A MULTIMEDIA SYSTEM AS AN AID FOR SELECTION OF QUALITY TOOLS AND TECHNIQUES

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2000

ABSTRACT

The proper use of quality tools and techniques (QT&T) is vital to the success of quality improvement efforts. QT&T are employed to help alleviate quality problems and improve business processes. However, they are often found not properly used due to users' lack of understanding. In this research, I propose a taxonomy to help quality practitioners to select proper QT&T for various application domains. The taxonomy was established based on a comprehensive literature review on various uses of QT&T in support of quality improvement. The taxonomy classifies 25 popular QT&T, based on their functionality, into five application domains, namely problem identification, problem analysis, problem prevention, ideas generation and decision making. A survey was conducted to seek the opinion of quality experts in quality software companies about the validity of the taxonomy. The survey results validate the taxonomy, which will give quality professionals a useful means to select and apply proper QT&T for their quality improvement efforts. I have conducted an empirical research on the use of QT&T. The survey results indicate that the use of QT&T is associated with two influencing factors: 1) lack of understanding, and 2) lack of training and education.

A Multimedia-based Advisory System for Selecting QT&T (MBAQ) was developed. The objective of the multimedia-based advisory system is to assist the user in identifying the appropriate QT&T according to the problems that the quality practitioners face. System evaluation was conducted and 64% and 86% of the respondents (36 potential users) agreed that MBAQ could help the practitioners select the proper QT&T, and learn their use respectively. About 80% of the

respondents agreed that MBAQ could provide better training to staff as it is an effective means for learning QT&T.

ACKNOWLEDGEMENTS

This project would not have been completed without the generous support I received from many individuals. I would like to thank my chief supervisor, Professor Cheng, Tai Chiu Edwin, for his patient guidance, valuable suggestions and encouragement during this project. I would also like to thank Dr. Ngai, Wai Ting, Eric, my co-supervisor, for all his patient guidance, help and support he has generously provided.

A general appreciation statement must be made to the following people. Dr. Hong Yan and Dr. Vincent Yeung helped me to arrange MSc students to complete the survey questionnaires. Mr. Albert Tsang and Dr. Yu, Kai Ming provided a lot of advice on this project. Mr. Kevin Saxton proof read part of this thesis. Miss Stella Chan, Miss Loretta Sze, Mr. Thomas Man, and Mr. Kwan, Kai Wing gave me moral support throughout this project.

I would like to express my deep love and appreciation to my mother, my family members, and Mr. Cheung, Man On for their emotional support. Most importantly, I wish to thank Mr. Mok, Siu Lung for all his help, patience, understanding and encouragement for this project.

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1. INTRODUCTION

Quality tools and techniques (QT&T) play a pivotal role in the successful implementation of organisational continuous improvement efforts (Ozeki and Asaka, 1990; Dale and Shaw, 1991; Yoest, 1992; Marsh, 1993; Krumwiede and Sheu, 1996; Bunney and Dale, 1997; Scheuermann, *et al.*, 1997). They are most often used to help alleviate quality problems and improve business processes, as well as deemed as a panacea for solving an organisation's quality ills. Traditionally, tools and techniques have been categorised into basic quality tools (Mears, 1995), new seven management tools (Nayatani, *et al.*, 1994; Anjard, 1995; Mears, 1995), and advanced techniques (Mears, 1995). In terms of application domains, the seven basic quality tools and the new seven management tools are generally employed for process control, process improvement and inspection of manufacturing processes (Woods and Page, 1991; Nayatani, *et al.*, 1994; Coyne, 1995). The advanced techniques such as quality function deployment (QFD), failure mode effect and criticality analysis (FMECA) and Taguchi method are often used for design for quality and design for manufacture (Swift and Allen, 1992; Gustafsson, 1997; Spring, *et al.*, 1998).

1.1 Problem Identification

A variety of difficulties associated with the use and application of QT&T have been highlighted and discussed. In a recent study, Bunney and Dale (1997) summarised the difficulties of using QT&T as shown in Table 1-1, and pointed out that the major problem is lack of understanding on how to use appropriate tools and techniques to tackle problems.

