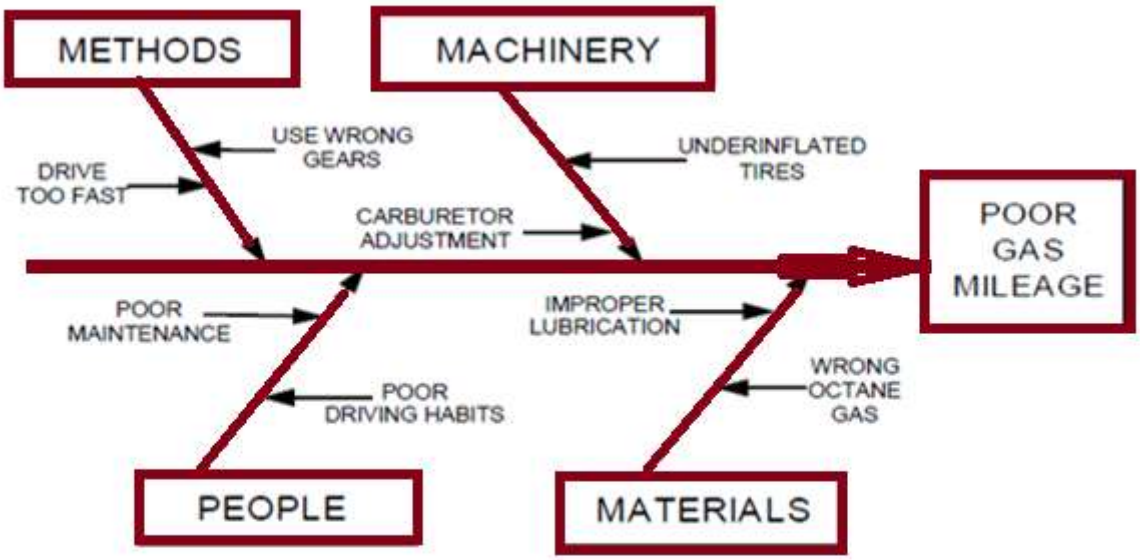


Figure 9 Cause and effect analysis

Self-Check- 2	Written Test

Directions: For each of the following question matching from column **"B"** to column **"A"**

column 'A"	**column "B"**
_____1. Environment	A. Study/find facts .
:____ 2. Cause analysis	B. System, methodologies
_____3. Machine	C. electricity, smell, humidity
_____4. Human:	D. size of mixing tank
_____5. Soft/ method	E. knowledge, skills

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

Information Sheet - 3	Identifying causes of the problems.

3.1 How to precede cause analysis?

List all possible causes of the problem

The Circle brainstorms on the causes of the problem. A very important question in this step begins with the word why. Why the orders are incorrectly served? The Circle members enumerate their answers to this question until they have exhausted all possible causes.

Think of the causes

Come up with as many factors as you can that could contribute to causing the variance (nonconformance) highlighted in fact analysis.

- Have all QC circle members participate in identifying factors relevant to the characteristics.
- Have brainstorming session to come up with factors and organize and them on a cause-and-effect diagram.
- Take another look are the factors on the cause- and-effect diagram and see if anyone can add more factors.

3.2 Identify increasingly more detailed levels of causes and continue organizing them under related causes or categories

Q: Why couldn't the driver hear the engine?

A: The radio was too loud.

A: Poor hearing

Q: Why were the TIRES UNDERINFLATED?

A: No record of tire pressure

A: Difficult air stems

Q: Why were the air stems difficult?

A: Poor design

Q: Why was MAINTENANCE POOR?

A: Lack of money

A: No awareness

Q: Why was WRONG OCTANE GAS used?

Self-Check- 3	Written Test

Directions: For each of the following question say **True** or **False.**

1. Lack of knowledge is one of causes of the problems.
2. Poor material is not causes of the problems.

Note: Satisfactory rating - 1 points **Unsatisfactory - below 1point**

Information Sheet - 4	Selecting root causes.

4.1 Definition

- Root cause analysis (RCA) is a class of problem solving methods aimed at identifying the root causes of problems or events.
- RCA is based on the belief that problems are best solved by attempting to correct or eliminate root causes, as opposed to merely addressing the immediately obvious symptoms.
- **Principles of RCA?**
  - ✓ Aiming corrective actions at root causes is more effective than just treating the symptoms of a problem.
  - ✓ To be effective, RCA must be performed systematically and conclusions must be backed up by evidence.
  - ✓ There is usually more than one root cause for any given problem and therefore there may be more than one corrective action.

4.2 Analyse the diagram

Steps 1 - Analyze the diagram.

Analysis helps you identify causes that warrant further investigation. Since Cause-and-Effect Diagrams identify only possible causes, you may want to use a Pareto Chart to help your team determine the cause to focus on first.

- Look at the- balance of your balance checking for comparable levels of detail for most of the categories.
- A thick cluster of items in one area may indicate a need for further study.
- A main category having only a few specific causes may indicate a need for further identification of causes.
- If several major branches have only a few sub branches, you may need to combine them under a single category.
- Look for causes that appear repeatedly. These may represent root causes.
- Look for what you can measure in each cause so you can quantify the effects of any changes you make.
- Most importantly, identify and circle the causes that you can take action on.

Self-Check- 4	Written Test

Directions: For each of the following question say **True** or **False.**

1. Root cause analysis (RCA) is a class of problem solving methods aimed at identifying the root causes of problems or events.
2. Analysis helps to identify causes that warrant further investigation.
3. To be effective, Root cause analysis must be performed systematically and conclusions but not backed up by evidence.

Note: Satisfactory rating - 2 points **Unsatisfactory - below 2 point**

Information Sheet – 5	Selecting the root cause which is most directly related to the problem

5.1 Selecting root causes

From the valid causes, the QC Circle selects the root causes. If there is a direct relationship between the cause and the problem and this cause is seen repeatedly in the cause and effect diagram, then it is a root cause. Seek root cause relentlessly and narrow them down Narrow the long list of factors down to the critical cause.

- Use facts, data, past history, and personal opinions to focus on the most important factors.
- Draw on management and administrative techniques, as well as specialist expertise, to narrow down the number of factors. **EXAMPLE**: Let's analyze the diagram we have been constructing.
- The level of detail is pretty well balance.
- No causes are repeated.
- Poor maintenance appears to be a cause for which you could develop measurements.

Moreover, Poor Maintenance appears to be a cause that you can take action on. It is circled in View graph 8 to earmark it for further investigation.

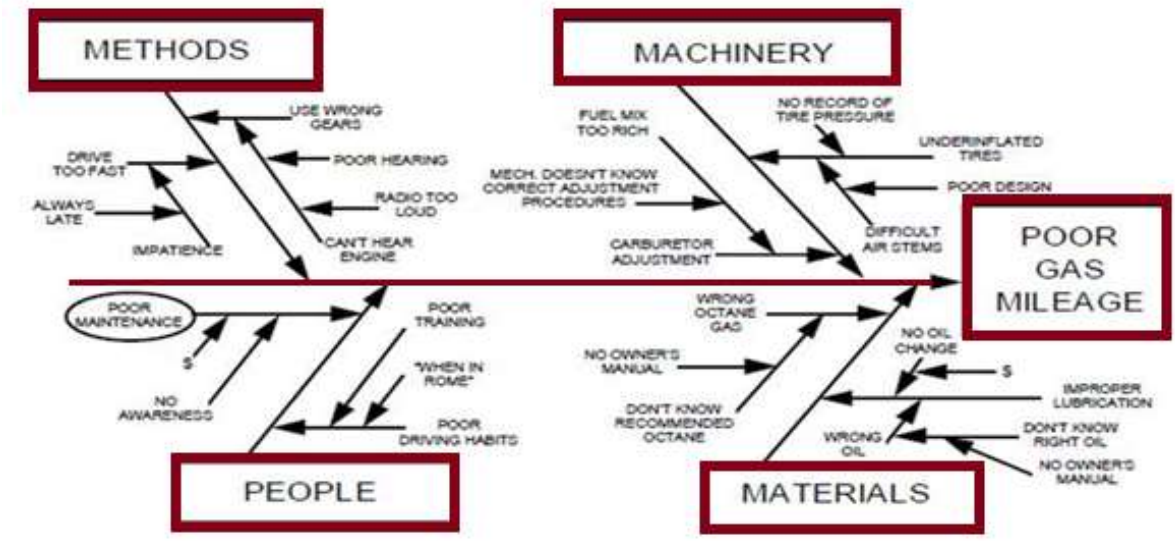


Figure 10: Selecting root cause

Table 7: Analyses of causes of Poor Gas mileage

No	Causes	Occurrence
1	Improper Lubrication	6
2	Poor Driving Habits	12
3	Poor Design	5
4	Poor Maintenance	230
5	Radio Too Loud	4
6	Fuel Mix Too Rich	8
7	Use Wrong Gears	7
8	Wrong Octane Gas	9
9	Others causes (each of them less than one)	10

5.2 Select most critical root cause

Among the root causes, the Circle selects the one that is most directly related to the problem. Voting can be used to decide which root cause to work on.

