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# **Application of Seven New QC Tools**

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# APPLICATION OF SEVEN NEW QC TOOLS

by

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## BACKGROUND

Most of us are familiar with the original Seven QC Tools, those are check sheets, graphs, histograms, Pareto diagrams, cause & effect diagram, scatter diagrams and control charts. These tools have proved to be extremely effective instruments for data collection and analysis, process control and quality improvement. These tools are so simple to understand and use, that they are regularly used by workplace supervisor, QC circles leaders as well as by specialist QC staff and there is little doubt that these tools will continue to be widely used. However these tools are mainly applied on numerical data. So the need of some tools for organizing the verbal data was felt. As a result of this, a committee with the aim of developing new QC tools was set up in April 1972 with the affiliation of the Japanese Scientists and Engineers (JUSE). The committee announced the results of its research in 1977 in the form of a new set of methods called The Seven New Q.C Tools or Seven Management & Planning Tools.

The Seven New Q.C Tools are specially designed for sorting out verbal data, putting complex problems into solvable form, simulating creativity, and ensuring that nothing is left out when planning. They are rapidly gaining acceptance as a valuable asset in the campaign for total quality and are widely used by managers and staff in all departments from R & D through production to after-sales service. These tools are designed to supplement existing Q.C Tools and methods and not to replace them.

## INTRODUCTION

The objective of this paper is to provide an easy introduction of the Seven New QC Tools and familiarize with the practical implementation of these tools especially in problem solving and planning purposes.

This paper includes

- 1- Significance of the Seven New QC Tools
- 2- Role of these tools in Total Quality Management
- 3- An overview of the tools
- 4- Tips for successfully using these tools
- 5- Benefits of these tools
- 6- Conclusion

## 1. SIGNIFICANCE OF THE SEVEN NEW QC TOOLS

The Seven New QC Tools differ from the conventional basic Seven QC Tools, which are used mainly for analyzing numerical data (data based on facts, not fancy). However facts cannot always be adequately expressed by numerical data alone. For example, suppose that a washing machine is being redesigned. Its purchasers are dissatisfied, complaining that it is difficult to use because its control are poorly positioned. The new model's designers should incorporate this information in the new design. Users may also have opinions about the machine's styling, color, and other characteristics as well as its convenience of use. Many such customer requirements cannot be expressed numerically, only verbally. Nevertheless, even verbal statements can be expressions of facts, because it represents facts, we ought to use verbal data as well as numerical data in managing quality. The Seven New QC Tools act as a new kind of driving force propelling quality management in fresh directions as we enter the age of total quality.

The Seven New Q.C Tools are Affinity diagrams, Relation diagrams, Tree diagrams, Matrix diagrams, Priorities matrix, Arrow diagrams and Process decision program charts. When properly used in various combinations, they can dramatically increase the effectiveness of many TQM activities. They are also compatible with the original seven tools, in fact they complement them. When used together, the two sets of tools can greatly assist the promotion of total quality.

The Seven New QC Tools are very effective in problems solving and improving the planning process. Imagine that if someone is given the task of improving the efficiency of his company's accounting procedures. As soon as he sits down to think about it, numerous questions come to mind:

- ◆ What does efficiency mean?
- ◆ Exactly what procedures need to be made more efficient?
- ◆ What are the particular problems with each of these procedures?
- ◆ Do the company's formal training programs and on-the-job training need to be improved?
- ◆ What about recent developments in office automation?

The issue seems to have endless ramifications.

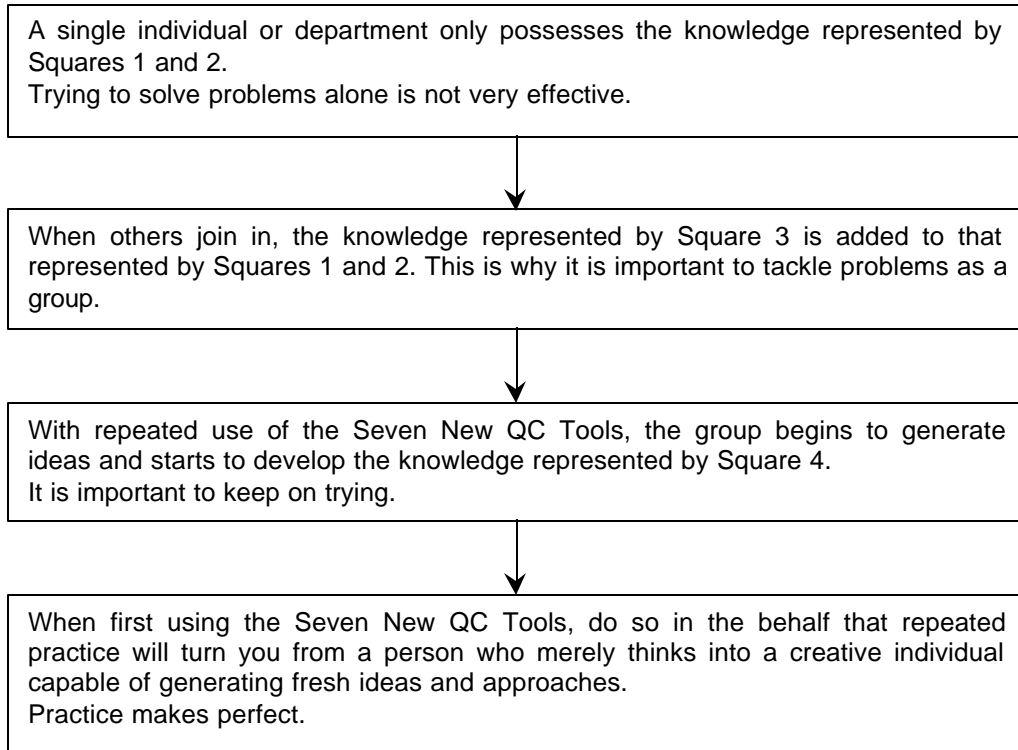
Like this one, many of the problems we encounter in life are amorphous and complex. Before we can find a solution, we have to define the problem, identify its causes-and-effect relationships, and put it into solvable form. Before we can even start the problem-solving process, we have to create order out of chaos.

When people try to tackle fuzzy, intractable problems without the aid of the Seven New QC Tools, they often get bogged down in the frustrating situation. The Seven New QC Tools makes it easy to clarify the situation, establish a plan, and get to the heart of the problem. It also makes it easier to explain the situation to others and secure their cooperation.

### 1.1 SIGNIFICANCE IN PROBLEM SOLVING

It is very important that everyone cooperates to solve problems. For this to work effectively, it is essential for all the members of a group to share their thoughts, pool their knowledge, and eager to solve the problem. The Seven New QC Tools, help this process by using easily

understood diagrams to organize both verbal and numerical data. Figure 1 shows what happens when a group gets together to determine how to tackle a problem. It illustrates how each member shares his or her knowledge with the whole group and how the group exercises collective creativity and imagination in generating problem-solving ideas.



<b>Self</b>	<b>Known</b>	<b>Unknown</b>
<b>Others</b>	<b>①</b>	<b>③</b>
<b>Known</b>	<b>②</b>	<b>④</b>
<b>Unknown</b>	<b>②</b>	<b>④</b>

Fig. 1 The Importance of Pooling Knowledge in problem solving

**1.2 SIGNIFICANCE IN PLANNING**

Figure 2 illustrates the importance of planning in solving problems. The horizontal line at the bottom shows how allowing sufficient time for Planning (P) decreases the amount of time needed for checking (C) and corrective action (A) after completion of the Do (D) phase. The bottom line represents the ideal situation and illustrates that proper planning is most important. The top horizontal line illustrates what happens when not enough time is allowed for planning. So much time is required for checking and corrective action that the overall time taken to complete a job increases dramatically. This is the type of situation we should avoid.

Actual practice usually falls somewhere between these best and worst cases. However, every effort should be made to bring the line down as far as possible. As techniques for organizing verbal data (including information on similar problems that have occurred in the past), the Seven New QC Tools can be extremely effective in improving the planning process.

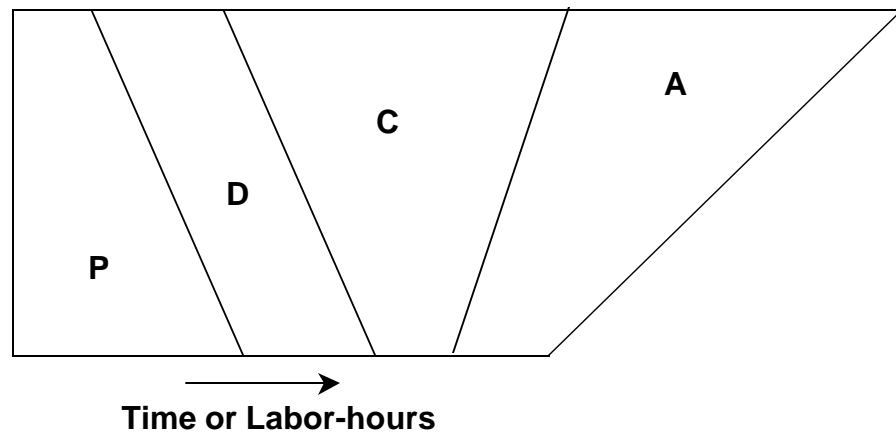


Fig. 2 The Importance of Planning in Solving Problems

## 2. THE ROLE OF THESE TOOLS IN TOTAL QUALITY MANAGEMENT

Today quality control is undergoing a major transformation through its evolution into Total Quality Management (TQM), it is involving people in every department and at all levels. Although quality was traditionally the exclusive province of Quality Control Department but it has now become everyone's business. The Seven New Q.C Tools or the Seven Management & Planning Tools are exactly what is needed to meet the demands of new total quality era.