Table 1-1 Difficulties encountered with the use of tools and techniques (Bunney and Dale 1997)

	Difficulties					
Tools and Techniques	Time	Understanding	Terminology	Resources	Flexibility	Accuracy
Cause and Effect		✓			✓	
Pareto Analysis						
SPC		✓	✓	✓		✓
Quality Costing		✓				
Flowchart		✓		✓		
FMEA	✓			✓		
QFD	✓			✓		
Check Sheet						
Histogram		✓				
Scatter Plot		✓				

Lascelles and Dale (1990) found that quality practitioners tend to employ QT&T in isolation. Quality practitioners will not be helped by the way in which some practitioners treat statistical process control (SPC) in isolation and emphasise its importance over other QT&T in a process of quality improvement.

Lam (1996) conducted a survey about the usage of the tools and techniques for quality improvement. He found that the most common tools used in Hong Kong include brainstorming, control chart, cause-and-effect diagram, histogram and flowchart. Only a few of the respondents were found to have used some of the QT&T like the new seven management tools and the Taguchi method. The main barriers of using the QT&T are shown in Table 1-2.

Table 1-2 Barriers of the use of QT&T (Lam 1996)

Barriers	No. of companies	Percentage
Not relevant to the existing quality problems	44	75
Not understand the tool	32	54
Lack of resources	30	51
Not understood by top management	26	44
Tool complicated	21	36

The main difficulties are concluded as lack of management support, lack of resources, lack of understanding, and lack of training and education. McQuater, *et al.*, (1996) defined the difficulties associated with the use of QT&T as experience, management, resources, education and training, and they proposed guidelines for the effective use of QT&T at a strategic level. However, there have only been a few attempts to deal with the problem and they are not comprehensive enough for implementation at an operational level, that is no remedies for addressing the key issues of lack of understanding, and lack of training and education provided to organisations have been proposed.

1.2 Objective and Scope

From the problem identification of using QT&T, the following objectives are formulated for this research. This study aims to:

1. propose a taxonomy on classifying QT&T to facilitate quality practitioners to select the proper QT&T for quality diagnosis and improvement. The taxonomy is proposed as a remedy aiming at resolving one of the problems – lack of understanding in selecting proper QT&T.
2. provide details of an exploratory investigation of the use of QT&T at an operational rather than a strategic level. An empirical research of QT&T, focusing on companies' employees understanding and the provision of training and education in companies is conducted. In order to explore the impact of the above two influencing factors on the use of QT&T at an operational level, hypotheses testing to examine the association of the influencing factors with the use of QT&T is performed.
3. design and develop a multimedia advisory system to assist the users in identifying the appropriate QT&T. For the aspect of lack of training and education, a comprehensive state-of-art review of training systems is conducted. Results of the review reveal that there is an immediate need to develop a

multimedia-based guidance system to help quality practitioners to learn the skills and select the proper QT&T according to different manufacturing and business process circumstances.

This thesis is organised as follows. In chapter 2, I present a review of the literature on the application domains of QT&T, taxonomies of classifying QT&T, and training systems on QT&T. Chapter 3 describes the research methodology in four aspects: 1) proposing a taxonomy, 2) contributing a quality software tools list, 3) conducting an empirical research for hypothesis testing on the impact of the influencing factors on QT&T usage, 4): development of a multimedia-based advisory system in selecting QT&T. Chapter 4 presents the results of data analysis in two aspects: 1) a taxonomy and a quality software tools list, 2) an empirical research. Chapter 5 describes the development of a prototype of the multimedia-based advisory system. Chapter 6 concludes the whole thesis.

2. LITERATURE REVIEW

2.1 *Quality Tools and Techniques*

QT&T play a pivotal role in the implementation of continuous improvement in organisations. They are most often used to help alleviate quality problems and improve business processes. Dale, *et al.*, (1993) defined tools as devices to assist problem solving while techniques are described as skills with wider application than tools do. In the literature, many quality management researchers have defined a vast number of QT&T. In a comprehensive analysis of tools, Greene (1993) described 98 QT&T, used by organisations. Kanji and Asher (1996) defined 100 QT&T for solving problem and process improvement. Mears (1995) defined and classified QT&T into four categories as basic quality improvement (QI) tools, supporting QI tools, basic QI techniques, and advanced QI techniques. Yoest (1992) presented eight QT&T as flow diagrams, brainstorming, cause and effect diagrams, etc. which were claimed to be powerful in practice. Oakland (1993) presented ten simple QT&T, which offer organisations means of collecting, presenting, and analysing most of their data. He also suggested using the QT&T in a systematic manner for quality improvement.

