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<JICA DEVELOPMENT STUDY>

THE STUDY
ON
THE MASTER PLAN FOR
QUALITY/PRODUCTIVITY IMPROVEMENT
IN
THE REPUBLIC OF TUNISIA

FINAL REPORT
(QUALITY/PRODUCTIVITY IMPROVEMENT
MANUALS
- FOOD PROCESSING SECTOR -)

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CHAPTER 1. QUALITY / PRODUCTIVITY IMPROVEMENT OBJECTIVE

In this chapter, we will define what Quality and Productivity are in the food processing industry and we will present the objectives of an improvement of the Quality and the Productivity.

The meaning of the word Quality could seem obvious, but in fact, there exist several definitions of this word. We will check, among these different definitions, which “Quality” this manual is aiming to improve.

In regard to Productivity, the studies conducted until today show that the exact definition of this word is seldom understood. There also exist several definitions of this word, and we will check, among these different definitions, which “Productivity” this manual is aiming to improve.

1.1 Definition of the Quality in Food Processing

There are 3 kinds of Quality: « conception Quality », « manufacturing Quality » and « market Quality ». The difference between these 3 Qualities depends on which level of the value chain Quality is considered: product plan, manufacturing or marketing.

Conception Quality is a well know notion in electric and electronic industries but not very familiar to the food processing industry. It consists in Quality criteria aimed during the product plan stage (product development). Applied to food processing, this word corresponds to the Quality defined when the product is planned in terms of specifications, such as the standards on taste, texture, weight, shape, sugar content, PH, colour, water content, number of initial bacteria, foreign bodies presence, consumption limit or packaging date. In case of traditional products such as olive oil, conception Quality is often considered as if it has always been determined, but the different companies still have to determine their own conception Quality. Because, in fact, this Quality is used as a standard during the control of the manufacturing Quality. This will be presented in the next section.

Manufacturing Quality designates the Quality of a manufactured product. Generally, Quality Control is carried out with the only objective to eliminate the differences between conception Quality and manufacturing Quality, so Quality tends to be understood as manufacturing Quality.

Market Quality designates the product Quality as evaluated by the market. This notion of Quality isn’t limited to the Quality of the product itself, but also includes the assessment of a broad range of marketing values such as the brand value, the packaging design or the image of the product food security. The Quality, in the narrow sense of the term, doesn’t include this marketing notion of the

Quality, but it is essential to have this approach of the market Quality and not to be only satisfied with self-satisfaction Quality if one wants to improve his company's products Quality in order for his products to be renowned on the market as being of very high quality.

Food hygiene is an important element in the conception Quality, the manufacturing Quality as well as in the market Quality. Food that would not respect hygienic conditions will not be able to develop long-term customer loyalty even if it could temporarily show good sales. In this sense, food hygiene is an essential condition to secure a market, but it is not a sufficient condition because, by itself, it doesn't allow to develop this market. Food hygiene works as ISO or HACCP standards in terms of increasing the market competitiveness.

These different notions are synthesized in Figure 1-1.

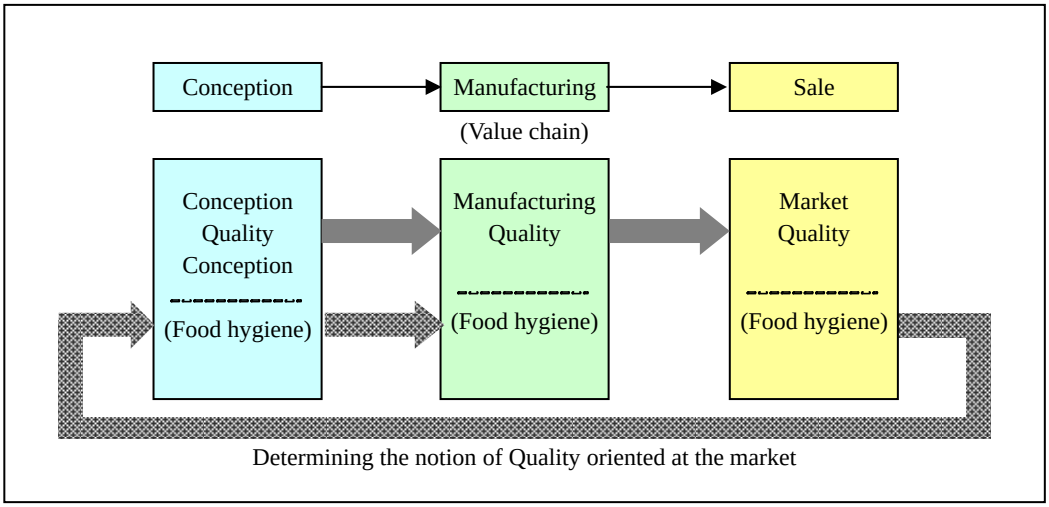


Figure 1-1 The 3 Notions of Quality

In this handbook, Quality improvement is mainly dedicated to the manufacturing Quality. The reduction to the minimum of the gap between the manufacturing Quality and the conception Quality represents an essential element of Quality Control at this stage. More than a Quality improvement in the voluntarist sense, it is about a thought close to the Quality maintenance. We will also broach, when necessary, the questions of the conception Quality and the market Quality.

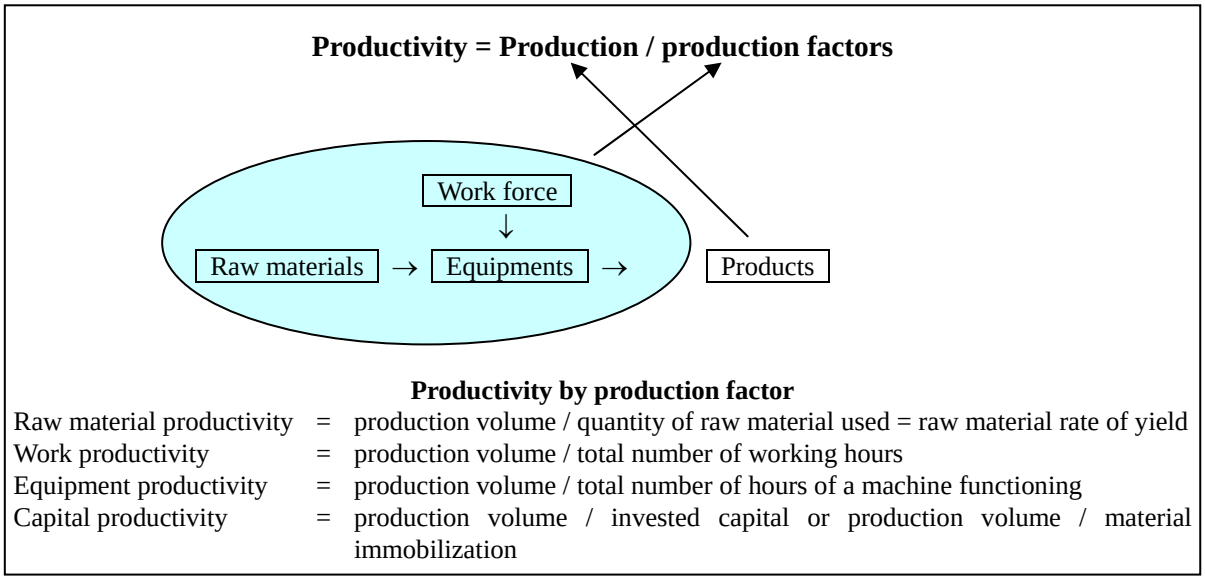
1.2 Definition of the Productivity in Food Processing

Productivity designates the ratio between the total production and the fixed factors of production used to reach that level of production. Products manufacturing requires a supply of intrants such as the raw materials, machines and equipments, energy or work force. Productivity enables to judge the production increase in comparison with these factors. Thus, increasing Productivity does not consist in

increasing equipment investisments or the number of operators to increase production, as it is often mistakenly thought. For example, suppose that the production capacities have doubled following equipment investments but that the real production has only increased by 50%. It means that, in this case, the equipments Productivity has decreased by 25% compared to the previous period that preceded the investments.

It is possible to distinguish several types of Productivities depending on the different production factors: raw materials Productivity, work Productivity, equipment Productivity and capital Productivity. The raw material Productivity, which applies to the raw materials as a production factor, is often designated in the food processing sector by the term raw materials' yield rate. When 240kg of olive oil have been obtained by pressing a ton of olives, the raw materials Productivity (raw materials yield rate) is 24%. The raw materials yield rate has an important meaning in the food processing industry as a control indicator of the raw materials cost. The work Productivity is often defined as the ratio between the production and the total number of working hours, or in other words, as the production volume per working hour of an employee. These 2 types of productivities are essential indicators in the food processing industry where the share of expenses in raw materials and workforce in the production value is higher than in the other industrial sectors. Equipment Productivity is expressed by a ratio between the production volume and the number of machines or the production volume and the total number of hours of the machine functioning. The capital Productivity is expressed by a ratio between the production volume and the invested capital, or the ratio between the production volume and the material immobilization.

Until now, we have used the production volume to express production but it is also possible to use the production value or the amount of value added.



Productivity by production factor

Raw material productivity	=	production volume / quantity of raw material used = raw material rate of yield
Work productivity	=	production volume / total number of working hours
Equipment productivity	=	production volume / total number of hours of a machine functioning
Capital productivity	=	production volume / invested capital or production volume / material immobilization

Figure 1-2 The Different notions of Productivity

1.3 Quality / Productivity Improvement Objectives

Market is not only domestic: there also is an export market. Competitors are not only domestic companies but also foreign companies. We are witnessing globalization of the competition, which should speed up from 2008 and cause an explosion of the competition between companies. In this context, the Quality and Productivity improvement aims an increase in the market competitiveness and company growth. The objective of the Quality improvement is to provide products that best fit to the clients' needs. Quality is what enables to increase efficiency compared to the market, which is a condition for a company to survive. As for Productivity, it indicates how much could have been produced with limited resources, that is to say the resources efficiency or to talk straightly, cost competitiveness. It is impossible to maintain long term competitiveness if we pay attention to only one of these 2 elements.

However, it sometimes may occur that Quality and Productivity are considered as contradictory notions. This point of view consists in saying that improving Quality leads to a decrease in Productivity, or that improving Productivity leads to a decrease in Quality. It happens that these kinds of phenomena are observed on the short term, but Quality and Productivity should not consequently be considered as contradictory. It is important to pursue the improvement of both.

But the Quality and Productivity improvement should follow a certain order. The correct way to proceed consists firstly in getting down to an increase in Quality before trying to improve Productivity. Indeed, it happens that actions taken to improve Quality lead to a temporary decrease in Productivity. Therefore, it is necessary to wait until the production of the products, which Quality level has increased, stabilizes before improving Productivity. By proceeding this way, the Quality improvement leads to an increase in competitiveness and an increase in products sales, which easily leads to an improvement of the Productivity through the effects of mass production.

CHAPTER 2. QUALITY / PRODUCTIVITY IMPROVEMENT PROCEDURE

In this chapter, we will broach the question of the procedure to continue to improve Quality and Productivity. This procedure is the management cycle. First, we will specify the meaning of the term «management» and we will tell about the advantage of following the widely admitted procedures to implement this management.

We will then present the 4 practical rules to follow during the application of the management cycle and we will indicate, for each step of this cycle, the critical points as well as the methods to improve Quality and Productivity.

2.1 Management Cycle

Control designates all the activities required to achieve an objective in a rational and effective way. It is based on the effective application of the PDCA (plan, do, check, act). In the general sense of the word, control includes maintenance actions and improvement actions. Maintenance actions consist in carrying out work according to the standards and to check if the results are in accordance with the expectations, as well as taking necessary measures if these results don't meet the expectations. Improvement actions consist in determining objectives in terms of Quality improvement and cost price decrease to a level superior to the current one, to define and implement a plan which enables to achieve these objectives and to take the necessary measures to achieve these objectives while controlling the plan results permanently. The increase in the control level generally takes the form indicated in Figure 2-1.

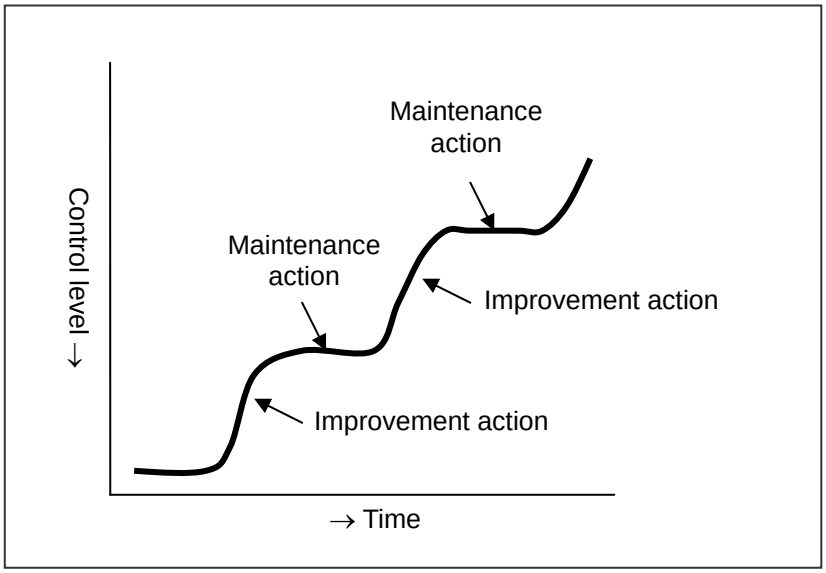


Figure 2-1 Control Activities

Maintenance and improvement actions are inseparable: if one starts lacking, control will no longer be carried out in a satisfactory way. Mechanisms which enable to maintain improved elements at a high level and to prevent their regression to the initial point are essential, like the actions aimed not only at maintaining production (Quality and Productivity) to a certain level but also at improving it and increasing competitiveness. This handbook, which objective is to try to improve Quality and Productivity, will concern consequently both the maintenance actions and the improvement actions.

Whether it is a matter of maintenance actions or improvement actions, it is essential to repeat the PDCA cycle presented in the Figure 2-2, that is to say plan, do, check, act. The Figure 2-1 describes precisely these 4 steps.

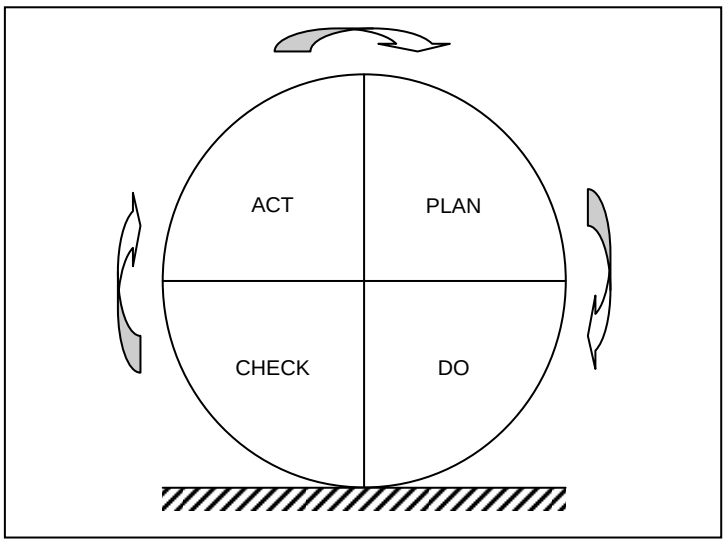


Figure 2-2 PDCA Cycle

Table 2-1 PDCA Cycle

PDCA	Actions details
PLAN	1. Specify the goal and define the control targets (Quality characteristics and Productivity indicators)
	2. Fix objectives backed up by figures
	3. Determine methods to achieve these objectives
DO	1. Teach and train to the work methods
	2. Do
	3. Collect data about the control targets by applying the defined methods
CHECK	1. Check if operations have been carried out according to the standards
	2. Check if the different values measured and the experiment results comply with the norms.
	3. Check if the control targets are in accordance with the objectives backed up with figures.
ACT	1. In case of a gap in comparison with the work standards, take corrective measures in order for the standards to be applied.
	2. In case of abnormal results, search for the causes of these abnormalities and take measures to prevent from their recurrence.
	3. Continue improvements in terms of organisation and work methods.

2.2 The 4 Practical Rules of the Management Cycle

Applying the management cycle requires the observance of 4 practical rules. These 4 principles are: the definition of priorities, the control by facts, the process control and the client's orientation.

2.2.1 The Definition of Priorities

Production sites are confronted to many problems. The causes of disparities in the work results are innumerable, therefore, among these different causes, it is necessary to define and to resolve the ones that need to be settled. It is neither possible, nor effective to deal with all of these factors with limited financial, hourly and human means.

Therefore, it is essential to search for the causes which have an important impact on the results and to find a remedy for these causes or, in other words, to deal with the priority problems which have decisive improvement effects.

Indeed, experience shows that:

1. Even if there are various problems, the number of really important problems is extremely limited.
2. By dealing with the priority problems and finding a solution, the effects are higher for the same amount of efforts provided.

2.2.2 The Control by Facts

Applying the management cycle requires many judgements and decisions. It is important to carry out the control based on data and facts, and not to rely on experience or intuition. In order to be able to rely on facts, these facts need to be quantified in data.

The 6 following stages enable to understand the facts:

1. Observe correctly the places and the reality on site
2. Define the control targets
3. Define the goals of the data
4. Gather exact data
5. Analyse correctly these data with statistic methods
6. Examine and gather relevant information

The 7 tools of the Quality Control are a useful method when applying these different stages. Despite its name, it can apply effectively to the Quality problems as well as to the Productivity problems or even to other subjects.

2.2.3 The Process Control

It is impossible to find radical solutions by examining the Quality and Productivity questions only from the results perspective. For example, if Quality is unstable, the number of faulty products will decrease only if the control of the finished products is reinforced, and if the Productivity has decreased, the problem will not be solved only by a warning designed to increase the production yield. As Quality, as well as Productivity are related to the 4M, (which are the material, the machines, the methods and the man) it is essential to examine and to check the work process and not only the results.

There are 4 important points in this matter:

1. It is necessary to search for better work methods in order to reverse the existing situation and not stick to the past processes.
2. It is necessary to analyse the gap factors between objectives and results and to check the causality system.
3. It is necessary to admit the importance of standardisation and to elaborate, implement then renew the rules in terms of relevant work methods.
4. It is necessary to check the causes of the problems that have occurred, find improvements and search for the origin of these problems by going back to the source in order to prevent problems due to the same causes from happenning again.

2.2.4 Clients Orientation

There exist different forms of competition, between companies in the same sector, but also with import products or substitution products. However, the most important point is to compete on the client satisfaction level. Therefore, the principle of the “Market” in is essential.

Market consists in introducing in the company, the idea that the clients come before everything and that the consumer is in the centre, that is to say to produce products that meet the market needs by placing ourselves from the user point of view. The opposite term is “Product out”. It designates the fact to impose on the market goods produced according to the manufacturer point of view.

Quality and Productivity should be improved from the clients' orientation. It is necessary to be particularly vigilant in case of the Productivity improvement, which tend to be followed by the unique company perspective.

2.3 «plan» with a View to Improve Quality / Productivity

The plan stage of the management cycle includes the 3 following actions:

1. Specify the goal and define the control targets (Quality characteristics and Productivity indicators)
2. Fix objectives backed up with numbers
3. Determine the methods to achieve these goals

It is possible to check if these actions have been carried out appropriately by using the following check list:

1. Have the real Quality characteristics wished by the client and the price (cost price) been perceived?
2. Are the relations between Quality and the 4M (machine, man, material, methods) clear?
3. Are the normative documents (recipes, mixes charts, standard operatory procedure, Quality control process diagram, etc) established?
4. Are the normative documents appropriately understood?
5. Are the elaboration, revision and normative document management procedures fixed?
6. Does the thought on the operatory standards take the opinions of the managers of the product development department and production department into consideration?
7. Does the standard operatory procedure indicate work methods feasible without difficulty and does it mention the important points and remarks?
8. Is the machines, equipment, kitchen tools, measure instruments mode of use fixed?
9. Are the measures to be taken in case of abnormalities and the persons to contact designated?
10. Are the standard operatory content and the standard operatory meaning subject to a sufficient teaching and training?

The Pareto diagram and the Causes and Effects diagram are effective ways to determine concrete objectives.

2.3.1 Pareto Diagram

The Pareto diagram is useful to distinguish the real problems among numerous problems. The Pareto diagram presents the problems that have occurred on the production site (faulty articles, manufacturing defect, complaints, accidents etc) under the shape of a bar graph, by ranking the problems depending on their characteristics and their causes and by classifying the obtained data in decreasing order from the problems for which the number of faulty pieces or financial loss is the most important. Figure 2-3, which present manufacturing faults dependant on their characteristics, from the characteristic for which the number of faulty pieces is the highest, shows that the first 3 characteristics represents 85% of the faulty pieces. As this example indicates, in reality, the majority of faulty pieces and financial loss are due to a very low number of default types, therefore, it is more pragmatic to choose and to improve the few important points rather than many irrelevant ones.

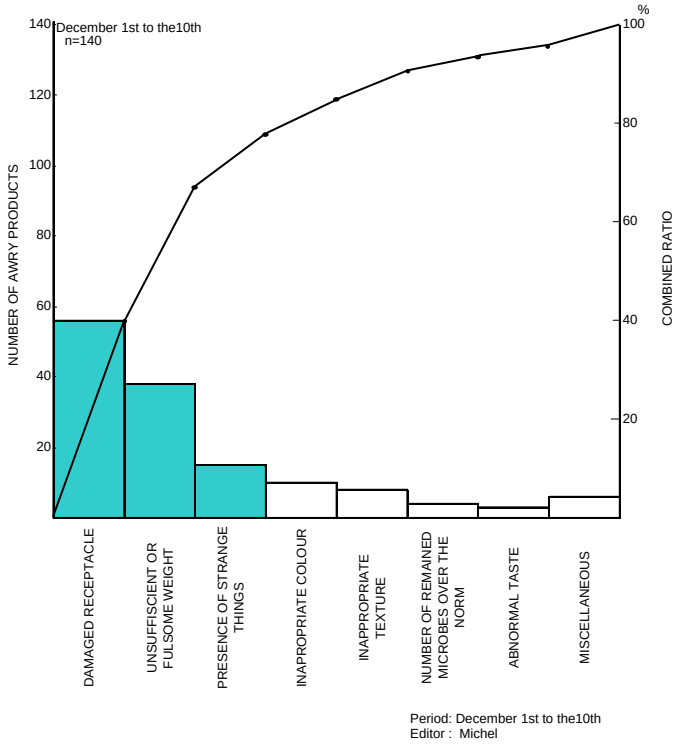


Figure 2-3 Manufacturing Default Pareto Diagram

The Pareto diagram is elaborated according to the following procedure.

Stage 1 : Define the study object and gather data

Decide the methods and the period of data collection, and gather data by content and causes. The classification by cause is composed of different factors such as materials, machines, operators or manufacturing methods, and the classification by content is composed of factors such as the default types, the place, the process or the time.

Stage 2 : Classifying data and calculate accrued values

Present data in the decreasing order of the categories composed of the highest values, and fill in the values for each category. At the end of a category, indicate « other ». The accrued values are calculated by adding in order the data values, from the category, which includes the highest value.

Stage 3: On the graph sheet, indicate the X-axis and the Y-axis and build the bar graph

On the X-axis, write from left to right the name of the different categories from the category presenting the highest value, and on the Y-axis, indicate the value of the controlled points (in the case of the Figure 2-3, the number of faulty articles).

Table 2-2 Ordering Data

No.	Type of default	Value	Accrued value
1	Damaged container	56	56
2	Insufficient or excessive weight	38	56+38 =94
3	Presence of foreign bodies	15	94+15 =109
4	Inappropriate colour	10	109+10 =119
5	Inappropriate texture	8	119+8 =127
6	Number of remaining bacteria superior to the norm	4	127+4 =131
7	Abnormal taste	3	131+3 =134
8	Other	6	134+6 =140
TOTAL		140	140

Stage 4: Design the accumulation curve

Indicate on the top right of each bar graph, the accrued value and join the points together to draw a curve

Stage 5: Insert a Y-axis at the far right and graduate this axis

Make the curve lowest point corresponds to 0 and the highest point to 100(%), then graduate the axis by dividing in 5 equal parts the space between these 2 points.

Stage 6 : Add the necessary information

Indicate the name of the graph, the period of the data measure, the total of the values, the name of the process, the name of the writer etc.

2.3.2 The Causes and Effects Diagram

The Causes and Effects diagram consists in representing on a diagram shaped as a fish bone in a systematic way the relations between a problem and the causes which can influence this problem. (cf Figure 2-4). It is a useful tool to analyse the problems by going back to the origin of the causes.

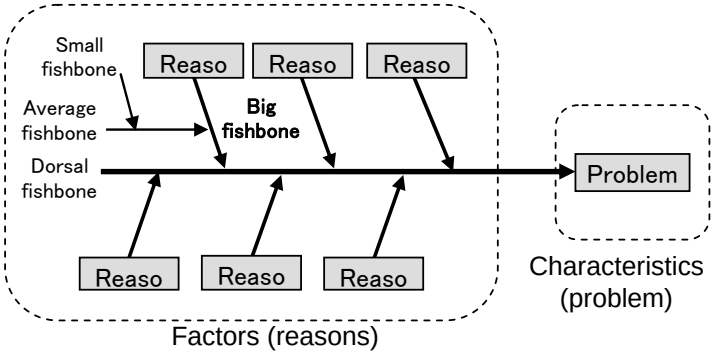


Figure 2-4 Causes and Effects Diagram

It is preferable to gather the concerned persons in order to share the different points of view rather than to build this diagram alone. Therefore, it is possible to go back to the source of the causes of the problems and to adopt the appropriate measures. It also presents the advantage to enable a flexible application of the measures by sharing these problems.