Human resource development is essential for attaining the goals of TQM, because developing people is the secret of improving a company's internal environment. The aim is to create a culture and organization in which all employees constantly use their heads, generate ideas, and exercise their abilities in the total quality activities.

Figure 3 lists the seven main objectives of cultural and organizational reform together with seven keys to achieving these goals. The figure also shows the relationship between these keys and the functions of the Seven New QC Tools.

Some undesirable characteristics that TQM attempts to correct are copycatting (forgetting that an approach that was successful once does not always work the second time), the complacent all's well that-ends well attitude (neglecting the process as long as the results are acceptable), trying to be all things to all people, and doing alone. TQM tries to eliminate such tendencies and stimulate people to think for themselves.

To achieve this, it is important to view problems from a broad prospective, prioritize objectives, and involve everyone in the search for solutions. It is also important to tackle improvements proactively by forestalling potential problems. The Seven New QC Tools are extremely helpful for making these kinds of changes to a company's culture (see fig. 3)

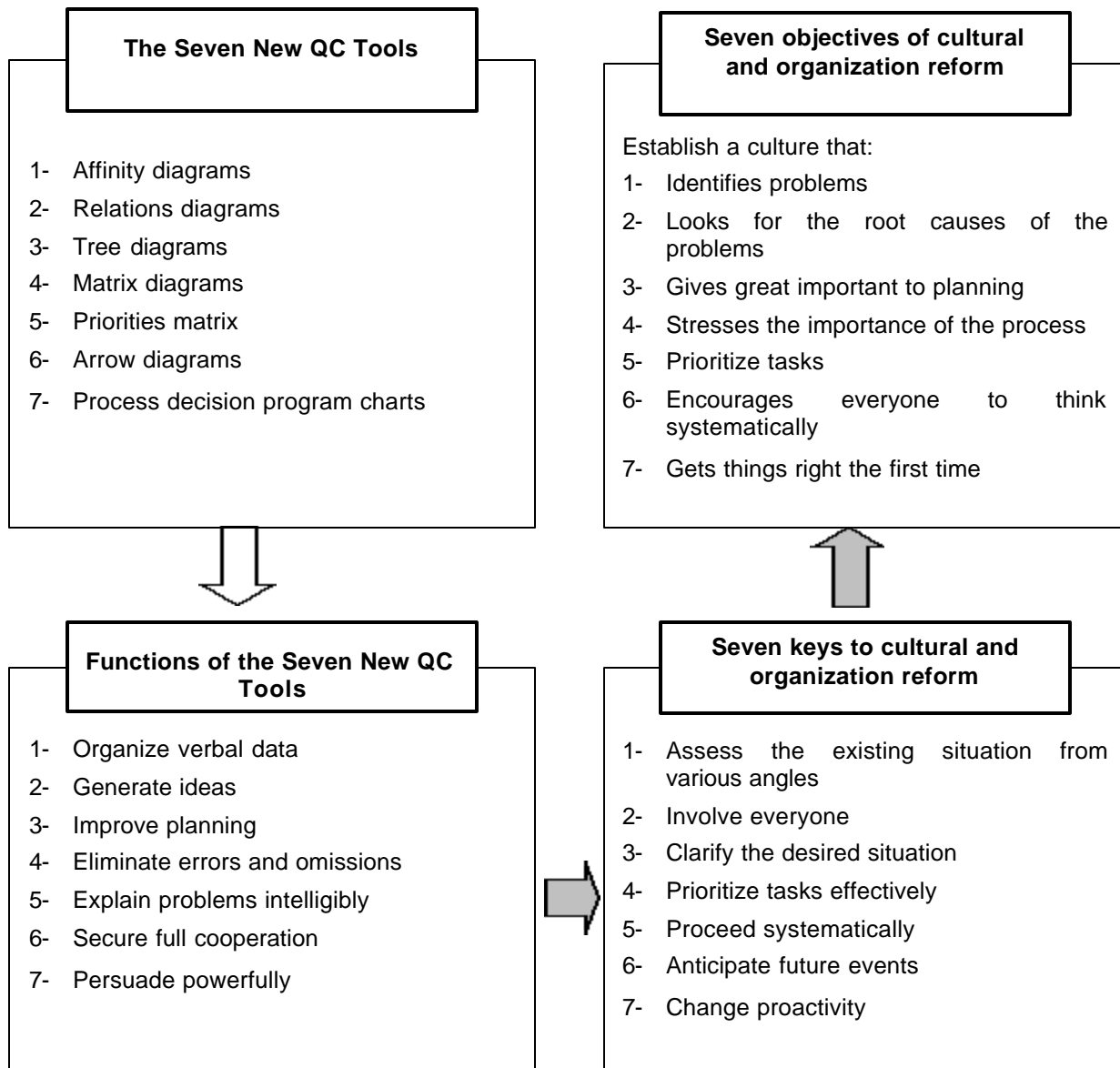


Figure 3 The Seven New QC Tools and organizational Reform through TQM

The Seven New QC Tools are very useful in strengthening creativity and originality and building the kind of thinking culture that is now required in pursuing total quality. When using these tools, the secret is to continue adding information to the diagrams until everyone is happy with them. Draw and redraw the diagrams until everyone clearly understand the problem. The idea is to ensure that everyone becomes actively involved in solving the problem, thinks hard about it, and generates plenty of ideas. The experience of generating ideas leading to the solution of problems builds people's self confidence and encourages them to address even more difficult topics in future. This is excellent practice for strengthening the personal characteristics that form the basis of effective problem solving within TQM.

### 3. AN OVERVIEW OF THE TOOLS

The Seven New QC Tools or Management and Planning tools are

- a) Affinity diagram
- b) Relation diagram
- c) Tree diagram
- d) Matrix diagram
- e) Priorities matrix
- f) Arrow diagram
- g) Process decision program charts

#### A)- AFFINITY DIAGRAM

The affinity diagrams are used to reduce the number of ideas generated by different members/ groups to a workable number of ideas by consensus. They systematically identify the facts of a confused, unknown situation.

Figure 4 describes the affinity diagram and its method of construction and key points in constructing the diagram.

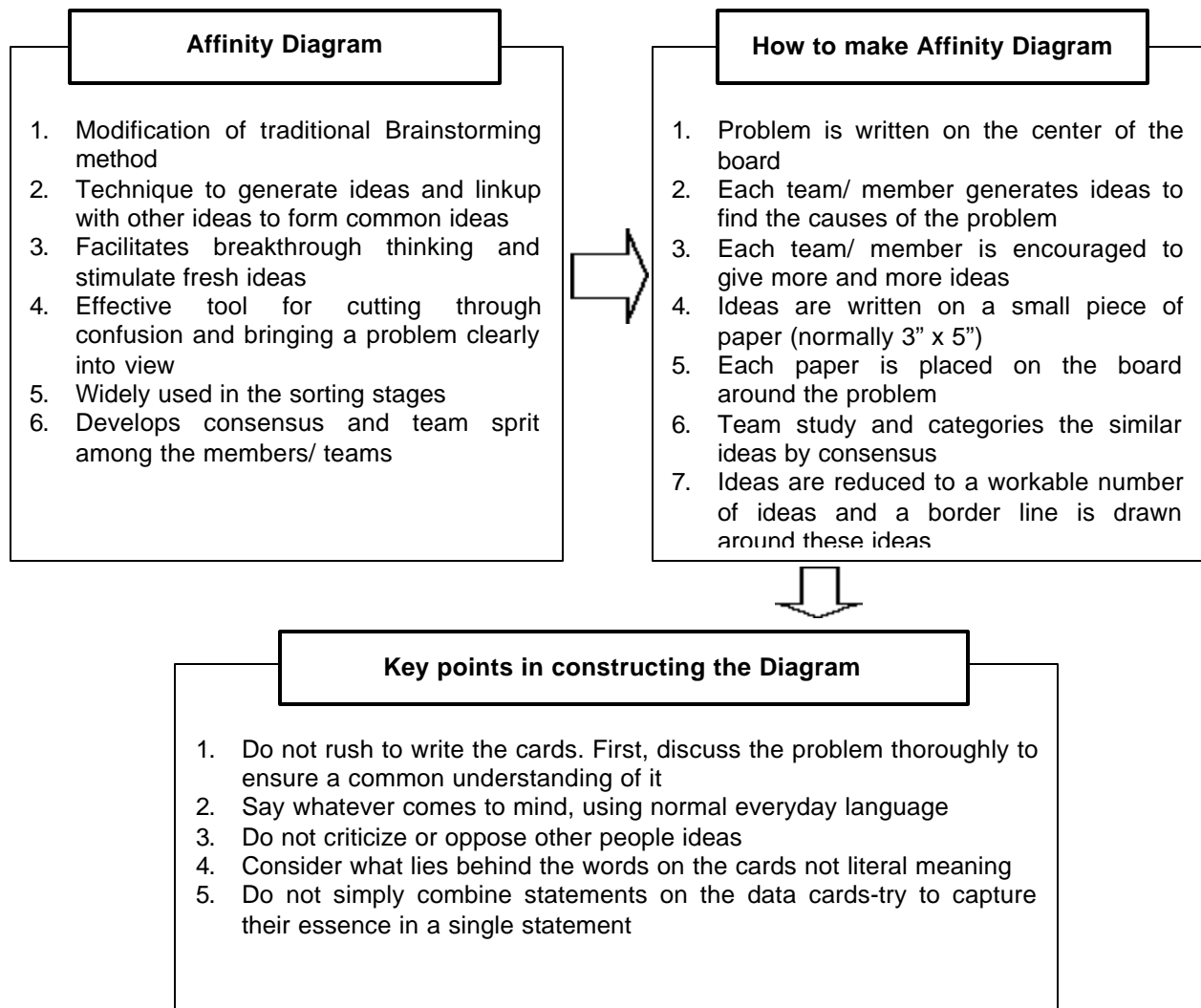


Figure 4

## B) RELATION DIAGRAM

The Relation Diagrams are used for finding appropriate solution strategies by clarifying the causes of the problem using why, why technique.