In general, QT&T have different roles to play in a process of quality improvement. Their roles include data collection, summarising data, data presentation, discovering problems, understanding problems, finding and removing causes of a problem (Dale, 1994), planning for quality, improving design of product and process, controlling the process, etc. (Lascelles and Dale, 1990).

Traditionally, tools and techniques have been categorised into basic quality tools (Mears, 1995), new seven management tools (Nayatani, *et al.*, 1994; Mears, 1995; Anjard, 1995), and advanced techniques (Mears, 1995) (see in Table 2-1). Their features and usage are attached at Appendix A (Mears, 1995).

Table 2-1 Popular-used QT&T

Basic Seven Quality Tools	New Seven Management Quality	Advanced Quality Techniques
1. Cause and Effect Diagram 2. Charts (Pie, Bar, Run and Spider) 3. Check Sheet 4. Control Charts 5. Flow Chart 6. Pareto Diagram 7. Scatter Diagram	1. Activity Network Diagram 2. Affinity Diagram 3. Interrelationship Diagram 4. Matrix Analysis Diagram 5. Matrix Diagram 6. Process Decision Program Charts 7. Tree Diagram	1. Failure Mode Effect and Criticality Analysis (FMECA) 2. Quality Function Deployment (QFD) 3. Taguchi Method

Jayaram, *et al.*, (1997) collected and summarised the definitions of particular QT&T emphasised in the literature that were modified and presented as shown in Table 2-2:

Table 2-2 Definition of Particular QT&T Emphasised in the Literature (modified from Jayaram, *et al.*, 1997)

QT&T	Author and Year	Definition
Acceptance sampling	Montgomery 1991	An inspection procedure, as a part of a quality assurance system, that facilitates the decision to accept or reject a product based on adherence to a standard
Taguchi method	Greene 1993	A set of principles for creating experiments that define regions of variable value that accomplish customer satisfaction
Failure mode and effect analysis (FMEA)	Dale and Shaw 1990	A systematic analytical and quality planning tool for identifying, at the product and process design stages, what might go wrong either during the manufacture of the product or during its use by the customer
Fishbone charts	Huge 1990	A chart depicts and organises by major category the potential causes of the undesired or desired effect
Histograms	Huge 1990	A visual display of the distribution of real variables in frequency form
Pareto analysis	Huge 1990	A technique that identifies the significant few causes that account for the bulk of the problem(s)
Pakayoke (Foolproof)	Mizuno 1988	The system of preventing careless mistakes by designing fail-safe systems that can be readily understood by a novice
Process flow chart	Huge 1990	A visual depiction of the relevant steps in a process that enables the understanding of a process
Quality function deployment (QFD)	Greene 1993	A quality technique that aligns internal company and cross-unit actions to account for their impact on particular wants of the customer
Quality circles	Mizuno 1988	A formal or informal group that takes the initiative in seeking out problems and solving them in an atmosphere of free exchange of ideas
Check sheets	Huge 1990	A technique that provides quantitative evidence of the frequency of events
Control chart	Huge 1990	A series of techniques that enables the determination of the nature of the cause of variation (i.e., common causes or special causes)

Initially, a number of QT&T are introduced as vital components of problem solving and as a means of increasing awareness of the total quality management concepts and the importance of continuous improvement process (Bunney and Dale, 1997; Ozeki & Asaka, 1990; Scheuermann, *et al.*, 1997; Straker, 1995; Dale, 1994). In general, the introduction of the 7 basic quality tools is considered as being a means of finding ways for process improvement. To support and develop a process of continuous improvement, an organisation needs to use a selection of QT&T. It is wise to start with the more basic tools and to ensure the QT&T which are currently employed are used effectively before attempts are made to introduce other tools. A planned approach for the application of QT&T is necessary. The temptation to single out one tool or technique for special attention should be resisted, and to get maximum benefit from the use of QT&T they should be used in combination. It should be recognised that QT&T play different roles, and quality practitioners should fully understand the main purpose and use of QT&T they are considering to apply in their organisations. QT&T should be used to facilitate improvement and be integrated into the business processes. The ways in which QT&T are applied and how their results are interpreted are critical to their successful use (Dale, *et al.*, 1994).