The Causes and Effects diagram is built according to the following procedure:

Stage 1: Define the problem

Stage 2: Write the problem on the right and draw a thick arrow from the left to the right

Stage 3: Order the possible causes to the problem in big categories considered as the big fish bones and indicate it with arrows

The appropriate number of big fish bones is 4 to 8. The big categories are divided in 4M (man, machine, methods and material) or 7M (tools, measure and transport added to the 4M).

Stage 4: Search for the causes of the big fish bones, and indicate precisely the average and small fish bones

This way, indicate all the way to the final causes, which enable to settle these actions.

Stage 5: Check nothing has been forgotten

Stage 6: Indicate with a mark the cause which impact is the most important

Debate and decide the priorities by a show of hand by analyzing the data, the Pareto diagram and a free discussion.

2.4 «Do» in Order to Improve Quality / Productivity

The implementation stage of the management cycle is composed of the 3 following stages:

1. Teach and train the work methods
2. Do
3. Collect data about control targets by applying the defined methods

2.4.1 Training and Apprenticeship

Organize a training and an apprenticeship in order for the improved work methods to be appropriately assimilated on site. For the simple work methods modifications, it is sufficient to give explanations, to show and to have the operations carried out, but the broader modifications require training and an apprenticeship according to the procedures indicted in the Table 2-3.

Table 2-3 Training and Apprenticeship According to the TWI Method

Preparation	Prepare a forward-looking training chart	- Who will be the trainees? - What will be the taught operations? - When will the training take place?
	Operation breaking down	- List the main steps - List the essential points (work tips)
	Carry all the preparation out	- Gather the appropriate machines, tools and materials as well as all that is necessary.
	Straighten places	- Sort and straighten the places appropriately
Procedure	Prepare mentally to the apprenticeship	- Warm-up - Present the operations that will be carried out - Check the degree of knowledge about these operations - Make them want to learn these operations - Put in the correct position
	Explain the operations	- Describe orally each of the big steps then carry them out and present them in writing - Insist on the crucial points - Teach clearly, without neglecting anything and with patience - Do not impose more than the person can understand
	Have the operations carried out	- Have the operation carried out and correct mistakes - Ask to explain the operations while they are executed - Have the operations carried out again by asking to indicate the essential points - Check until being sure that the operation is well understood.
	Observe after the training	- Place in a working situation - Designate the person to contact in case of doubt - Carry out frequent checkings - Encourage to ask questions - Progressively decrease instructions

2.4.2 Collect Data About the Control Targets

There is a tool, which enables to check if the improved processes are carried out appropriately and to grasp the situation in real time: it is the control graph. The main control graphs are the x-R control graph and the p. control graph. The first one is used for control objects expressed by continuous values such as weight, number of bacteria or raw material yield rate ; the second one is used for control objects expressed with values calculated per unit 1, 2, 3 etc. such as the number of faulty products or the number of cases observed.

Here, we will take the example of the x-R control Table to back up our explanations. Thanks to this graph, it is possible to know according to the time, the average value and the gap between the measured data. The Figure 2-5 enables to grasp immediately if the data is contained between the maximal control limit (UCL: upper control limit) and the minimal control limit (LCL: lower control limit) and to know the data tendency.

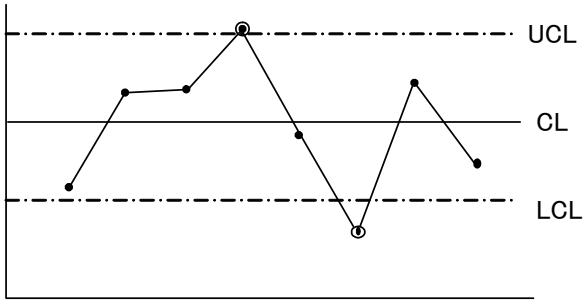


Figure 2-5 x-R control Graph

With the following checklist, it is possible to check if these different actions are applied appropriately:

1. Is the OJT training carried out until the operator is able to surely apply the improved processes?
2. Is he provided with materials and machines that correspond to the standards?
3. Are the light, ventilation and temperature adapted?
4. Do the operations and post designation take into account the operators capacities and aptitudes?
5. Are the operations carried out according to the standards?
6. Are the methods, period and manager of the data collection related to the control targets determined and are the records stored?

2.5 «Check» in Order to Improve Quality / Productivity

The checking stage of the management cycle is composed of the 3 following actions:

1. Check if the operations have been carried out according to the standards
2. Check if the different measured values and the experiments results' comply with the norms
3. Check if the control targets are in accordance to the objectives backed up with figures

During this phase, it important is not to be satisfied with only examining the results but also to go back to the causes. The control Graph, the histogram and the scatter diagram are useful tools to achieve this. As we have briefly presented the control graph in the 2-4 section, here, we will only explain what the histogram and the scatter diagram are.

2.5.1 Histogram

The histogram is a graph which distributes the data used as control indicators in determined range sections and which indicates the occurrence of the data in each section. The Figure 2-6 represents a histogram of the results of a study conducted a 100 times on the time of functioning for a certain operation.

Generally, it is frequent that histograms present the highest values near the centre, and that the values on the left and on the right decrease symmetrically from the centre. In fact, it often happens that histograms take the forms indicated in the 2-7 Figure. It is possible to interpret these different forms the following way.

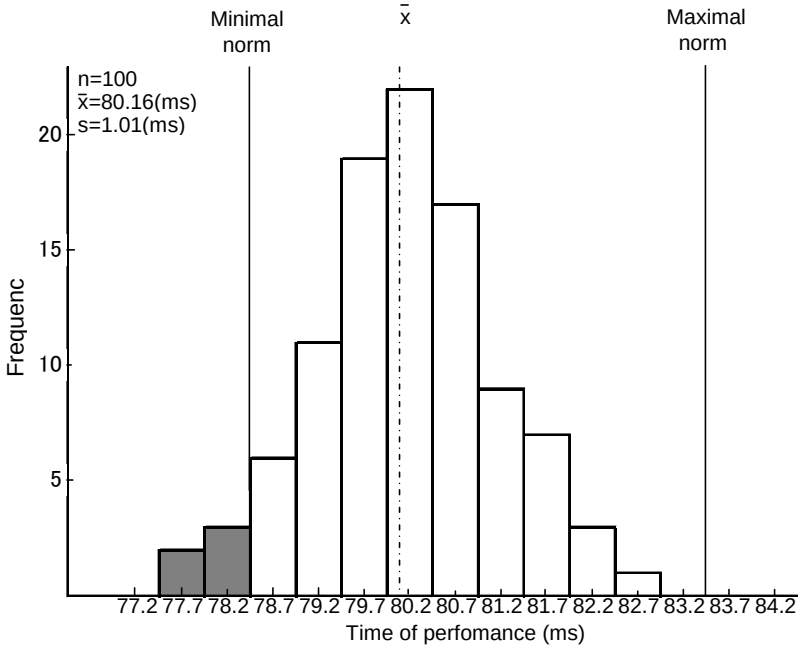
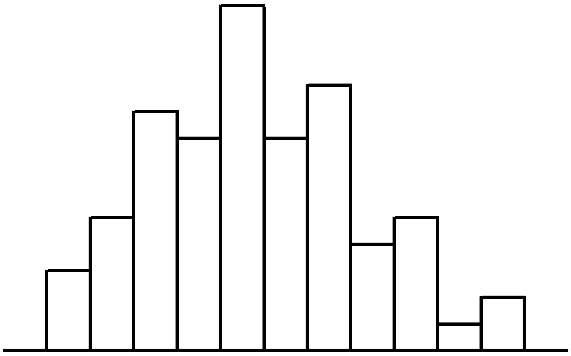
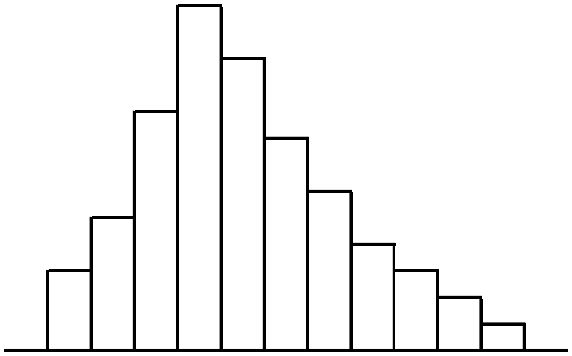


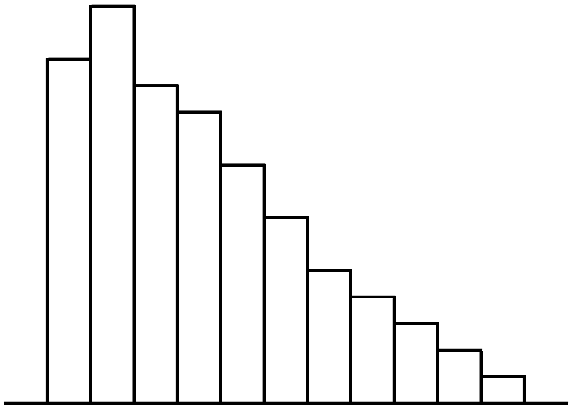
Figure 2-6 Histograms of operation time



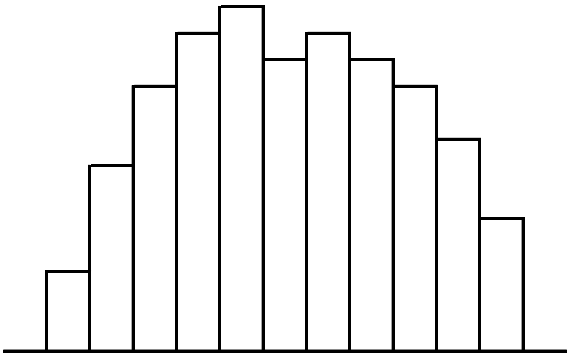
We can think that the determination of the intervals' value is not suited or the way of reading the values who made the measures is not exact.



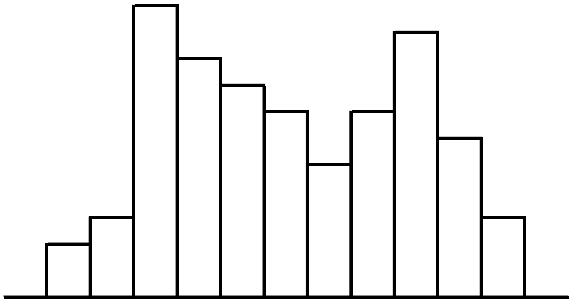
This case occurs when the values lower than a certain level are not taken into account because of the organization of the processes or the machines, either when the number of defects is close to zero.



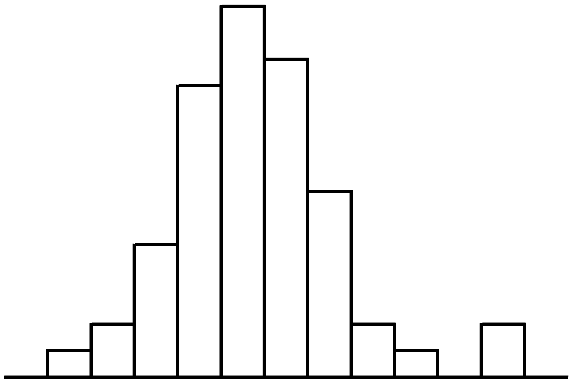
Case where the values lower than the standards were chosen and deleted and where there were errors, gaps and forgeries at the level of the measures.



This case appears when several distributions presenting slightly different mean values are mixed. It is good to build a histogram by separating various strata to proceed to comparisons.



This case appears when 2 distributions in the different mean values are mixed. When there are distances between 2 machines or 2 types of materials, the construction of a histogram by separating the strata allows to understand the differences.



This case appears when the data of different distributions are slightly mixed. It is necessary to verify the history of the data and to see if there is no abnormality at the level of the processes, of the error of measure or mixture of data of the other processes.

Figure 2-7 Form and Interpretation of Histograms

2.5.2 Scatter Diagram

The scatter diagram associates 2 variables in pair depending on the X-axis and the Y-axis. It is used to check the existence of a correlation between different data and to know to which data to adjust the data indicating the causes in order for the one indicating the effects to be included in the tolerance field. For example, when the initial number of bacterias in a product frequently exceeds the norms, the representation on a scatter diagram of the relations between sterilization temperature, sterilization time and initial number of bacterias enables to indicate which measures should be adopted in terms of definition to the inferior limits of the sterilization temperature and the sterilization time.

There are 3 types of possible relations between the 2 combined variables:

1. Relation between cause and effect

   For example, the relations between the size of the ingredients and the raw material yield rate, or between the storage temperature and the number of viable bacterias.

2. Relation between some effects and other effects

   For example, the relation between the water content and the raw material yield rate.

3. Relation between 2 causes and the same effect

   For example, the relation between the number of initial bacterias and the storage temperature.

The shape of the scatter diagram enables to judge of the correlation link as the Figure 2-8 indicates.

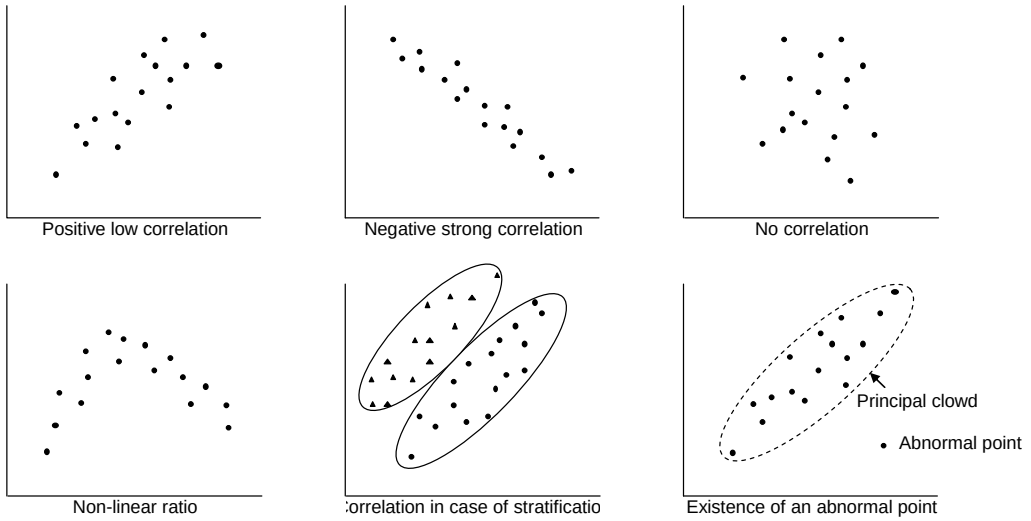


Figure 2-8 Interpretation of the Scatter Diagram

2.6 «Act» in Order to Improve Quality / Productivity

The action stage of the management cycle is composed of the 3 following points:

1. In case of a gap compared to the work standards, take corrective measures in order for these standards to be applied.
2. In case of abnormal results, search for the causes of these abnormalities and take measures to prevent from their reccurrence.
3. Continue the improvements in terms of organization and work methods

It is necessary to check the improvement effects and to proceed to the standardisation as well as to the control foothold.

2.6.1 Check the Improvement Effects

Checking the improvement effects requires the following actions:

1. Assess the effects by comparing the objectives and the results between the previous period and the period following the improvement.
2. Check the impacts on the input and output processes
3. Check that there haven't been negative results on the other control characteristics (objects other than the Quality and the Productivity, such as the costs)
4. In case of insufficient effects, go back to the «plan», «do» and « check » phases and repeat the analysis and the measures.

2.6.2 Standardisation and Control Foothold

The following actions will be conducted with view to a control standardisation and foothold.

1. Once the effects have been checked, we will proceed to the standardization and the revision of the standard operatory procedures (recipes, process diagrams, standard operatory etc.)
2. We will check if the work is carried out according to the standards
3. We will control the improvement progression, which will be synthesized in a report in view to accumulate techniques.

CHAPTER 3 QUALITY IMPROVEMENT METHODS

In this chapter, the quality improvement methods will be presented. Regarding the food quality, a distinction can be made between quality related to healthiness and food safety and the other forms of quality. In this chapter, the 7S are adopted as the first method of quality improvement and the standards' organization and directions for use of the 7 quality tools are presented as the second method of quality improvement.

3.1 Quality of Food Processing

Food quality is roughly divided in two parts; the first one corresponds to the healthiness and food safety and is known as hygienic quality; the second one concerns everything related to taste, colour, texture, weight, packaging, and design… Hygienic quality is related to the number of germs and to the consumption limit; it does not enable to increase sales but it is the minimal condition to sell products. This quality level is broached through ISO 9000 and 22000 standards and through the HACCP's approach; CTAA advices to the companies are also focused on this aspect of the quality.

The quality of the second category can also be divided in two parts. The first one is known as the manufacturing quality related to the capacity to manufacture according to the industrial standards (standards that don't include health criteria). In this case, quality flaws are products that could not have been manufactured correctly, for example, candies that don't have the appropriate shape or broken cookies, pasta with black spots, a weight that has not been respected, torn out wrapping or rusted tins of food. Within the company, quality flaws related to manufacturing are discarded by the inspections so that there is no effect on the sales. But it only prevents from faulty products to be released and as it doesn't enable to decrease the number of faulty products generated by the manufacturing process, it cannot be considered as a radical solution to the problem. Some companies are focusing on solving this problem but there are also many companies, which, in desperation, renounce to resolve this problem.

Another quality level concerns conception quality. The conception quality is a term widely used in mechanical engineering industries or electric industries; it means that quality is determined from the product's conception, before products are even produced. The conception quality of taste, colour, weight or packaging design is decided according to studies on targeted clients' needs and according to the studies on competitors. The good or bad quality according to that aspect is often judged by sensory tests and has a great impact on sales.

In this chapter, we will take interest in both the hygienic quality and the manufacturing quality.

3.2 Quality Management Points

With regard to the improvement of the hygienic quality, HACCP and ISO 9000 and ISO 22000 systems of reference are efficient.

However, many companies neglect the fact that preliminary conditions are required to achieve these standards. An introduction to the 7S of food hygiene is adopted as a preliminary condition in the hygienic field and as a quality improvement method. In this chapter, we will not deal with the ISO standards or the HACCP.

Concerning the manufacturing quality, the quality improvement method is presented according to the PDCA cycle: *Plan:* plan actions and expected results (definition of the quality attributes), *Do:* apply these actions, *Check:* check results and *Act:* take corrective measures if necessary (after analysing the causes resulting in quality flaws).

3.3 Workshop and Factory Segmentation

3.3.1 Separation between the Clean One and the Unclean Zone

The food manufacturing process is carried out according to the flow presented in Figure 3-1 where the cleanness level required is presented at each stage of the manufacturing process. When a factory diagnosis is conducted, it is necessary to examine if the physical condition of the factory make the hygiene maintenance easier or not before dealing with the particular phenomena.

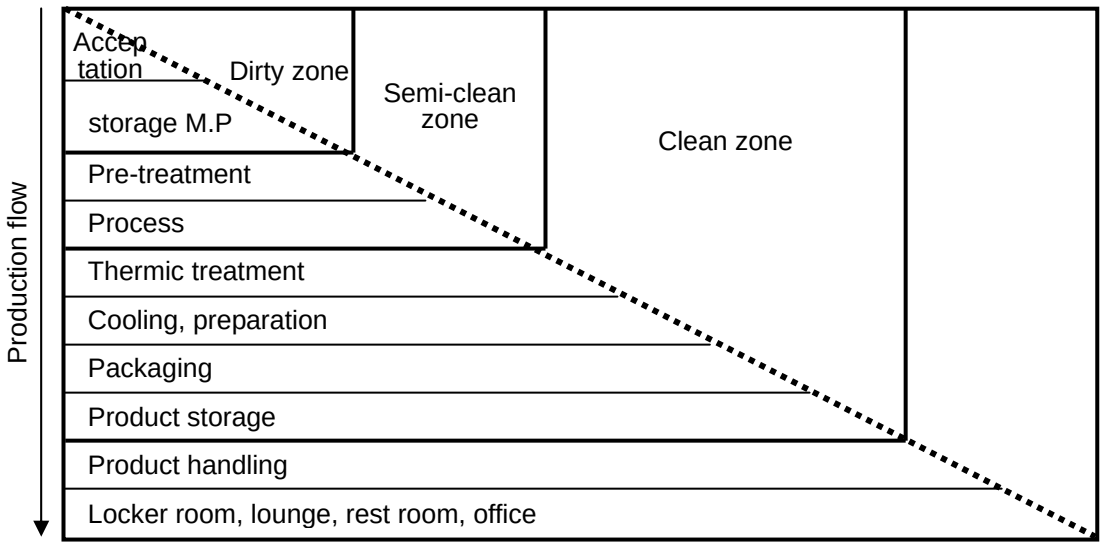


Figure 3-1 Food Processing and Distinction between the Clean Zone and the Unclean Zone

Regarding the operations segmentation, it is necessary to divide precisely an unclean zone, a semi-clean zone and a clean zone depending on the phase of the production.

With regard to the agricultural and fishing raw material, a selection and washing are carried out when they are leaving the unclean zone and they become clean through the manufacturing process. The products' sterilization has to be carried out in a clean zone. Because, if afterwards germs or foreign bodies contaminate food, there is no way to protect from it.

Note: When the product is packed individually, as there is no longer a risk of food contamination, the external packaging such as the boxes and the storage are carried out in a semi clean zone.

Regarding the segmentation of the operation zones according to the cleanliness degree, the following points need to be monitored.

- Is the clean zone hermetically separated by walls and ceiling?
- No ventilator should be installed in the clean zone. There should be an air conditioning system in order to lower the room temperature.
- If there is a ventilator, does it have a filter that can be dismantled and that is washable?
- In the clean zone and semi clean zone, the ceiling should not favour condensation. If there is condensation, by inclining the ceiling, the condensation can run down the walls in order to avoid running down directly on the products.
- Do the clean zone water evacuation pipes have grates that prevent from insects and rats to enter?
- Are double doors or plastic shutters installed at the entrances and exits of the clean zones and un/semi clean zones?
- Are the entrances and exits between the clean zones and un/semi clean zones for products that are being manufactured as small as possible?
- At the clean zone entrance, is there a basin to wash boots in order to avoid bringing outside soil?
- Is there a washbasin in the clean zone?
- Concerning the factory, does its structure reduce the cross contamination risks?

Cross contamination can occur when raw material go through the clean zone or when unpacked sterilized food go through the unclean zone or follow the same path as the raw materials.

- When there are visitors, is the unclean zone presented after the clean zone?

When we present the raw material treatment zone first, then there is a risk to enter the clean zone with white blouses and dirty shoes.

In order to conduct the operation segmentation as it is presented above, the building structure needs to be changed, which involves some costs. And in small factories, there are some cases where the space is too small and it is difficult to install partitions. In these cases, a minimal segmentation is required instead of an ideal segmentation.

3.3.2 Precise Segmentation between the Work Zone and the Outside

In the food processing industry, it happens that the factory and the site cannot be precisely segmented.

Especially when it comes to the reception of the raw material, it often happens that the first washing is carried out outside. For the following operations, it happens that there is no precise segmentation between the inside and the outside of the factory. In this case, it is necessary to pay attention to the following points.

- Are different shoes used outside the factory and inside the factory?
- Is a washbasin installed near the factory's entrance?

3.4 Equipments

When machines or equipments that are in direct contact with food are handled, it is necessary to monitor the following points.

- Are the containers in direct contact with food put down directly on the floor? It is necessary to put them down on pallets (it is preferable to use plastic pallets rather than wooden pallets) or tables. When containers are used elsewhere than on tables, the colour of these containers should be different from the others.

- At the beginning of operations, do we use containers and equipments that are correctly cleaned and, if necessary, disinfected? Are they also cleaned and, if necessary, disinfected at the end of the operations?

- When ground water is used, is the lack of quality problem previously checked with a water quality test? Is chlorine added when used?

- Is a metal detector (Figure 3-2) used for products after packaging? Pebbles and dirt are removed while the raw materials are treated but it often happens that metal parts are incorporated during manufacturing. It happens that we discover blade pieces in products,

nut and bolt from machines or metal smudge. The metal detector allows us to find out if metal has entered the final products. This device is usually installed after the packaging line.

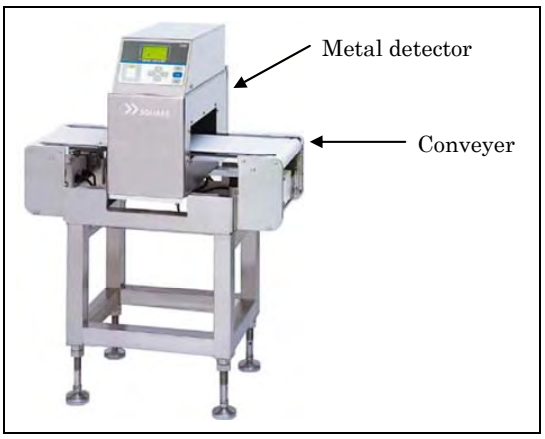


Figure 3-2 Metal Detector

3.5 Standards for the Manufacturing Process Management

3.5.1 Manufacturing Standards

The objective of the manufacturing process management is to produce quickly and at low cost, products that comply with the standards.