Figure 5 below illustrates the Relation Diagram

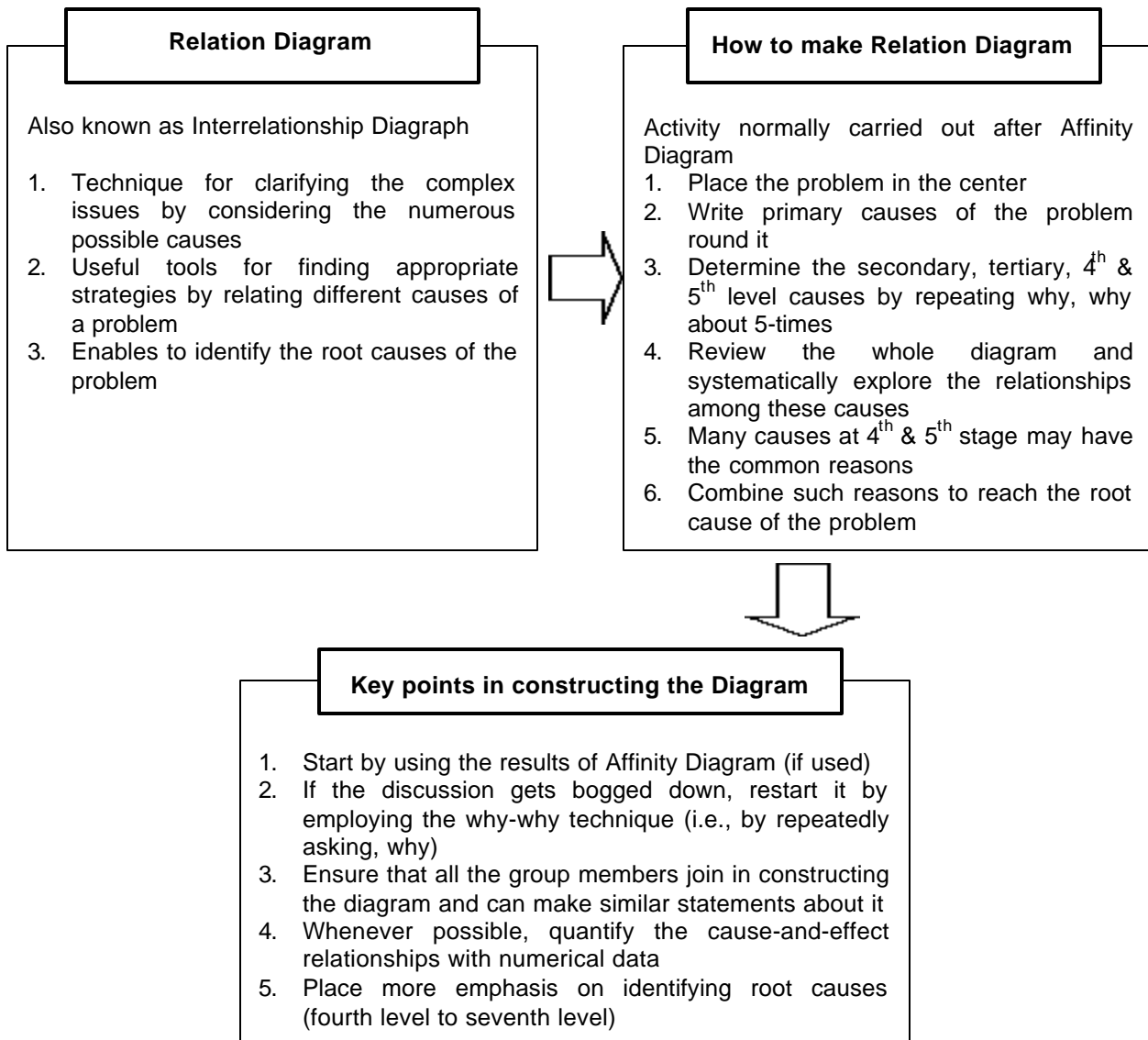


Figure 5

## C) TREE DIAGRAM

Tree Diagrams are drawn to develop a succession of strategies/ means for achieving an objective (target, goal or result) systematically and logically.

Constructing this diagram yields specific guidelines for solving a problem. Tree Diagrams are also classified as strategy-development or component development diagrams.



Figure 6 illustrates Tree Diagram

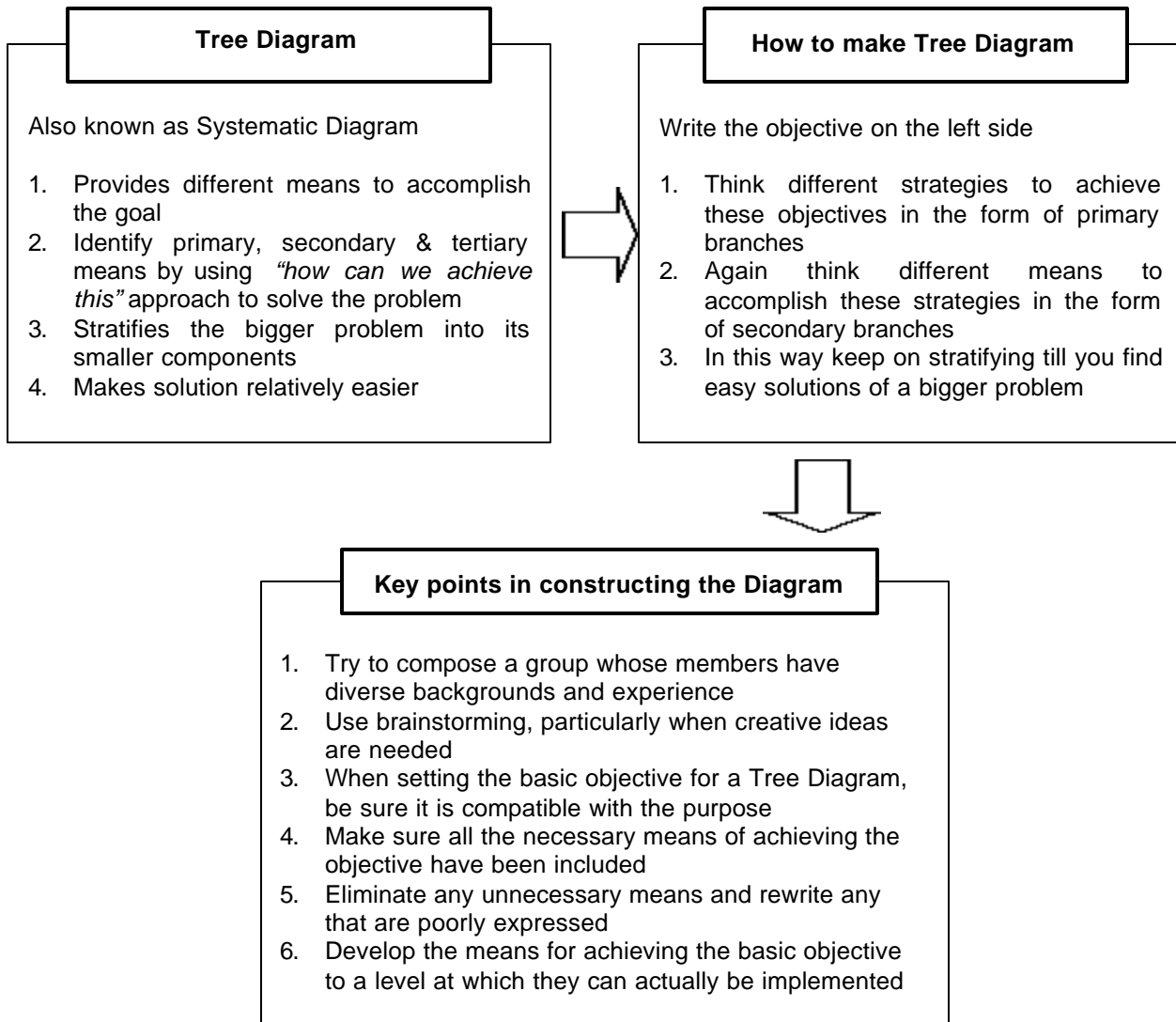


Figure 6

#### D) **MATRIX DIAGRAM**

Matrix Diagrams enable the data based on ideas to be employed effectively for examining the relationships.