2.2 Application of the Basic Tools and New Management Tools

General speaking, the seven basic quality tools and the new seven management tools are employed for process control, process improvement and inspection in manufacturing processes (Coyne, 1995; Nayatani, *et al.*, 1994; Woods and Page, 1991). Ishikawa (Graves, 1993) is quoted as saying that 95% of all problems can be solved with simple tools, for instance, pareto analysis, graphs, control charts. Statistical process control (SPC) is referred to as the use of statistical techniques to analyse a manufacturing process, quality, and reliability (Hirning, 1989). Woods and Page (1991) claimed that SPC methods still play a vital role in TQM for testing and repairing operations. SPC is a systematic approach to identify and prevent defects and provide the basis for determining process capability, which means to improve product quality and process productivity (Krumwiede and Sheu, 1996). In studies of manufacturing companies, a containers manufacturing co., Bowater and a printed circuit broad (PCB) fabricator have taken SPC as one of the tools and techniques for process control and quality improvement (Babinec, 1990; Conye, 1995).

2.3 Application of Advanced Techniques

The advanced techniques such as quality function deployment (QFD), failure mode effect and criticality analysis (FMECA) and Taguchi method are often used for design for quality (DFQ) and design for manufacture (DFM) (Swift and Allen, 1992; Gustafsson, 1997; Spring, *et al.*, 1998). The advanced techniques are usually employed by companies in which high sophisticated skills and particular training are demanded of the employees. FMEA or FMECA is a systematic and analytical quality planning tool for identifying, in the product, service and process design states, what potentially could go wrong either with a product during its manufacture or end-use by the customer or with the provision of a service (Aldridge and Dale, 1994). QFD can identify the true voice of customer and is best thought of as a systematic approach to identifying and recording areas for priority action in DFQ (Burn, 1994). Taguchi method enables quality to be designed into a product or process, thereby reducing its variability (Disney and Bendell, 1994).

To summarise, basic QT&T can assist with problem solving and identification, data collection and analysis, process control and evaluation (Spring, *et al.*, 1998). On the other hand, advanced QT&T can help in specific applications such as product design and development (Morup, 1992; Teng and Ho, 1995; Zairi and Youssef, 1995; Vonderembse, *et al.*, 1997; Antony, *et al.*, 1998; Spring, *et al.*, 1998).

2.4 Literature Review of Taxonomy of Classifying QT&T

Prior research on classification of QT&T has existed in the literature. Mears (1995) classified QT&T into four categories, namely basic QI tools, supporting QI tools, basic QI techniques, and advanced QI techniques. His study is mainly focused on how to use particular QT&T. Kanji and Asher (1996) classified 100 tools into four categories, namely management methods, analytical methods, idea generation and data collection, analysis and display. They also presented some guidance on when and how to use the various QT&T. Brocka and Brocka (1992) classified QT&T into eight categories, which are creativity tools, companywide techniques, data analysis tools, decision-making tools, graphical tools, modelling tools, preventive tools, and problem identification tools (shown in Table 2-3). In a comprehensive analysis of tools, Greene (1993) described 98 QT&T, used by organisations, grouped into 14 categories including advanced statistics tools, commitment tools, customer understanding tools, group dynamic tools, implementation tools, innovation tools, knowledge tools, management tools, management-by-event tools, process tools, statistical tools, social connectionism tools, software tools, and systems tools. However, this classification falls short of providing useful guidelines to quality practitioners on selecting appropriate QT&T in a way conducive to continuous quality improvement. Therefore, intending to overcome these shortcomings, I propose a taxonomy of classifying QT&T based on their functionality so that quality practitioners can easily select the proper QT&T for various application domains.