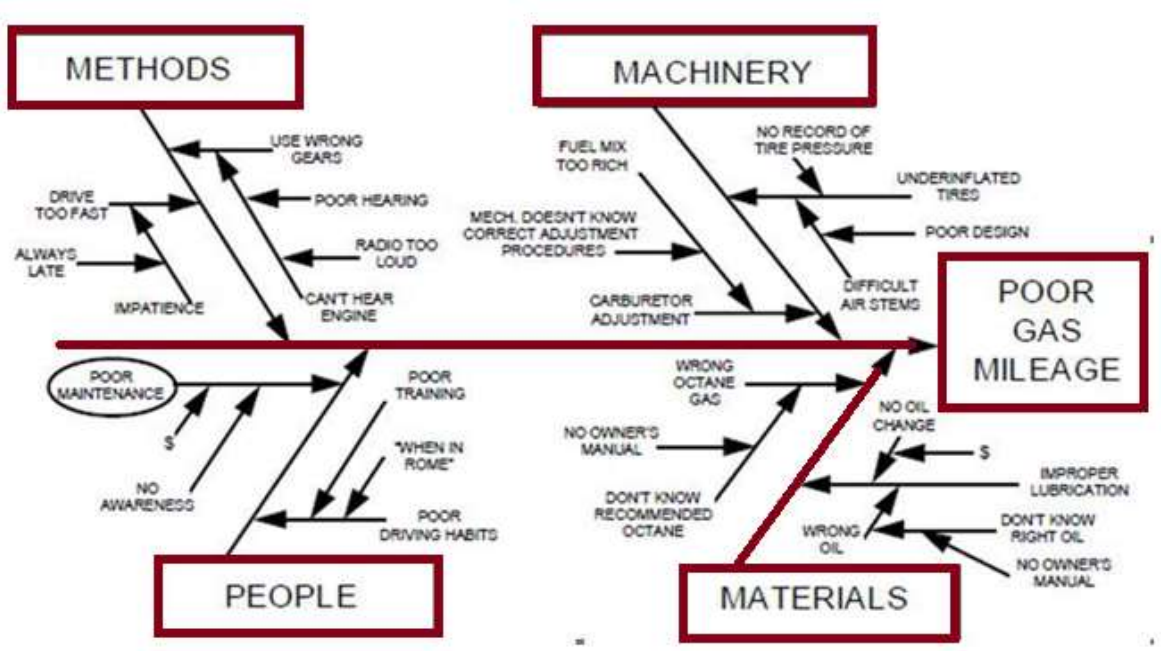


Figure 11: Select most critical root cause

Self-Check- 5	Written Test

Directions: For each of the following question say **True** or **False.**

1. Most critical root cause **means** among the root causes, the Circle selects the one that is most directly related to the problem.
2. All cause indicates are critical root cause **of** the **problem**.

Note: Satisfactory rating - 1 points **Unsatisfactory - below 1 point**

Information Sheet – 6	Creative idea generating all possible ways is listed using to eliminate the most critical root cause.

6.1 Problem Solution Types

- Reactive mode: Solving the abnormality that has occurred, gathering and analyzing data aims to provide a customer protection and countermeasure.
- Pro-active mode: Analyzing failures and looking for improvements.
- Preventive mode: Putting in place solutions before undesirable condition, defect or failure occurs Note: It may be a non conforming product but also a late delivery, an incorrect paperwork, incorrect process (production or QMS related), etc…
- Correction: the action taken to fix the nonconformity
- Corrective Action: the action taken to fix the cause of the nonconformity and to prevent recurrence
- Preventive Action: the action taken to prevent nonconformities or problems from occurring
- Apparent Cause: The event or action that immediately results in or precedes the nonconformity. May also be called Obvious Cause, Direct Cause, Immediate Cause
- . Immediate Correction: Action(s) taken to immediately fix the nonconformity.
- Immediate Corrective Action: Action(s) taken to eliminate, prevent, or reduce the probability of any additional non-conformances related to the apparent cause from happening again in the short term.
- Note: These actions may be temporary and should remain in place until root cause(s) is(are) identified and permanent root cause corrective action(s) is(are) implemented and verified to be effective.
- Root cause corrective action (or permanent corrective action): The corrective action(s) implemented to address the root cause(s) and contributing cause(s) of the undesirable condition, situation, nonconformity or failure and that will permanently prevent recurrence
- Root cause (or Permanent) corrective action verification: Actions taken to verify that the planned actions were taken as scheduled.

Self-Check- 6	Written Test

Directions: For each of the following question choose the best answers.

1. Analyzing failures and looking for improvements are:

A. Preventive mode B. Pro-active mode C. Reactive mode D. all

2. Putting in place solutions before undesirable condition, defect or failure occurs

A. Preventive mode B. Pro-active mode C. Reactive mode D. none

3. The action taken to prevent nonconformities or problems from occurring

A. Apparent Cause C. Preventive Action C. Corrective Action D. all

4. The event or action that immediately results in or precedes the nonconformity

A. Apparent Cause C. Preventive Action C. Corrective Action D. all

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet - 7	Testing and evaluating the suggested solutions are carefully for potential complications

7.1 Evaluating the Solutions

- The evaluation process can be divided into six stages:
  - ✓ defining the 'ideal' solution
  - ✓ eliminating unviable solutions, those which do not meet the constraints
  - ✓ evaluating the remaining solutions against the results required
  - ✓ assessing the risks associated with the 'best' solution and, if acceptable
  - ✓ making the decision

7.2 Defining the ideal solution

The criteria of effectiveness which you defined to guide your search for solutions are inadequate to make an effective evaluation. Each solution may differ slightly or radically in the way and the extent to which it achieves your various goals. To be able to evaluate these effectively' you need to construct a model of the ideal solution against which to measure them. Basically you need to identify and compare their relative values. This information must be recorded and presented in a meaningful way to aid comparison. It can also be used to persuade other people to accept the decision and help to communicate the solution to those involved in its implementation.

Figure 12: Ideal Solution

- The following questions must be answered:
  - ✓ What are the results required?
  - ✓ What are the benefits desired?
  - ✓ Any there obstacles or causes that need addressing?

- ✓ If the solution will be acceptable to the relevant stakeholders?
- ✓ What are the constraints that exist?
- ✓ What resources are available?
- ✓ What is the minimum acceptable result?
- ✓ What are the maximum levels of disadvantages that are acceptable?
- ✓ Are there any other factors that must be considered?

- You are now ready to begin evaluating your solutions. The method described below is intended to reduce the amount of time required for evaluation by first eliminating solutions which do not meet the constraints.

7.3 Eliminating unviable solutions

- **Evaluating the remaining solutions**

Each of the remaining solutions is now examined to see how well it provides the results required.

- **Assessing the Risks**

Although the solution you have chosen offers the best balance of benefits versus disadvantages, you need to examine the possible risks associated with this solution to ensure that they are acceptable and to identify areas where risks could be minimized.

- **Making the decision**

When you make a decision. You commit yourself to a particular course of action and take responsibility for its consequences. If you do not make this commitment you have not made a decision, so you can't proceed any further and you will not solve the problem.

- **Remember**
  - ✓ The 'best' solution is often a compromise between conflicting needs and between the advantages and disadvantages of the various options.
  - ✓ Solutions which don't meet the constraints of the situation must be rejected.
  - ✓ The best of the remaining options is generally the one which fits the ideal solution most closely, although you may use a different selection strategy.
  - ✓ Before you accept a solution you must decide if any associated risks are acceptable.

Self-Check- 7	Written Test

Directions: For each of the following question choose the best answers.

1. One of the following is not the evaluation process of problem solving.

A. defining the 'ideal' solution

B. eliminating unviable solutions, those which do not meet the constraints

C. making the decision

D. none

2. _____ is you commit yourself to a particular course of action and take responsibility for its consequences.