They clarify the relationship among the different elements based on verbal data (attribute data) like the scatter diagrams show the correlation between different parameters based on numerical data (variable data)

Figure below illustrates Matrix Diagram

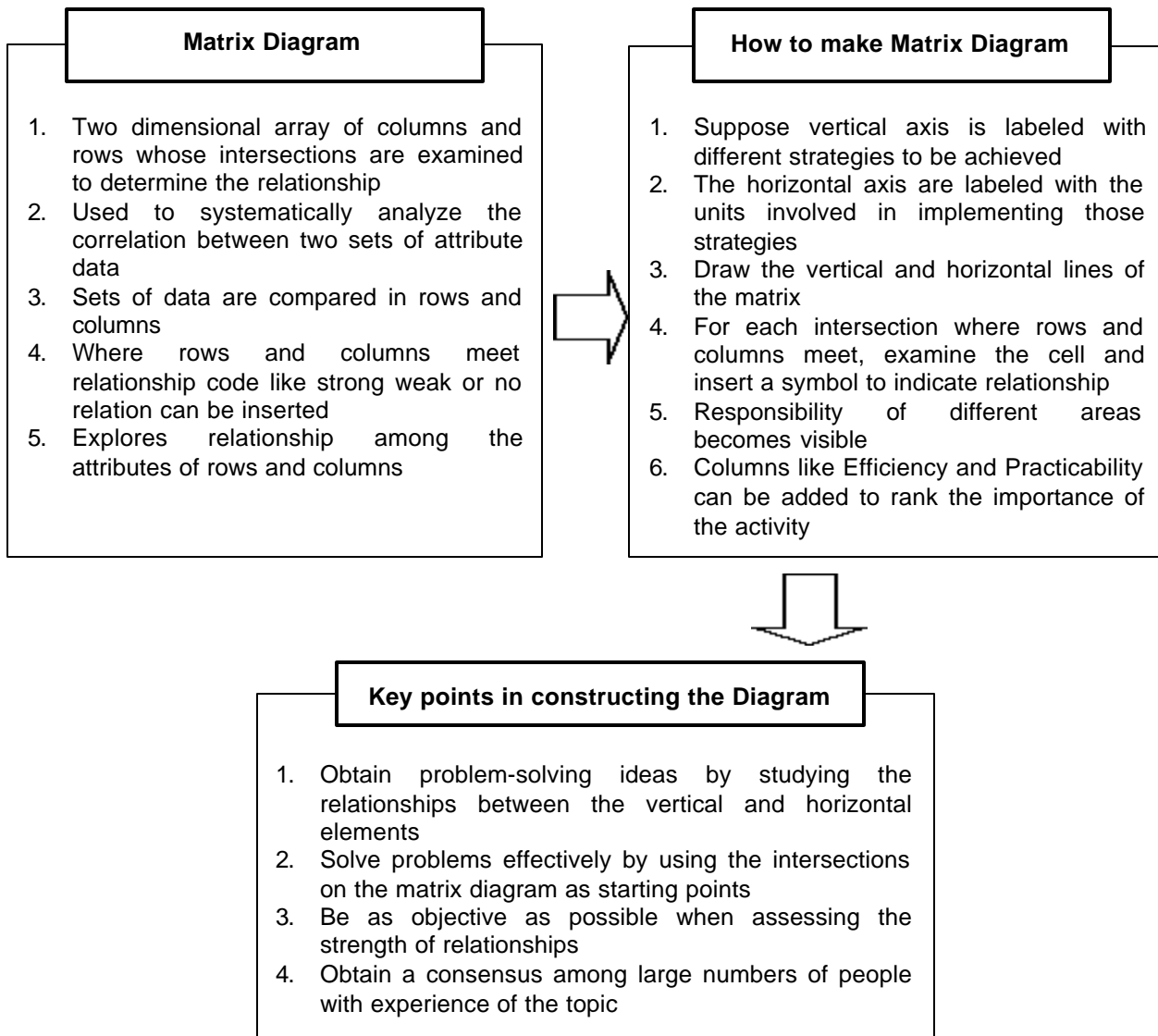


Figure 7

## **EXAMPLE**

### **AFFINITY DIAGRAM, RELATION DIAGRAM, TREE DIAGRAM AND MATRIX DIAGRAM**

This is the actual example covered during the learning of Seven New QC Tools in the PQM training course held in Yokohama JAPAN in September 2001. I was one of the member of the group who took part in preparing the Affinity Diagram, Relation Diagram, Tree Diagram and Matrix Diagram. The group chose the topic themselves with the consent of Japanese Professor as "There are many incidents of customer's complaints due to poor product quality". Our group consisted of most of the people from production units. The group discussed the different causes of poor product quality. The problem was written in the center and the ideas given by each member were placed around the problem then group studied and categorized the similar ideas by consensus and then the single statements of similar

ideas was formed. The figure below shows the ideas and then the single statement formed for similar ideas with dotted lines.

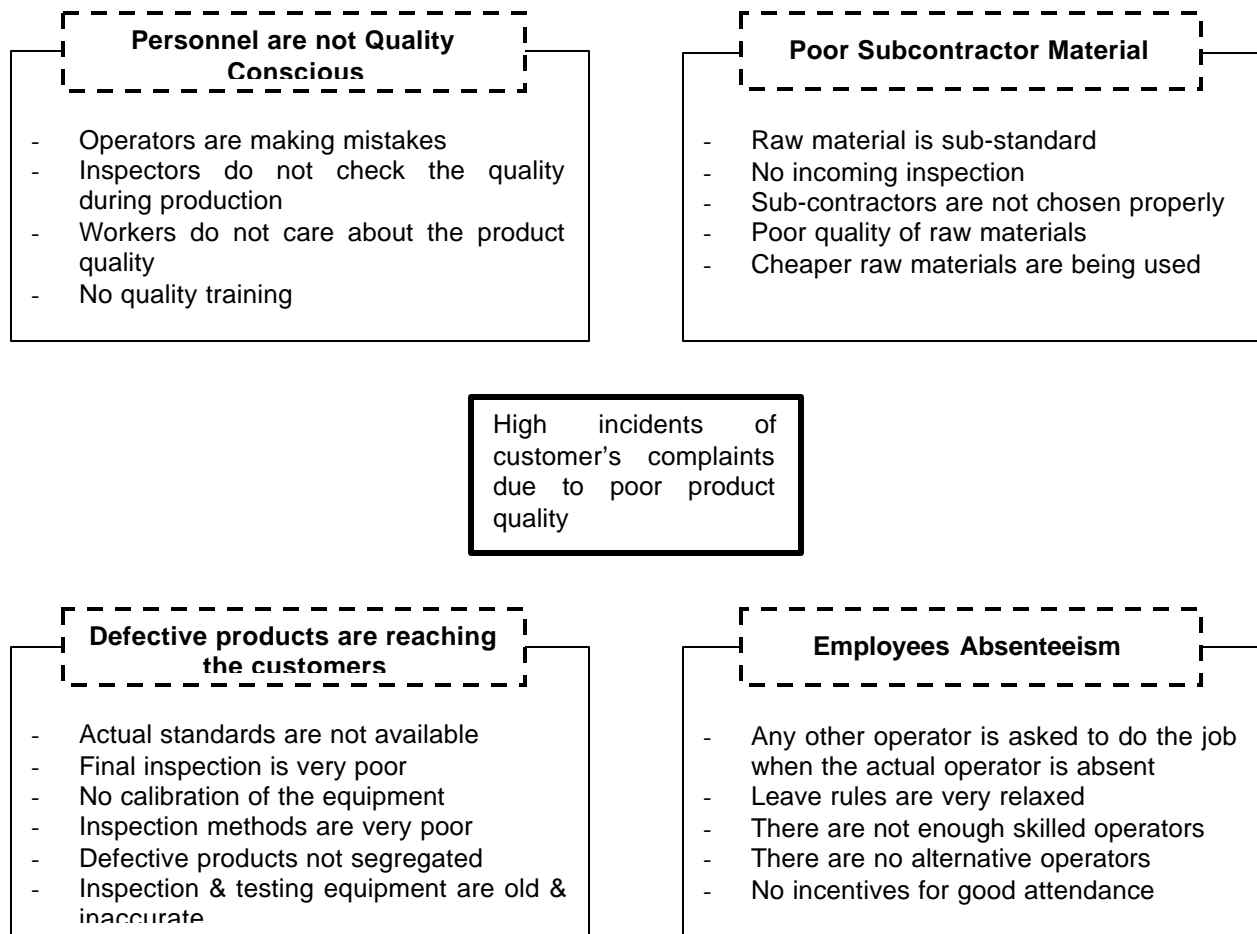


Figure 8

So the four primary causes of the problem were found by consensus.

After the construction of Affinity Diagram, the group constructed the relation diagram of the same problem "there are many customer's complaints due to poor product quality".

The four primary causes already determined through the Affinity Diagram are placed around the problem. Now why-why technique is used to determine Secondary, Tertiary, Fourth and Fifth level causes.

For example one of the primary cause was that personnel are not quality conscious. Now in why-why technique we question ourselves

**"why workers are not quality conscious?"**

the answer which comes to the mind of most of the members is that  
*No training is given on quality awareness to them*

then next question is

**"why quality awareness training is not given to them?"**

the answer is

*there are not enough resources for this training*

then again next question is

**"why there are not enough resources for quality training?"**

the answer comes to be

*because of poor management support for this function*

again next question is

**"why there is poor management support for this function?"**

the answer comes out

*because facts and data are not provided to the management*

If the management is provided a numerical data based on the losses incurred due to poor product quality in terms of money, definitely they will be convinced to spend a reasonable amount on training.

As we employed the why-why technique to other primary causes, we were surprised to reach the same answer that is "no facts and data are provided to management", which is the root cause of the problem. So relation diagrams helps us to find the root cause of the problems. See figure 9.

