Table 1. Quality Control Tools

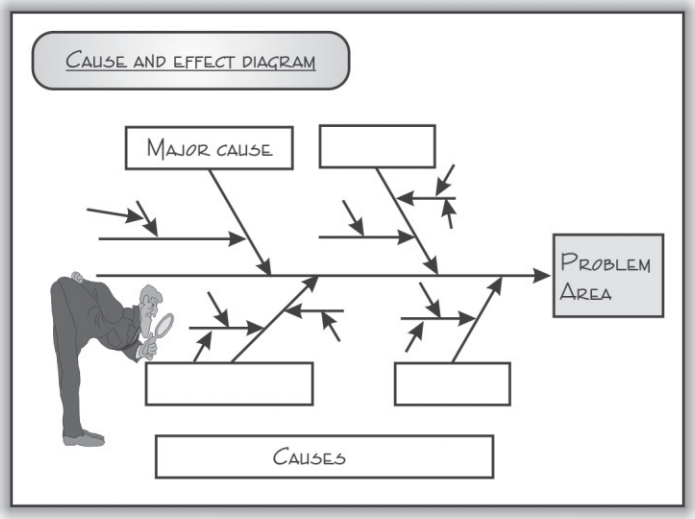
Tool	Purpose	Applicable cases
Cause and effect diagram	To clearly identify a problem (effect) and relationship between the effect and its causes without omission	Identification of the current situation and/or causes of a problem
Check sheet	To check all the items for the investigation and make data arrangement easy	Collection and processing of data
Pareto chart	To identify an important problem and its major causes	Theme setting, identification of causes of a problem
Graphs	To show characteristics of data as transition and/or trend	Understanding of background for theme setting, data arrangement
Scatter diagram	To identify relationship of a series of data	Causal analysis, identification of current situation
Histogram	To show the shape of the characteristic of data and identify frequency of events and unusual events	Identification of current situation and/or causes of a problem
Stratification	To divide information/data into several groups by characteristic or shape	Causal analysis, identification of current situation
Control chart	To grasp the trend of time-series data and identify trend and characteristics of the process	Identification of current situation and/or causes of a problem

3.3.1 Cause And Effect Diagram

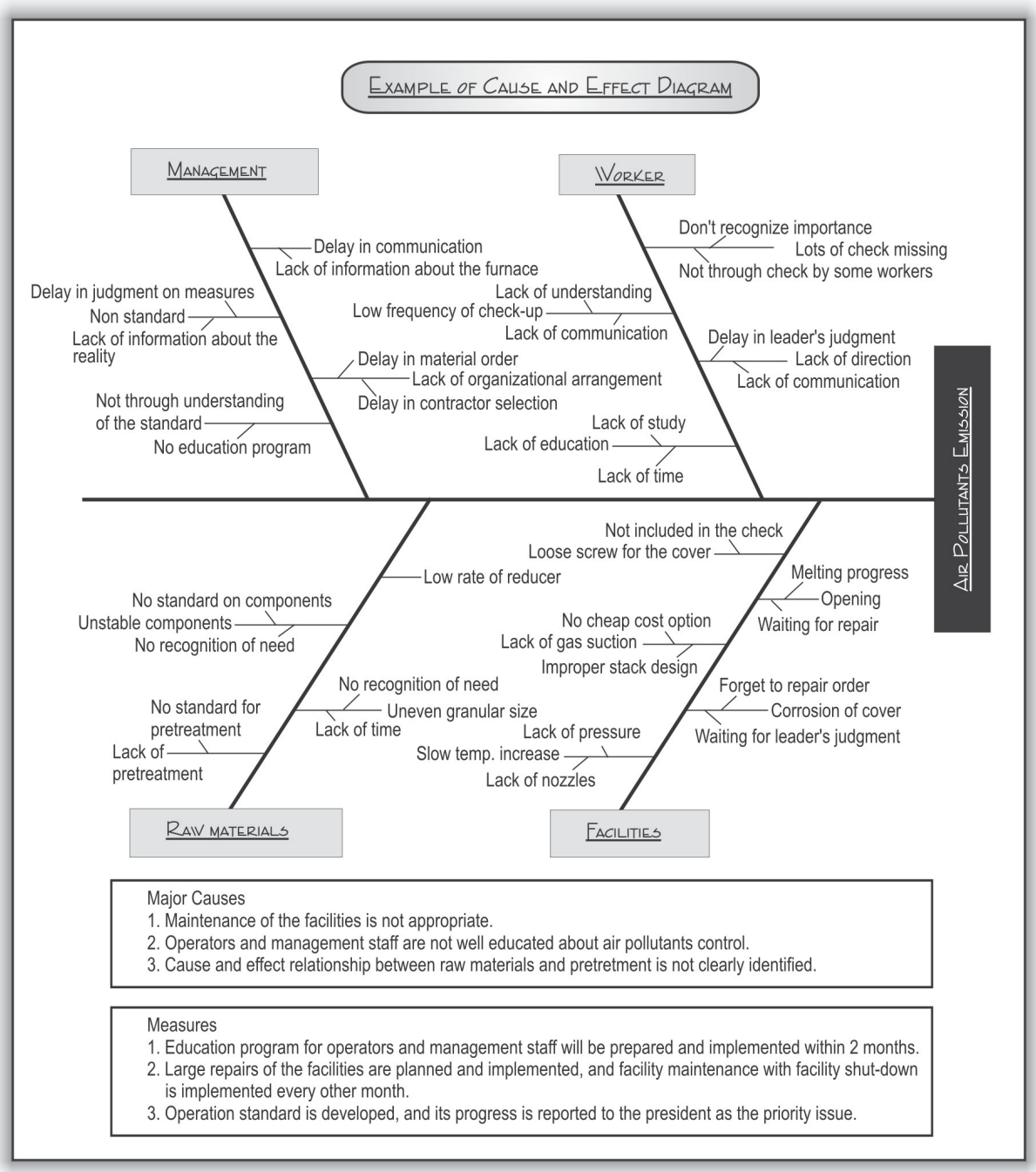
The cause and effect diagram is used to identify the relationship between a problem and its causes. In so doing, it helps in formulating measures/actions to solve the problem. The cause and effect diagram is constructed by the following steps:

1) Define the problem (effect).
2) Draw a large arrow horizontally pointing to the problem.
3) Identify major causes that directly affect the problem (cause categories are typically man, machinery, methods, and materials) and draw branches off the large arrow.

Figure 4. Cause and Effect Diagram



4) List minor causes that affect the major cause and draw as sub- branches
5) List additional causes that affect the minor cause.
6) Allocate relative weight to each of the causes.
7) Confirm the causes.
8) Confirm relevant items.



3.3.2 Check sheet

A Check sheet has a list of items for which information and/or data are collected. A check sheet is constructed by the following steps:

1) Define objectives of the survey/data collection
2) Specify items to be checked
3) Specify format of diagrams and tables
4) Record necessary information/data on the check sheet
5) Write down the title of the check sheet, data collection period, and the like

Figure 6.
Example of a Check Sheet

Name of Supplier							
Date			Operator				
Parts number		Category	Product name				
	No.	Check item	Evaluation				
			1	2	3	4	5
Operation Standard	1	Has the QC process sheet been prepared?					
	2	Has the operation standard been prepared?					
	3	Are the directions in the operation standard appropriate?					
	4	Are items, frequency, and measuring instruments of qualifty check identified?					
	5	Is there a way to check product quality at the initial stage?					
	6	Are safety items clearly indicated?					
	7	Are orperations following the operation standard?					
Implementation of operation	8	Are the self-quality check responsively conducted?					
	9	Do the operators know importants points of the quality check?					
	10	Are the control charts used?					
	11	Are safety items clearly indicated?					
Defective products handling	12	Are types of defective products identified?					
	13	Are defective products removed?					
	14	Are measures to prevent recurrence of defective products implemented?					
Overall evaluation							
Problem							
Remark							

3.3.3 Pareto chart

A Pareto chart is used to identify significant events and causes. Causes and events of the problems are categorized and then arranged by order of frequency, costs, and the like; Frequency or costs for each cause/event is expressed by bar and cumulative percentage of the frequency or costs is expressed by sequential line. A Pareto chart is constructed by the following steps:

Figure 7.
Example of frequency counting

Frequency of Cutting Length of Copper Wire

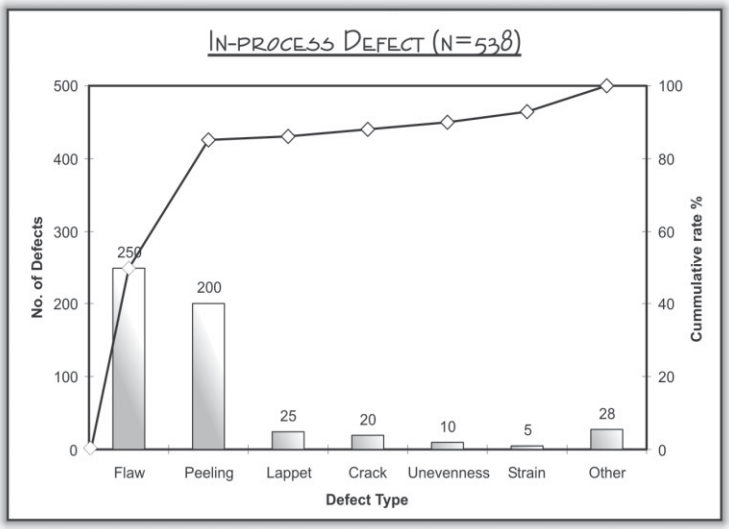
No.	Internal	Median	Frequency check	Frequency
1	250.5 ~ 251.5	251	/	1
2	251.5 ~ 252.5	252	///	3
3	252.5 ~ 253.5	253	𝍸 𝍸	15
4	253.5 ~ 254.5	254	𝍸 𝍸 ////	19
5	254.5 ~ 255.5	255	𝍸 𝍸 𝍸 ////	24
6	255.5 ~ 256.5	256	𝍸 ////	14
7	256.5 ~ 2.57.5	257	𝍸 //	12
8	257.5 ~ 258.5	258	𝍸 //	7
9	258.5 ~ 259.5	259	///	3
10	259.5 ~ 260.5	260	//	2
	Total			100