A. Evaluating the remaining solutions

B. Making the decision

C. Assessing the Risks

D. none

Note: Satisfactory rating - 1 points Unsatisfactory - below 1 point

Information Sheet - 8	Preparing detailed summaries of the action plan to implement the suggested solution.

8.1 Setting countermeasures

- **Establish a detailed plan**

The next step is for the QC Circle to flesh out the details on the implementation of the solution by asking the question —How? For each activity, someone is given responsibility and a timetable. The details of the plan are summarized in a Gantt chart.

Plan the countermeasures action

Plan the countermeasures action so that the cause identified in cause analysis does not recur.

- ✓ Plan corrective actions for each conforming causes.
- ✓ Do not worry about practicality of the countermeasures actions at this point. . Come up with a wide range and large number of suggestions.
- ✓ Put the priority on those actions that your circle can implement on its own authority.
- ✓ Narrow dawn the countermeasures action plan and focus on the one(s) you want to implement.
- ✓ Actively solicit management and staff opinions.

- **Points to remember:**
  - ✓ Make a table that shows the problems, the corrective actions, what you are trying to accomplish, how you intend to accomplish it, and who is going to be responsible for doing it.
  - ✓ This is an excellent way to show the linkage between the problems and the countermeasure actions. It shows clearly how the countermeasure actions address the problems identified in the cause analysis stage, thereby highlighting the cause analysis's effectiveness.
  - ✓ Be sure to indicate what the actions are intended to accomplish and who is going to do what.
  - ✓ Adding information on each of countermeasure actions helps every one understand what is being done, how, and why.

Table 8: detailed plan

No	COUNTERMEASURE	PURPOSE	METHOD	WHO DOES
1	Delivery takes a long time because location is unclear	Create and post maps to customer sites so delivery people will not get lost	- Shorten delivery times -Draw up short cut maps (see I below)	YAMADA
2	Do not know how long things will take	Rank customers (A, B, C, D) by how long it takes to get there and Back	-Avoid impossible scheduling -Draw up at-glance travel time guides. (see II below)	ALI
3	Do not know beforehand how many trucks are needed	Create a delivery truck log patterned after the work schedule for part time workers, to Minimize reservation Duplication	-Get better scatter in truck reservation and more efficient use of people -Draw up weekly delivery schedules (see III below)	HAGOS
4	Person in charge is not there	Delegate authority for getting trucks and buses ready	-Facilitate smoother operation -Draw up weekly work schedules with area of Responsibility.)	HADUSH

Self-Check- 8	Written Test

Directions: For each of the following question say **True** or **False.**

1**.** The detailed summaries of the action plan is the end result of the problem solving.

2. Adding information on each of countermeasure actions helps every one understand what is being done, how, and why.

Note: Satisfactory rating - 1 points **Unsatisfactory - below 1 point**

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 70

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-5 LG-70**
TTLM Code	**EIS PIM4 0920 V1**

LO5: Examine countermeasures and Their implementation.

Instruction Sheet	Learning Guide:-70

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

- Implementing action plan by medium KPT members.
- Monitoring implementation according to the agreed procedure and activities are checked with preset plan.

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:-

- Implement action plan by medium KPT members.
- Monitor implementation according to the agreed procedure and activities are checked with preset plan.

Learning Instructions:

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

Information Sheet – 1	Implementing action plan by medium KPT members.

1.1 Activities of Medium KPT

The KPT (**kaizen promotion Team**) provides an opportunity for members to develop their creative thinking as they look for better ways to do their work, which is imperative as customers become more demanding and their needs become more varied and complex. As the members study and learn together, their full potential is realized.

1.2 Characteristics of KPTs

Based on this definition, which has been adopted in many countries, the QC Circle Headquarters enumerates the following features of a QC circles:

a. Small group

- The circle is normally composed of three to ten voluntary who come from the same workshop and are under the same supervisor. Keeping the group small enables the members to participate actively in Circle activities.
- During meetings for instance, each members has a chance to contribute ideas; whereas, if the group is more than ten, it may happen that a member is not able to contribute an idea because of lack of time, for the Circle usually meets for an hour at most.
- If the group is small, the chances are high that members are able to foster better interpersonal relations and develop cohesiveness.

b. Continual control and improvement in the quality of work, products, and service

KPTs continuo to look for opportunity for improvement from the time they receive their inputs to the time they deliver their product or service to their customers. They employ the concept of the Plan-Do-Check-Act (PDCA) continual improvement. Because the customer is never satisfied, the Circles never stop looking for better ways of doing the work.

.

c. Autonomous operation

Circles solve problem in their work shops; so, they operate autonomously in the sense that they are free to choose the problems to solve, they identify what data to collect in order to better understand why the problems exist, and their members analyze the problems' causes among themselves (though they sometimes consult other departments that affect their work).

d. Utilization of quality control concepts, tools and techniques

The circle works with the aid of data throughout -solving activities. They show that a problem exists by collecting data (using a data collection form, like a check sheet) that they then summarize and analyze using simple statistical tools and use problem-solving techniques.

e. Self-Development

A KPT contributes not only to the development of a sound working environment but also to the enhancement of individuals' abilities and potentials. In other words, the activities lead also to self-development of individuals. Through the activities, each member can develop various qualities, such as sound personal relations, analytical skills, presentation ability, and knowledge on various QC tools.

1.3 Objectives of KPTs Activities

A. Establishment of a pleasant workplace

The atmosphere of a workplace has two dimensions; the psychological and physical. The psychological is usually measured through organizational climate surveys in which people are asked about their perceptions of leadership, availability of information and resources to do their job well, teamwork, rewards and recognition, and job satisfaction. The physical pertains to orderliness and cleanliness; access to raw materials, tools and machines; and safety.

B. Establishment of a state of control

It is very important that people operate their tasks according to specific way. As Ishikawa (1981) avers,—Well controlled workshops are those that observe agreed standards, take adequate corrective measures or preventive measures, remove causes of abnormal or out of control conditions before problems become readily apparent, and revise standards if necessary.

C. Enhancement of morale

KPT activities are aimed at enhancing the morale of circle members. Ishikawa (1981, 29) suggests that —the morale should be elevated as a natural consequence of taking part in the activity.

D. Establishment of sound human relations

✓ KPTs provide a place where people can solve problems with active communication toward the achievement of common objectives. It is in this respect that a KPT can contribute to develop human relations among its members and even with management. Members learn interpersonal skills through their discussion with other members, acquiring a sense for building up harmonious relationships.

E. Better income

✓ In the long run, with company income increase through KPT activities, the income of the members will often increase. But we should not think of such increases as direct increases. As it will be stated later in this book, the benefit of the Circles can be measured not only by tangible impacts but also by intangible impacts.

F. Improvement in Quality Assurance

The ultimate goal of KPT activities is to achieve quality assurance. By solving problem in the workplace in a systematic manner, the Circle can achieve quality assurance in the workplace, which consequently leads to improvement in the quality of life of the individual operator

1.4 How to Get Started: KPT Activities

The installation of a KPT program in a company needs careful planning for it to be successful. It cannot be left to chance, because once an attempt to introduce it fails, the effect on the company's people may last long. The experiences of some companies, for instance, show that after an initial failure, people are apathetic to new attempts at introducing participation-based programs.

Self-Check- 1	Written Test

Directions: For each of the following question choose the best answer.

1. One of the following is Characteristics of KPTs

   A. Small group B. Autonomous operation C. Self-Development D. all

2. One of the following is not Objectives of KPTs Activities.

   A. Establishment of a pleasant workplace B. Establishment of a state of control

   C. Enhancement of morale D. none

3. By solving problem in the workplace in a systematic manner, the Circle can achieve quality assurance in the workplace.

   A. Improvement in Quality Assurance B. Establishment of sound human relations

   C. Better income D. none

Note: Satisfactory rating - 1 points Unsatisfactory - below 1 point

Information Sheet - 2	Monitoring implementation according to the agreed procedure and activities are checked with preset plan.

2.1 Testing and implementation of countermeasures

After causes are identified, countermeasures are examined, evaluated, and selected. This stage aims both to correct the root causes and to establish the most effective measures to prevent the reoccurrence of the problems. All the people concerned on the issue are gathered to discuss it, considering factors such as effectiveness, cost, condition of restrictions, and impacts on the other factors. Members then implement countermeasures in daily operations, according to the plan, and monitor the results.