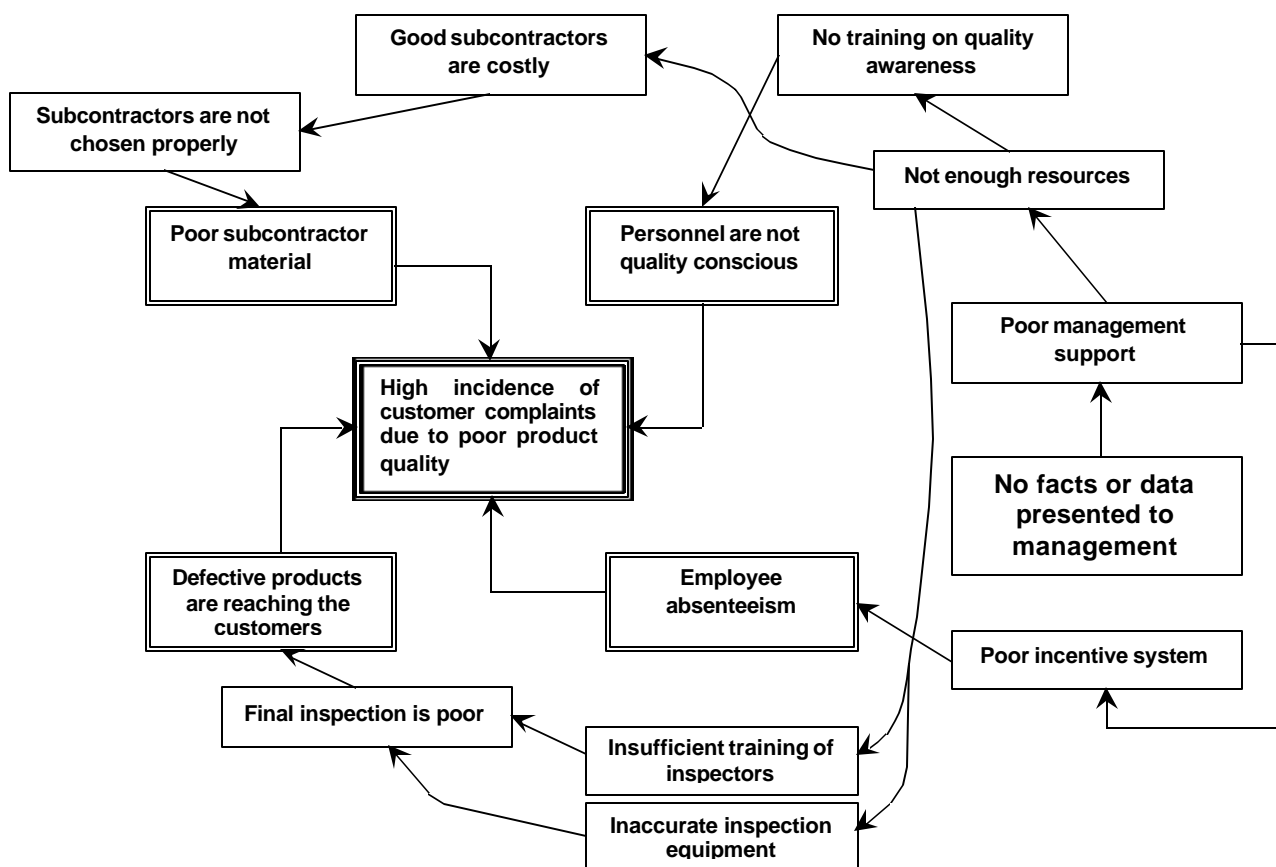


Figure 9

Now after finding the root cause of the problem through "Relation Diagram" it was supposed that the management would be convinced after the facts and data are presented to them. So now the objective of the organization is "to eliminate/ reduce the incidents of customer's complaints by improving the product quality". Now how to proceed to achieve this objective. For this Tree Diagram is very effective instrument

So a Tree Diagram is prepared to find the strategies to achieve this goal by using "How can we achieve this approach". See figure 10

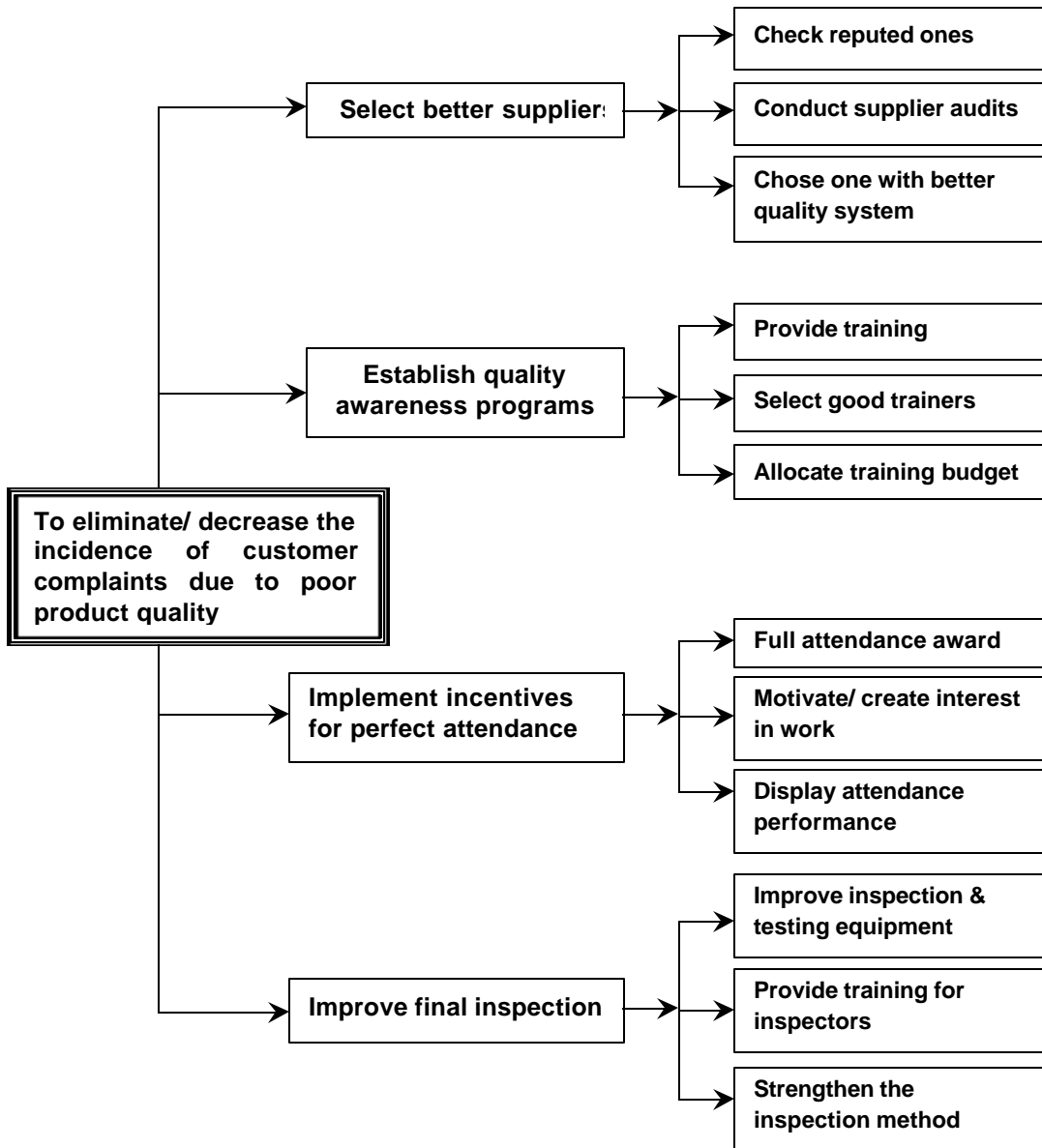


Figure 10

The objective/ goal is written on the left side, then strategies to achieve these objectives are written in the form of primary branches. Then different means to accomplish these strategies are written in the form of secondary branches. Now once the means to achieve the goals are decided through "Tree Diagram", the next step would be to assign the responsibilities for achieving these means. A Matrix Diagram is perhaps the most suitable tool for this. So a Matrix Diagram was drawn for this purpose. The means to be achieved are written along one axis and the different departments (responsible to implement these means) are written along the other axis. Then where rows and columns meet each other, the involvement of this department to achieve that mean is examined and a sign for principal or subsidiary responsibility is placed accordingly. The cell is left blank if this department has no involvement achieving that mean. In this way responsibilities of each department become visible.

The first three columns are added just to prioritize the tasks, these columns show the practicability and effectiveness of implementing that mean. If the implementation seems to be *very practical* and also *very effective* then it is given *Rank 1*. If it is *quite practical* and *very effective* then it is given *Rank 2* and if it is *very practical* and *quite effective* then it is given *Rank 3* and if it is *quite practical* and *quite effective* then it is given *Rank 4*. See Fig 11.

Means	Efficacy	Practicability	Rank	Responsibility					
				President	Production	Quality Control	HRD	Finance	Purchasing
Check reputed ones	<	□	3		:	:			T
Conduct supplier audits	□	<	2		:	T			:
Check with better quality system	<	<	4		:	T			:
Provide training on quality awareness	□	□	1		:	:	T		
Select good trainers	<	<	4		:	:	T		
Allocate training budget	<	□	3	:			:	T	
Full attendance award	□	□	1	T			:	:	
Motivate/ create interest in the work	<	<	4		:	:	T		
Display attendance performance	<	□	3		:	:	T		
Improve inspection & testing equipment	<	□	3	:		T		:	:
Provide training for inspectors	□	<	2			T	:		
Strengthen the inspection method	<	□	3		:	T			

**Efficacy/ practicability**

**Responsibility**

Scoring Key	
□ Good	□ □ = 1   < □ = 3
< Satisfactory	□ < = 2   < < = 4

T Principal
; Subsidiary

Figure 11

## E) PRIORITY MATRIX

It is just a kind of matrix in which same attributes/ strategies/ tasks are written both horizontally and vertically. Then instead of finding relationship among two different attributes, the importance of horizontally placed attributes is compared with the vertically placed attribute. In this way the importance of each task when compared to all other tasks become visible. This type of matrix is drawn when there are many tasks but there are not enough resources. So instead of just thinking which tasks are more important, the Priority Matrix is drawn. See figure 13