Table 2-3 Brocka and Brocka (1992)'s categorisation of QT&T

Companywide techniques Auditing Benchmarking Deming cycle Goal setting Quality costs Quality circles Quality function deployment Service Quality	**Decision-making tools** Auditing Benchmarking Force field analysis Nominal group techniques	**Preventive tools** Control charts Design of experiments Evolutionary operation Failure mode effects analysis Foolproofing Goal setting Pareto analysis Process decision program chart
Creativity tools Brainstorming Evolutionary operation Foolproofing Nominal group techniques Process decision program chart Quality circles Who-what-when-where-why-how	**Graphical tools** Cause-effect diagrams Control charts Data presentation Flowcharts Pareto analysis Process decision program chart Quality function deployment Systematic diagram Work flow analysis	**Problem identification tools** Brainstorming Cause-effect diagram Check sheets Control charts Data presentation Delphi technique Force field analysis Nominal group techniques Pareto analysis Quality circles Quality function deployment Root cause analysis
Data analysis tools Check sheets Control charts Design of experiments Evolutionary operation Force field analysis Pareto analysis Sampling	**Modeling tools** Benchmarking Flowcharts Quality function deployment Work flow analysis	

2.5 *Literature Review of Training Systems for QT&T*

In order to design and develop a comprehensive multimedia-based advisory system - MBAQ, it is crucial to review the existing training systems for QT&T.

Alexander and Jagannathan (1986) presented a framework of a computer based advisory system that can be used to assist in the selection, design, and construction of control charts. The advisory system is developed using expert systems technology. Hosni and Elshennaway (1988) presented a knowledge-based system for selecting proper types of control charts and providing general explanations. Evans and Lindsay (1988) proposed a framework for developing expert systems for statistical process control applications. The problem solving approach is divided into three phases: (1) analysis rules for determining conditions which signify the potential lack of statistical control; (2) interpretative rules for analysing patterns in the control chart in terms of process changes; and (3) diagnostic rules for determining assignable causes of out-of-control conditions. Franz and Foster (1992) designed a decision support system with an imbedded knowledge-based system to assist quality practitioners, in both assessing areas to target for improvement and in selecting QT&T which are appropriate for the organisation. The proposed system, TRANSIT PQR, is accomplished in three phases: (1) a profile of 12 key organisation characteristics is developed; (2) an improvement plan is devised via the selection of specific organisational characteristics to target for improvement; (3) QT&T are suggested to facilitate those organisation changes. However, the TRANSIT PQR does not provide insights into the selection of QT&T; it merely lists appropriate techniques and assesses their potential with respect to the characteristic where improvement is desired. Masud and Thenappan (1993) developed a knowledge-based advisory system, ASQC, for providing assistance in: (1) the selection and design of appropriate quality control charts; (2) process monitoring analyses; and (3) providing corrective advice based on the monitoring analyses results. Their study is based on

Dagli and Stacey's system – ASCC (1988). It improves their ASCC system by proposing a three-phase problem solving approach instead of only one phase. The phases are to: (1) select and design an appropriate control chart; (2) provide advice about the appropriate sample size to be used; and (3) perform process monitoring analysis. Deslandres and Pierreval (1995) proposed a knowledge-based system of selecting QT&T, namely SYSMIQ, for manufacturing system and shop floor management. The problem solving approach is composed of two stages: problem identification and problem analysis. Deslandres and Pierreval (1997) proposed a more advanced intelligent decision support system (DSS) for selecting QT&T, namely QAS, also for manufacturing system and shop floor management. The problem solving approach is composed of three stages: problem discovery, in-depth analysis, and problem solution. Tables 2-4 and 2-5 compare and summarise the advisory systems. However, the above advisory systems for QT&T can be concluded as not comprehensive enough. First of all, the above systems are for the manufacturing industry and none of them is considered for the service industry. Second, the problem solving approaches of those systems are not comprehensive enough for quality improvement. For example, the latest one – QAS – is composed of three stages only. Third, the above systems do not provide a flexible approach to learning and training which can be done by multimedia-based systems. For these reasons, it is both necessary and desirable to design and develop a multimedia-based advisory system to assist quality practitioners in selecting and learning QT&T.

2.6 *Summary*

In this chapter, literature reviews on the use of QT&T and their application domains have been discussed. From the literature, a vast number of defined QT&T are introduced as vital components of problem solving and as a means of increasing awareness of the total quality management concepts and the importance of continuous improvement process.