2.2 Implement action plans

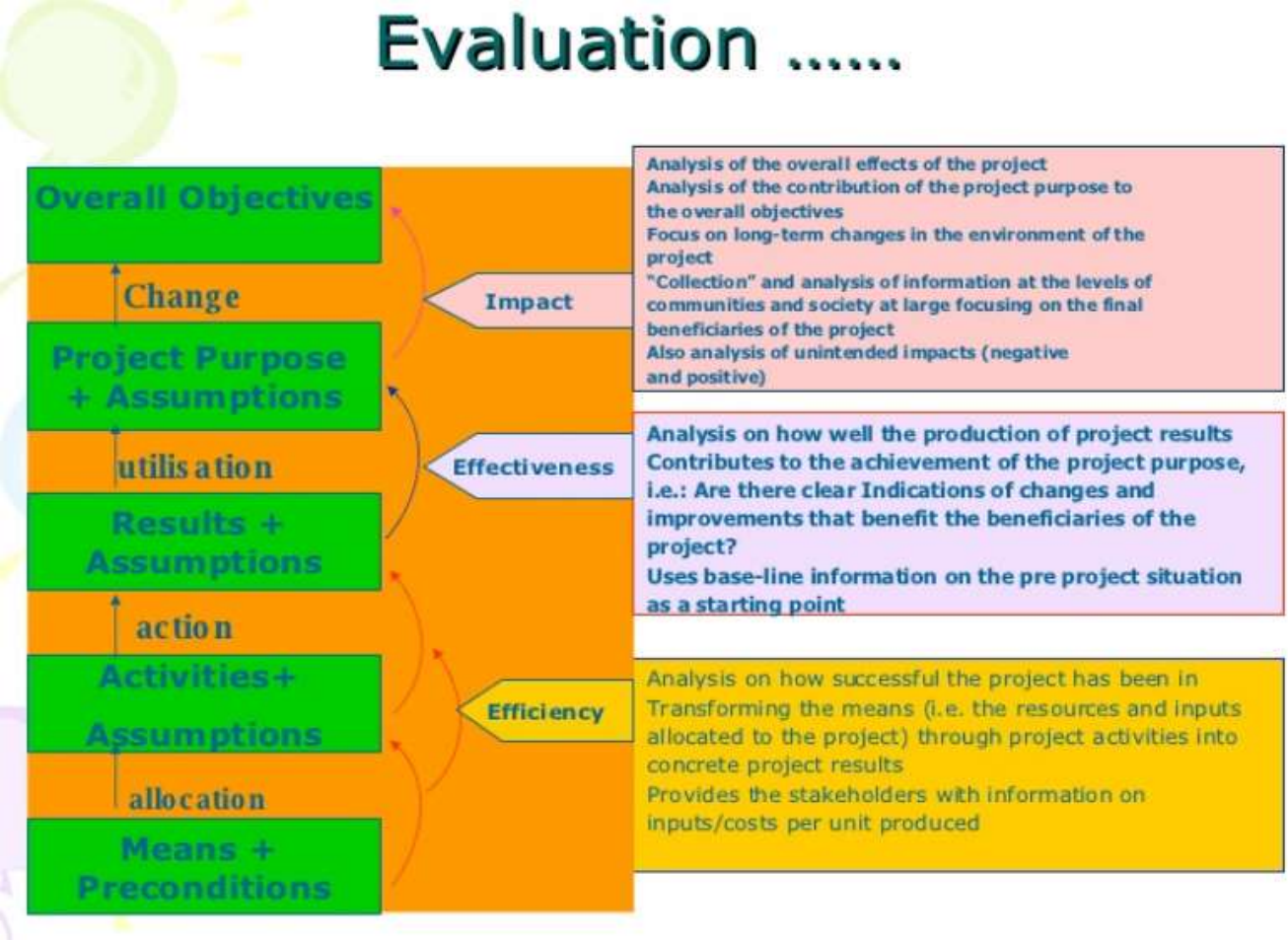
Step one: Implement action plans . You need to have management check the corrective action and approve its implementation. The Circle is now ready to implement its action plans. Teamwork is very crucial in this step. The solution may be a very good solution and the plans may be very detailed, but if not everyone does their share of the work, the desired result may not be achieved. Planning and implementing countermeasure action using 5W1H

- **Points to remembers:**
  - ✓ Set deadlines. When does it to be done by?
  - ✓ Write in short, coherent sentences. Adding figures makes it more understandable.
    - The 5W1H has to be parts of planning and clear parts of confirmation.
    - Because these circles showed the results of corrective action, it is easy to see in clear terms how complete implementation was.

2.3 Monitor activities and results

Implementation must be monitored according to the agreed procedure to check both if the activities are implemented according to the plan and if the expected results are observed. Actual implementation dates must be reflected against the planned dates as seen in the Gantt chart. Here is below the actual implementation dates must be reflected against the planned dates as seen in the Gantt chart.

Table 9: **Monitor activities and results**



2.4 operation sheet testing and implementation of countermeasures

- Planning corrective action
- Implementing corrective action
- Monitor activities and results

Implementation must be monitored according to the agreed procedure to check both if the activities are implemented according to the plan and if the expected results are observed.

Self-Check- 2	Written Test

Directions: For each of the following question say **True** or **False.**

1. After solving the problem the management check the corrective action and approve its implementation.
2. Monitor activities is flow up the implementation of the solving problems.
3. After causes are identified, countermeasures are examined, evaluated, and selected.

Note: Satisfactory rating - 2 points **Unsatisfactory - below 2 point**

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 71

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-6 LG-71**
TTLM Code	**EIS PIM4 0920 V1**

LO6: Assess effectiveness of the solution

Instruction Sheet	Learning Guide:-71

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

- Identifying tangible and intangible results.
- Verifying the results over time.
- Comparing tangible results with targets using various types of diagram.

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:-**

- Identify tangible and intangible results.
- Verify the results over time.
- Identify tangible results with targets using various types of diagram.

Learning Instructions:

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

Information Sheet - 1	Identifying tangible and intangible results.

1.1. Tangible and Intangible Results

Then an assessment is carried out to see whether the impediments have been overcome or to what extent the initial objectives have been met. It is carried out together with evaluation for further improvement of the work. The Circle identifies the tangible and intangible results, verifies using data, and compares them with the initial goal. Tangible results are results targeted through changes in processes, whereas intangible results are those in areas such as improvement in employee learning skills and education. If the results do not meet the goal, then the Circle needs to return to previous stages and reexamine the processes.

1.2. Identify tangible and intangible results

Tangible results are those that can be quantified, like when a defect rate is reduced by a certain percent. Intangible results on the other hand are those that are qualitative, like when teamwork among the members is improved.

1.3. Compare the target value and the actual value (for tangible effects)

Step one: Compare the target value and the actual value (for tangible effects)

- See if the target value was met. See in below figures
- If the target value was not met, go back over the previous steps to see what went wrong, correct it, and try again.
- The effect should be measured using the same QC method and criteria as used in fact analysis.
- The effect should be conformed for each corrective action.
- If the target has been determined as the first priority, make sure to see what impact to this has had on the whole.
- **Identify other effects**

Step two: Identify other effects,

Identify effects other than the immediate tangible effects. Convert the effect in to monetary value. They are very specific numerical values that everyone can understand.

1.4. Confirm the intangible effects

Step three: Confirm the intangible effects

- What impact has the activity had on human relations in the workplace, skill levels, teamwork, morale, and the work environment?
- These in tangible effects are easier to understand if you use multidimensional comparisons with radar charts and other tools.
- Below POINTS showing the effect with **"before"** and "**after**" Pareto charts

#**BEFORE**

1. The group compared pre-kaizen quality and post-kaizen quality with Pareto charts, showing very clearly that major improvement was made in large sheet processing, which went from being the most important problem to being third most important.

#AFTER

1. This shows the data on hours lost due to stoppages and on days worked, thus clearly showing the impact that the kaizen had on workplace efficiency.

Self-Check- 1	Written Test

Directions: For each of the following question choose the best answer.

.1. Tangible results effects are

A. that can be quantified B. defect rate is reduced by a certain percent

C. qualitative and improved D. A&B E None

2. What is the impact has the activity had on human relations in the workplace,

A. skill levels B. teamwork C. morale

D. work environment E. all, and

Note: Satisfactory rating - 1 points Unsatisfactory - below 1 point

2.1 Verification of results using various types of diagrams

- **Line graph**

Line graphs are used to show actual situations given points in time. They may also be used to predict future trends. They may be broken lines or straight lines.

How to construct a line graph

Step 1: Draw the horizontal and vertical axes of the graph, using the horizontal axis for the period and the vertical axis for the value.

Step 2: Plot the points corresponding to the values.

Step 3: Connect the points.