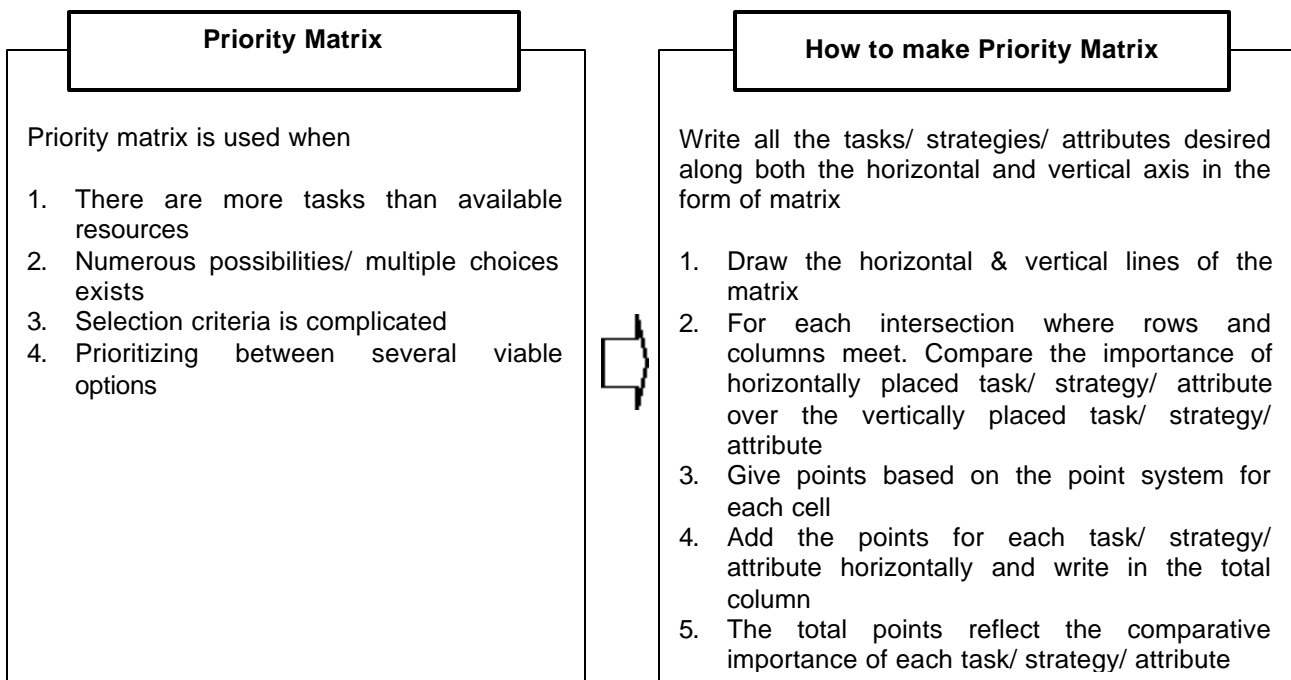


Figure 12

## EXAMPLE OF PRIORITY MATRIX

There can be a number of requirements when you are going to buy a new car but just for the sake of easy understanding of how to make a Priority Matrix only four attributes of a car are chosen for prioritization. These are superior sound system, fully automatic windows, fuel economy and four wheel drive.

Now these items are written on both sides of a matrix as shown in figure 13 horizontally the importance of each item is compared with the importance of all other items by giving points to each cell where rows and columns meet each other according to the point system given in figure 13. Then the points for each attribute are added horizontally. The score shows the overall comparative importance of this item. Then suppose you have to choose between a vehicle of fully automatic windows and four wheel drive and the other having fuel economy and superior sound system, then instead of thinking just compare the total points (sum of the scores for the two attributes) as follows:

Fully automatic windows and four wheel drive = 0.4 + 30.0 = 30.4

Fuel economy and superior sound system = 5.2 + 20.2 = 25.4

So the obvious choice will be the first option, which has more points

	Superior sound system	Fully automatic	Fuel economy	Four wheel drive	Total	
Superior sound system	X	5	1/10	1/10	5.2	1 → Equally important
Fully automatic	1/5	X	1/10	1/10	0.4	5 → More important
Fuel economy	10	10	X	1/10	20.2	10 → Much more important
Four wheel drive	10	10	10	X	30.0	1/5 → Lesser important
						1/10 → Much lesser important

Figure 13

**F) ARROW DIAGRAM**

Imagine that you have used a Tree Diagram or a Matrix Diagram to decide on the best possible strategies for solving a problem. The next question that arises is when and in what order to perform the numerous operations required to implement these strategies. Arrow diagrams are useful for planning this kind of action. They show the sequence and relationships among different activities effectively. They also indicate how altering one operation will effect the other and which activities are critical to the time schedule and which have some slack or spare time. The figure below describes arrow diagram.

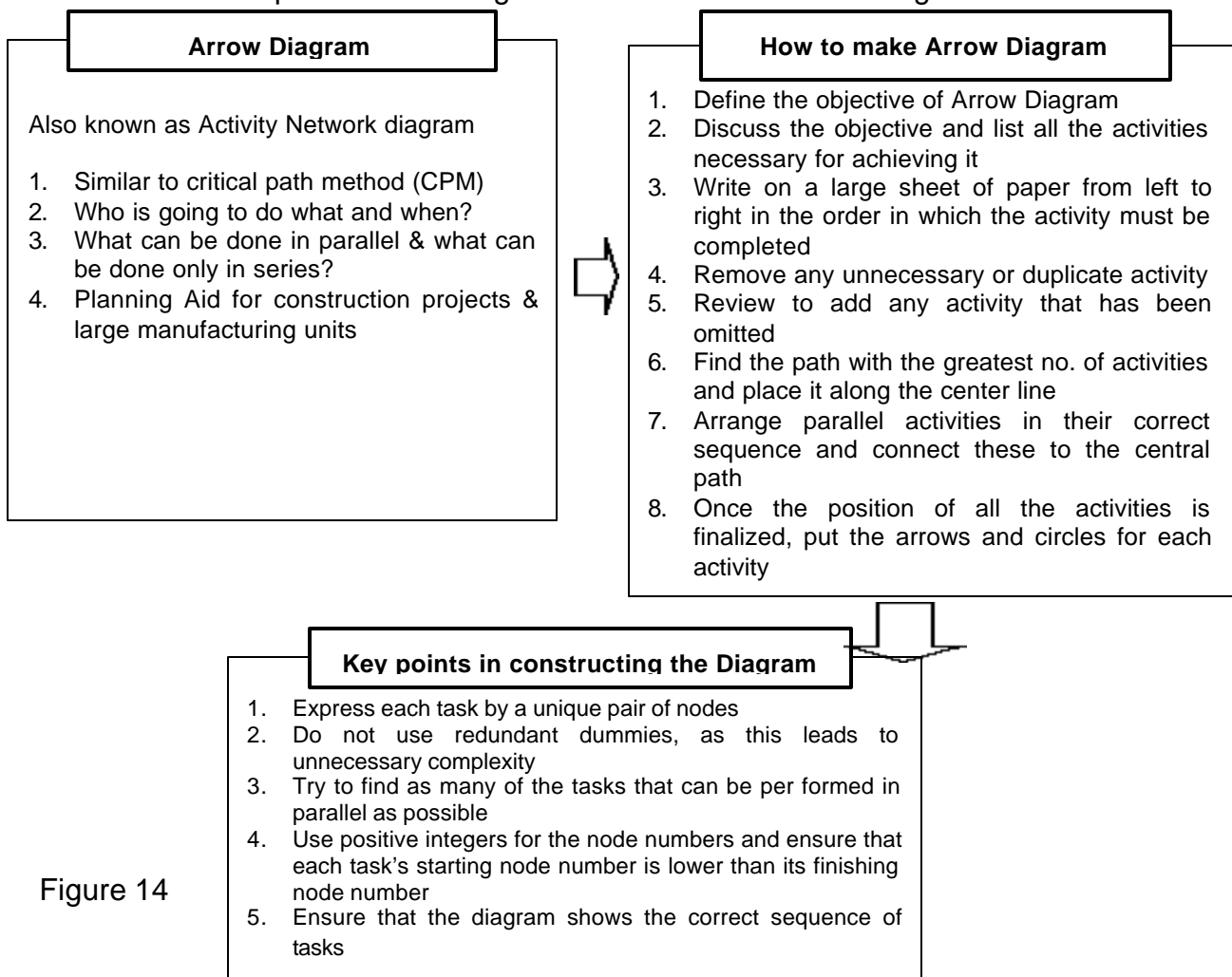


Figure 14



## EXAMPLE ARROW DIAGRAM

Figure below shows an Arrow Diagram for building a Q.C classroom. The diagram shows the sequence of activities and what can be done in parallel. The number written below the lines shows the time required in carrying out that activity.