In order to do so, it is essential to produce accordingly to the manufacturing standards that define the product and the way to produce it. Firstly, we will explain the way to define the standards used for the manufacturing, and then we will explain the management method in accordance with these.

Before the products manufacturing, it is important to establish what is going to be managed and how, that is to say, to establish what is going to be the subject of a management in accordance with the standards. In the production management, essential standards are called manufacturing standards.

There are 5 standard categories or manufacturing specifications presented in Figure 3-3.

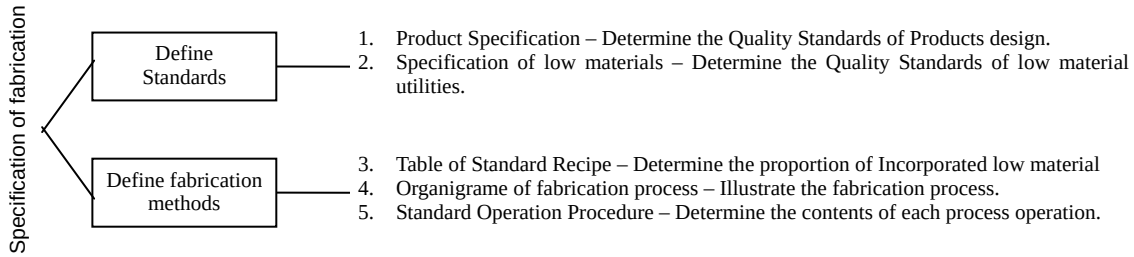


Figure 3-3 Manufacturing Specifications

3.5.1.1 Product Specifications

The product specification may appear as the product quality plan, and may so be used as the product database. In order to do so, it is composed of the 6 following elements.

- Quality standard

  It is often difficult to express a quality standard with figures but we try to present data backed up with figures as much as possible

- Hygienic standard

  Written standards are usually defined by law but when the company has its own standards, we take note of it.

- Labelling

  Indications shown on the package are noted down. The indications' content is determined by regulation.

- Package configuration

  Specification of the package size and material

- Storage condition and consumption limit

  Temperature, humidity, luminosity for products preservation as well as the consumption limit for these products under those conditions are written down.

- Nutrition information

  Information about calories, sodium, sugars, fat… as well as the ingredients are indicated.

Table 3-1 is an example of a product specification.

Table 3-1 Product Specification

PRODUCT SPECIFICATION

creation : 20 Nov. 2002

Brand Name	Specification	Article Number
PULPA DE PIÑA	1kgx8	7592375000240

Classification	commercial application

		size	material
package form	inner package / film	1kg 250x150	PP 0.65
	outer package / cardboard box	1kg 310x260x100	C210xSCP125 xC210

Quality Spec.	Sugar contet degree 15 over by Brix pH3.8 to 4.1 Color the range of yellow 4 to 5 of the company standard
Hygiene Spec.	viable bacteria count 1 x10^4/g and under coliform bacteria (−) salmonellastaphylococci (−)
indication / entiriy indication	frozen food name of product Pulpa de Piña name of material piña, azúcar amount of contents 8kg (1kg x 8 pack) date of manufacture mentioned on the back outside the frame expiration date 6 months storage condition Keep it with less than minus 18℃ manufacturer Frutopia C. A.
indication / the way of usage	Please drink after thawing

storage temperature	Less than minus 18℃
expiration date	6 months

nutrition information			recipe	
component name	unit	The inside of 100g	name of material	%
carbohydrate	g	16.1	pulp de piña	96
dietary fibre	g	4.6	azúcar	4
ash content	g	3.9		
calucium	g	3		
phosphorous	g	12		
iron	g	6		
vitamin A	IU	14		
vitamin B_1	mg	3		
vitamin B_2	mg	1		
vitamin C	mg	61		

3.5.1.2 Raw Material Specification

In this document, the raw materials quality standards are written down. The raw material quality has a big influence on the final products quality. Therefore, it is necessary to determine the evaluation criteria in the raw material specification, for the raw material acceptance when they are received. As the quality and shape of agricultural raw materials is not always consistent, it is necessary to fix a tolerance margin in the specification. The agricultural and fishing raw material specification is composed of the 3 following elements.

- Acceptance criteria when the raw material is received

  Creating criteria when the main raw materials are received

- Standard regarding the place of production and the variety

  For the same product, there can be a quality difference depending on the producer, the variety or the harvest time. In this case, if necessary, we note down the production area, the variety or the harvest periods of the raw material that can be received.

- Supplier

  We note down the name, address and phone number of the suppliers.

  Table 3-2 is an example of the raw material specification

Table 3-2 Raw material Specification

Raw Material Specification

creation date	Nov. 21.02

Raw material	brand name, area of production	Specification			Supplier
		term	benchmark	measures to be disqualified	
banana	Vigia	through the year	yellow is from a litlle to 1/3	after riping, be using	Carlos Gonzalez, Antonio Riva, Luis Rangel

3.5.1.3 Basic Recipe Chart

The basic recipe chart is even more important for the product quality. It is usually used at the manufacturing site. Therefore, it has to be clear and easy to understand at the production site.

For complex products, it becomes necessary to use several basic recipe charts to make a single product. For example, there must be a chart for the seasoning ingredients and there must also be a recipe chart when the seasoning is incorporated to the other ingredients, it is thus necessary to have a recipe chart as the different ingredients are added along.

The quantity of composition is usually indicated in kilograms or in grams. As it is easy to mix up mass units and volume units and to make mistakes, it is preferable to standardize units by using only mass units. By using mass, measure as well as the cost price calculation becomes easier.

The process yield is the proportion between the mass of the final product and the mass of the raw material used.

To make olive oil, it is 24% of the olives mass, to make tomato purée, it is 17% of tomato mass but in reality, it varies depending on the raw material standards, the production conditions and the machines used. Furthermore, it often occurs that the yield is bad when starting the production of a new product, however it keeps improving afterwards. But the fact remains that yield is an important index for the cost price management in the food processing industry.

Table 3-3 is an example of basic recipe.

Table 3-3 Basic Recipe

Basic Recipe of passion fruit juice creation : 3. Dic. 02

name of raw material	%	quantity of composition (kg)				brand name
pulp of passion fruit	43.5	20	40	60	80	passion fruit
sugar	6.5	3	6	9	12	white superior soft suger
water	50.0	23	46	69	92	drinkable water
theoretical completed amount		46 kg	92 kg	138 kg	184 kg	
yield ratio		97.8%	97.8%	97.8%	97.8%	
standard completed amount		45 kg	90 kg	135 kg	180 kg	
number of pack (1kg pack)		45	90	135	180	

3.5.1.4 Process Flow Chart

The process flow chart shows the raw material flow until the products are shipped. Each stage is presented inside a rectangular box. Important management elements such as the temperature, the length of processing and the mass are written on the flow in numerical value, which facilitate the use of the flow.

It is preferable that the flow remains as simple as possible, and since the detailed process conditions are presented in the standard operating procedure, it is good that it enables to understand the flow of the whole manufacturing easily.

Figure 3-4 is an example of the process flow of orange juice's manufacturing process.

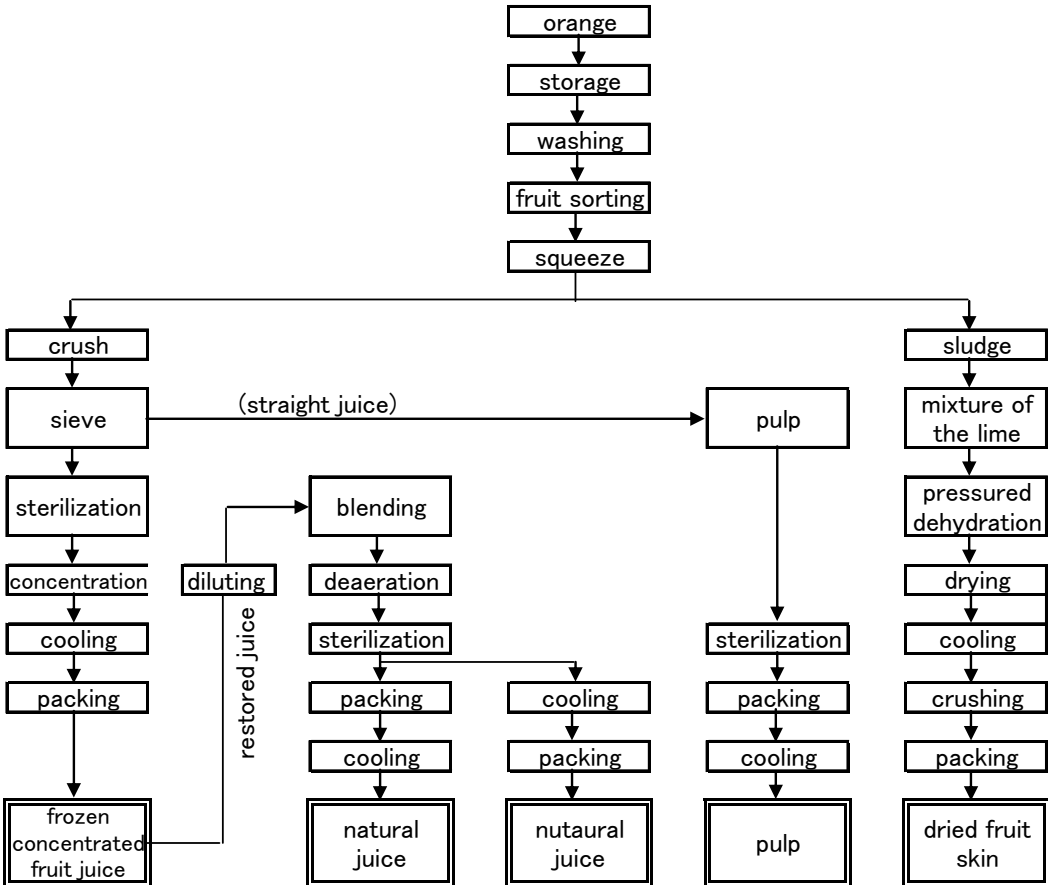


Figure 3-4 Diagram of Orange Juice Production Process

3.5.1.5 Standard Operating Procedure

The standard operating procedure concretely explains the operations of the manufacturing process. As the standard recipe chart, it is placed at the operation site. The operating process is created based on the results of the products development and on the pilot tests. The recorded elements in the standard operating procedure are the following.

- Large bold fonts and charts are used in order to be understood at first sight
- Each operation elements are written in short sentences.
- Numerical values are presented as much as possible and abstract expressions are avoided.
- Standard operating procedure is gathered on a single page (on both sides)
- Standard operating procedure is kept in a plastic insert or is laminated

Table 3-4 is an example of the standard operating procedure.

Table 3-4 Standard Operating Procedure

The work standard of pineapple pulp

Process	Heat sterilization	creation	Dec.10.2002

Brand name	Fresh pineapple juice
Heating pot	VK-3 type

Spec.	1kig x 8 pack

Start time

1. Preparation for the boiler
   - The confirmation of volume of water in the boiler
   - The ignition of the boiler
   - The confirmation of the steam pressure

2. Heat pot
   - The confirmation of whether washing is finished.
   - It is washed before using it if dirt is found.

Heat sterilization

1. The charge of juice
   - Quantity to throw into the treatment of 1 time is 50kg.
   - Juice is raked out using the spatula so that juice may not be left in the container as much as possible.
   - To put the container of juice on the base (It isn't put directly on the floor)

2. Heating
   - It is heated first with making the valve of the steam the best and mixing sometimes.
     * Do it because lack of the sterilization happens if it isn't mixed surely.
   - When center temperature is 70℃, the cook of the valve is closed in 1/3, and that condition is maintained for 5 minutes.

Cooling

1. Cooling
   - After heating is finished, the valve of the steam is closed, and water is passed through the heating pot at once.
   - Juice is cooled with mixing sometimes.
     * The spatula which is mixed to is completely being disinfected.
   - It is made to finish cooling if center temperature of juice is less than 20℃.
   - Juice is transferred into the disinfected container.

3.5.2 Elaboration of the Manufacturing Standards

The 5 standards are the main lines of manufacturing. When operators work accordingly to the standard operating procedure and to the basic recipe, the product registered in the specification is manufactured. In order to do so, they should not move away from it in practice.

The product's quality and 80 to 90% of the cost are determined when the standards are written and they influence quality management and cost price management.

Half of this elaboration is made when the product is developed. Raw materials, recipe, manufacturing process and standard operating procedure are temporarily determined according to the trials during development.

Then, mass production tests are carried out. Since the test conditions conducted on an industrial scale differ from the lab tests, this stage is crucial. When the product is mass-produced, the taste can be stronger, it could be necessary, in some cases, to modify the raw materials incorporation proportions. The tests always need to be repeated and their conditions need to be written down. If the results are satisfactory, bacteriological and sensory tests need to be conducted several times in the end. It often happens that the tests need to be repeated several times when the standards are not achieved. Then, the various manufacturing standards are achieved. This process flow is presented in the Table 3.5.2.

Manufacturing standards are the company's know-how, it is forbidden to take these documents outside of the company and even inside the company, they have to be strictly managed. In order to do so, it is preferable to treat the manufacturing standards the following way.

- All manufacturing standards should be kept in an office used only by a limited number of people.
- All standard operating procedure and basic recipe charts should be kept close to the corresponding operations at the production site. A manager for these documents preservation should be designated.
- The company should forbid the copies of the manufacturing standards by the employees.

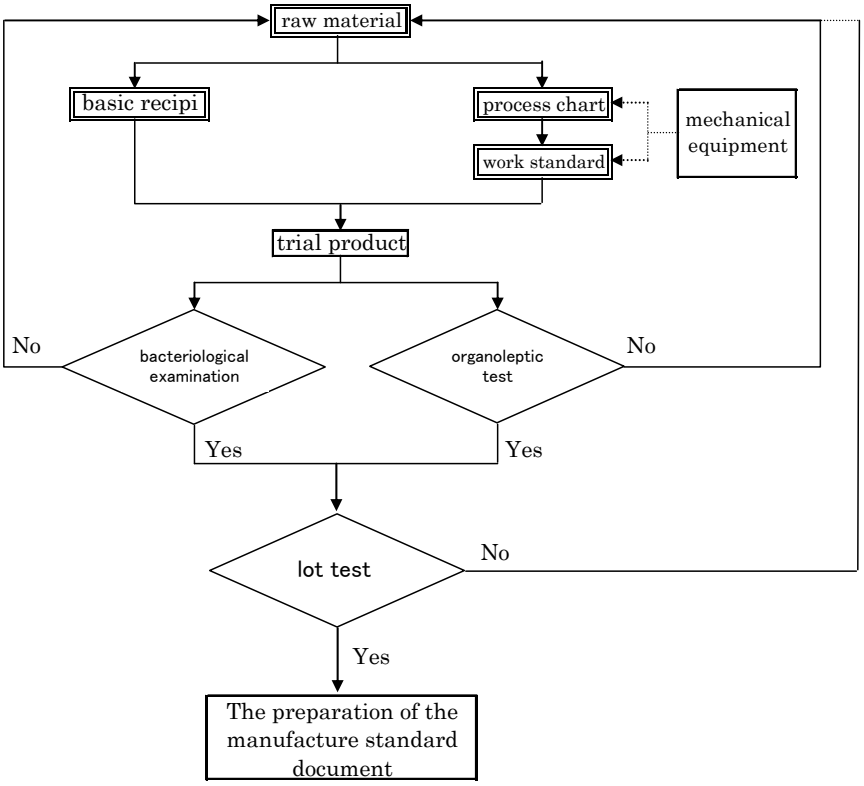


Figure 3-5 Diagram of the Manufacturing Standards Elaboration

3.5.3 Process Management Based on the Standards

Explained here is how to make the operators know the manufacturing standards as well as the revision procedure.

3.5.3.1 Standards Respect

Being that all operators are conducting their job according to standards, the product quality is guaranteed.

The reception and selection of raw materials should not be accomplished according to the personal judgement of the people in charge; the way to proceed should not vary freely. The following points need to be monitored in order to treat products according to the standards.

- Operators should be in possession of the standard operating procedure and/or the basic recipe chart and they need to understand these documents clearly.
- When a new product is starting to be produced, operators who are concerned by this production should meet and they should be explained the whole manufacturing process.

- For operations where mistakes can easily be made and which have a big influence on the food quality and hygiene, a control document needs to be prepared and this document should be checked out at each control. For example, the raw material mass measure for the mixing operation, or the temperature and length of warming during the pasteurisation process.

3.5.3.2 Standards Revision

After the standards elaboration, it may occur that quality is improved or that we discover production methods that improve yield. It may also occur that, because of irregular quality, it is necessary to amend a part of the process. It can also happen that an operator would want to increase the raw material mass by 50% to add in one time in order to facilitate his work. In such cases, it is preferable that the standards revision is carried out according to the following rules.

- The amendment of the operating methods causes a change in the products quality and in the sanitary level (number of germs). If it is necessary to amend the operations conditions, the standard operating procedure should be revised after checking the consequences through microbiological analysis and sensory tests, after which, production can be carried out with the amended operation conditions.

- Of course, it should be clear that operating methods and conditions cannot be modified freely and one should act according to the procedure.

3.6 The 7S

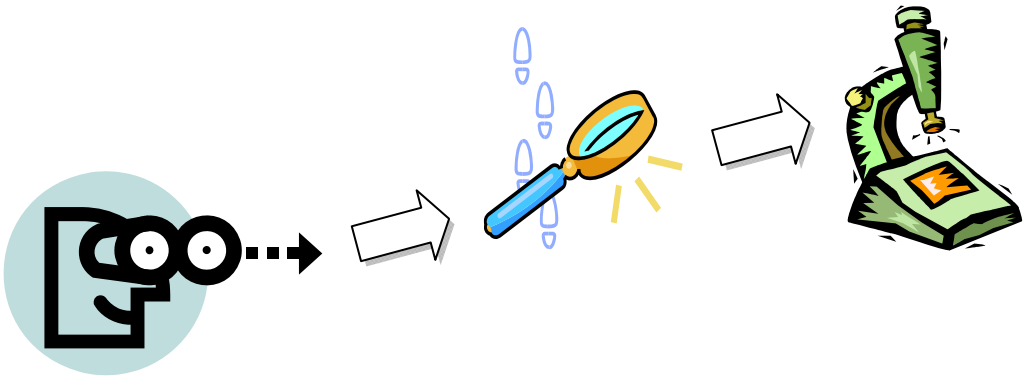
The 7S in food hygiene are like the prerequisite programme (PRP) for the HACCP approach or the ISO 22000 setting.

In regard to the ISO 22000, in order to avoid the numerous dangers defined in the danger analysis, thanks to the PRP, the essence of the approach lies in the cleaning, washing and sterilization.

However, it is necessary, at first, to clear/tidy in order to continue to function correctly; the disposal requires a discipline brought by the training. The result of this approach is to obtain cleanliness, which enables to guarantee food safety by imposing food hygiene.

3.6.1 The Importance of the 7S

In the 7S of food hygiene, we don't only target cleanliness visible to the naked eye, but a level of cleanliness visible even if we use an instrument such as a microscope. It is a higher level of cleanliness, which is called "high level cleanliness concept" (Figure 3-6).



Cleanliness visible to the naked eye is limited. Even if we use a magnifying glass, we cannot see ordinary germs. A food factory requires microscopic level cleanliness. One step is rarely sufficient to pass from a visible to the naked eye level to a microscopic level. It requires patient efforts.

Figure 3-6 High Level Cleanliness

3.6.2 Overview of the 7S

The 7S of food hygiene consists of the following 7 points: arrangement, order, cleaning, washing, sterilization, discipline, cleanliness. Since in Japanese, these 7 words starts with an S, they have been called the 7S. Even in English, they could be presented with, admittedly some nuances, by words starting with S: Sort, Straighten, Sweep, Scrub, Sanitize, Self-discipline, Sustain.

"Sort" implies separating useful objects from useless objects and throwing useless objects away.

"Straighten" consists of the stowage of everything that is disorganised and in organising in such a way that everything that is necessary could be used immediately at will.

"Sweep" and "Scrub" consist in eliminating waste, dirt and foreign bodies.

«Sanitize» consists in actively killing germs and in lowering the bacterial contamination level. It involves sterilization and disinfection.

“Self discipline” enables to follow the 5S, the proper respect of what has been decided becomes a routine.

“Sustain” is the result of the previous points. It corresponds to an environment where cleanliness at a bacterial level is sustained.

The above 7S conceive and settle the procedure to maintain cleanliness. In other words, sort and straighten are preliminary conditions to facilitate sweep, scrub and sanitize.

Then cleanliness at a microbiological level is achieved by sweeping, scrubbing and sanitizing. A training of all concerned employees is necessary to carry out these operations correctly accordingly to the operating procedure. Moreover, “self-discipline” is required to apply the training.

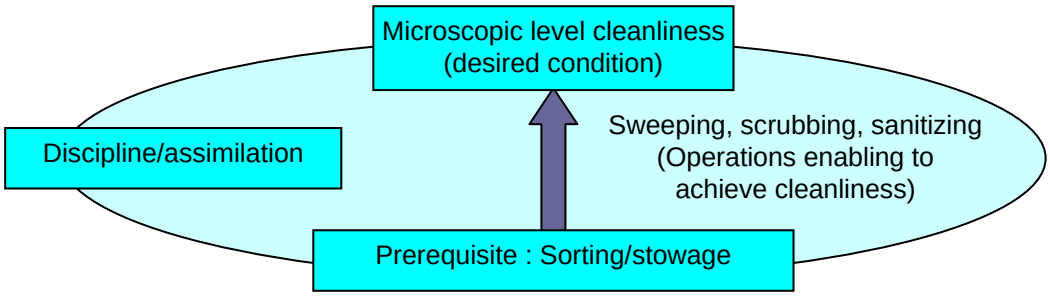


Figure 3-7 7S Overview

3.6.3 Sort

3.6.3.1 Definition

To sort means “sorting out what’s useful and what’s useless, then throwing out what’s useless or store it for a determined period in another place”

3.6.3.2 Objectives of Sorting

Sorting follows the 3 following objectives.

1) We only manage objects that are necessary to the production and we don’t keep the useless ones. As a result, space’s exploitation can be planned.
2) As only the necessary objects remains, as a result, operations productivity can be planned.
3) Monitoring becomes possible and enables to prevent from the deterioration of the working environment.

When the production place is not sufficiently sorted out, it could cause the 3 following important problems.

1) Germ outbreak.
2) Vermin outbreak such as rats or cockroaches.
3) Working environment deterioration

3.6.3.3 Sorting stages

Sorting is carried out according to the following 5 stages:

1) Separate useful objects from useless objects.
2) Put useful objects away
3) Throw useless objects out.
4) When it's difficult to sort things out, store in another place for a determined period.
5) If objects are not used for a determined period of time, throw them out.

Sorting stages are briefly presented in Figure 3-8.

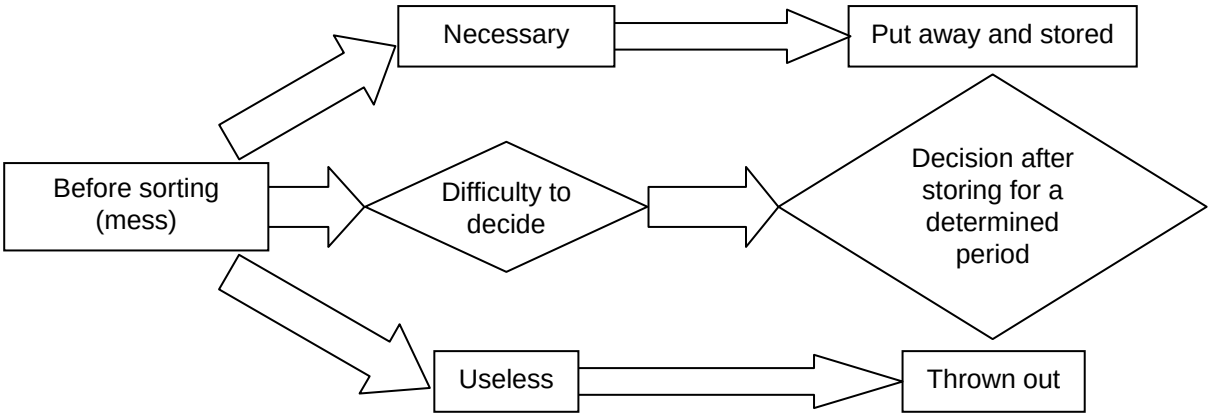


Figure 3-8 Sorting stages

3.6.3.4 Creating the Red Tags

In practice, to sort things out, we follow a progression method called the "red tag strategy". It is applied according to the following procedure.

(1) Define the object.

Normally, the sorting objects are the stock, the machines/equipments and it also enables to create space around.

(2) Define the sorting criteria, that is to say, define what is necessary or not. For example, for what is stocked on the floor, we consider as useless objects those used less than once a week.

(3) Creating the red tags

In order for everyone to know which objects are useless, we use a red A4 sheet on which we write down the name and the management department concerned.