1) Specify survey items and categories for the items
2) Collect and arrange data
3) Calculate ratio of frequency or costs
4) Plot the ratios of frequency or costs by descending order from the left end of the diagram
5) Plot the cumulative frequency curve (Pareto curve)
6) Put scale on the vertical axis from 0 to 100 with the interval of 10
7) Complete the diagram with indicating diagram title and axes labels.

3.3.4 Graph and Scattered diagram

A graph or scattered diagram can help identify factors that should be controlled or improved through an examination of the relationship of two types of data. Measured values are plotted using according to X and Y axes. A scattered diagram is constructed by the following steps:

Figure 8.
Example of Graph



1) Collect data (it is desirable to collect more than 30 sets of data)
2) Identify the maximum and minimum values of the data
3) Plot the data
4) Write down title and axis labels

3.3.5 Histogram

A histogram is used for identifying frequency or impact of events in specific ranges.

A histogram is constructed by the following steps:

1) Collect more than 100 data
2) Identify the maximum and minimum values of the data and their gap
3) Specify the number of the interval (square root of the number of the data)
4) Specify the width of the interval (= 2)/3), starting from the value of subtracting a half of the interval with from the minimum)
5) Specify the boundary value for each interval
6) Specify the median value for each interval
7) Prepare a frequency table
8) Plot the frequency for the interval

3.3.6 Stratification

Stratification is used for data collection and processing in order to make data analysis effective. Stratification is to divide a group into several sub-groups based on specific characteristics, for example, as the following:

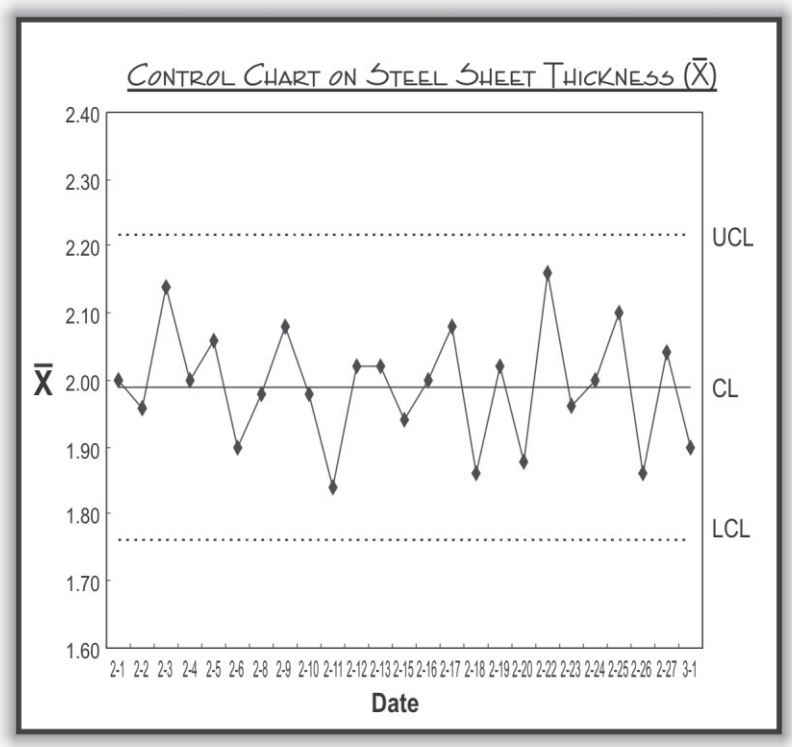
- Raw material
- Production machine
- Workplace
- Worker
- Time
- Operation method or condition