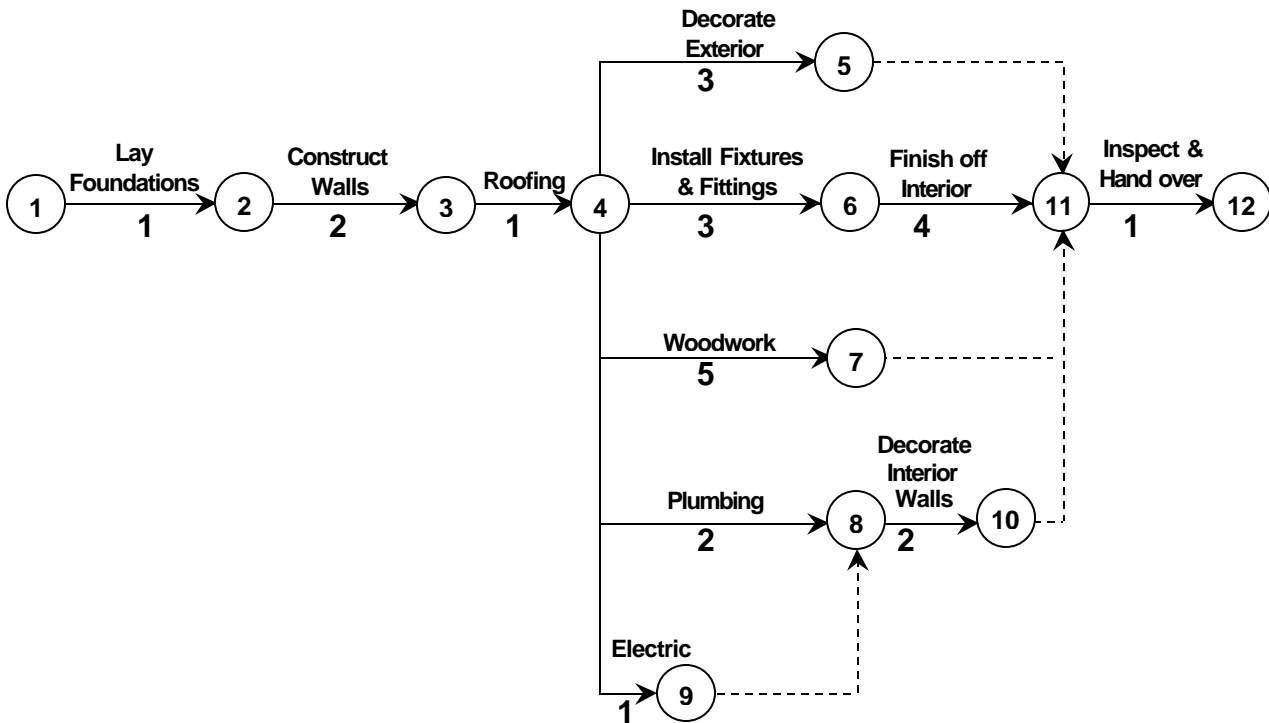


Figure 15 Arrow Diagram

The diagram shows that

Activity 2 can only be completed after the completion of Activity 1.

Activity 10 can only be completed after the completion of Activities 8 & 9.

Activity 12 can only be completed after the completion of Activity 5, 7, 10 & 11.

## G) PROCESS DECISION PROGRAM CHARTS

PDPCs are used for planning the activities needed to solve problem when information is incomplete or the situation is fluid and hard to forecast. Examples include planning an R & D project, mapping out countermeasure against long-term chronic problems, and planning a sales campaign.

A PDPC consists of a series of steps linked in sequence. Its goal is to depict the events and contingencies likely to occur when progressing from a starting point to one or more final outcomes.

It is unusual to keep a PDPC the same all the way through a project. The idea is to update it continually to take account of fresh contingencies and deal with unexpected obstacles as the situation evolves and new facts come to light. Figure below illustrates PDPC.