Figure Line Graph

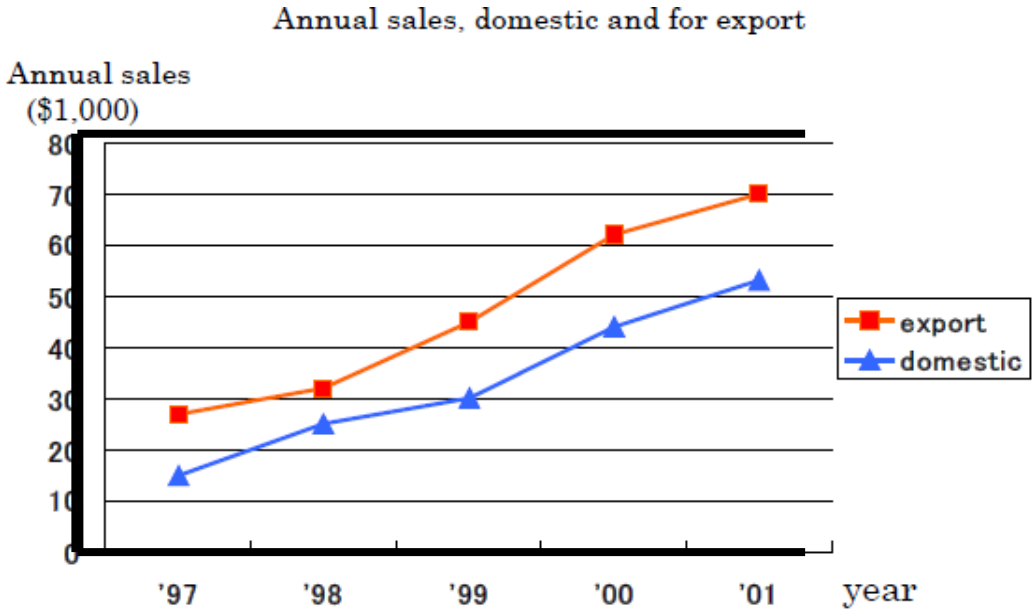


Figure 12: Line graph

- **Bar graph**

Bar graphs are used to show trends (e.g., of a product or service). They make use of bars whose lengths represent the size of the factors under consideration. The bars may be positioned vertically or horizontally.

How to construct a bar graph

Step 1: Draw the horizontal and vertical axes of the graph, using the horizontal axis for the period and the vertical axis for the value.

Step 2: Divide the horizontal axis into equally spaced vertical columns, each column representing a period.

Step 3: Divide the vertical axis into as many equally spaced horizontal rows as required, each higher row representing a higher value.

Step 4: Draw the bars.

Figure shows bar graph

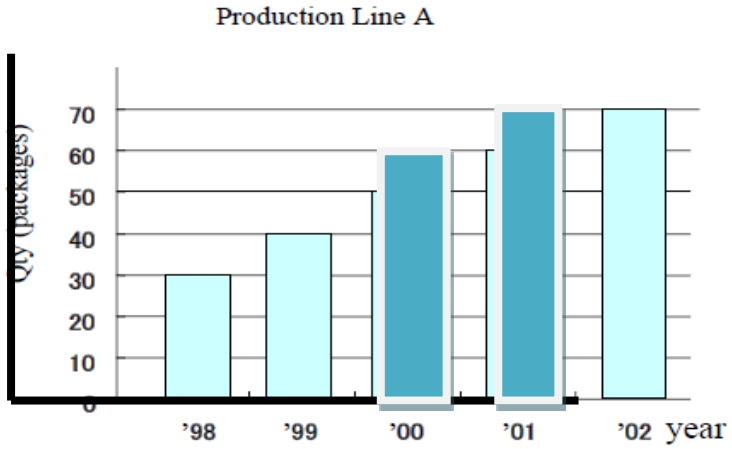


Figure 13: shows bar Graph

- **Pie chart**

A pie chart is used to denote relative portions of a situation; each slice of pie represents a percentage of the whole.

How to construct a pie chart

Step 1: Draw a circle.

Step 2: Divide the circle into slices that correspond in size to the relevant percentages. For instance, if you divide the circle into four equal slices, then each is 25 percent of the whole.

Step 3: Moving clockwise from the topmost part of the chart, arrange the items in order of percentage size, unless another order is inherently logical.

Step 4: Indicate the name of the item and its percentage.

Step 5: Consider what color or pattern to use for identification of items.

The by-objective bases of selecting a graph:

When comparing the size of numbers

- ✓ Bar graph, band graph

  When showing a change over time

- ✓ Line graph

  When giving a breakdown

- ✓ Pie graph, band graph

- **Scatter diagram**

A scatter diagram examines the relationship between paired data. This tool is usually used by the QC Circle when it wants to establish the relationship between cause and effect, the relationship between one cause and another or a relationship between one cause and two causes. Examples include the relationship between an ingredient and the hardness of a product, the relationship between the speed of cutting and the variation in the length of parts cut, the relationship between the level of illumination in a room and mistakes in validating a bank transaction slip. The scatter diagram is used when a number of people or procedures are producing widely varying results. The scatter diagram may show that two variables have positive correlation, have negative correlation, or have no correlation at all.

How to construct a scatter diagram:

Step 1: Collect data samples of pairs whose relationship is to be studied. Enter these data in a data sheet (figure 48).

Step 2: Draw a vertical axis (effect); calibrate it from smallest to largest value (from top to bottom).

Step 3: Draw a horizontal axis (cause); calibrate it from smallest to largest value (from left to right).

Step 4: Plot the paired values. If values are repeated, make concentric circles (in the graph indicated as pink).

Step5: Plot data in a graph, with material content.

Figure shown below common Scatter Diagrams

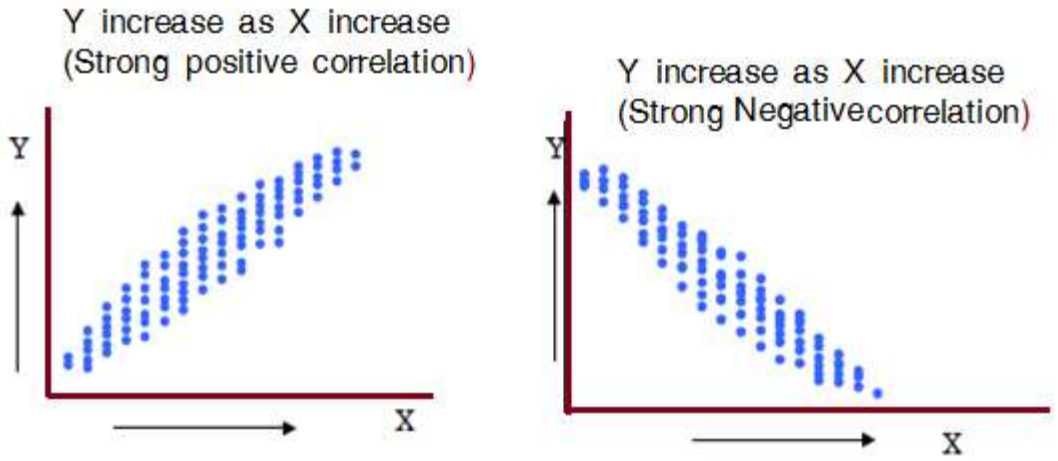


Figure 14: common Scatter Diagrams

- **Affinity diagram**

An affinity diagram is a tool to clarify the nature of an uncertain problem or chaotic event by coordinating ideas and obtaining concepts through the integration of relevant verbalized data on the basis of affinity.

Preparations of affinity diagram

A. Determine a theme.

B. Collect data by way of brainstorming.

C. Get an understanding of all verbal information collected from every member. In some cases the data must be rewritten to prevent any misinterpretation or misunderstanding.