(4) Red tag collage (Figure 3-9)

We stick the red tag on the useless objects that are concerned by the sorting.É

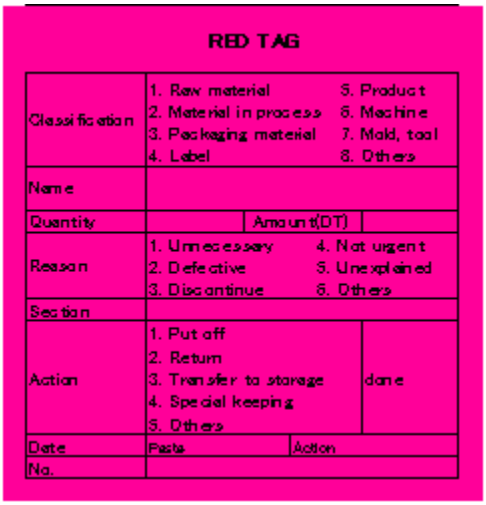


Figure 3-9 Red Tag

(5) Installing the warehouse for unnecessary objects

The objects with a red tag should be removed at the appropriate time.

3.6.3.5 Sorting Checklist

Table 3-5 Production Site Sorting Checklist

Points to check	Results	Comments
a. Are papers or equipments placed on the control panel or electricity supply?	Yes - No	
b. Do the desk drawers contain, for example, more pens than needed?	Yes - No	
c. Are various boxes meant to be thrown away left in corners?	Yes - No	
d. Are various machine tools or accessories abandoned?	Yes - No	
e. Are objects put in the cloakroom?	Yes - No	
f. Are objects put in the big cold room?	Yes - No	
g. Are heating or cooling devices installed even off-season?	Yes - No	
h. Are neon tubes or fluorescent lamps abandoned?	Yes - No	
i. Is unused cleaning material abandoned?	Yes - No	
j. Are there tools or equipments forgotten by outside companies' employees?	Yes - No	
k. Are there machines under dusty covers?	Yes - No	

Warning: If 'yes' is ticked, the concrete content should be written in the "comments" column.

Table 3-6 Production Area Sorting Checklist

Points to check	Results	Comments
a. Are there raw materials without a delivery date?	Yes - No	
b. Are there old raw materials that stay in corners or shelves?	Yes - No	
c. Are there abandoned boxes behind shelves?	Yes - No	
d. Are there useless objects between walls and cold room or freezers?	Yes - No	
e. Are there objects put on cold rooms or freezers?	Yes - No	
f. Are there objects that don't correspond to the inventory results?	Yes - No	
g. Are there pallets or wood rack left?	Yes - No	
h. Are there old bills left?	Yes - No	
i. Except raw materials, are there other objects stores in the warehouse?	Yes - No	
j. Are there warehouses, cold rooms or freezers for which a sufficient brightness is not guaranteed?	Yes - No	

Table 3-7 Raw Materials Warehouse Sorting Checklist

Points to check	Results	Comments
a. Are there abandoned materials that stay in corners or shelves?	Yes - No	
b. Are there abandoned boxes behind shelves?	Yes - No	
c. Are there useless objects between walls and cold room or freezers?	Yes - No	
d. Are there objects put on cold rooms or freezers?	Yes - No	
e. Are there objects that don't correspond to the inventory results?	Yes - No	
f. Are there pallets or wood rack left?	Yes - No	
g. Are documents or stationary put down?	Yes - No	
h. Is there abandoned waste near doors or shutters?	Yes - No	
i. Are there objects, which are not allowed into the factory?	Yes - No	
j. Is waste or scrap stored outside of the appropriate place?	Yes - No	
k. Is unused cleaning material abandoned?	Yes - No	
l. Are there cigarette ends or empty cans?	Yes - No	
m. Are the insect killing lamps switched off?	Yes - No	

3.6.4 Straighten

3.6.4.1 Definition

Stowage (Seiton) consists of creating a situation where necessary objects are placed where they should be. It is important to define the warehouse place, mode and quantity. It will then be easy to take and replace these objects. The reservation of places for the warehouse and the installation of storage units are preliminary conditions.

Stowage criteria are:

- Efficacy (minimize research time)
- Safety (mind the falls and hurts)
- Quality (mind the rust, shocks, pieces mix-up)

3.6.4.2 Objectives of Stowage

The purpose of stowage in the production area is to improve yield. Consequently, sweeping, scrubbing and sanitizing are carried out appropriately.

Stowage will have the following effects:

1) The factory space can be exploited more effectively by suppressing unnecessary objects. In a factory where stowage is not carried out correctly, usable space is reduced even if the factory space is large.

2) Targeted objects are found immediately. Consequently, yield is improved.

3) Stock condition is optimised. Loss suppression leads to cost reduction.

4) The stock of unnecessary products can be suppressed by improving storage management.

5) Mistakes while collecting products can be reduced, which can increase credibility toward clients.

But there are factories where stowage is not carried out even if stowage is done appropriately. It could cause the following events:

1) The advantages of stowage are not properly understood.

2) The necessity of stowage is not felt. It means that the principle of stowage is not applied. Stowage neglect in the production area could lead to the following problems:

   a. Objects are not where they should be and they are not found when needed.

   b. If the factory employees are used to a situation where objects are not where they should be, no one will notice if they are lost.

   c. Incongruous objects such as tool or machine fragments could be mixed to the product.

   d. Employees who have just joined the factory don’t know where the objects are placed.

3.6.4.3 Stowage Checklist

Points to check during stowage are the following:

1) Keep space to put objects.
2) Determine the position of the necessary objects
3) Label the warehouse zone, defining the designation and the quantity of objects.
4) Define how to carry out the setting up and use
5) Appoint managers

3.6.4.4 Stowage the Production Area

The checklists regarding stowage out areas are the following:

Table 3-8 (1) Production Site Sorting Checklist

Points to check	Results	Improvement suggestions
a. Are papers placed on the control panel or electricity supply?	Yes – No	- Handbooks are bound to special files and are kept in an office
b. Do the desk drawers contain, for example, more pens than needed?	Yes – No	- Each person carries a pen attached to them with a string - Write down the exact number of pens in drawers. - Appoint a manager for stowage/ organising each office
c. Are various boxes meant to be thrown away left in corners?	Yes – No	- Define not only a storage place for finished or semi-finished products but also a storage place for material or raw material waste.
d. Are various machine tools or accessories abandoned?	Yes – No	- Appoint a person in charge of management. - Regarding tools, write down their name and shape in the storage place and place a colour marker. - Regarding machine accessories, store in a special box on which its content is written.
e. Are objects put in the cloakroom lockers?	Yes – No	- To prevent it from happening again, install a 45° slope.
f. Are objects put in the big cold room?	Yes – No	- To prevent it from happening again, appoint a checking manager
g. Are unused heating or cooling devices put down?	Yes – No	- install a warehouse such as a prefabricated outside of the factory and store inside of it. - Rent and return once the period is over.
h. Are neon tubes or fluorescent lamps abandoned?	Yes – No	- Appoint a manager for replacing neon tubes and fluorescent lamps who will be the only one who could carry this operation out. - Entrance and exit management should be accomplished by the general affair department.
i. Are unused cleaning material abandoned?	Yes – No	- Appoint a manager for cleaning materials - When the object is abandoned because it is out of order, create a communication system in order to fix it. - Define a cleaning tool storage place clear to the cleaning employees (draw a line on the floor and write clearly that this is the cleaner warehouse).
j. Are there tools or equipments forgotten by other companies' employees?	Yes – No	- Make the other companies employees present the list of objects brought into the factory, check after work if there are any forgotten or lost objects, and write them down on a document - Theoretically, outside companies workers should not use objects that don't belong to the factory. When they have to, write it down imperatively on a document
k. Are there machines under dusty covers?	Yes – No	- Install a prefabricated place, for example, outside of the factory where they will be managed. - Create a management program for the unused machines, carry out a cleaning once a week or twice a month.

Table 3-8 (2) Raw material warehouse stowage checklist

Points to check	Results	Improvement suggestions
a. Are there raw materials without a delivery date?	Yes – No	- If it is possible to manage stocks in first in first out, store in order for the expiry date and consumption limit to be visible. - Regarding the unpacked materials, make sure to write the opening date. - Check that one doesn't forget to also write down the delivery date of the packaging materials. - Also check for the seasoning packed individually. - In cases where the same raw materials are continuously received, store new products received in the back while managing the date's indication,.
b. Are there old raw materials that stay in corners or racks?	Yes – No	- Check the warehouse condition once a week. - If there are shelves or racks, define with tags the objects that should be stored and their place of storage. - Do not store in places difficult to find - Check that what should be thrown away is appropriately thrown away.
c. Are there abandoned boxes behind shelves?	Yes – No	- If a package is open, move it to the place where waste are left immediately after the end of work. ・Check the inside of the warehouse at least once a month - Put the shelves at least at 30 cm from the walls to make it difficult to put boxes against it. - Check that what should be thrown away is appropriately thrown away .
d. Are there useless objects between walls and cold room or freezers?	Yes – No	- Create a useless objects management procedure. - Arrange things so that there is no space between walls and cold rooms or freezers. - Check that what should be thrown away or moved is done so appropriately.
e. Are there objects put on cold rooms or freezers?	Yes – No	- Appoint a manager, check everyday after operations. - Limit to people using a fork-lift truck (because often, fork-lift trucks are used to move objects on cold rooms or freezers)
f. Are there raw materials that are supposed to be thrown away and that don't correspond to the inventory results?	Yes – No	- A person other than the warehouse manager carries the inventory out (several people if possible). - The inventory shouldn't be carried out in a rush. - Carry it out in order to specify the objects in the warehouse as well as their places and operate subsequently
g. Are there pallets or wood rack left?	Yes – No	- The ban on entering or using certain objects in the factory is carried out the same way in the warehouse, proceed to checking - Check if the raw material delivery date on the pallets or wood racks are in order
h. Are there old bills left?	Yes – No	- Clearly write the name of the persons who have posted bills as well as the posting day and the posting limit date. - Above all, do not cover bills
i. Except raw materials, are there other objects stored in the warehouse?	Yes – No	- If these are necessary objects, specify a storage place and transfer the objects there. - Appoint a manager for 7S of food hygiene in the raw material warehouse.
j. Are there warehouses, cold rooms or freezers for which a sufficient brightness is not guaranteed?	Yes – No	- Install sufficiently bright equipment. However, be careful that the brightness increase does not attract insects.

Table 3-8 (3) Product warehouse stowage checklist

Points to check	Results	Improvement suggestions
a. Are there old raw materials that stay in corners or shelves?	Yes – No	- Install a place for material storage or a material zone and keep it in this place. In cases where there is a separation by zone, divide zones by using for example, vinyl curtains. - If equipments are used in the product warehouse, consider this necessity, if they are not used currently, keep them in another place.
b. Are there abandoned boxes behind shelves?	Yes – No	- Immediately throw away abandoned boxes and set up rules to prevent it from happening again. → Specify by whom, when and where the temporary storage and the waste elimination should be carried out, then specify who should check it.
c. Are there useless objects between walls and cold room or freezers?	Yes – No	- Throw away or store in another place. - Do not leave space between walls and cold rooms and freezers. - Create a procedure for the treatment of useless objects. → Who judges of the uselessness of objects, the determination of this measure is essential
d. Are there objects put on cold rooms or freezers?	Yes – No	- Throw away useless objects, store what's necessary in a visible place. - In cases where objects need to be put down, put down as much as possible in front and clearly state the denomination and the condition of the object as well as when and by whom it has been put down.
e. Are there objects that don't correspond to the inventory results?	Yes – No	- Search every corner and check if there is a wrong inventory. - Check if there is a wrong inventory somewhere else than in the product warehouse.
f. Are there pallets or wood rack left?	Yes – No	- Check if old products are put on it. - Throw away the pallets or wood rack. → Act in order not to abandon it outside.
g. Are useless objects, such as documents, put down?	Yes – No	- Carry in another place, or if it could not be done otherwise, really separate the product zone by putting vinyl curtains.
h. Are there abandoned waste near doors or shutters?	Yes – No	- Keep waste in an identified container which should be far from the zone where the product is and if it represent a source of important contamination, carry it immediately outside of the factory in a waste management area. - Clearly mark waste that is meant to be thrown away.
i. Are there objects whose entrance is forbidden in the factory and in the warehouse offices?	Yes – No	- Throw away immediately, stick a list of what's forbidden in or in front of the offices and make it clear to the person in charge of the warehouse. - Label objects reserved to the warehouse in order to distinguish them from identical objects reserved to the inside of the factory.
j. Are waste or scrap stored outside of the appropriate place?	Yes – No	- Firstly, check if the zone of waste or scrap storage covers a sufficient space. - in case the space is not sufficient, assure a sufficient space or increase the waste evacuation frequency.
k. Are unused cleaning material abandoned?	Yes – No	・Throw it away if they will not be used afterwards. - Appoint a person in charge of the cleaning material management. - Keep the cleaning material reserved to the warehouse, differentiate them with tags.
l. Are there cigarette ends or empty cans?	Yes – No	- Train or train again the person in charge of the product warehouse. Hygiene should be a central preoccupation. Ban smoking.
m. Are there electric devices to kill insects?	Yes – No	- Ban the use of electric devices to kill insects. Indeed, as electrocuted insects explode, there is a big risk that they fall down on products.
n. Are there products directly put down on the floor?	Yes – No	- If the number of pallets is not sufficient, restock it. - Train or train again people in charge about the problems caused by products put down directly on the floor.

Table 3-8 (4) Cold room stowage checklist

Articles	Results	Comments
a. Are materials and semi-finished products stored in separated cold rooms or are separations established for each product?	Yes – No	The best way to store is to put materials, semi-finished products and finished products in separated cold rooms. If the circumstances force to put everything in the same cold room, a zone should be reserved for each product in order to prevent from cross contamination. Separation with, for example, a vinyl curtain is preferable.
b. Are all materials and finished products removed from the cold room for the freezing process?	Yes – No	Semi-finished products are often stored in a cold room, which is not designed for this use, in overproduction period because there is a lack of time (to dispatch immediately) or because there is no space for freezing (too many semi-finished products are waiting)
c. Is the date of all objects displayed ahead?	Yes – No	Checking the objects date in the cold room often takes time. Most of the products date is displayed on the packaging (card box) as well as the consumption limit. But it could be hidden between objects. The products dates need to be displayed in front because there could be products whose date has expired.
d. Are all the objects in front of the thermometer and the temperature sensor moved?	Yes – No	Thermometer and temperature sensor are important to measure the temperature inside the cold room. If objects such as materials, semi-finished products or finished products are placed in front of these instruments, the accurate temperature cannot be measured. Ask thee instruments manufacturers the distance between these instruments and the products because it varies with the products. Clearly mark the forbidden zone with strips.
e. Are products whose manufacture/dispatch cycle is short stored ahead?	Yes – No	The inside temperature of an open cold room increases because outside air enters. Therefore, the opening length and frequency should be reduced. If products whose manufacture/dispatch cycle is short are stored at the back of the cold room, the prolonged opening length could affect products and materials.
f. Are objects to throw away identified?	Yes – No	Objects checking in the cold room is usually not sufficient when we take them out quickly to reduce the opening length. In this case, objects to throw away should be marked, otherwise they could be used or dispatched by mistake. The tag of the objects to throw away is often displayed on the product packaging but it is necessary that the date is displayed in a place easily identifiable such as the cold room.
g. Is the condition of all the cold rooms correctly displayed?	Yes – No	The photography of the correct condition of the cleaning tools cupboard is displayed on some factories door. As for the cold room, the correct condition is not often specified. If it cannot be photographed, an illustration could be useful. This kind of document is not used as long as it is kept in the office. It should be displayed on an identifiable place such as the cold room door.
h. Is there a temperature defect?	Yes – No	The product temperature cannot always be identified. It could happen that a product real temperature should be preserved between 0 and 5°C but is actually preserved at 7°C (the displayed thermometer temperature could be 5°C). As precautionary measure, it is necessary to lower the inside temperature or change the way objects are stored in order to line up the real inside temperature with the temperature measured previously.

3.6.5 Cleaning

Cleaning is the elimination of stains, food residue, dirt, fat or every other unwanted material. *(Codex ,CAC/RCP 1-1999, Rév. 4-2003)*

Sweeping is one way to clean, it relates to the fact of sweeping a place until there is no more dust.

Conditions required for cleaning are the following:

1) Sorting and stowage should be carried out in order to facilitate cleaning.
2) All equipments except the bin are installed 30cm above the floor in order to facilitate cleaning.
3) Reserve a space between the equipment and the wall for the person in charge of cleaning.
4) The use of a high-pressure cleaning machine is not advisable. It cleans a space while dispersing the residue and the waste outside of the visible area. These invisible scraps cause recontamination and insects spread.

3.6.5.1 Sweeping

3.6.5.1.1 Equipment sweeping

Equipment sweeping neglect has serious effects. The lack of sweeping on an area that is in direct contact with food could lead to sanitary incidents caused by the left out residue.

The conditions that facilitate equipment sweeping are the following:

(1) Improve equipments sanitary level: chose equipment that is easy to clean.

Here are the conditions to consider when buying new equipment.

Table 3-9 Sanitary conditions required for the equipment sweeping

№	Article
1	Residues are not stuck to the surface that is in direct contact with food.
2	The surface in contact with food is easy to sweep
3	There is no accumulation of dirt above the products and materials passage. If there are, it should be easily swept.
4	All the machine parts should be at hand to be swept.
5	Type C channel, which often leaves a powder and residue accumulation, should not be used as an equipment.
6	The machine parts where residues accumulate should be easily dismantled.
7	The cover of a machine part where residues are accumulating should be easily dismantled.
8	A residue container that could be dismantled is expected.
9	A space of over 30cm is reserved between the floor and the machine.
10	Over 1meter space is reserved between the wall and the opening of the machine for maintenance.
11	The electronic supply structure, which can be cleaned with water, is shaped as a hat.
12	Material and matters falls are reduced to the maximum.

(2) Definition of the method for prevention of risks spread.

The sweeping method should be chosen while being vigilant on the following conditions:

- Theoretically, avoid air sweeping.
- In case air sweeping is carried out in a specific goal, a measure for the prevention of risks spread should be taken.
- Prevent dust spread during the vacuum reject.
- Sticky and persistent dirt should be scraped and scrubbed.
- Greasy dirt should be removed by cleaning and draining should be collected in a reservoir in order to prevent spread.

(3) Define the annual sweeping planning

It is important to define the general sweeping planning before defining the concrete procedure. Sweeping frequency and criteria should be considered. Here is a planning example.

Equipment	Machine XX		
Article(place, part)	Assembly conveyor	Bottom of the engine	angle
Criteria	there is no residue	there is no residue	there is no old material
Method	dry wiping	hand wash	drain
Frequency	before operation start	after operation	weekend
Manager	A	A	A
Record verification	production card	production card	production card
Listing frequency	Once a day	Once a day	Once a day
Checking frequency	before operation start	after operation	regular checkinng
Manager	○○	○○	ΔΔ
Document	handbook	handbook	handbook

(4) Improve tools for more effective sweeping.

(5) Control on site the sweeping efficiency and write reports.

It is possible that the equipment sweeping is not carried out according to the planning and that it don’t have the expected results. In this case the planning should be corrected in order to be more realistic. The relevance of the amendment should be checked by an onsite control. The control result should be reported as concrete orders in the sweeping program.

3.6.5.1.2 Floor Sweeping

Here are the four steps to follow during the floor sweeping.

(1) Remove the cause of the dirt on the floor and reduce the dirt to the maximum.

The floor dirt is not worsening because of the lack of sweeping but because of the spread of residue.

1) The spread of powder should be removed with a vacuum, a cover or airflow.

2) In case there is powder residue, the quantity of product transfer or the speed of the flow line should be controlled.

3) Unpackaged and package management should not be carried out randomly.

4) A container should be installed under the sticky material that drips by accident.

5) A partition should be installed to reduce droplets.

6) The cleaning of the operators' soles is obligatory in order to prevent dirt from spreading.

7) Overflow of water in a flow line should be channelled perfectly all the way to the bung.

8) The workers flow should be controlled in places where scrap falls are inevitable.

9) If scrap falls are inevitable, sweeping tools should be installed beforehand.

(2) Define and execute the sweeping calendar while considering the dirt's real situation.

The floor surface is not always highly clean, but the risk control according the dirt level is necessary. Risks and sweeping frequency should be in accordance.

Here are the judgement criteria:

Table 3-10 Estimated problems and risk control criteria

Problem	Criteria	Frequency
Mix of the floor residue and the food	Visible size	More than once every 1-7 days
Outbreak of insects (flies) in a wet environment	No old residue	More than once a week
Outbreak of insects (small insects) in a dry environment	No old residue	More than once a month
Mix of allergic substances	Visible accumulation	- When the type of the manufactured product changes - When discovered
Spread of dirt in a hard to clean area	Do not leave for more than 15 minutes	When discovered
Reduction of the sweeping frequency to maintain cleanliness	Invisible dust and waste	More than once a month

(3) Considering measures to prevent recontamination

It is possible that floor dirt is repeated by an irrelevant practice. In order to prevent from dirt recurrence:

1) Move materials and equipment if possible.
2) Do not disperse residue in the air.
3) Sweep floor after sweeping the equipment.
4) Start sweeping from the dirtiest area and go back to the less dirty area.
5) Eliminate pool of water
6) Reject inevitably collected waste.
7) Sweep and put the tools back.

(4) Use special tools for a more effective sweeping.

Ordinary brooms or brushes are not a good enough solution to scrape stubborn dirt on the floor. The brush advised for a factory is very rigid and flexible. Though it is more expensive, the total cost can be reduced by reducing the sweeping time and increasing the brush's life span.

3.6.5.1.3 Wall Sweeping

Wall sweeping could be the most neglected. But it should be carried out carefully because walls are often occupied by insects, mould and bacteria transmitted by hand contact.

The sweeping targets are:

1) Walls (including the parts covered by the machines)
2) Window
3) Door and door handle
4) Objects installed on walls and their accessories
5) Switchboard and fire hydrant
6) Wiring, pipes and hinges

It is important to decide before hand the order in which a zone will be swept. Theoretically, wall sweeping is carried out after the ceiling sweeping and before the equipment and floor sweeping.

3.6.5.1.4 Sewer Cleaning

Workers tend to think that sewers are part of the bin. Waste and rubbish are then often thrown away in the sewers. Cleaning becomes more difficult because of these objects. Therefore, it is necessary to consider the following points:

(1) The cleaning objective

The cleaning object is not only the sewer bottom but also the side, the cover support, the cover, the back of the grate, the box, the waste container, the inside and the back of the trap. The wall surface and the accessories such as the grate are often occupied by insects.

(2) In order to complete an effective sweeping, the following criteria need to be considered:

1) Solid residue: reduce the food residue thrown away in the sewer.

The most important is to not emit waste while producing but it is also important to collect waste immediately. Installing bins around the production area could reduce waste.

2) Trap conception

It is important to prepare several large reticulation trap layers in order to avoid the obstruction of a small reticulation trap

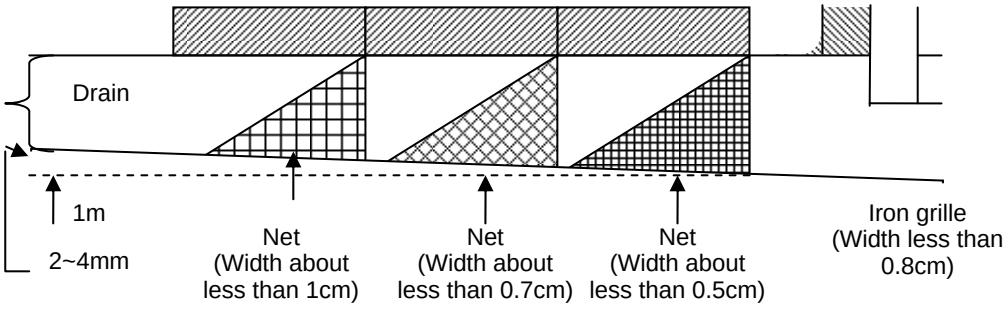


Figure 3-10 Example of Drain's Trap Zone

3) Trap cleaning procedure

It takes time to remove the waste from the trap reticulation. To avoid losing time, trap replacement parts can be used, which could reduce the total cleaning length. Then, the trap can be cleaned without problems. The cleaning can be achieved by high pressure water jetting after being immersed in an alkaline solution. The trap reticulation can be replaced by a disposable piece.

4) The material of the cover and the trap

The cover and the trap are made out of metal, which are heavy for women. For this reason, cleaning is often neglected. But these pieces could be replaced by plastic pieces hard enough to support the normal charge.

(3) The frequency of the sewer cleaning

In case where 1) and 2) from (2) are carried out, the sewer cleaning is necessary at least once a week. If waste is accumulating on the trap, the cleaning frequency should be intensified.

3.6.5.1.5 Air Conditioning Channel and Equipment Cleaning

The daily cleaning of the air conditioning channel and equipment is not easy because they are installed at the top and pipes can be winding. But the contamination of the air conditioning channel by polluted air could be the cause of food rot. The introduction of flammable scraps in the duct can provoke fires in the air conditioning system. For this reason, the air conditioning channel cleaning needs to be considered as an integral part of the risk control. The following points needs to be considered:

(1) Filter cleaning (every 2 weeks)

After dismantling the filter and removing dust, clean it with soft detergent diluted in hot or cold water.