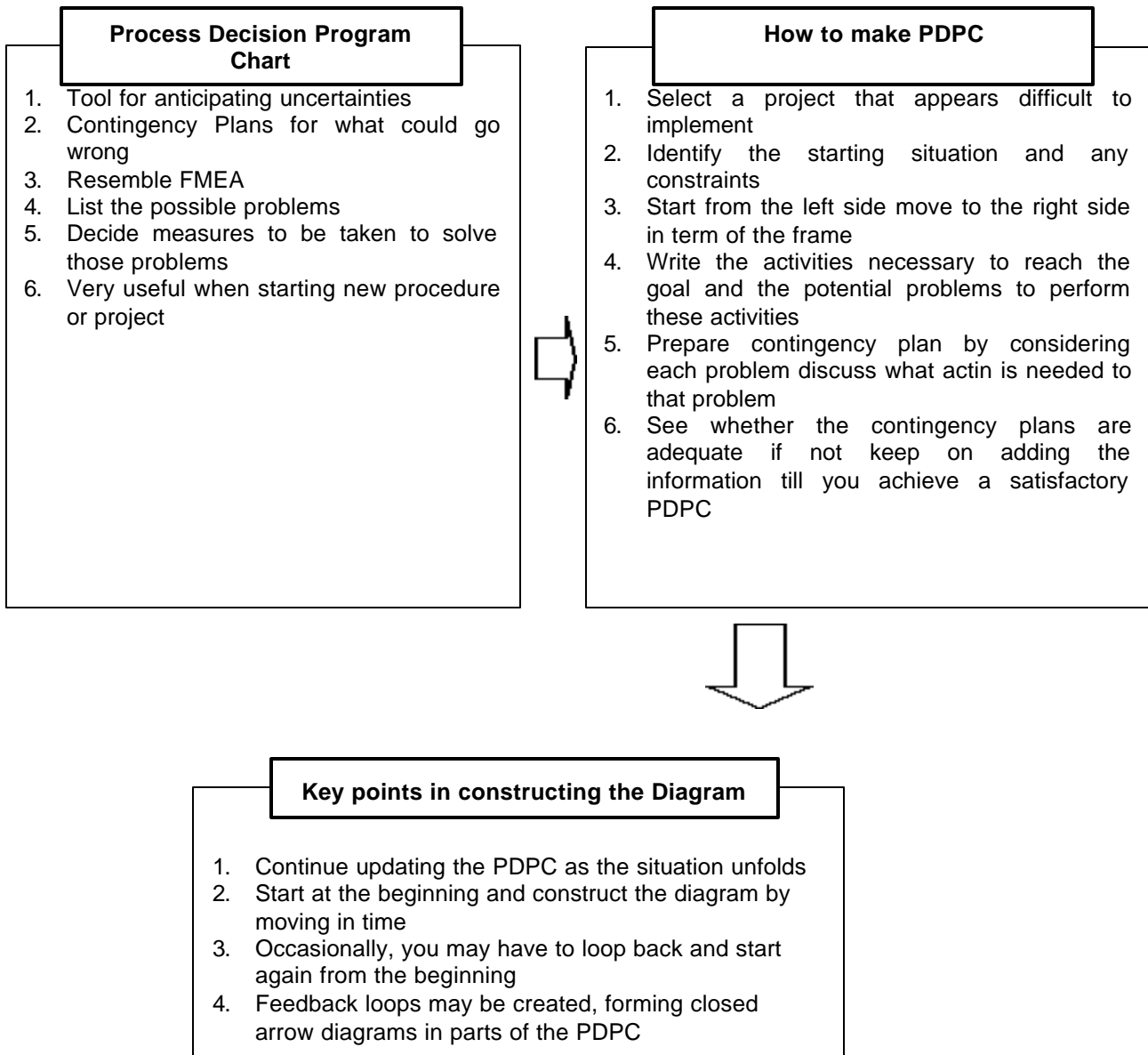


Figure 16

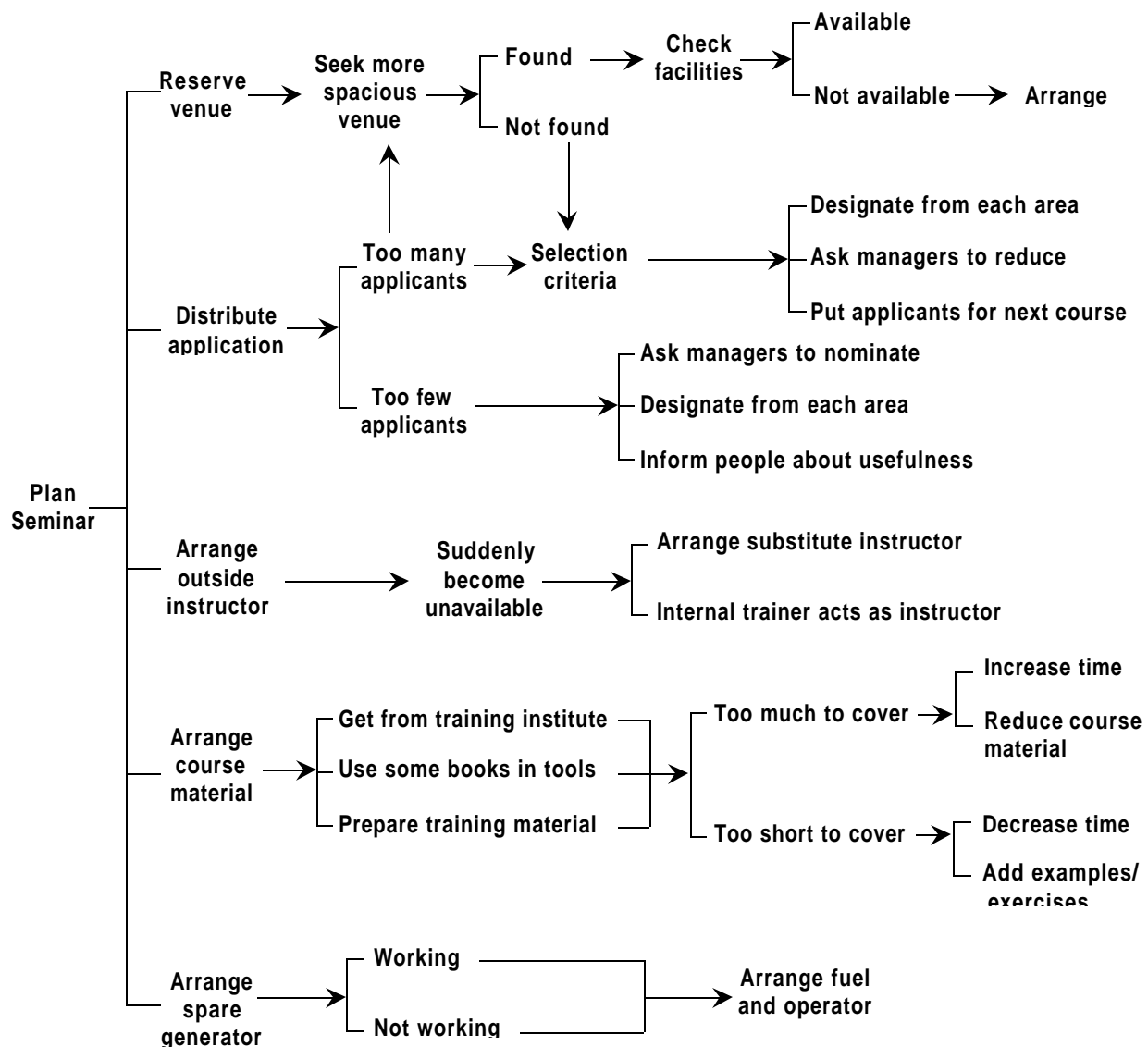
**EXAMPLE PDPC FOR HOLDING IN-HOUSE SEMINAR ON SEVEN NEW QC TOOLS**

Figure 17 PDPC

**4- TIPS FOR SUCCESSFULLY USING THESE TOOLS**

The mental attitudes required by anyone thinking of using the Seven New QC Tools is to be keenly aware of the problem and extremely eager to solve it. Anyone using the tools must first be highly motivated. Without this, the tools will be of little avail. The following four points are particularly important for the abilities needed to use the tools skillfully.

- 4.1- Understand problem
- 4.2- Select right tool for job
- 4.3- Obtain appropriate verbal data
- 4.4- Interpret analytical results

#### **4.1 UNDERSTANDING THE PROBLEM**

When solving a problem using the Seven New QC Tools, it is essential to know exactly which stage of the problem-solving process you have reached. These are three stages to the solution of a problem:

1. Stage 1 – The problem requiring a solution is still unclear. At this stage, various minor events are occurring, but it is still not obvious which constitutes the real problem. The important action at this point is to find out exactly what issue should be addressed.
2. Stage 2 – The problem is obvious, but its causes are unknown. The problem to be tackled has taken shape by this stage, but it is still unclear why it has arisen. Various possible causes must be explored and the true ones singled out.
3. Stage 3 – The problem and its causes are understood, but the required action is not known. The problem and its causes are clear at this stage, but the specific strategies required to solve the problem have still not been worked out. A concrete plan must be developed.

#### **4.2 SELECTING THE RIGHT TOOL FOR THE JOB**

Be sure to choose the appropriate tool depending on whether you are at stage 1, 2, or 3 of the problem-solving process.

When you know which stage you have reached in solving the problem, the goals of your analysis will become clear and you will be able to select the right tool and the correct method of using it.

When faced with a stage-1 problem, collect verbal information on whatever is happening and use an affinity diagram to structure it. This will enable you to identify the problem that must be tackled.

For a stage-2 problem, choose a tool that will enable you to identify its causes. The relations diagram is more appropriate when complex relationships exist among the many causes of a single result. A matrix diagram is effective when there are many problems or effects and these can be related in a row and column format to a list of causes.

For stage-3 problems, some method is needed to list and plan the activities required to solve the problem. Ideas can be elicited by using a tree diagram to develop certain key points and to generate a list of strategies intended to achieve a particular objective.

Once the requisite activities for solving the problem have been identified by these methods, it becomes necessary to devise a schedule for carrying them out. Use an arrow diagram for this. When it is impossible to determine in advance everything that must be done, or when certain decisions will depend on the outcome of previous activities, use the PDPC method to develop and continually modify an initial plan.

### 4.3 OBTAINING THE APPROPRIATE VERBAL DATA

Figure 18 illustrates how to collect verbal data. All the techniques listed in this figure are important but the most being the group discussion technique.

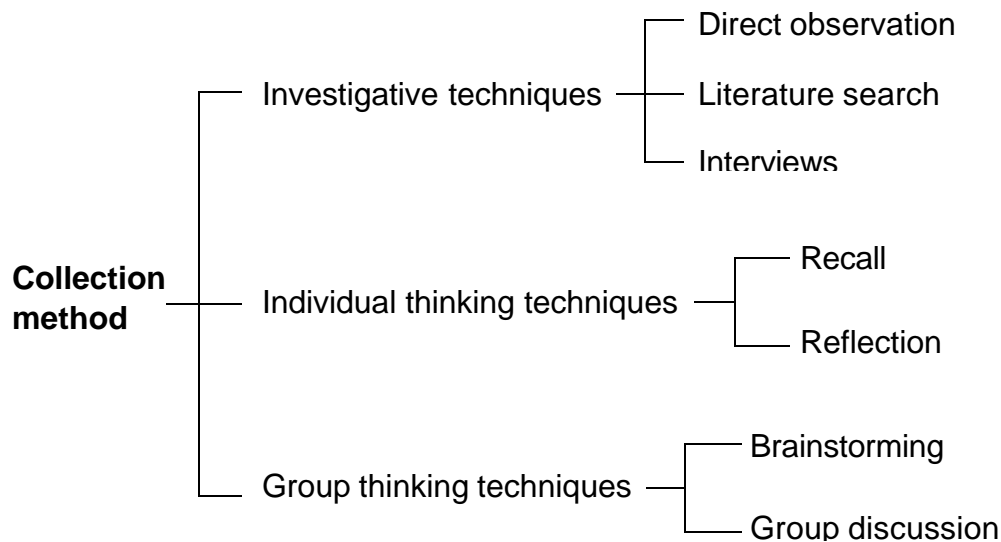


Figure 18 Methods of Collecting Verbal Data

The following are some hints on gathering verbal data by group discussion

- ◆ Ensure a common understanding of the problem-solving
- ◆ Collect all data without bias or distortion
- ◆ Collect data that fits the objectives of the analysis
- ◆ Use the right kind of data for the right purpose. There are three types of verbal data:
  - Facts. *Factual observations expressed directly in words*
  - Opinions. *Factual information colored by opinion*
  - Ideas. *New concepts created by analyzing and reconstituting facts*

Table below shows the usefulness of these three types of verbal data for different purposes.

Type of verbal data \ Purposes of analysis	Facts	Opinions	Ideas
Structuring problem	<b>T</b>	;	<
Investigating causes	<b>T</b>	<b>X</b>	<b>X</b>
Developing strategies	<	;	<b>T</b>

**T** Strongly related      ; Related < Possibly related      **X** Not related

#### 4.4 INTERPRETING ANALYTICAL RESULTS

It is essential to obtain the information needed for accomplishing the objectives, either from the completed diagrams or from the process of completing them. To do this, you must think about the information obtained. Some hints on this follow.

- ◆ Prepare a brief report summarizing the information obtained – when using the Seven New QC Tools, never just construct the diagrams and leave it at that. Always make a record of the findings obtained and conclusions drawn from the diagrams and the process of constructing them, even if it is only a list of key points. This is particularly important when using affinity diagrams or relations diagrams.
- ◆ Check whether the necessary data has in fact been obtained – Do not forget to check the results of your analysis to ensure that you have actually obtained the data you need. If you have not, it is due either to insufficient data or unskillful use of the tools. Discover the cause and take appropriate action.

### 5- BENEFITS OF THESE TOOLS

- i- Make possible to express verbal data diagrammatically
- ii- Overall picture and fine details become visible
- iii- Get more people involved
- iv- Provide training in thinking and generating ideas
- v- Raise people's problem-solving ability
- vi- Increase people's ability to predict future events
- vii- Build people self confidence

- viii- Strengthen creativity and originality
- ix- Help to organize information
- x- Eliminates errors and omissions
- xi- Improve cooperation
- xii- Improve planning

## 6. CONCLUSIONS

**T**he Seven New QC Tools are definitely a very useful addition in the quality toolbox. These tools are very useful in organizing the verbal data, solving the complex problems and properly planning the jobs.

The organizations using these tools after clearly understanding and practicing it, will definitely be benefited. The continuous use of these tools upgrades the personnel characteristics of the people involved. It enhances their ability to think generate ideas, solve problem and do proper planning. The development of people improves the internal environment of the organization, Which plays a major role in the total Quality Culture.

## ABOUT THE AUTHOR

**M**uhammad Amjad is an Electrical Engineer who graduated from the University of Engineering & Technology, Lahore in 1978. He started his carrier from WAPDA as Assistant Director Planning. He served WAPDA for more than 4 years. In October 1982, he joined SCECO (East) Saudi Arabia as Sr. Electrical Engineer. There he was involved in Design & Planning activities. He worked with this company for more than 9 years.

He returned to Pakistan and joined the Newage Cables (Pvt) Limited as Manager Quality Assurance in 1992. He took extensive training in the field of Quality through participation in number of seminars and International Conventions on Quality. He lead the Newage Cables team to achieve the ISO 9002 certification in May 1997. Newage Cables was among the first 25 companies and First in the field of Cables and Conductors in Pakistan to receive the ISO 9000 Certification. He also presented the case study of Newage Cables in UET and LUMS, Lahore.

He has received his training in the field of Quality from Japan where he participated in an extensive Quality Control training course comprising training and visits to production sites in Osaka. He is a Certified Auditor/Lead Auditor for ISO 9000 QMS (SGS Yarsely UK) and ISO 14000 EMS (IQCS Certification Singapore).

He is Senior Tutor (Part Time) for the Pakistan Institute of Quality Control, Guest Speaker for the Chamber of Commerce and Industry, Lahore. He has conducted a number of seminars on ISO 9000 Quality Management System, Statistical Quality Control and Total Quality Management. He was also the Lead Tutor for the previous Certified Quality Professional course conducted in Lahore.