D. Do the same as for individual preparations' steps C and D.

In Figure could show affinity Diagram for House Cleaning

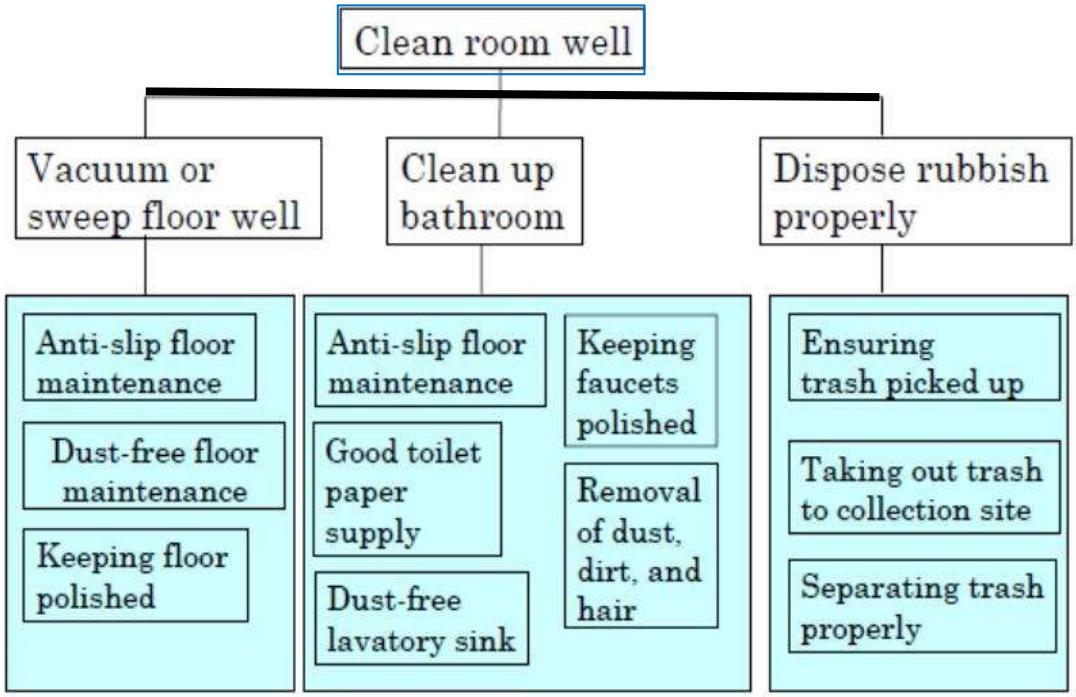


Figure 15: affinity Diagram for House Cleaning

Self-Check- 2	Written Test

Directions: For each of the following question say **True** or **False.**

1 Line graphs are used to show actual situations given points in time.

2. AN affinity diagram is a tool to clarify the nature of **certain problem** or chaotic event.

3**.** A scatter diagram examines the relationship between paired data.

4. Bar graphs are used to show trends (but not show a product or service).

5**.** Scatter diagram show the relationship between an ingredient and the hardness of a product.

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

Information Sheet - 3	Comparing tangible results with targets using various types of diagram.

3.1 Graphs

Graphs of various types are used for pectoral representation of data. Pectoral representation enables the user or viewer to quickly grasp the meaning of the data. Different graphical representation of data is chosen depending on the purpose of the analysis and preference of the audience. The different types of graphs used are as given below:

- **Type of graph purpose**
  - ✓ Bar Graph to compare sizes of data
  - ✓ Line Graph to represent changes of data
  - ✓ Gantt chart to plan and schedule
  - ✓ Radar chart to represent changes in data (before and after)
  - ✓ Band Graph Same as above

- **Histogram**

Histograms or Frequency Distribution Diagrams are bar charts showing the distribution pattern of observations grouped in convenient class intervals and arranged in order of magnitude. Histograms are useful in studying patterns of distribution and in drawing conclusions about the process based on the pattern. The Procedure to prepare a Histogram consists of the following steps :

- ✓ Collect data (preferably 50 or more observations of an item).
- ✓ Arrange all values in an ascending order.
- ✓ Divide the entire range of values into a convenient number of groups each representing an equal class interval. It is customary to have number of groups equal to or less than the square root of the number of observations. However one should not be too rigid about this. The reason for this cautionary note will be obvious when we see some examples.

✓ Note the number of observations or frequency in each group.

✓ Draw X-axis and Y-axis and decide appropriate scales for the groups on X-axis and the number of observations or the frequency on Y-axis.

✓ Draw bars representing the frequency for each of the groups.

✓ Provide a suitable title to the Histogram.

✓ Study the pattern of distribution and draw conclusion.

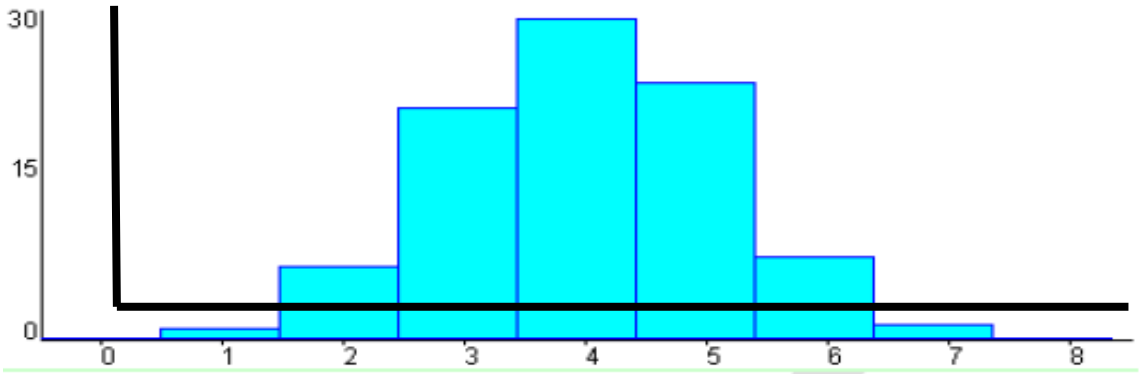


Figure 16: Normal histogram

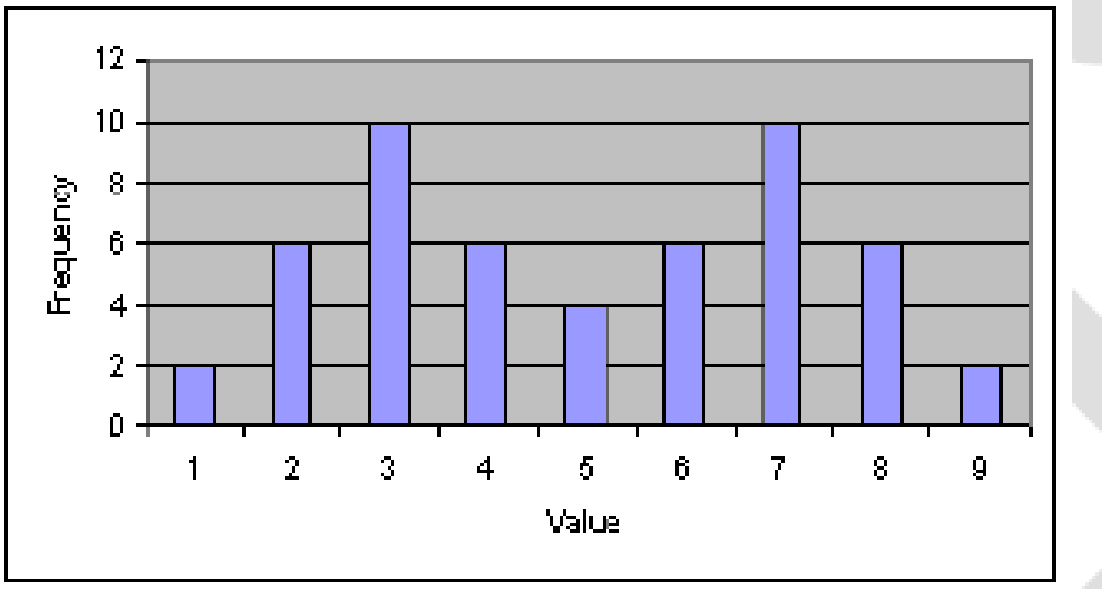


Figure 17: Bi modal

3.2 Control Charts

Variability is inherent in all manufacturing processes. These variations may be due to two causes;

i. Random / Chance causes (un-preventable).
ii. Assignable causes (preventable).

Control charts were developed by Dr. Walter A. Shewhart during 1920's while he was with Bell Telephone Laboratories. These charts separate out assignable causes. Control chart makes possible the diagnosis and correction of many production troubles and brings substantial improvements in the quality of the products and reduction of spoilage and rework. It tells us when to leave a process alone as well as when to take action to correct trouble

Self-Check- 3	Written Test

Directions: For each of the following question matching from **column "B" to column "A"**.

column "A"	**column "B"**
_____1. Bar Graph	A. represent changes of data
_____2. Line Graph	B. represent changes in data (before and after)
_____3. Gantt chart	C. compare sizes of data
_____4. Radar chart	D. pectoral representation of data
_____5. Graphs	E. plan and schedule

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

Solar PV System Installation and Maintenance

Level-IV

Learning Guide- 72

Unit of Competence	**Apply Problem Solving Techniques and Tools**
Module Title	**Applying Problem Solving Techniques and Tools**
LG Code	**EIS PIM4 M16 LO-2 LG-72**
TTLM Code	**EIS PIM4 0920 V1**

LO7: Standardize and sustain operation.