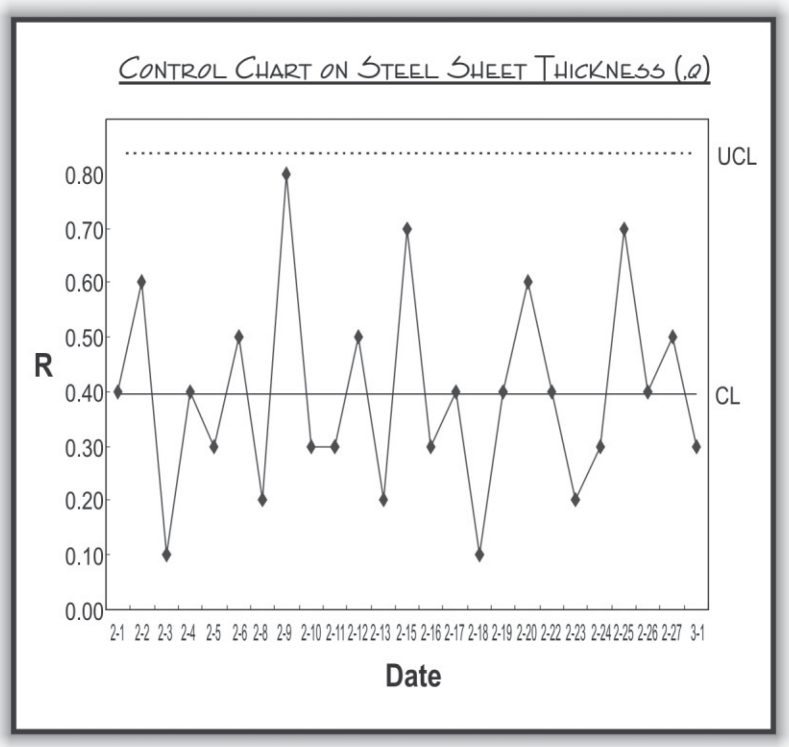
3.3.7 Control chart

A control chart is used for identifying unusual situations at the place of production. A producer tries to manufacture good quality products in a stable manner by controlling 4M (Man, Machine, Material, and Method) through sample check. A control chart provides information about fluctuation of product quality, which enables workers to take necessary actions when the product quality exceeds the acceptable range. A control chart is considered as an alarm for operation. The most often used control chart at the production facilities is X-R control chart. It identifies an unusual situation by gearing the average of the samples with their variance.

There are other tools and techniques that may be used for analyzing current operations and problems to identify opportunities for WM and productivity improvement. The above discussions are just examples and were included in this guidebook for information purposes only. The succeeding discussions present WM and productivity improvement techniques specific to the target four industry sectors: food processing, foundry, chemical processing, and pulp and paper

Figure 9.
Example of Control Chart





3.4 WM Techniques for the Food (Fruit) Processing Sector

3.4.1 Industry Profile of the Food Processing Sector

There are 4,914 food-processing companies in the country, 30% (1,455 companies) of which are located in Metro Manila and the rest are scattered among the different provinces in the country. Although most are considered small or medium scale enterprises, it constitutes almost 25% of the total employment created.

The fruit processing sector involves dried or dehydrated fruits like canned pineapple, bottled jams, jellies and marmalades, nata de coco, nata de pina, kaong, jackfruit, banana chips, etc. Fruits are also processed in brine, sauces or paste, pulped, pickled and quick-frozen or made into purees, juices and concentrates. Processed marine products, on the other hand, are fish (such as galunggong, tuna, milkfish), shrimp/prawn and seaweeds.

3.4.2 Typical Process Description

The typical food manufacturing process involves sorting, washing, drying, cutting/slicing, mixing, grinding and bottling. A smaller number of fruit processors use evaporation, filtration, coating, canning and extrusion. Most of the manufacturing procedures are company owned and operate on a continuous basis. However, majority of the equipment are manually operated and very few are fully automated.

The fruit-processing sector uses tremendous amount of water which is usually obtained from the local / municipal water supply. Most of this water is treated. However, micro, cottage and small-scale level of processing often do not use treated water for processing.

The common source of power supply is the local power generator. Most medium and large-scale processors have their own power supply. But many of the smaller ones do not have alternate power supply in case of power failure.

Liquefied petroleum gas (LPG) is also used in the production process. Other utilities commonly used by fruit processors are crude oil, coal, steam and other agricultural wastes.

Quality control of both raw materials and finished products are not as stringent. Some test only either the raw materials or the finished products. Many food processors belong to the micro, cottage and small-scale industry do not test both their raw materials and finished products at all.

3.4.3 Environmental Concerns

Aside from wastewater, disposal of solid wastes is also an environmental problem of food processors. These wastes are disposed of by burning or by throwing on the ground. Other methods of waste disposal employed by food processors include discharging in public sewage and water bodies or use into other products.

Food processors use large quantities of water in product washing and a number of preparation and