(2) Cover cleaning

The evacuation pipe can be clogged by dust. It is necessary to clean the cover, remove dust at the entrance of the evacuation pipe and wipe with a wet cloth.

(3) Cleaning the inside and outside of the cooling devices (every 2 or 3 years)

(4) Cleaning the water cooling devices

The cooling device in direct contact with water is covered with foam and water dyeing. It should be cleaned regularly. In an area where water quality is not good, intensify the cleaning frequency.

(5) Cooling tower cleaning

Clean the cooling tower before and while it is used, keep on cleaning it every 2 weeks according to the following method:

- Remove the air intake and the strainer and clean it with water.
- Clean the water reservoir once a month: clean it by brushing with water. Polluted water could cause a malfunction and the corrosion of the cooling device.
- The cleaning frequency depends on the nature of the manufactured product and on the conception of the manufacturing workshops.

3.6.5.1.6 Factory Peripheral Area Sweeping

It is not necessary to clean the factory's peripheral area with the same intensity as the inside of the factory. However, cleaning should be carried out once a month or once every 2 months. It is also important to inspect regularly.

Here is the checklist:

Table 3-11 Factory peripheral area sweeping checklist

To be checked	Results	Comments
a. Are unnecessary containers and pallets left?	Yes - No	
b. Is the side ditch angle sufficient?	Yes - No	
c. Are there piles of dead leaves under deciduous tree?	Yes - No	
d. Are there waste in the parking or around a vending machine?	Yes - No	
e. Are there used tires?	Yes - No	
f. Are the trees pruned?	Yes - No	
g. Is there bird dirt?	Yes - No	
h. Are there objects left by other companies employees?	Yes - No	
i. Are there weeds?	Yes - No	
j. Are unnecessary materials left?	Yes - No	
k. Is there an accumulation of dead insects bodies?	Yes - No	
l. are there cigarette ends?	Yes - No	
m. Are there spider webs or bird nests under the eaves?	Yes - No	

Note : If the answer is Yes, note the detail in the 'comments' column.

3.6.5.1.7 Cold Room Sweeping

Most operators think the cold room temperature stops the spread of bacteria. For this reason, various objects are stored there temporarily or for longer periods. It reduces the space reserved for the products storage.

It is not easy to clean once and for all a cold room full of objects. Cleaning a dark cold room doesn't allow to completely clean.

3.6.5.1.8 Cleaning Practice in the Cold Room

Inspect the cold room regularly and take notes. It is more effective to clean the inside of the cold room during the production, the dispatch or the periods where stocks are lower.

The measures to treat damaged food should be specified beforehand. Specify the checkpoints and eliminate mould if a visual inspection noticed its presence. Clean the ceiling, walls and floor. Check cleanliness inside the cold room with a microbiological test.

Here are the cold room hygienic criteria:

Table 3-12 Cold room cleaning criteria

Cold room cleaning criteria	
Objective	The objective is to maintain the cold room in clean condition by using as a main mean the “temperature management”. The maintenance of a cold room left at a low temperature is often forgotten. Therefore, it is necessary to focus on the management program as well as on the method of use.
Products storage	It is preferable to use a warehouse exclusively for the products. It is necessary to carry out a cleaning program to prevent from contamination, by taking care of not mixing the products (different storage temperature, prevention of cross contamination), and controlling the temperature of certain points (inside and outside) including the cooler.
Semi-finished products storage	It is a temporary warehouse for semi-finished products. They are often left there for a long time, which is the cause of cross contamination during the frequent entrances and exits of products. The power of the cooling function is lowered by the difference of the products storage temperature. Clean regularly as part of the cleaning program of the inside of the cold room, of the products containers, shelves and cooler.
sufferance warehouse	There is no direct contamination in the cold room between finished products on hold and packaged products. However, it is necessary to complete the cleaning program regularly to maintain the cleanliness level

3.6.5.2 Scrubbing Methods

The purpose of scrubbing is to make things clean. The procedure is the following:

1) Check the dirt condition.

   If the dirt is minor, it could be removed with cold or hot water.

2) Know the dirt characteristics and determine the detergent and tools to use (ex: brush).

3) Write the scrubbing plan/program.

3.6.5.2.1 Scrubbing Equipment

It is important to consider 2 factors for an effective equipment scrubbing:

1) Cleaning difficulty due to the equipment structure (see **Table 3-9)**

2) Method and procedure of the equipment cleaning (education, training) and make the employees aware of this problem.

The interaction between these 2 factors enables to define the scrubbing program to maintain a high level cleanliness.

Manual scrubbing and automatic scrubbing are the main ways to clean. The cleaning method should be chosen depending on the equipment structure, the location of the equipment, the environment etc….

The main equipment scrubbing methods are the following:

1) Brushing
2) Immersion cleaning
3) High pressure cleaning
4) Foam cleaning (cleaning with a gel)
5) CIP (cleaning in place)

a. Brushing

Method of cleaning where dirt is removed with a brush or a sponge. It is one of the best methods if it is done significantly.

b. Immersion cleaning

Method of cleaning where the object to clean is soaked in a detergent solution. If the dirt is stubborn, the immersion cleaning can be associated with brushing.

c. High pressure cleaning

Method of cleaning where the dirt is chased by shooting detergent or hot water through a nozzle. It is not advisable to use this method for a surface cleanable by hand because the liquid jetting or the spread of dirt residue could re-contaminate.

d. Foam cleaning (cleaning with a gel)

Method of cleaning, which decomposes the dirt with a detergent foam or gel applied on the object surface. The foam and the gel could remain in contact with the dirt for longer time than the detergent solution, which facilitates the dirt detachment.

e. CIP(cleaning in place)

Method of cleaning which removes the dirt by automatic or semi-automatic circulation of the detergent without dismantling the reservoir, the pipes or the loader.

3.6.5.2.2 Scrubbing the Floor

In order to carry out an effective floor scrubbing, it is necessary to use a material appropriate to the floor and change the scrubbing method for the clean and unclean zone.

(1) Floor material

Most of the materials used for the floors of food factories are resins (epoxy, methacrolein, ester vinyl, polyurethane). A choice should be made according the use of space. Rigidity and scraping degree could be diversified by the change in the ratio of the resin layer thickness and the aggregate (alloy and mineral are often used).

Here is the comparison Table of the resin floors.

Table 3-13 Comparison of the resin material for floor

	Performance						Food flow line	Cold room Freeze	Clean room
	Heat Resistance	Low temperature Resistance	Water Resistance	Shock Resistance	Scrubbing efficacy	Maintenance easiness			
Epoxy resin	○	○	●	○	○	●	●	●	●
MMA resin		●	●	○	○	○	●		○
Vinyl ester resin	●		●	○	●	○	○	○	
Polyurethane resin			●	●		○	○		○

Note : ● : Excellent
○ : Good
Unfilled : undefined because the result depends on the circumstances of use.

(2) Unclean zone and clean zone scrubbing

The scrubbing of the unclean zone is more important than the scrubbing of the clean zone.

The dirt is more serious in the unclean zone. The neglect of scrubbing in this zone is the cause of germ spread and the outbreak of rats and insects. These are causes of cross contamination. On the other hand, in the clean zone, the cleanliness of the operations is maintained permanently. Therefore, dirt is minor.

3.6.5.2.3 Scrubbing of the Ceiling and the Walls

In order to facilitate the scrubbing of the ceiling and the walls, it is important to use appropriate material and to change the scrubbing method between the unclean and the clean zone.

- Materials

Here are the selection criteria for the ceiling and walls materials:

Table 3-14 Allowed materials for the ceiling and walls according to the area

Kitchen	Wall	Ceiling
Cooking	Tile in stainless alloy, aluminium, ceramic	Plastic covering or fibre panel with metallic covering, dry partition for stone walls, laminated plastic with soft surface
Formulation Preparation	In addition to the above materials, plastic panel, laminated by composite glass fibres, wedge covers with epoxy resin or with a soft surface	Same.
Warehouse	Plastic panel laminated by composite glass fibres, wedge covers with epoxy resin or with a soft surface	Soundproofed tiles, plaster panel
Cold room	Aluminium, stainless alloy, enamelled iron (or other anticorrosive materials)	Aluminium, stainless alloy, enamelled iron (or other anticorrosive materials)

3.6.5.2.4 Detergent choice

Detergents used in a food factory could be soft detergent, soft alkaline detergent, strong alkaline detergent or acid detergent.

Table 3-15 Examples of the categories, components, and usage of detergents used in a food factory

Category	Components	Usage	Characteristics
Strong alkaline based detergent	Sodium hydroxyde Inorganic salt Organic binder Tensioactive agent	Automatic bottle washer Heating machine CIP (dairy, fermented products) Machines manufacturing livestock or sea food	- Appropriate for stubborn organic dirt. - Detergent associated with a binder can eliminate scale
Soft alkaline based detergent	Soft alkaline based organic and inorganic salt Tensioactive agent	Soaking or semi automatic bottle washer. CIP (Fizzy drinks or fruit juices) Automatic container washer Cleaning of manufacture machine, floor and walls	- Appropriate for dirt that is difficult to remove with the soft detergent. - Strong buffer power and dispersibility
Soft detergent	Soft organic and inorganic salt Tensioactive agents	Raw material cleaning Container hand wash Machine cleaning Hand cleaning	- Appropriate for minor general dirt. - Requires brushing for medium to stubborn dirt
Acid detergent	Inorganic acid Organic acid Tensioactive agents	CIP (dairy, fermented products) Elimination of the rust on bottles Elimination of the scale in the bottle washer	- Appropriate to remove heavy scale on inorganic substances or rust

3.6.5.2.5 Writing the scrubbing program

The effect of the same detergent differs depending on the scrubbing method. Therefore, it is important to define an appropriate scrubbing program and to make people sensitive to its application

Scrubbing programs should specify:

- Zones, equipment and tools to scrub;
- Responsibilities for the various tasks;
- Scrubbing methods and frequency;
- Follow-up procedures ***(Codex ,CAC/RCP 1-1999, Rév. 4-2003)***

Here is an example of a scrubbing program:

Table 3-16 Scrubbing program

Object			Kitchen utensil (knife, chopping board, sieve, tank, stainless alloy tray etc)		
Objective			- Prevent the spread of bacteria and cross contamination		
Time of execution			- Before starting the operation - For each use - At the end of the operation		
Detergent used			Name of the detergent	Density	Main components
			Soft disinfecting detergent	5% diluted	Non ionic tensioactive Quaternary ammonium
			'Safecall'	No diluted	Ethyl alcohol Glycerol ester
Tools			・Sponge (green), bottle of detergent solution, alcohol atomizer		
Procedure			Designation		Comment
Before starting the operation	a	Make a detergent solution	- put 2 pump pressures of detergent and add water until the upper line		
	b	Disinfection	- Syringe alcohol		
During and after the operation	c	Residue elimination	- Rinse with running water and remove food residue		- Use drinking water
	d	Scrubbing, disinfection	- Scrub with a sponge soaked with soft disinfecting detergent		- Use a sponge reserved for this use
	e	Rinse	- Rinse with running water for more than 5 minutes		- Use drinking water
After the operation	f	Disinfection	- Syringe alcohol		
Tools	g	Knife, chopping board	- Drain off the water and put in a sanitizing warehouse.		- Check that the UV lamp is switched on
		Sieve, tank, tray	- Drain off the water and put in a sanitizing warehouse..		- Check that the UV lamp is switched on
Other comments - Do not mix soft disinfecting detergent with other detergents. - After draining the water off the sponge, rinse thoroughly and dry before storing it.					
Writing date and revision date			Manager	Assistant manager	Writer
Written the	D/M/Y				
Revised the	D/M/Y				
	D/M/Y				

3.6.6 Sanitizing methods

Sanitizing is a technique, which aims at eliminating all germs from a preparation, for example, by exposing it to high temperatures. Sanitizing is a process used to eliminate viable or revivable germs.

By definition, the sterile condition of a product means that the probability to find a viable or revivable germ in a product is at most of $1 / 10^6$ (wikipedia,2007).

For a food factory, there is no need to eliminate all the germs. It is only necessary to evaluate the risk in each factory and to control the number of germs according to pre-determined criteria. Here are the main points of sterilization:

(1) Fix the bacteria threshold that should not be exceeded.

In a production phase, which is in direct contact with products after cooking and before packaging, the objective must be severe (zero). However, during other phases, this threshold can be inferior to $10^2/cm^2$.

(2) Reduction of the number of germs before sterilization.

During sterilization, the number of germs is reduced proportionally to the length of treatment. The horizontal axis represents time. The vertical axis represents the number of living germs on a logarithmic scale. This germ elimination is called ‘the logarithmic germ elimination’.

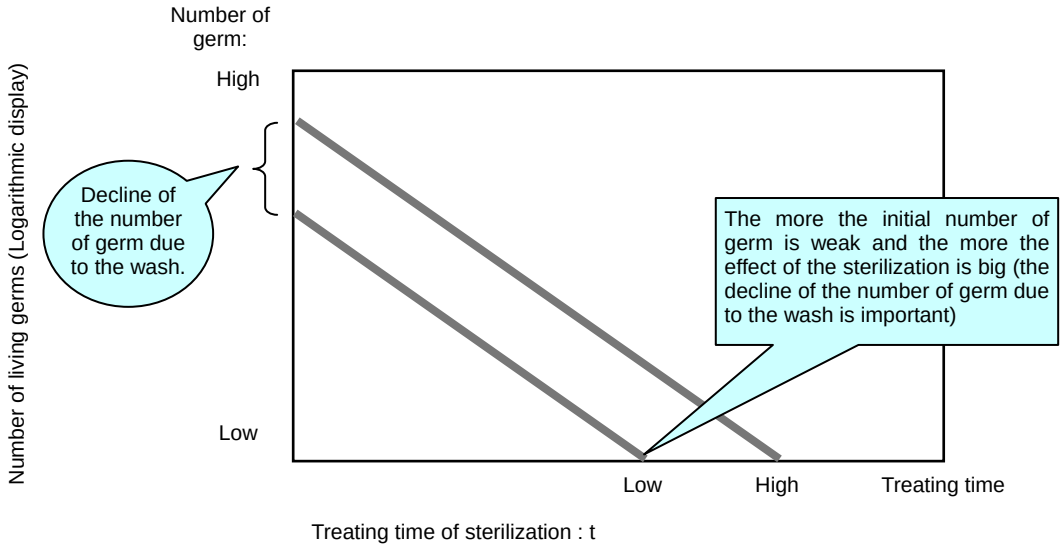


Figure 3-11 Logarithmic elimination of microbes

The above Figure shows that the sterilization should be long if the previous stages are not clean. Generally, the extension of the length of sterilization affects taste and colour. Consequently, the products’ quality is damaged even if they are clean. Stowage and cleaning before sanitizing facilitate the sterilization and then improves the products quality.

(3) PDCA to maintain cleanliness

Sterilization is not carried out once and for all, but it is programmed according to the factory procedure.

First step : define the operating zone and the targeted cleanliness level for each machine and equipment.

It is important to consider the measurement of the cleanliness level and to choose criteria, which can be backed up with figures.

Step 2 : Sterilization, the big cleaning process, to improve cleanliness

Firstly, carry out the sterilization to achieve a higher than expected cleanliness level.

Step 3 : Maintain the expected cleanliness level. Daily sterilization

The daily production activity quickly damages the cleanliness even if it has been improved temporarily by sterilization. It is necessary to carry out a daily sterilization in order to maintain the expected cleanliness level.

Step 4 : Study of the cleanliness level

Examine the cleanliness level of each place following the determined method and report as regularly as possible the cleanliness level with data backed up with figures.

Step 5 : Compare real figures with the expected level.

Assess the average value and the distribution and determine the measures that have to be taken.

1) If the assessment results show sufficient cleanliness, go back to step 3 and continue the daily sterilization.
2) If the assessment results are out of the norms, go back to step 2 and carry out a "wide cleaning" sterilization.
3) If the assessment results are very good or on the opposite very bad, go back to the first step and reconsider the expected cleanliness level.

Step 6 : Continue with the same PDCA cycle.

3.6.7 Self-Discipline

The objective of the '7s' is to maintain a high cleanliness level against germs. Therefore, it is necessary to organize the stowage to facilitate sweeping and scrubbing. Sanitizing will be carried out after these stages. Cleanliness is maintained by regularly executing these operations, which can be done by educating people. This is the 6th "S" ('shituké)'.

This cannot be achieved with only one training session. Hygienic training is essential.

Sessions should be recorded. The attendance sheet, the time, the name of the concerned persons, the subject of the sessions, the name of the trainer, the documents handed out should be kept in a file. The training effectiveness will be evaluated by a checklist.

Table 3-17 (1) Example of an education program

Month	Program
January	Introduction to the '7s'.
February	Sorting methods
March	Checking places, discussion 'seiton' methods (places reservation, tag)
April	Checking places after organisation Sweeping method (regular cleaning task sharing, method)
May	Checking the swept places, discussion Scrubbing methods (regular task sharing, method)
June	Checking places, report of the wiping exam result, discussion Sanitizing method (regular sanitizing task sharing, method)
July	Checking sanitized places, report of the exam results, discussion Audit methods for the '7s' (Communication of the points that need to be checked)
August	'7s' audit report
September	'7s' audit report
October	'7s' audit report
November	'7s' audit report
December	'7s' audit report

Table 3-17 (2) Example of a report of the employee training (format)

	Number of training hours	Session's participants	Article	Trainer	№ Document

Table 3-17 (3) Awareness to hygiene checklist

№	Checked articles	Judgement
1	Did the operators wash their hands and are they dressed correctly?	
2	Are shoes and arms covers clean?	
3	Is the factory temperature well maintained?	
4	Are the product's temperature and time well controlled?	
5	Are the material packs well controlled?	
6	Are the raw materials treated appropriately?	
7	Are the raw materials stored appropriately?	
8	Are objects put directly on the floor?	
9	Is waste thrown away each time?	
10	Are the chemical substances well controlled?	
11	Are the cloths well controlled?	
12	Are the production equipment and tools well cleaned?	
13	Is the furniture well straightened and cleaned?	
14	Are the cleaning tools and wagon well straightened and cleaned?	
15	Are other equipments well straightened and cleaned?	
16	Is the cold room well straightened and cleaned?	
17	Are installations (wall, floor, window, air conditioning pipes) cleaned regularly?	
18	Is any equipment or tool broken or fixed with scotch tape?	
19	Are insects and rats eliminated?	
20	Is all the procedure checking carried out?	

3.6.8 Practice of regular 'seiton' : cleanliness

The most effective way to maintain 'seiton' is regular 7S audit, every month or every 2 months. If there are problems, instructions need to be given.

Here is the 7S checklist:

Table 3-18 (1) Area checklist

Sort	a. Is the entire team concerned by the training?	Yes / No
	b. Have the discussions been held on the basis of the production site reality?	Yes / No
	c. Has the sorting program been established and carried out on this basis?	Yes / No
	d. Have problems been solved?	Yes / No
	e. Has the sorting progress been recorded?	Yes / No
Straighten	a. Has the stowage system been conceived by the team?	Yes / No
	b. Has the stowage been carried out according to plan?	Yes / No
	c. Have problems been identified?	Yes / No
	d. Have problems been solved?	Yes / No
	e. Has stowage been maintained?	Yes / No
Sweeping/scrubbing	a. Are the cleaning tools placed on the determined place?	Yes / No
	b. Is the cleaning tools list displayed?	Yes / No
	c. Are there all the necessary tools?	Yes / No
	d. Are the tools handled appropriately?	Yes / No
	e. Is the sweeping procedure for each area displayed?	Yes / No
	f. Is sweeping carried out according to the determined procedure?	Yes / No
	g. Has sweeping been completed before the production started?	Yes / No
	h. Are the measures to take against dirt and residue during production determined?	Yes / No
	i. Is urgent sweeping during production carried out according to the determined procedure in order not to contaminate products?	Yes / No
	j. Is the site manager present during sweeping to control and check?	Yes / No
	a. Are the tools and detergent placed on the determined place?	Yes / No
	b. Is the list of tools and detergent displayed?	Yes / No
	c. Are there the required functional tools and detergent?	Yes / No
	d. Are tools and detergent handled appropriately?	Yes / No
	e. Is scrubbing carried out according to the determined procedure?	Yes / No
	f. Has scrubbing been completed before the production started?	Yes / No
	g. Are the measures to take against dirt and residue during production determined?	Yes / No
	h. In case scrubbing is necessary, is the procedure determined?	Yes / No
	i. Is urgent scrubbing during production carried out according to the determined procedure in order not to contaminate products?	Yes / No
	j. Is the site manager present during scrubbing to control and check?	Yes / No
	k. Are the scrubbing progress and results recorded for the manager to check it?	Yes / No
Disinfection	a. Is the disinfectant is placed on the determined place?	Yes / No
	b. Is the list of disinfectant displayed?	Yes / No
	c. Is there the required disinfectant?	Yes / No
	d. Is disinfectant handled appropriately?	Yes / No
	e. Is the disinfectant's specific weight correct?	Yes / No
	f. Is sanitizing carried out according to the determined procedure?	Yes / No
	g. Has sanitizing been completed before the production started?	Yes / No
	h. Are the measures to take against dirt and residue during production determined?	Yes / No
	i. In case sanitizing is necessary, is the procedure determined?	Yes / No
	j. In case sanitizing is carried out during production and treatment, is the relevant measure taken in order not to mix disinfectant with raw material and product?	Yes / No
	k. Is the site manager present during disinfection to control and check?	Yes / No
	l. Are the progress and results recorded?	Yes / No
	m. Is the action checked by the site manager?	Yes / No

Table 3-18 (2) Objects checklist

Sort	a. Has training been achieved in order to sort containers, packaging and open materials and the reject procedure?	Yes / No
	b. Has the sort out and waste reject procedure for each process been defined by the team?	Yes / No
	c. Are used container and packaging appropriately straightened out?	Yes / No
	d. Have all the problems been solved?	Yes / No
	e. Has the sort progress been recorded?	Yes / No
Stowage	a. Has the stowage system for raw material and product of each process been defined by the team?	Yes / No
	b. Has stowage been carried out according to the defined procedure?	Yes / No
	c. Are there problems?	Yes / No
	d. Have these problems been solved?	Yes / No
	e. Is the stowage maintained?	Yes / No
Sweeping/scrubbing	a.	Yes / No
	b. Is the list of the tools necessary for checking and sweeping displayed?	Yes / No
	c. Is there the necessary tool for checking and stowage?	Yes / No
	d. Are the tools for checking and stowage appropriately maintained?	Yes / No
	e. Is the checking and stowage procedure for each raw material displayed?	Yes / No
	f. Is the checking and cleaning of the raw materials carried out according to the defined procedure?	Yes / No
	g. Are the cleaning and checking of the raw materials completed before the production starts?	Yes / No
	h. Is the site manager present before cleaning for control and checking?	Yes / No
	a. Is the raw material cleaning carried out at the appropriate area with the determined equipment?	Yes / No
	b. Are tools, detergent, measurement instruments for the raw material cleaning put on the determined area?	Yes / No
	c. Is the list of the instruments and detergent displayed?	Yes / No
	d. Is there functional tool and necessary detergent?	Yes / No
	e. Are tools and detergent appropriately handled?	Yes / No
	f. Is cleaning carried out according to the determined procedure?	Yes / No
	g. Are the measures to take against dirt and residue during production determined?	Yes / No
	h. If scrubbing is necessary, is the procedure determined?	Yes / No
	i. Is the site manager present during the urgent cleaning for control and checking?	Yes / No
	j. Are the cleaning progress and results recorded for the manager to check it?	Yes / No
Sterilization	a. Are tools, disinfectant, measurement instruments put on the determined area?	Yes / No
	b. Is the list of tools and disinfectant displayed?	Yes / No
	c. Is there the necessary measurement instrument and disinfectant?	Yes / No
	d. Is the disinfectant appropriately handled?	Yes / No
	e. Is the disinfectant specific weight correct?	Yes / No
	f. Is sanitizing carried out according to the determined procedure?	Yes / No
	g. Has sanitizing been completed before the production started?	Yes / No
	h. Are the measures to take against dirt and residue during production determined?	Yes / No
	i. In case sanitizing is necessary, is the procedure determined?	Yes / No
	j. In case sanitizing is carried out during production and treatment, is the relevant measure taken in order not to mix disinfectant with raw material and product?	Yes / No
	k. Is the site manager present during disinfection to control and check?	Yes / No
	l. Are the operation progress and results recorded?	Yes / No

Table 3-18 (3) Operators body checklist

Sort	All the unnecessary objects which could be the cause of a contamination are removed?	Yes / No
	a. Earrings	Yes / No
	b. Ring	Yes / No
	c. False eyelashes	Yes / No
	d. Cat or dog hair (did the operator changed clothes?)	Yes / No
	e. Long nails	Yes / No
	f. Badly fixed button	Yes / No
Stowage	a. Is hair correctly arranged?	Yes / No
	b. Are coins and personal belongings appropriately put aside?	Yes / No
Cleaning	a. Is hair cleaned and done? (Falling hair or dandruffs are not accepted. Il is advised to wash hair every morning)	Yes / No
	b. Are nails brushed? (Dirt around the nails are not accepted)	Yes / No

Table 3-18 (4) Employees behaviour checklist

Sort	a. Are unnecessary objects not kept in the locker room?	Yes / No
	b. Are cakes or other food not brought along?	Yes / No
	c. Is the list of objects forbidden in the production area and in the other area displayed?	Yes / No
	d. Are the objects displayed in the list put aside?	Yes / No
Stowage	a. Are the locker -room and the closet well straightened? (Is there a distinction between personal belongings and the company equipment?)	Yes / No
	b. Are instructions updated?	Yes / No
	c. Are instructions clear?	Yes / No
	d. Are the shelf and the warehouse straightened according to the instructions?	Yes / No
Sweeping / scrubbing	a. Is an adhesive roll used according to the procedure?	Yes / No
	b. Is the roller maintained according to the procedure?	Yes / No
	c. Is the operation record written down?	Yes / No
	d. Are the assessment criteria of the roller operation known?	Yes / No
	a. Is the colour of the water used to wash hand not red?	Yes / No
	b. Is liquid soap used to wash hands?	Yes / No
	c. Is a nailbrush used?	Yes / No
	d. Are hands washed according to the procedure?	Yes / No
	e. Is the hand dryer clean?	Yes / No
	f. Is the liquid soap refilled?	Yes / No
	g. Is the soles or boots washer clean?	Yes / No
	h. Is the cleaning carried out?	Yes / No
	i. Is the rubber apron cleaned?	Yes / No
	j. Are the rubber gloves cleaned?	Yes / No
Disinfection	a. Are hands disinfected after cleaning?	Yes / No
	b. Is the choice of disinfectant good?	Yes / No
	c. Is the disinfectant solution diluted to the correct specific weight?	Yes / No
	d. Is the disinfectant refilled?	Yes / No
	e. Is the soaking method in the basin avoided?	Yes / No
	f. Is abnormality in the disinfectant solution specific weight reported?	Yes / No

3.7 Management of the Beginning of New Products

Every product follows its life cycle. A product sale goes through phases from market introduction, growth, gestation, to decline. The product is finally taken off the market. The introduction of a new product is a major factor, which offsets the reduction in sales and makes the company grow. As a product life cycle becomes shorter, it is preferable to develop new products at an appropriate time. But the start of a new product never goes according to plan and sometimes causes problems. If these problems are about the product quality and if the concerned products are consumed by clients, the situation can be disastrous for the company.