Instruction Sheet	Learning Guide:-72

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

- Standardizing and made If the goal is achieved, the new procedures part of daily activities.
- Training all employees on the new Standard Operating Procedures (SOPs).
- Verifying and following SOP by all employees.
- Selecting the next problem to be tackled by the team.

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

- Standardize and made If the goal is achieved, the new procedures part of daily activities.
- Train all employees on the new Standard Operating Procedures (SOPs).
- Verify and follow SOP by all employees.
- Select the next problem to be tackled by the team.

Learning Instructions:

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

. Information Sheet - 1	standardizing and made If the goal is achieved, the new procedures part of daily activities

1.1. The Concept of Standard Operation Procedure (Sop)

- **Standard**

Standard defines the acceptance criteria for judging the quality of an activity. In the Kaizen context Standards refers to rules, procedures and guidelines for activities carried out in the workplace. According to Taiichi Ohno **(**the father of TPS**)**

No standard, There can be No Kaizen

- ✓ There can be no basis for comparison (before / after)
- ✓ One cannot objectivity tell if there was a difference or change
- ✓ No improvement is possible in regards to time, Quality, Quantity, Cost etc.

- **Standardization**
  - ✓ Formulation, publication, and implementation of guidelines, rules, and specifications.
  - ✓ Is a standard specification, unit, instruction or something that is understood globally?
  - ✓ Standardization promotes effective teamwork by teaching employees similar terminology, skills and rules of play at the work place (GEMBA).

- **Why Implement Standard Work?**
  - ✓ To make it possible to identify and eliminate variations in operation' work "variability is the breeding ground of defects, and high costs."
  - ✓ Team member own choice are dramatically reduced, eliminating the —"Do it your own way".
  - ✓ Abnormal conditions are clearly defined and tracked.
  - ✓ To sustain the gains achieved from improvement activity.
  - ✓ To provide a base line for future improvement.

- **Kaizen will succeed only if you pay regular attention to Standard Work.**

Standardization

- ✓ Reduce variation
- ✓ Enables flow
- ✓ Eliminates waste
- ✓ Fuels continuous improvement

Standardized work place and working materials

Figure 18: the Standardized work place and working materials

1.2. Steps to Standardization

- **Identify and set a standard**
  - ✓ The standard method must be established and should be regarded as a “good” method.
  - ✓ But the standard method is only “good” - not —best. Each method challenges us for a better way. The consistent updating of Standard Operations is the cornerstone of Continuous Improvement.

Self-Check- 1	Written Test

Directions: For each of the following question say **True** or **False**.

1. The standard method is only “good” - not —best. Each method challenges us for a better way.
2. Kaizen will succeed only if you pay regular attention to Standard Work.
3. In the Kaizen context Standards refers to rules, procedures and guidelines for activities carried out in the workplace.
4. Standardization promotes effective every one work than teamwork.
5. Formulation, publication, and implementation of guidelines is not leading to standardization.

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

Information Sheet – 2	Training all employees on the new Standard Operating Procedures (SOPs).

2.1 Ensure everyone in organization understands & commit to the standard.

- Confirm the standard is reasonable & fair
  - ✓ Continuous improvement

    a. Improving every aspect of every activity every day – forever

    b. Think of continuous improvement as a journey rather than a destination.

    c. Continuous Improvement enhances —people supportive practices

    - ☞ Provides new skill to employees, empowering them to design and improve their own work.
    - ☞ By standardizing on a new method, it gives people the ability to reduce the variation.

2.2 Continuous Improvement is needed:

- Increased competition
- Customer demands for lower price.
- Expectation higher quality.
- Changing technologies.
- Need for improved participation and self -direction.
- Wider base of knowledge.
- Safer, better workplace.
- Zero accidents

Kaizen and standardization.

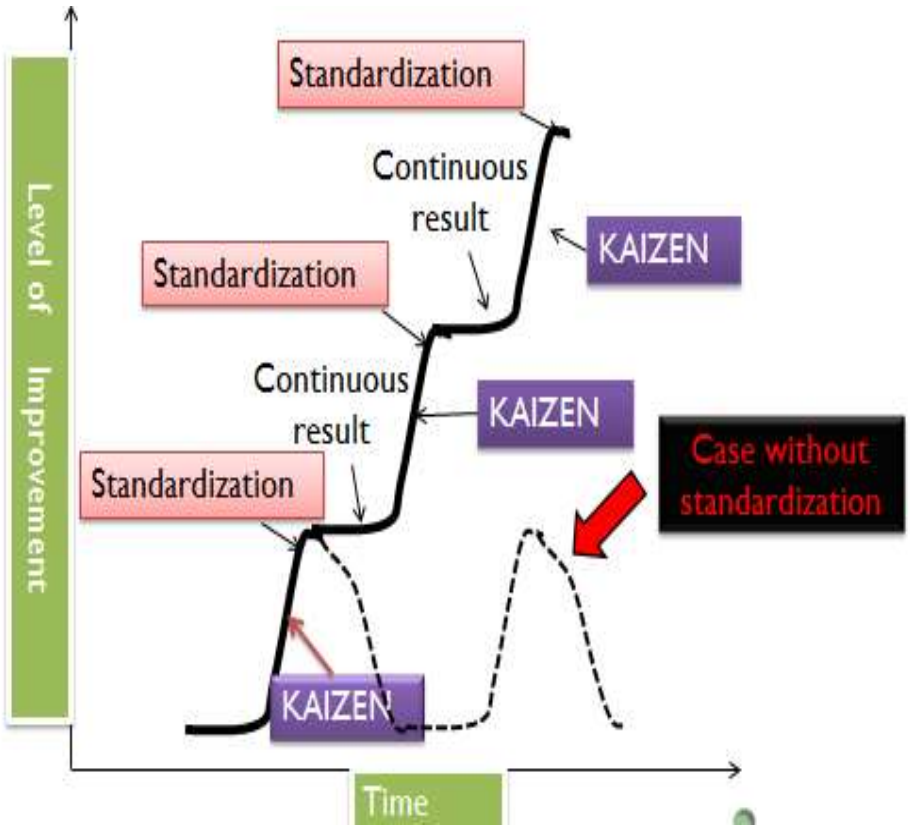


Figure 19: kaizen and standardization.

2.3 Continuous improvement process steps

- Observe current method.
- Document current method.
- Identify improvements (steps to eliminate).
- Implement improvements.
- Validate quality and productivity of new method.
- Standardize new method.
- Document —Before‖ and —After‖ conditions.
- Recognize achievements.
- Look for next improvement.