Problems at the start of the production of a new product are unavoidable. The 5 following points are essential to eliminate or resolve them before it's too late:

(1) Establish a quality management system for the number of packs, number of stages, and cost since the project of the new product until the production and sale.

- After producing a prototype, improve quality, equipment, procedure, flow line organisation… and define a standard.
- At the beginning of the mass production, improvement is completed the same way. These measures should be taken immediately.

(2) Clearly mark the start and the end of the initial control.

- Establish the calendar of each stage since the project until the end of the initial control. As for the wide project, the calendar will be determined by the PERT graph.
- Determine the conditions of the end of the initial control based on detailed figures: rate of faulty products, number of bacteria, number of unconformities, process operational capacity, real process number, step length, real quantity of used material, historic cost of each elements etc.

(3) Provide the standard document for the initial control.

- Essential base documents are: standard operation, basic recipe, product specification, raw material specification, organoleptic evaluation standard, microbiological test, quality standard document, process capacity chart, time standard document, cost standard document (cost table).

(4) Provide documents with real figures resulting from the initial control.

- Data backed up with figures: control table for initial control (number of bacteria etc), PERT, quality, real produced quantity, budget, stocks, employees, operation capacity, global yield, delivery delay etc.

(5) Take measure immediately for an initial control.

Give a strong and special authority to some managers for the initial control. Problems are crossing so they are difficult to solve if managers only have a limited authority.

CHAPTER 4. TRACEABILITY

With the appearance of the ESB and the GMO (Genetically Modified Organism), with the EU in head, the interest for the safety and the food trust is increasing in the world. The "safety" resides in the scientific validation, the trust implies the confidence of the consumers, which is produced by the food-processing industry from its offer's results of "sure" foodstuffs, a notion which finds its origin in subjectivity. The traceability is not a means to guarantee the safety of food but play an important role to connect the "safety" of food to the trust of the consumers.

This chapter presents at first the objectives and the definition of the traceability and explains then techniques used for the traceability. Thirdly, it explains the procedure for the constitution of a system of traceability, and lastly, it covers a certain number of points susceptible to raise problem for the constitution of a system of traceability and presents the measures of resolution.

4.1 Definition and objectives of the traceability

4.1.1 Definition

It is planned in the ISO and the Pharmacopoeia(Codex) (FAO / WHO) to standardize the system of food traceability in ISO 22005 standard. Here, the traceability is defined as follows:

" Capacity to follow the trace of the food's movement or the foodstuffs through the precise steps of production, transformation and traffic ".

In the traceability defined in the ISO 22005, it is not necessary to know all the products and the information concerning the food chain, but only a partial knowledge is necessary. In the case of the companies of foodstuffs' manufacturing, it is a question of tracing products and information from the reception of raw materials until the delivery to the privileged customers.

In the " system of traceability " the possibility to sail up the information, the follow-up in both directions of upstream and downstream. In case of the sail up of the information from the downstream to upstream, it is called "trace back", and in the other direction, it is called "trace forward".

4.1.2 Objectives

The system of traceability pursues the following 2 objectives.

1. In case of appearance of a food accident, be able to make quick recall of products and a clarification of the causes.
2. Assure the trust of the consumers by showing the safety and the quality of the products.

In case of appearance of a food accident, while recalling quickly the concerned products, clarify exactly and quickly the causes, and it is necessary to stop the consumption so that the expansion of the victims of the accident can be maintained in the smallest scale. It is necessary to be able to search for the stream of the products and information retroactively, from downstream to upstream, in order to clarify the causes. To stop the consumption in order to maintain the expansion of the victims the smallest possible, it is necessary to follow the trace of the products and information's stream since the process at the origin of the accident until downstream.

It is not necessarily essential to expose the information of the traceability relative to the safety to the consumers. However, it often happens that this information is required from the customers.

4.2 Techniques used for the traceability

Generally, in the industrial companies, products and information circulate according to the Figure 4-1. As regards products and information in the system of traceability, there is a case where products and information circulate separately and the case where the information circulates by being connected to products. The methods of transmission of information and the used techniques are grouped in the Table 4-1.

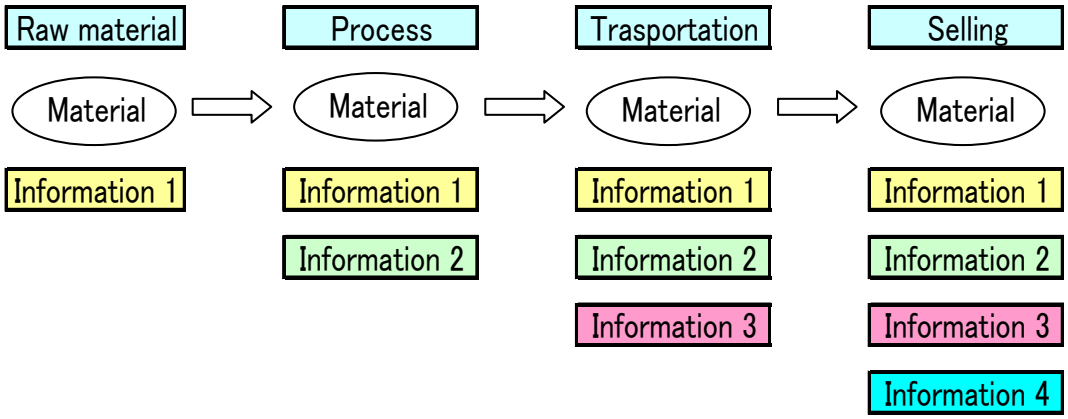


Figure 4-1 Flow of Material and Infomation

Table 4-1 Methods of information and used techniques' transmission in the system of traceability

Information transmission mode	Information transmission mode
Separated circulation of products and information	1. Slip
	2. Identification Code
	3. Unidimensional bar codes
Simultaneous circulation of products and information	4. Bidimensional bar codes
	5. RFID tag

The characteristics of every transmission method of information are presented below.

4.2.1 Slip

With a single slip attached with the product, as we cannot check the entirety of the information on the process since the reception of raw materials up to the finished product, if the slip is needed, the products and the information circulates separately. The method by slip is suited for the cases where the manufacturing process are simple, the cases where a big investment in information technologies for the constitution of a system of traceability is not possible and the cases where the operators do not know how to use the devices of information technologies for the traceability. In the case of small and medium-sized firms intending to introduce a system of traceability, at the beginning, it is practical to progress according to this method or the method with identification code.

4.2.2 Identification code

This method consists in attaching identification codes for every lot, these codes are printed on labels or patches attached to the products that circulate and the information on the process and raw materials are treated separately. The conversion of products and information is made according to their respective identification codes. This method is adapted to the same cases as the method with slips. This method is also adapted to companies that want to introduce a system of traceability for the first time.

4.2.3 Unidimensional bar codes

This method is the replacement of the identification codes by bar codes, bar codes applied to products are read with bar code reader. This method is adapted to the same cases as the identification code, the volume of information and the search for information are certainly limited, but requires only moderate introduction costs and it presents the advantage of not requiring big changes for the current operators.

4.2.4 Bidimensionel bar codes

Whereas bar codes show information according to the size and the space of bars, in this method we express the information in 2 dimensions as it is presented by the figure 4-2, besides being able to record a large number of information, it remains legible even in case of staining. So, with this method, we make the information circulate on the products. As bidimensional bar codes do not allow, unlike the RFID tag, to add information on same bidimensional bar codes, in case of necessity of adding information, it is necessary to edit new bidimensional bar codes containing the last information.

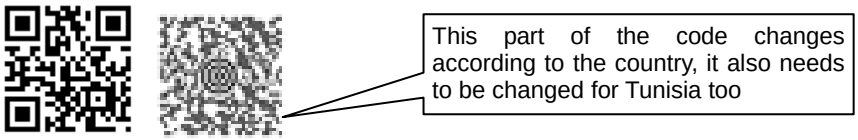


Figure 4-2 Bidimentional Code

A simple example of traceability system using bidimensional bar codes with fruits and vegetables is presented below.

At first the producer registers the information concerning the products with a computer and creates a database. The registered data are for example the date of the harvest or the field that was cultivated.

When products are sent, the information on these products is transcribed and printed in bidimensionals bar codes. Printed bidimensionals bar codes are pasted on products and sent with.

The consumer reads the bidimensional bar codes with his mobile phone pasted on the bought product and can verify the information concerning the production.

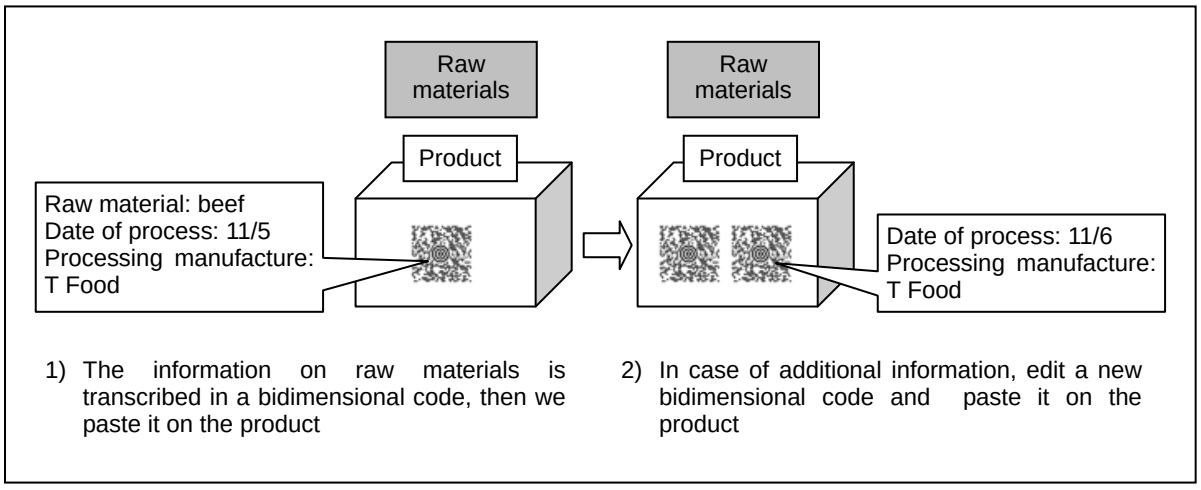


Figure 4-3 Bidimensional Code

4.2.5 RFID tag

The RFID (identification by radio frequency) is a small device combining a small chip on which the information is recorded and an antenna is set for the wireless connections. The peculiarity of RFID tag is to allow the reading and the writing of a lot of information at one time and with no contact with the label, it allows a reduction in working hours for the reading, furthermore we can even use it in environments that stains easily because the reading comparatively possible in spite of the stain.

When the device of reading and writing called Reader / Writer sends waves, the antenna of the RFID tag receives these waves and transcribes them in electricity. The information on the chip is read thanks to this electricity and are sent back towards Reader / Writer. The sent information goes into the computer connected to Reader / Writer and are used as information. For the bidimensionals codes and the RFID codes, as the development costs of the equipment and the systems are raised, it is difficult in the current situation to introduce them outside big companies. Furthermore, as the price of a RFID tag is still several tens of centimes more expensive, we cannot put it on every food product.

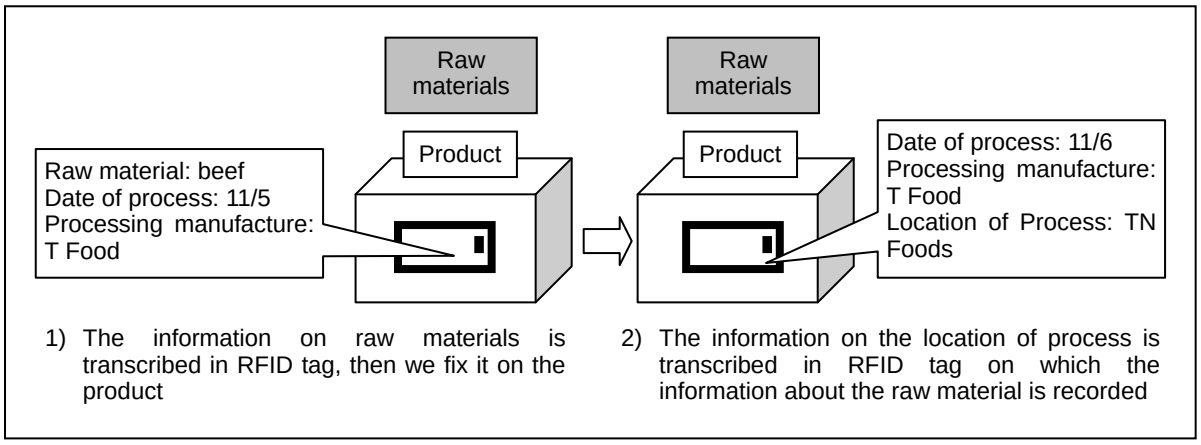


Figure 4-4 RFID tag

4.2.6 Comparison of the transmission methods of information

With considering the method by slip as an exception, the transmission methods of information are compared in the chart 4-2 according to 4 criteria: the volume of information, the research speed, the resistance to stain and the cost of its introduction.

Table 4-2 Comparison of the transmission methods of information

Method	Information volume	Information research	Resistance to satin	Cost
Identification code	Limited	Quite slow	Quite low	Low
Unidimensional bar codes	Several tens	Quite fast	Low	Quite low
Bidimensional bar codes	2000 to 3000 characters	Fast	Quite low	Quite high
RFID tag	High	Fast	High	High

4.3 Procedure for the constitution of a system of traceability

The constitution of a system of traceability can progress according to 8 stages presented in the figure 4-5. The stages 1 - 3 correspond to "plan" the stage 5 to "do", the stage 6 to " check ", stage 7 and 8 with "action".

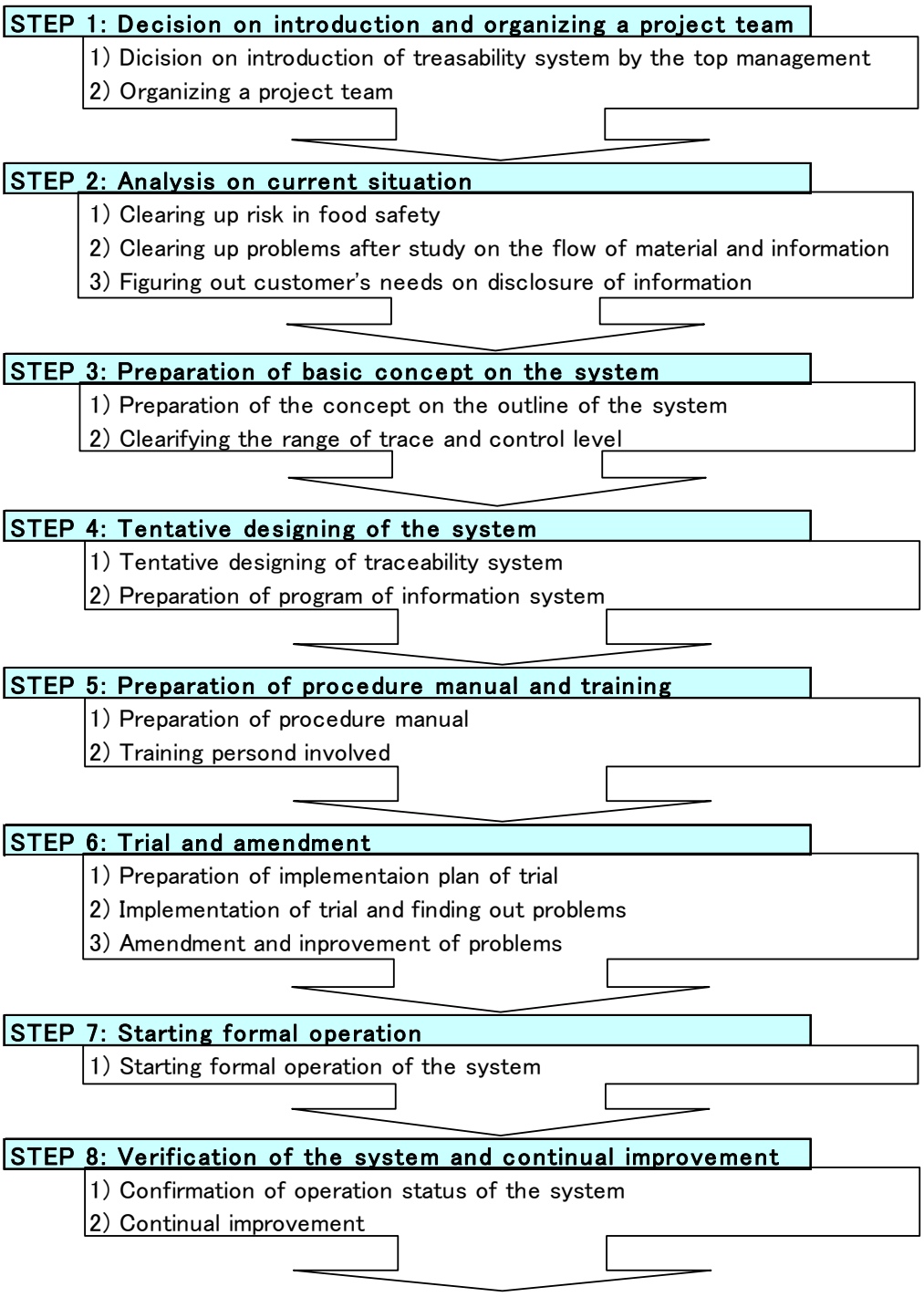


Figure 4-5 Step toward Preparation of Traceability System

4.3.1 Step 1: formation of the team project and decision of introduction of the traceability system

As regards the introduction of the traceability system, it is the decision of the top management that is decisive. The introduction of a system resorting to the technologies of information implies certain cost for its development, and, even if the operations do not use the technologies of information, it implies an increase of operators' work quantity. The only decision of the managers and the people in charge will be insufficient, especially when it concerns small and medium-sized firms: it is necessary that the senior officials get involve. There are two necessary points for the formation of a team for the constitution of a system of traceability. The first one: choose the staff from all the departments which are in touch with the traceability; the second: clarify the role of each member of the staff.

4.3.2 Step 2: analysis of the current situation

It is necessary to establish a convenient system of traceability which is in accordance with the current situation of the concerned company. It is necessary to verify the following three points to analyze the current situation.

(1) Clarify the risk of the food safety

Clarify for every product the kind of risk which can arise concerning the safety of the food-processing products, the level that it can reach, and if it is realized, evaluate the degree of seriousness. It is necessary to refer to past circumstances in which the complaints of the consumers arose and in the contents of the past accidents that provoked a recall of products. By their analysis, it will be possible to clarify the kind of the information needed for the traceability.

(2) Clarify the problems and the level of the involved field of the company concerning the system of traceability

Usually, the field concerned by the traceability starts from raw material, which is the preceding step of the food-processing products' manufacturing and its process, to the transport until the destination, which is the first downstream step. Clarify the problems by becoming aware of transportation method and current process of raw materials.

(3) Be aware of consumers and customers' needs on traceability

There is a high probability that the information on the traceability is required for products intended for the U.E. market.

4.3.3 Step 3: preparation of the basic concept of the system

In the system of traceability, in case of problem, the following three points are required:

- It is possible to identify the level of the supply chain where the concerned product is
- Speed and correctness in the research on the cause
- Speed and correctness of the recall in case of problem detected in products

(1) Field of follow-up of the information and the products

Usually, the concerned domain is located between the arrival of raw materials and the delivered destination.

(2) Concerned raw materials and products

Determine if all products or major products that are concerned. And determine if the follow-up concerns only the major raw materials or if it also concerns additives and seasonings as packaging material of secondary raw materials.

(3) Level of management

The level of management is the lot's size of the concerned product (raw materials and products) and the information concerning the product (ex: date and time of production, place of manufacturing or harvest of raw materials, time of sterilization). Decrease the size of the traced lot and to increase the quantity of information leads to increase the correctness of the traceability but also implies more work. Increase the size of the lot and to decrease the quantity of information leads to lower the correctness of the traceability but asks for less work and is more easily practicable. Concerning the size of the lot, it is required to make an analysis of the risks (investigate the probability of risk) according to the HACCP method. Also, it is recommended to reduce the size of big lot for the products with high risk and conversely. Furthermore, in the assembly-line production, the products' lots of are often distributed according to the date and the hour.

First, before to commit, it is important to be aware of the adequate level of management and of the possible limits of the field, because if the objectives concerning these three categories are too idealistic, often, the capacity of execution of the company is exceeded.

4.3.4 Step 4: conception of the system

The constitution of the system is made according to the following four categories.

1) Concerned field
2) Method and category of information to exchange and to emit
3) Content of the information to archive
4) Internal inspection

By taking the example of olive oil, here is in the chart 4-3 the application of theses four categories.

Table 4-3 Example of system constitution

Categories	Details	Example : olive oil
Concerned field	Concerned product	Extra virgin olive oil
	Raw material	Olive
	Purchaser	Export market, Carrefour
	Concerned field	From the raiser of oliver grove until the buyers.
	Lot definition	A lot represent a truck at the departure of the farming field.
	Method of lot distinction	Month-day-year-number of raiser, example : 111507AZ01
Method and category of information	Information diffuse and exchange	Information about the raiser, the process and the feed
	Tools	Between the farming field and primary process: with a delivery sheet or a slip. Between the refinement and the storage, the bottling and the storage: with electric data.
Information content	Information content to archive	Raiser, category of product, primary process/refinement/date of bottling
	Preciseness of information	Information concerning categories of management, HACCP to CCP, as the lot's determination, product's quantity and raw material
Internal inspection	Inspection points	Preciseness of monitoring's archive, preciseness of quantity management.
	Method and content of inspection	Meticulous inspection and matching of monitoring's archive, archive of accidents' handling.

To determine the merits of the constitution of the system, it is enough to verify the following points:

- Is the unit (unit of identification) of raw materials of followed product determined?
- On what rules are the signs of identification are decided to determine the unit of identification?
- How to manage the distribution of products and raw materials according to the identified unit?
- Does the method of management of the distribution allow to be safely made in the workplace?

- Is the filing, after identifying the relation between the unit of identification of products and semi-finished products, and raw materials, made with the determined support (on paper or by electronic data)?
- When raw materials or products are unified or separated, is the filing made properly with the determined support after identifying the relation between the unit of identification before and after the operation?

4.3.5 Step 5: Preparation of the manual worker and the training

Once the program of the information system is done further to the constitution of the traceability system, the manual is prepared for its realization and the concerned staff is taught.

In order to archive the monitoring of the information allowing to adapt itself to objects and to their movements, the rules of four categories, mentioned below, are clearly inscribed in the manual.

- When
- Who
- Which kind of operation
- With which method

The manual owes be visually simple and easy to understand.

Then, it is important that the concerned staff participates actively in the training mentioned in the manual, and implement it, it is necessary to consider as much as possible the opinion of the concerned staff between the step 2 and 5. It is effective to make the training by following the method (TWI) mentioned in 2-4-1.

4.3.6 Step 6: Test and adjustment of the system

Once the training is realized, a test is made to verify if the functioning takes place without problem. To identify the problems that appear during the test, to gather beforehand the points to be verified susceptible to raise problem (points to verify mentioned in 4-3-4) to then verify the progress of the test.

Adjustments will be brought when problems appear but, in the reality, it is difficult to remedy all the appeared problems. Therefore, it is useful to classify the problems in three levels as mentioned in the Table 4-4.

Table 4-4 Approach of the Problem

Level	Degree of the problem's seriousness	Approach
A	It is indispensable to resolve it or to bring improvements to it	Resolve it or bring improvements to it uppermost
B	It's better to resolve it or to bring improvements to it	Further to the official introduction, remedy with the new problems which will appear
C	It is possible to operate without resolving it or without bringing improvements to it	Operate and see that happens there, resolve it or implement improvements if necessary

4.3.7 Step 7: Outset of the system's official operations

Once the problems of the system are resolved or partially resolved in the step 6, bring the necessary modifications in the manual and, once the totality of the concerned staff is informed, apply the system officially.

4.3.8 Step 8: Check system and continuous improvement

It is necessary to examine periodically the right functioning of the system and its right application. The check can be made by an internal or external examiner. In case the check is made by an internal examiner, this person owes be capable of detecting the problems and in a relevant way. In that case, it is not enough to detect the problems: it is necessary to resolve them and then to verify the result of the improvement. It is recommended to make the examination by following the points to be verified indicated in the Table4-5.

Table 4-5 Checkpoint of the System of Traceability

Categories	Points to be verified	Check method
Data management	Is the monitoring correctly implemented, archived and indicated? Are the contents of the manual relevant? Is there concordance between the quantity of accepted raw material and the performance of the product?	Verify the contents of the receipt and listen to the person responsible. Verify in the workplace.
	Is there any distorsion of archives?	Verify the coherence of the data by following the flow of the process.
	Do the movement of the information and the flow of objects' movement match and is its management continuous?	Choose randomly a date and verify if the information of the same day can be followed.
Check the content of the operation	Are the operations made according to the manual?	Verify in the workplace.
	Are the contents of the manual relevant?	Verify the validity of the procedure's contents.
Management of the quantity	Is there concordance between the quantity of accepted raw material and the performance of the product?	Make a check of the lot's follow-up, of the chosen day, with for example the index card of management of the product's daily performance of admitted invoice of raw materials.

When points to be improved in the system are detected during the examination, when modifications are made (the object of the traceability, the contents or the category of information) with regard to the system elaborated initially or in case a new technology concerning the system of traceability is created, it is necessary to bring improvements to the system.

4.4 Formulation of the system and consideration of the tasks

The measures for three categories susceptible to cause problem during the formulation of the system are indicated as below:

- Before and after the operations, take the adequate measures in case lots are unified or separated
- Add to the database and the recording of the information
- Search information

4.4.1 Adequate measures in case lots are unified or separated before and after the operations

In case there is a unification or a division of the lot during the process of production or in the supply chain, it is necessary to identify the adequate measures. The method is indicated in the Table4-6. Besides, the common examples for the distinction of products are indicated in the Table4-7.

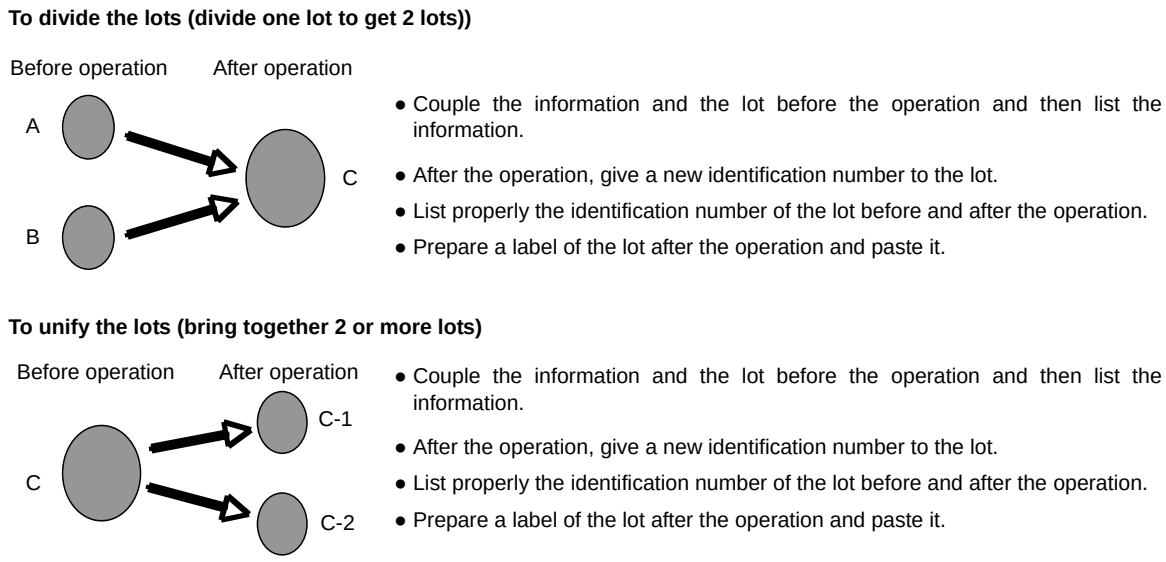


Figure 4-6 Adequate Measures for the Distinction of the Identification Number Concerning Unification / Division of Lots

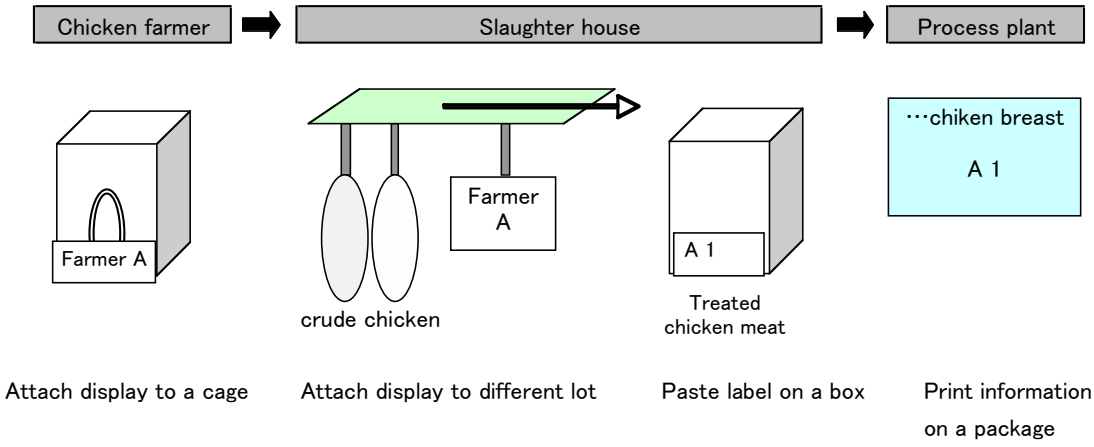


Figure 4-7 Method of Identification Control (Chicken meat)

4.4.2 Recording of the information and creation of a data base

The information which must be registered can be separated in two categories. The first one concerns directly the traceability as the number of the lot, the distinction of raw materials, date of process and name of the factory, and the other one concerns the management of the information as the raw material or the product. For the first one it is necessary to record everything as database but, it will only be necessary for the important information for the second category.

There are mainly three methods to record the information as it is indicated in the Table4-6. There are advantages and inconveniences for every method, the most suited to the concerned company will be chosen. The recording on paper is the cheapest method but require of time to look for the information. The most safe and the most wide-spread method is the recording of the important information on computer, and this is not made in every change of lot but once after the information of the day are gathered. In case information is recorded in real time, the recording is made at the workplace with an automatic recorder or a potable terminal.

Method of recording	Means	Information research	Convenience to the task	Cost
Recording on paper	By hand	Slow	Easy	Low
Recording of only the important information on computer	Computer	Quite fast	Quite easy	Quite low
Recording in real time the information on computer	Computer	Fast	Hard	High

4.4.3 Information search

The information search concerns the place of products and the information related to it. As type of search, there is " Trace back " and " Trace forward ". Their association allows four types of search as it is indicated in the Table4-6. Verify that it can be made with the elaborated system of traceability without mistake.

Table 4-6 Types of information search

	Search the location of the product	Information related to the product
Trace back	Search for the location of manufacturing and the raw materials wich the product is composed of. Search the conditions of manufacturing with which the raw material was manufactures as well as the manufacturing date.	Search for the conditions of manufacturing with which the product was made as well as the manufacturing date.
Trace forward	Search on which product the raw material was used in the end.	Search the conditions of manufacturing with which the raw material was manufactures as well as the manufacturing date.

CHAPTER 5. PRODUCTIVITY IMPROVEMENT

5.1 Introduction

Productivity refers to the ratio of the overall production to the fixed factors of products manufacturing.

Products manufacturing requires the supply of production factors also known as input, that is to say the supply of the manufacturing fixed factors and the material and human resources needed.

Thus, the production variation in relation to these fixed factors enables the evaluation of a possible productivity improvement, whereas, neither the investment increase in terms of equipment or personnel, nor the production increase enables to come to the conclusion of productivity improvement.

Moreover, we are noticing a globalization of competition, which could increase from the year 2008 and could lead to an “explosion” of the competition between companies.

In this context, quality improvement and productivity improvement is aimed at the market competitiveness and the company’s growth.

Here, it is worth to emphasize that quality enables efficiency increase on the market, which is the survival condition of the company since it can supply a product that fulfils customer’s needs.

Whereas productivity designates the ratio of the overall production to the fixed factors of products manufacturing.

The different production factors or parameters enable to differentiate 4 types of productivity:

1. Raw material productivity, also called raw material yield rate
2. Labour productivity
3. Equipment productivity
4. Capital productivity

For a better understanding of the following chapter, it is very useful to define these 4 types of productivity.

5.2 Definition

Raw material productivity, also called raw material yield rate corresponds to a control indicator of the raw material cost.

Labour productivity is often defined as the ratio of output to hours worked.

Equipment productivity corresponds to the ratio of output volume to the number of machines (or the number of working hours of the machines).

Capital productivity is defined as the ratio of output volume to invested capital (or capital assets).

5.3 Steps to the productivity improvement

As this chapter aims at explaining the productivity improvement, it leads us to detail its decisive steps:

1. Assembly line design
2. Waste elimination
3. Machines layout improvement
4. Production flow balancing in order to avoid obstruction
5. Manual operations improvement

5.3.1 Assembly line design

Different steps must be considered in order to set up or improve an assembly line.

Six steps are singularly efficient to design and supervise a process as shown in the following case of a moving conveyor belt with several operators.

5.3.1.1 Calculate the step length

Make sure that the step length matches the requested length to make a product.

And if the requested capacity of the packing line is for example 1200 packs per hour, the step length of the packing line is calculated in second per pack as followed:

60 minutes x 60 seconds / 1200 packs = 3 seconds / pack

Then, we measure the length or the requested time for each element as shown below.

5.3.1.2 Measure the requested length or time for each element

Suppose that the packing process consists in the measuring of the following parameters:

- Placing on tray
- Packing, labelling
- Boxing

And that the normal time requested for the measuring of 100 units consists in:

- 28 seconds to measure a pack
- 14 seconds for placing on tray
- 3 seconds for packing (automatic)
- 2.5 seconds for labelling (automatic)
- 10 seconds for boxing

So we can calculate the number of operators needed for the step length as shown below.

5.3.1.3 Calculate the number of operators needed in relation to the step length

In this case, the measuring consists in calculating the number of operators in relation with the requested length to make a product (or in relation with the step length). It corresponds to the following calculation:

28s/3s=9.33 persons ≒ 10 persons → measuring length = 28/10=2.8s

Placing on tray : 14s/ 3s = 4,67 persons ≒ 5 persons → placing in tray length = 14/5 = 2,8s
Packing : 3s / 3s = 1 person (this operation can be automated)
Labelling : 2,5 s/3s = 0,833 person (this operation can be automated)
Boxing : 10s / 3s = 3,33 persons ≒ 4persons → boxing length = 10 / 4 = 2.5s.

It is interesting here to study if one element of the operation is shared or if one person is in charge of several elements. It is also worth studying the loss ratio of the lines and the relevance of the layout of the process elements. See below.

5.3.1.4 Study if one element of the operation is shared or if a person is in charge of several elements

In this case, several operators have been assigned after the movements' analysis.

There are 19 operators (10 operators for measuring, 5 operators for placing on tray, 4 operators for boxing).

5.3.1.5 Calculate the loss ration of the lines

The loss ratio of the lines corresponds with the ratio of the time not used for production to the overall working time.

It is calculated as shown below:

The loss ratio of the lines is equal to the product (P), according to the following calculation:

(P) = Σ (Pt－hands-on time of one element) × number of men}/(Pt×total number of men)

= {(3－2.8)×10+(3－2.8)×5+(3－2.5)×4}/(3×19) ≒ 0.0877 =8.77％

If the lines' loss ratio is significant, go back to the steps 2-4 after combining, dividing or changing the order of the elements.

5.3.1.6 Study the relevance of the layout of the process elements

The prior condition to the calculation of 4 is that there must not be any variation of the length of the process elements. In fact, if the assembly line is long and if several tasks are executed at the same time, the hands-on time variation is amplified downstream. The actual yield is not the one anticipated because of some inactive or overburden elements. Considering these facts, examine the relevance of the layout of the process elements. In this case, it is advised to set up small teams of two persons, one for measuring and one person for placing on tray.

5.4 Reducing wastes

There are 7 types of wastes:

- Overproduction waste
- Transportation waste
- Over-processing waste
- Inventory waste
- Defects waste
- Motion waste
- Waiting waste

There is no waste outside the company. Everything is generated inside the factory. That is why it is easy to put a stop to the seven wastes.

1. Improvement regarding the motion waste
2. Improvement regarding the waste at the operation level

3. Improvement regarding the waste at the layout changing level
4. Improvement regarding the transportation waste
5. Improvement regarding the waste at the correcting level
6. Improvement regarding the waiting waste
7. Improvement regarding the overproduction waste

5.4.1 Eliminate the waste

Another concept of the Kaizen is to generate profit by eliminating waste. Profit can be increased by eliminating waste instead of raising prices. This choice is very important to maintain price competitiveness. Prices cannot be raised without the consumers' acknowledgement. Workers are classified in two categories: those who are working and those who are moving. Thanks to these 2 categories we notice that half of the workers are working and the other half are moving. Being in motion means walking to an object, placing it, searching for it. These movements do not generate value added. Waste is classified in seven categories: overproduction waste, transportation waste, over-processing waste, inventory waste, defects waste, motion waste, waiting waste. There is no waste outside the company. Everything is generated inside the factory. That is why it is easy to introduce Kaizen.

5.4.2 The machines: layout improvement

5.4.2.1 Principles of machines layout

Machines layout is a factor that has a big impact on materials and staff movement. Since movements do not generate value added, the yield is increased by reducing movement uttermost. It is advised to check the following items:

- Clearly divide the zone where the materials are exposed to numerous bacteria from the zone less exposed to bacteria.
- Do not cross workers' movements with materials' movements.
- Set up machines in order to eliminate useless workers' movements and optimize operations yield.
- Set up machines on one level but also in three dimensions.
- Design the layout in relation with the yield but also to enable easy control.
- Design the layout to facilitate machines' cleaning and maintenance.
- Listen to staff opinion about allocation, height and width of the machines. These factors have a huge impact on yield.

Semi-automatic equipment has to be considered for the material pre-process. It is comparatively cheaper to set up equipment like a water tank with a foam generator, a cleaning machine with a water jet and a tank with water exchanger. An operation executed with a knife such as separation, bud cutting, is carried out surprisingly quickly with a simple jig. In this case, the yield can be reduced. This method is relevant for cheap raw materials. The movement can be automated through a moving conveyor belt or a tube. These equipments are mostly expensive, and they can even be unaffordable. The possibility of eliminating the process itself is recommended before trying to save up on the workforce. For example, the distance between two processes can be reduced and two processes can be unified. Consider the use of a rolling conveyor or a sliding conveyor without considering the automatic supplier. Heavy materials must be brought on a cart. Measuring and packing yield at the juice factory can be doubled through semi-automated measuring and use of labels printed on packs. The semi-automated volume measuring can be executed at low cost.

5.4.2.2 Changing the machines layout

Changing the layout is the best way to reduce waste generated by movement. A factory that has not changed during the past 5 years is going to generate lots of waste: articles and production quality often vary during such a long period. Layout changing involves many constraints such as the surface, the design of the building, the location of the doors and the toilets. So it is very difficult to design the optimum layout. It is however recommended to change the layout as often as possible; otherwise operation will generate an additional cost (loss of earnings). Two types of information are necessary to improve the layout: the first one is the process path diagram, the other one is the plan of the current layout.

PATH DIAGRAM OF PROCESS

Products by quantity decreasing order

Process sequences

No.	Part number	Name of product	Name of equipment	NCL 1	NCL 2	MC 1	MC 2	D1	P1
			Number of equipment	Lo 1	Lo 2	Mo 1	Mo 2	Do1	P01
			Production volume per month						
1	111	A	1,000	(1)	(2)		(3)		(4)
2	108	B	800		(1)	(2)			
3	113	C	700	(1)		(3)	(2)		
4	102	D	500		(1)		(2)	(3)	
5	145	E	430	(1)				(2)	
6	028	F	300		(1)	(2)		(3)	(4)
7	077	G	210		(1)		(3)		(2)
8	155	H	150	(1)		(2)			
9	164	I	80			(1)		(3)	(2)
10	130	J	50		(1)	(2)	(4)		(3)
		Total	4,220	(1)		(2)			

The process path diagram enables to represent in broad outline the products by quantity decreasing order and the process sequence of each product. The principle of this layout is that the product required in higher volume must be produced by a linear layout. On the contrary, the product required in lower volume can be produced through a layout similar to one of the models presented above. According to this diagram, the production of products A, B and C must be executed by machines in a linear layout. Products H, I, J can be transported on a comparatively longer distance.

The plan of the current layout can be made on a scale of 1/50. We draw the line of the products on the plan by following the order of the process path diagram. The colour of the line can change depending on the type of products and the shape of the line representing the volume of products. We also prepare sheets of paper representing the machines on a scale of 1/50. These sheets of paper are placed in order to produce high volume products in the most linear layout possible. A way for operators and materials must be kept in the new layout. The figure below shows the current layout and the plan of a new layout. The factory floor is rectangular-shaped.

More than 30% of working time is used for materials transportation. An efficient layout is therefore very important to improve the yield. We notice that the path to manufacture a product is long.

In the new layout, the length of the path is reduced by half.

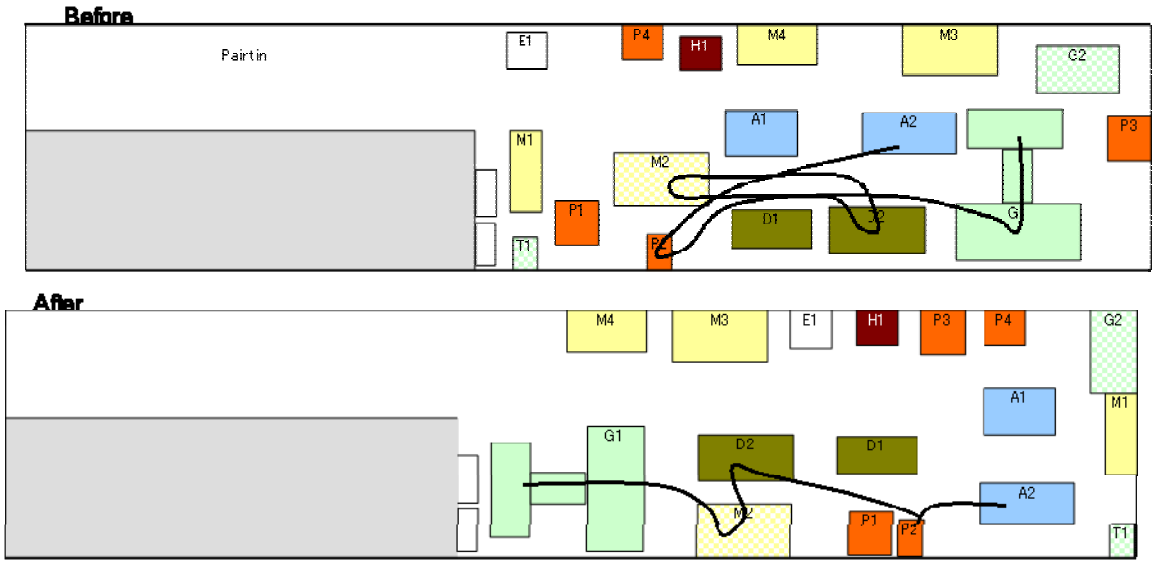


Figure 5-1 Layout plan

5.4.2.3 How to improve the yield by eliminating waste

Another concept of the Kaizen is to generate profit by eliminating waste. Profit can be increased by eliminating waste instead of raising the prices. This choice is very important to keep the price competitiveness.

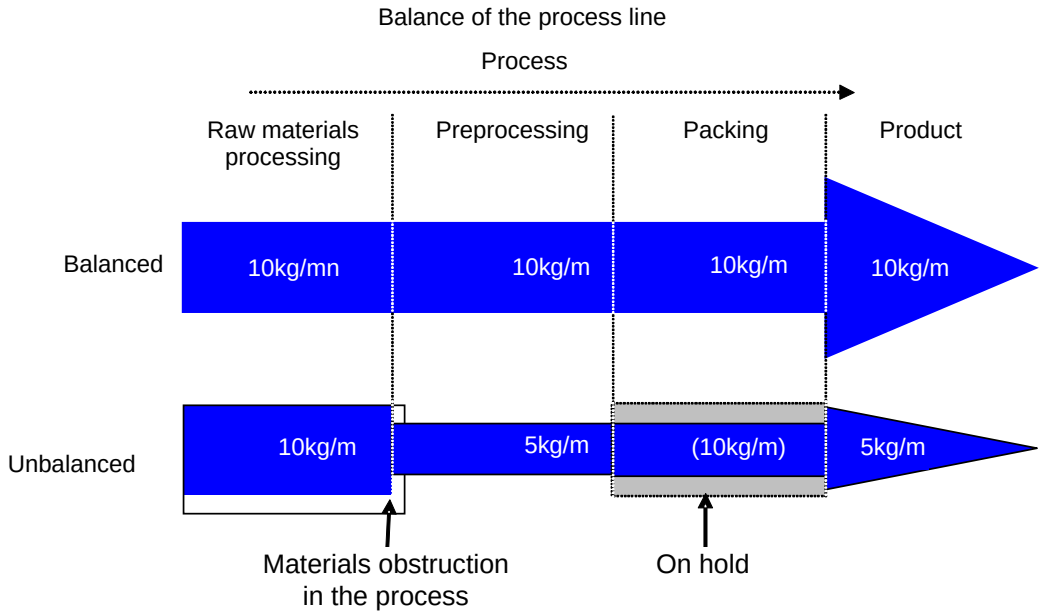
Prices cannot be raised without the consumers' acknowledgement. Workers are classified in two categories: those who are working and those who are moving. Thanks to these categories we notice that half of the workers are working and the other half are moving. Being in motion means walking to an object, placing it, searching for it. These movements do not generate value added.

There are 7 types of wastes:

- Overproduction waste
- Transportation waste
- Over-processing waste
- Inventory waste
- Defects waste
- Motion waste
- Waiting waste

There is no waste outside the company. Everything is generated inside the factory. That is why it is easy to introduce a system based on Kaizen.

5.5 Improvement of the production flow balancing in order to avoid obstruction



The balance between processes is executed by dint of perfect harmonisation of the capacity of each process that is to say by dint of the system coherency. But this case rarely happens. To achieve a balanced system, some means have to be considered: if there is a bottleneck process, investment to economize on the workforce, equipment installation or reorganization of the workers is executed. Otherwise, the capacity of upstream and downstream processes decreases in order to be in line with the capacity of the bottleneck process. There are gaps between hands-on time of each process.

- In this case, the material in the process is put on hold, and one must keep it inside the process.

Avoid putting a process that requires a lot of workers on hold. In order to achieve this goal, the upstream process must be monitored carefully. In order to allow workers to work a certain amount of time, some factories allocate the tasks according to the progress of the day: pre-processing of the raw materials in the morning, processing and packing in the evening. This system does not suit fresh raw materials (in food processing). All processes must be executed in the morning or during the day by raising the number of workers.

5.6 Improvement of one or several standard operations

In order to improve the yield of an operation using workforce, one has to standardize the operations and raise staff awareness of this operation by following the steps presented below.

5.6.1 Fast workers and slow workers motions analysis

Observe fast workers and slow workers motions during manufacturing operations. Analysed motions are those having a significant difference, for example « holding cookware in the left hand » or «shucking with the knife in the right hand».

5.6.2 Discover the difference between high yield worker and bad yield worker and define a temporary standard to execute an operation

The difference of yield between workers is linked to the difference of motions. The method of the workers according to their yield is chosen as the temporary standard for a given operation.

5.6.3 Analyse the temporary standard from the motion economy point of view

The 10 most important articles among the 22 articles of the motion economy are presented below.

One must analyse the relevance of the motions in the temporary standard according to these principles and rethink the motions through continuous improvement.