Standardization is waste Elimination tool

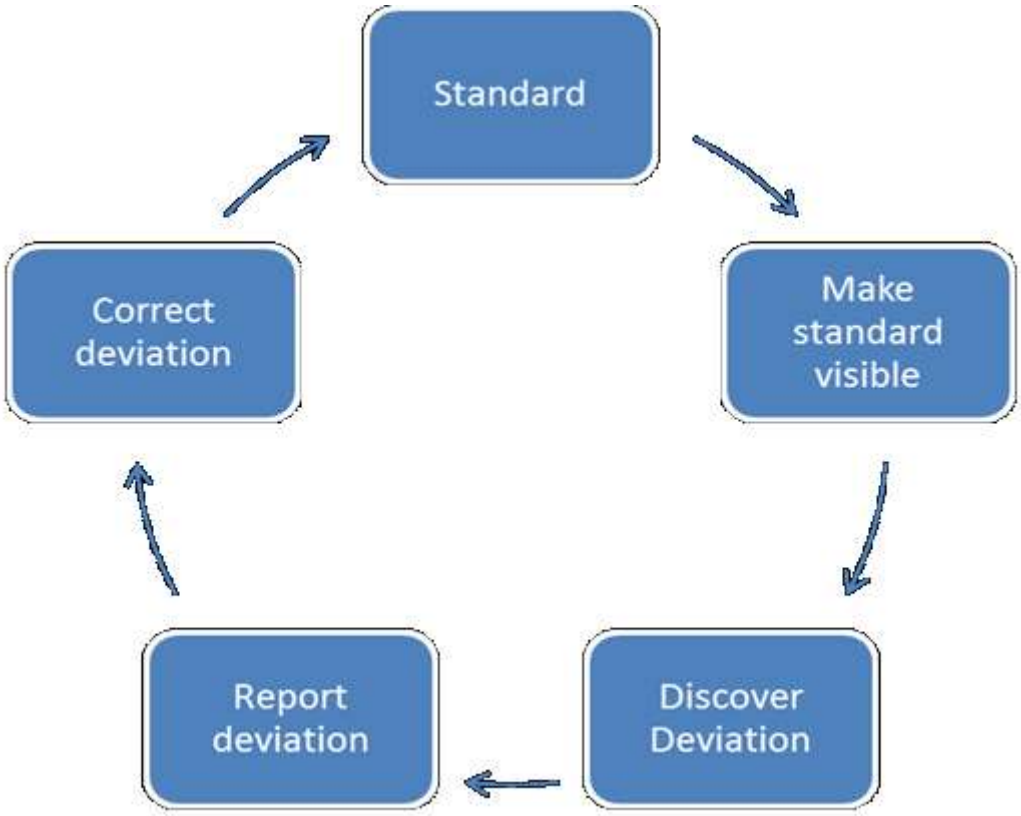


Figure 20: Standardization is waste Elimination tool

2.4 Standard operation and its benefits

Standard Operation

- It deals details procedures to perform an operation efficiently by anyone assigned for the task.
- An efficient production system which eliminates wasteful procedures by bringing together a number of jobs focused on the movements of workers.

“U” shaped work units

- Eliminates isolated islands.
- Integrates processes.
- Reduces transport and handling of parts.

- Enhances teamwork.
- Increases visibility
- Enhances cross training
- Improves safety
- Reduces inventory
  - ✓ In the kaizen contexts standard operation means creating a consistent way that an operation or a task is performed so that anyone can perform it.
- **Standardized processes are intended to:**
  - ✓ Ensure customer satisfaction
  - ✓ Drive consistent output.
  - ✓ Ensure consistent quality
  - ✓ Drive consistent cost and time.

- **Benefits of standard operation**
  - ✓ Ensure safety
  - ✓ Stable quality
  - ✓ Reduce cost and increase productivity
  - ✓ Visualize what is normal Vs. abnormal.
  - ✓ Stabilize delivery time
  - ✓ Eliminate wastes.
  - ✓ Simplifies process
  - ✓ Create baseline for KAIZEN

2.5 Three elements of standard operation procedure (sop)

2.5.1 Takt time

- The rate at which the end product or service must be produced and delivered in order to satisfy a defined customer demand within a given period of time.
- Is the time that is allotted for making one unit of product?

2.6 Standard in process stock

- It is the minimum quantity of parts always on hand for processing during and between sub-processes.
- It allows workers to do their job continuously in a set sequence, repeating the same operation over and over in the same order.

2.7 Operating Procedure

- Enter the layout of facilities and pallets in the sheet.
- Observe the target operator closely.

i. It is necessary to talk about the Operation Base (OB) and Starting Point (SP) with the target operator in advance.

ii. If the ―waiting‖ is expected during operation, it is also necessary to decide the point of waiting and the timing to resume the operation.

- ✓ OB = the place the operator is located when starting the operation.
- ✓ SP = the tool showing the timing when the operator start working.

iii. Enter operator's movement using numbers and flow lines in line with the procedure.

iv. Record work elements and time measured in numerical order.

v. Enter the quantity of Standard In-Process Stock (*) in the bottom of the format

vi. Enter the items about quality inspection and safety operations in symbols, if any.

vii. Enter the information necessary to help control and make follow up actions afterwards.“**Standard Operation Sheet** is subject to change after examining the effects of the corrective measures at the working site discussing with operators there.

2.8 Principle of Standard Formation

- Enhanced: Standard of Improved situation.
- Acceptability: Acceptable Standard to all employees.
- Practicality**:** Easy to Implement Standard

Self-Check- 2	Written Test

Directions: For each of the following question choose the best answers.

1. Standardized processes are intended to:

A. Ensure customer satisfaction B. Drive consistent output.

C. Ensure consistent quality D. Drive consistent cost and time. E. all

2. Benefits of standard operation

A. Ensure safety B. Stable quality

C. Reduce cost and increase productivity D. all E. none

3. An efficient production system which eliminates wasteful and bringing the movements of workers.

A. Eliminates isolated islands. B. Integrates processes.

C. Increases transport and handling of parts. D. Enhances teamwork.

4. Continuous Improvement is needed:

A. Decreased competition B. Customer demands for lower price.

C. Expectation higher quality. D. Changing technologies

Note: Satisfactory rating - 2 points Unsatisfactory - below 2 point

Information Sheet - 3	Verifying and following SOP by all employees.

3.1 Verify that the SOP is followed

Verify that the SOP is followed like for any other SOP, monitoring is needed for this new one to see that everyone concerned is adhering to it all the time. If they are not, then the reasons must be determined and countermeasures must be put in place. Spot checks must be conducted from time to time.

- **Monitor results**

Create a system in which you can confirm that the standards are being followed and that the corrective action is continuing to have the desired effect. Establish follow-up procedures that help you get the most out of your activities.

- **Key points**
  - ✓ Monitor data constantly, using control charts and graphs to see that the effect and is sustained.This monitoring should be incorporated into the daily management routine and done without fail.
  - ✓ Establish a mechanism whereby other corrective actions can be devised and implemented if the effect wanes.
  - ✓ If you are reporting on your activity well after their completion, do a flow-up study to determine subsequent conditions and to see how well the kaizen effect is holding up.

Self-Check- 3	Written Test

Directions: For each of the following question say **True** or **False**.

1. Standard operation procedure (SOP) is Improving every aspect of every activity every day – forever.
2. Think of continuous improvement as a journey rather than a destination.
3. Establish follow-up procedures that help you get the most out of your activities.

Note: Satisfactory rating - 2 points **Unsatisfactory - below 2 point**

Information Sheet - 4	Selecting the next problem to be tackled by the team.

4.1 Standardizing new improvements

If the goal is achieved, the new procedure should be standardized. If the goal is not achieved, then the QC Circle must retrace its steps, starting with analysis of the causes. Standardization ensures that the solution stays permanent. Incorporate the most effective corrective actions into your operational and other standards in order to sustain the effect. In standardizing, seek to integrate and simplify procedures so that anyone can follow them and achieve the same results.

- **Key points**
  - ✓ Standardize effective, corrective actions
  - ✓ Develop operation procedures in to rules. Establish or revise standards, specification, rules, and manuals.
  - ✓ Be sure that the standards specify who, when, where, what, why, and how, and are easy to implement.
  - ✓ Look at the relationship between the operation under review and the upstream downstream processes. Standards should also be revised in other departments as necessary.
  - ✓ Specify when the new standards are to go into the effect.

Points to remember in using the 5W1H in standardization

i. Decide clearly on the 5W1H category items and who is going to be responsible for doing what. Be sure to include items to keep the problems from recurring.

ii. State explicitly what operating standards are to be followed and what the standard times are, thereby making the standard themselves explicit.

iii. Draw up quality and check sheets and exercise ingenuity to see the management tools used.

iv. Draw up a graph of actual process progress and show explicitly that affect is being sustained.

- **Standardization procedure**

Once a corrective action has been incorporated into the standards, follow the registration procedures and make it official.

- ✓ Be sure to follow the official procedures for establishing, revising and discontinuing standards.
- ✓ Management approval is prerequisite for establish or revising any operating standards.
- ✓ Take the time to explain the new standards and the reasons for them to everyone's satisfaction.
- ✓ Do not revise or discontinue standards until after you have cleaned this with the upstream and downstream departments that will be affected.Standardization and horizontal deployment of the standardization

4.2 Introducing new sop to employees

- **Train employees on the new SOP**

If the work is done in more than one shift but the QC Circle members come from only one shift, then all employees in the other shifts must be trained on the new SOP (Standardized Operational Procedure). This way, the benefit from the new SOP is maximized. Once you have established the new or revised standards, devise a system that ensures that they will be followed.

- **Key points**
  - ✓ Educate trainees to understand the standards. At the same time, train them to request the necessary skills.
  - ✓ Develop a mechanism for education and training to accommodate operator change (e.g. new trainee)

Self-Check- 4	Written Test

Directions: For each of the following question say **True** or **False**.

1. To understand the standards are not needs educate trainees.
2. Management approval is prerequisite for establish or revising any operating standards.
3. If the goal is achieved, the new procedure should be standardized.

Note: Satisfactory rating - 2 points **Unsatisfactory - below 2 point**

List of references

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