1) Hand motions are executed at the same time and symmetrically.
2) Use feet motions by taking into account productive hand motions.
3) Use inertia.
4) Smooth continuous motions are preferable to straight-line motions or zigzag motions involving sudden changes in direction.
5) Fingers' and arms' motions must be executed at the periphery or outside the proper operation as much as possible.
6) Locate tools and materials to permit the best sequence of motions.
7) Transfer materials into a safe location, with no risks of accidents, where all containers and tools can be used.
8) Collect finished products in a concave device.
9) The height of workplace and chair must permit specific operations involving sitting and standing.
10) Put tools and materials in front as much as possible.

5.6.4 Observe the standard with the same workers in limited numbers

Since the new standard is different from the existing method, one must observe the impact of the new standard, at least during 5 days, in order to compare it with the former method.

The operation will be faster with the former method until workers get used to the new standard.

CHAPTER 6. MACHINE MAINTENANCE

In the food processing industry, machines are a factor that influences the product's yield, quality and taste. Considering mass production, even a breakdown in a part of the equipment could cause a stopping of all the machines and the consequent loss is often tremendous.

The machine breakdown could be the cause of a sudden yield decrease. In Tunisia, most of the machines used in the food processing industry are imported. Consequently, if the breakdown is serious, it is necessary to call the supplier's technicians, which provokes a delay to resume production. The yield is reduced while waiting for the repair, which causes an important loss cost.

The objectives of this chapter are:

1. Reduce the loss cost by reducing the machines' breakdowns.
2. Repair the machines in a short time span.
3. Extend the machines life cycle.

Reducing the breakdown frequency and the repairing duration not only improves the equipment yield but also the productivity per person yield as well as the quality.

6.1 Preventive maintenance principles

The principles of preventive maintenance are:

1. Fix the objectives of the preventive maintenance
2. Operators' participation to daily maintenance
3. Create a system to avoid breakdown
4. Application of the SMED principles (detailed later) for repairing
5. Spread a global solution rather than on a single sector

These principles will be broach below.

6.1.1 Fix the objectives of the preventive maintenance

The Mean Time Before Failure (MTBF) and the Mean Time To Repair (MTTR) are the criteria to evaluate the machines maintenance level. A high maintenance level is conveyed by the extent of the MTBF and a reduction of the MTTR. In order to fix the objectives of each criterion, data is collected on each machine which often breakdown or which effect on the whole production is considerable.

Ambitious objectives concerning the rate of radical improvement (50% to 70%) are preferred to the modest objectives (10%). Because, even if the breakdowns causes are numerous, it is only necessary to find and to resolve 1 or 2 major breakdown causes to eliminate more than half of the problems which are related (See the Pareto diagram in the second chapter, 2-3-1).

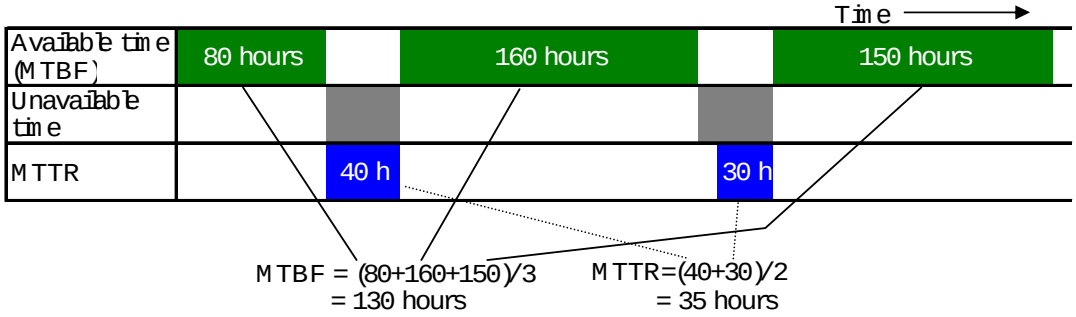


Figure 6-1 MTBF & MTTR

6.1.2 Operators' participation to the daily maintenance

In most factories, a frequent habit needs to be avoided: to only put the maintenance managers in charge of the whole equipment maintenance. The operators working on the machines are the ones who first notice changes. If they witness an abnormality signal on the machines and take the necessary measures at once, serious breakdowns could be avoided. Also, the systematic application of the SEIRI, SEITON and the cleaning can often avoid the causes of breakdowns. It is important that operators carry out a daily maintenance.

6.1.3 A system to avoid breakdowns

Create a system enabling to easily detect an abnormality and to prevent the serious breakdowns caused by shocks or parts loosening by using visible marks to check that the nut and bolt are tight in places that are crucial for the quality.

6.1.4 Application of the SMED principles for the repairing

Repairing consists in dismantling the broken down equipment to adjust or change parts then to put it together again. In order to reduce the working time, the integration of the SMED (Single Minute Exchange Die) is efficient.

6.1.5 Spread of a particular solution to the spread of a global solution

The efficacy of preventive maintenance proposed here should be checked by being applied to the equipment that breaks down the most frequently before being applied to all the sectors. If the results of these tests are positive, the application of this preventive maintenance method to other equipments, sectors and factories will be easier. And especially, it concerns the autonomous maintenance.

6.2 Practicing the autonomous maintenance

The autonomous maintenance starts from a situation where the operators, who are supposed to know best the equipment's condition, are not sufficiently aware of the reality of the situation. The role of the operators is to have appropriate knowledge of the optimal functioning and the real condition of the equipment during the daily operation, and to guarantee the respect of the equipment base conditions.

The autonomous maintenance consists in delegating to the operators the daily maintenance which used to be carried out by a specialized sector. It can not be done in one time, it is necessary to proceed by stages. The 7 stages are proposed in Table 6-1.

It is necessary to start with the first stage. For example, the criteria for the cleaning verification defined at the third stage would be useless if the preliminary cleaning of the first stage and the measures against the dirt source and the hard-to-clean places from the second stage would be skipped. And this method will no longer be applied afterwards. On the contrary, if the first and second stages are applied, it will be realistic to apply the criteria for the cleaning verification and they will be respected more easily by the operators.

Table 6-1 7 stages of the autonomous maintenance

Stage	Activity
Preliminary cleaning, Defaults discovery	• Systematically remove the waste and dirt around the equiment • Default discovery: their causes, their places, the abnormalities and the source of the quality defect. • Removing the unnecessary objects and products on hold, simplification of the equipment
Measures against the dirt source and the hard-to-clean places	• Reducing the working time by improving the sensitive points such as the petrol reload, the tightening and the manipulation; check, clean and avoid the spread of the sources of waste and dirt.
Definition of the potential criteria for the cleaning verification	• Define action criteria which enablesa quick maintenance of the cleanliness, tightening and petrol reload • Integrate the visual management and optimize the checking operations
Complete equipment verification	• Train to the checking technique with the checking handbook. • By systematically checking the equipment, find and correct the small defects so that the equipment is in a normal condition. • Improve equipment in order to facilitate the verification and to promote the visual management
Verification of all the processes	• Improve the handling reliability by training operators who knows thouroughly the process performance, the handling method and the continuous treatment via internet. • Group the cleaning verification criteria of each equipment in process criteria or verification zone and change regularily in order to cover all the necessary verification points and to avoid repeating the same verification.
Systematization of the autonomous maintenance (SEIRI and SEITON)	• Clarify the system flow and the standard criteria to carry out an infallible autonomous maintenance in order to guarantee quality and safety. • Improve the preparation and reduce the stocks of semi-finished products. • Establish an autonomous management system for the movement of the spare parts, semi-finished products, merchandise and material within the factory.
Systematic practice of the autonomous maintenance	• Continue improvement activities and actions that are relevant to the company and factory policy and promote the elimination of the MUDA and the cost reduction • Rigorously record the maintenance condition the same as for the MTBF, in order to be able to analyze and improve the equipment condition

6.2.1 First stage: Preliminary cleaning and defect discovery

The first stage consists in finding defects and abnormalities in order to eliminate them. In the Table 6-2, the phenomenon of equipment defect and their location are presented.

Table 6-2 Deficient Points

Defect phenomenon		Rust, dust, crack, waste, loosening, abrasion, bending, overflow, leak, dispersion, foreign bodies, etc.
Location	Movable part	Bolt, nut, chain, V-belt
	Axis	Bearing, key, connecting
	Lubrication system	Grease sediment, container, label, automatic lubricator
	Pipes system	Pipes, valve, fitting, hose
	Electric system	Engine, limit switch, ground conductor, photosensitive tube
	Control system	Voltage, voltmeter, timer, lamps, switch, control panel, wiring, ground conductor

There are other abnormalities found during the operation: abnormal noise, overheating or vibrations.

It is also useful to use the 3S checklist, such as the Table 6-3, to find defects. The articles in this Table are the 3S taken from the 7S presented in chapter 3.

Table 6-3 Checkpoint of 3S

SEIRI	- Are unnecessary objects not left by accident? - Are products and tools not put directly on the floor? - Are waste and unnecessary objects ordered and labeled according to the sorting method? - Are the measuring instruments and the tools clearly distinguished and sorted? - Are unnecessary objects and private objects put above or around the office or the machines?
SEITON	- Are machines and pieces boxes placed on a straight line? - Are the positions of the main passages and warehouse indicated? - Are personal tools and common tools distinguished in order to be used immediately? - Are there bulky objects on the floor, unevenness, cracks or sharp objects? - Is the door of the control panel closed? Are there useless objects? - Are the display panel and the bill visible? - Is non-skid used on dangerous places? - Are the electric system resistance and the control system guaranteed by a cover?
SEISOU	- Are there are oil stains, waste, dust on the floor? - Are machines covered with oil and material? - Are wires and pipes clean or harden by oil or heat? - Are there oil or wire remain in the electric supply box or in the commutation box? - Are there product remains or scraps? - Is the display panel stained, torn out or lost? - Are the lampshade, the light bulb and the troffer clean ?

6.2.2 Second stage: Measures against the dirt source and the hard-to-clean places

Identify the sources of liquid, powder, gas, steam, waste, dirt, abnormal noise, heat or vibration sources. Then, conceive the measures to implement. It is important to clearly distinguish the effects and the causes of the phenomenon. Conceiving measures at the source's level leads to avoiding the recurrence of problems. The example below shows that it is necessary to identify the real cause to take the necessary measures.

Identification of the cause of the interruption of the conditioning machine

Machine stops

↓

Corking of the leaning bottles.

↓

Contact between the bottles and a place of the machine

↓

Transportation bar bending = real cause → Measure: Straighten the transportation bar

It is often less costly to take measures after several researches on the cause rather than after a single research.

6.2.3 Third stage: Definition of potential criteria for the cleaning checking.

The cleaning and checking criteria defined here are temporary. The criteria final version is defined according to this base, after carrying out the 4th stage and amending the least realistic points. The Table 6.2.6 shows an example of the blender checking criteria. The criteria are classified in groups of articles for the global checking carried out regularly and daily. The points to check and the checking method are presented in this task manager training method. The places to check are indicated by an arrow on a simple diagram of the machine.

6.2.4 Fourth stage: Equipment global checking

This stage consists in carrying out a global checking based on temporary criteria while training the operators. After the global checking, the wrong points will be amended.

6.2.5 Fifth stage: Process global checking

This stage consists in clarifying the standard level in order to carry out a flawless autonomous maintenance enabling to guarantee the products quality and safety.

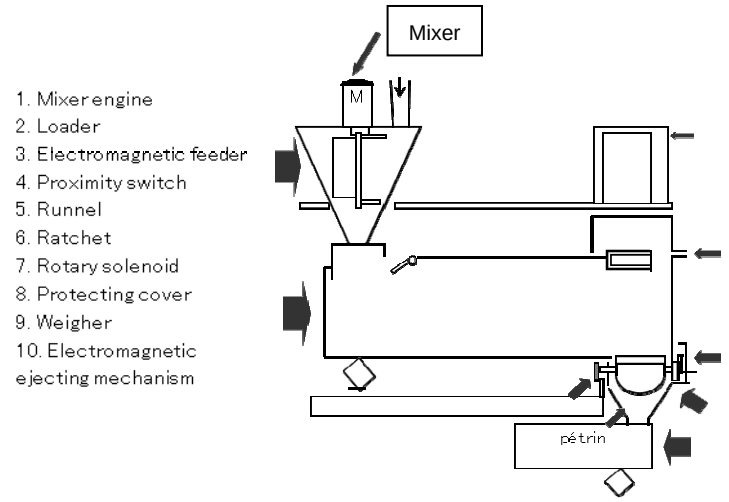
6.2.6 Sixth stage: Systematization of the autonomous maintenance

This stage consists in clarifying the standard to carry out flawlessly the autonomous maintenance and guarantee the products quality and safety.

Table 6-4　Items to check

Items for global checking						Items for daily checking					
№	Parts	Parts to check	Items to check	Checking method	Training category	№	Parts	Parts to check	Items to check	Checking method	Training category
1	Mobile parts	Engine	Are there any abnormal noise, overheating, vibrations?	Visual, tactile, sonorous check	On the job training	1	Mobile parts	Engine	Are there any abnormal noise, overheating, vibrations or dust dissemination?	Visual, tactile, sonorous check	On the job training
			Are bolts well tightened?	Visual and sonorous check	On the job training			Mixer	Is there any abnormal noise?Is there any contact with the inner wall?	Visual and tactile check	On the job training
			Is there any dust dissemination?	Visual check	On the job training			Basket stopper	Does it stop at the defined position?	Visual check	On the job training
		Mixer	Is the shaft well fixed?	Visual and tactile check	On the job training			Ratchet mechanism	Is the stopper entering in the drill? ?	Visual check	On the job training
			Is there any contact with the loader inner wall?	Visual, tactile, sonorous check	On the job training			Electromagnetic feeder	Are there any cracks on the fixation part of the vibration panel?	Visual check	On the job training
		Basket stopper	Is the stopper well fixed?	Visual and tactile check	On the job training			Rotary solenoid	Does the arm lift the stopper during rotation?	Visual check	On the job training
			Is there any dust on the stopper?	Visual check	On the job training						
		Ratchet mechanism	Is the stopper entering in the drill? ?	Visual check	On the job training						
			Is the arm deformed?	Visual check	On the job training						
		Electromagnetic feeder	Is the vibration panel well fixed?	Visual and tactile check	On the job training						
			Is the bucket cracked?	Visual check	On the job training						
			Are there any abnormal noise and vibrations?	Visual, tactile, sonorous check	On the job training						
		Rotary solenoid	Are there any overheating or abnormal noise?	Visual and sonorous check	On the job training						

《SFD、Figure》



1. Mixer engine
2. Loader
3. Electromagnetic feeder
4. Proximity switch
5. Runnel
6. Ratchet
7. Rotary solenoid
8. Protecting cover
9. Weigher
10. Electromagnetic ejecting mechanism

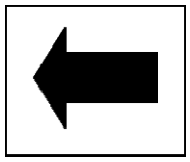
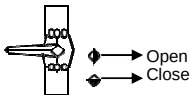
6.2.7 Seventh Stage : Thoroughness of Self–management

At this stage, in order to pursue self-management, implement infallibly the listing of maintenance like the MTBF, analyse them and improve the equipment.

6.3 Visual Management

In order to determine abnormalities easily and to implement the detection precisely and easily, each equipment precisely and easily, indicate each equipment and pipe which will allow the visual management. The table 6-5 is an example of it. The ingenious ways to recognize at one view bolts and nuts, gauge field of application, direction of liquid flow, valve and tap opening and closing are described.

Table 6-5 Visual Management

Article	Field of application	Objective	Marking method	Comment
Marking for the nut and bolt connection	Places which could cause serious reakdowns and have considerale effects on the products quality by the loosening of parts due to vibrations or shocks	Find the equipment abnormality (loosening)	* Coulour : red * Marking method : mark with a felt-tip pen	
Marking of the gauge field of application	Parts that stop functioning or breakdown because of a pressure or a temperature above the tolerated level	Insure and secure the normal operation and find the abnomrality by marking with different colours the tolerance zone in its normal condition of the manometer and the thermograph	* Marking method: draw the tolerance field in green or mark the border of the field with green stripes	The field of application is the one of the operation in its normal condition Show the dangerous zone if necesssary.
			* Colour: Normal→green	Colour: red
Marking of the direction of the liquid flow	Places which could facilitate the canalization and the handling of dangerous liquids or which could affect the environment	Make the direction of the liquid flow in the canalization visible in order to improve maintenance and handling	* Marking method : inside of the building = aluminium transfer process outside = paint * Size: adapt the size of the mark to the diameter of the canalization	
Marking the valve and tap opening and closing condition	Valve which opening and closing condition is not visible	Make the condition of the liquid in the canalization visible in order to improve maintenance, management and safety	* Marking methods: 1.Place insert designating the opening and the closing. 2. Put different colours with felt-tip pens.	
Label the material entrance and the name of the materials	Not visible material entrance	Make the material entrance visible to avoid leaks and mistkaes in the material choice	* Marking methods: 1. Aluminium transfer process, 2. Mark with felt-tip pens, 3. Place a label showing the material entrance	Put stickers with the designation
Mark the checking order		Don't forget to check an article	* Marking method: show the checking order with numbers	

6.4 Improvement of each equipment

The improvement measure for each equipment is not mentioned because it is a matter of specialized techniques. We will see below the methods principles to extend the available time of the machines and to carry out quickly the daily checking and repairing.

6.4.1 Reduce the unavailable time

In case there are several equipments to repair, the repairing order to respect in order to reduce the machines unavailable time, respects a logic that starts from the machine for which the estimated repairing time is the shortest, unless the priority is given to other specific machines.

For example, 5 machines broke down in the Table 6-6.

Table 6-6 Machines repairing rational order

Machine N°	Estimated repairing time	Initial repairing order		Rational repairing order	
		Repairing order	Machines unavailable time (h)	Repairing order	Machines unavailable time (h))
1	7	1	7	5	21
2	3	2	10	2	4
3	1	3	11	1	1
4	6	4	17	4	14
5	4	5	21	3	8
		Total	66	Total	48

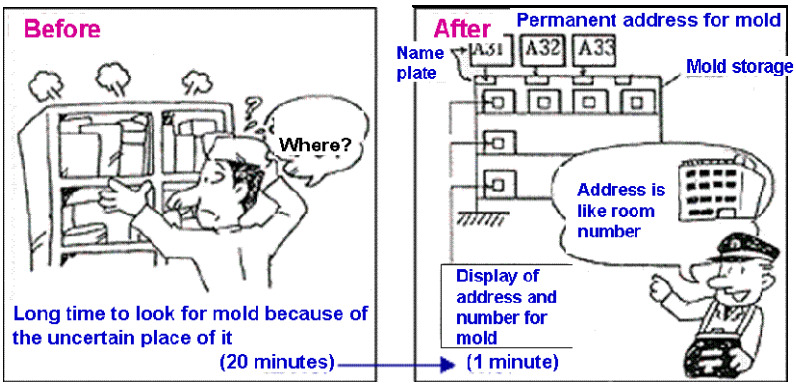
This Table shows the time of unavailability for the machines to be repaired according to the order of occurrence of the breakdowns and according to the short estimated repairing time.

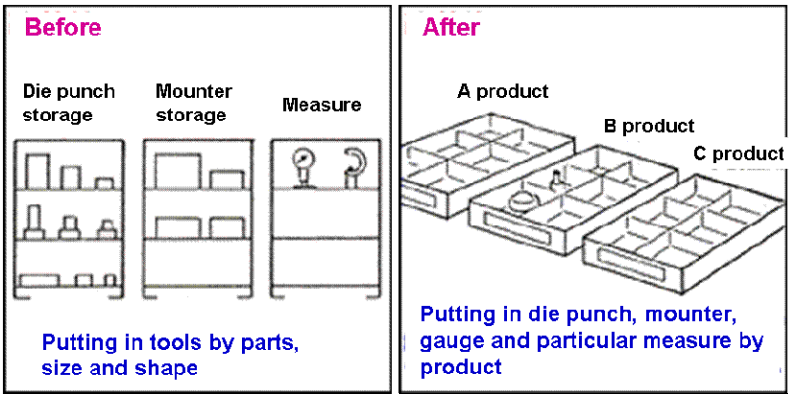
6.4.2 SMED application

The SMED method (Single Time Exchange Die) is efficient to simplify the removal and the installation of the parts while they are repaired or checked.

1/ Prepare a bundle of tools and spare parts for the repairing of the machines which often break down.

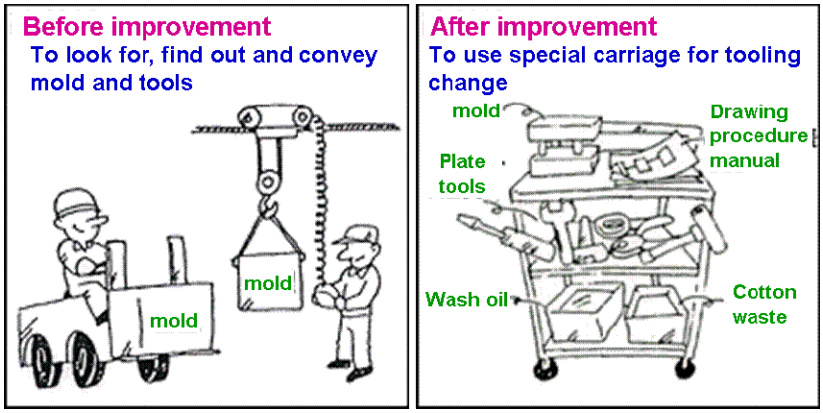
Almost half of the machines repairing time is spent finding tools and replacement parts. Therefore, it is useful to keep them together often to bring them on the work site.





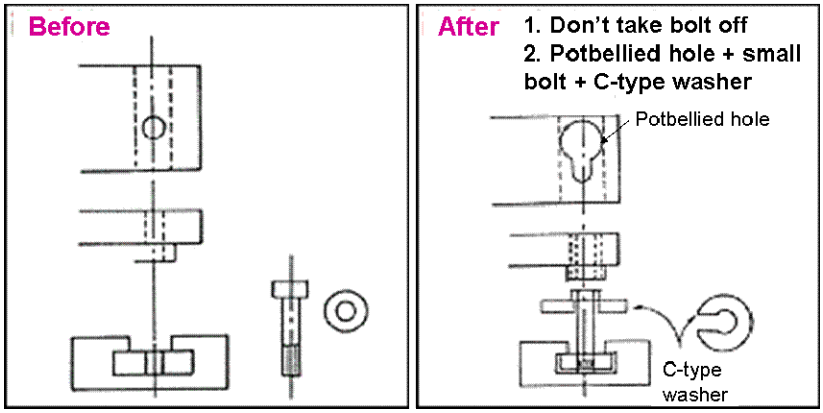
2/ Place the tools and replacement parts necessary for the repairing near the machines.

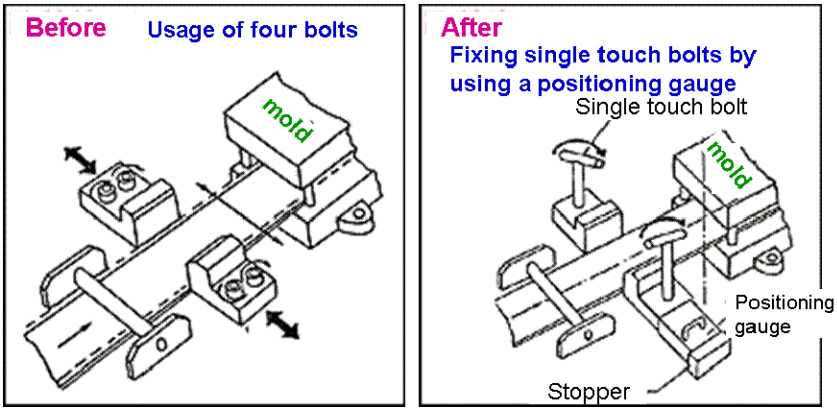
It could be useful because it is frequent that the machine to repair cannot be moved to the maintenance room.



3/ Reduce to the maximum the use of bolts

Bolt should be replaced by the C-type washer and the potbellied hole because removing and installing a bolt requires tools and time. These pieces are available on the market and could be customized within the company.



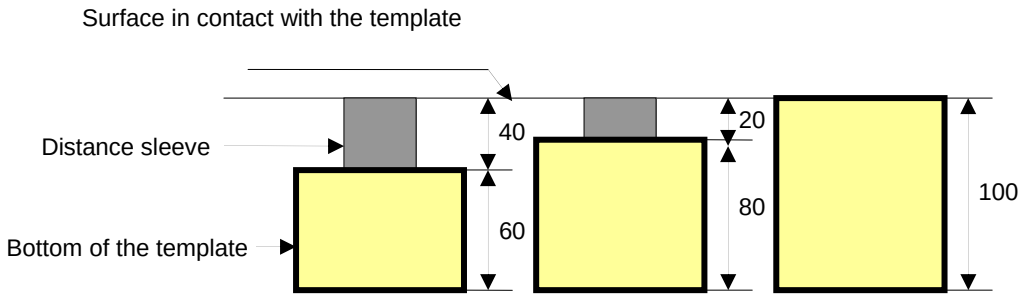


4/ Adopt tightening methods which don't require bolts or a chuck key.

For example, positioning gauge and the single touch bolt could be useful.

5/ Adjustment suppression

Testing the machine after the pieces have been changed and the adjustment can be considerably time consuming. It often happens because the machine default position is not clearly determined. In this case, the use of a template is useful to reduce the adjustment time.



6/ Matrix change and repairing without affecting the off-line setup

Regarding the set of the pieces which often breakdown, when it happens, it is necessary to replace it by another spare set in order to be able to carry out the repairing while the machine continues to function.