In terms of application domains, the seven basic quality tools and the new seven management tools are generally employed for process control, process improvement and inspection of manufacturing processes. The advanced techniques such as quality function deployment (QFD), failure mode effect and criticality analysis (FMECA) and Taguchi method are often used for design for quality and design for manufacture.

From the literature review of using QT&T and the problem identification, quality practitioners often have difficulties in selecting the proper ones to use (Dale and Lightburn, 1992; McQuater, *et al.*, 1996). On the other hand, Lascelles and Dale (1990) found that quality practitioners tend to employ QT&T in isolation. Therefore, a taxonomy of classifying QT&T is proposed to facilitate the quality practitioners to select the proper QT&T for quality diagnosis and improvement. The proposed taxonomy is established based on a comprehensive literature review on the use of QT&T in support of quality improvement and validated through expert advice of quality practitioners. It will encourage quality practitioners to employ the QT&T in a step-by-step and systematic manner instead of in an isolated way.

A state-of-art review of training systems for the selection of QT&T has been conducted. The characteristics and shortcomings of each advisory system have been examined. Owing to a lack of multimedia-based advisory systems to assist in selecting QT&T, the development of the multimedia-based advisory system for selecting QT&T (MBAQ) is urgently needed and highly desirable.

Table 2-4 Summary of Studies on Quality-related Advisory Systems

System name	QAS	SYSMIQ	ASQC	ASCC
Developer	Deslandres, V., and Pierreval, H., (1997)	Deslandres, V., and Pierreval, H., (1995)	Masud, A.S.M., and Thenappan, M.S., (1993)	Dagli, C.H., and Stacey, R., (1988)
System	Decision Support System	Knowledge Based	Knowledge based	Knowledge based
Application Domain	Manufacturing System, Shop Floor (TQC)	Manufacturing System, Shop Floor (TQC)	Process Control	Process Control
Number of Quality tools and techniques for selection	25	25	Not mentioned	14 Control charts
Selection Approach/Problem solving activity	1. Problem discovery 2. In-depth Analysis 3. Problem solution	1. Identify problem 2. Analyse problem	1. Select and Design an appropriate control 2. Provide advice about the appropriate sample size to be used (ASCC missing) 3. Perform process monitoring analysis (ASCC missing)	Not mentioned
Multimedia-Based	No	No	No	No
Remark			They proposes a ASQC system which improves what Dagli and Stacey, 1988 (ASCC) did.	

Table 2-5 Summary of Studies on Quality-related Advisory Systems (Cont.')

System name	TRANSIT PQR	Not mentioned	EXSYS	GENIE, IQ LISP
Developer	Franz., L.S., and Foster, S.T., (1992)	Hosni, V.A., and Elshennawy, A.K., (1988)	Evans, J.R., and Lindsay, W.M., (1988)	Alexander, S.M., and Jagannathan, V., (1986)
System	Knowledge Based + Decision Support	Knowledge-Based system	Knowledge based	Knowledge based
Application Domain	TQM	Process control (inspection)	Process control	Process control
Number of Quality tools and techniques for selection	Not mentioned	7 control charts	Not mentioned	Not mentioned
Selection Approach/Problem solving activity	Not mentioned	1. Define the type of control chart to be used 2. Based on value plotted, the system suggests the cause of process misbehaviour of plotted values	1. Analysis rules for determining conditions which signify the potential lack of statistical control 2. Interpretative rules for analysing patterns in the control chart in terms of process changes 3. Diagnostic rules for determining assignable causes of out-of-control conditions.	Not mentioned
Multimedia-Based	No	No	No	No
Remark	TRANSIT PQR does not provide insight into the selection of the techniques, it merely lists appropriate techniques and assess their potential with respect to the characteristic where improvement is desired			

3. RESEARCH METHODOLOGY

3.1 Phase I: Propose a Taxonomy of Classifying QT&T

From the problem identification, it was decided that the research should focus on the problems of lack of understanding (Lam, 1996; Bunney and Dale, 1997), and lack of training and education (Dale and Lightburn, 1992; McQuater, *et al.*, 1996). In order to alleviate one of the stated problems - a lack of understanding of QT&T, a taxonomy is proposed to facilitate quality practitioners to select the proper QT&T. The approach of developing it was to examine existing taxonomies and evaluate their features. During the development, the benefits and shortcomings of existing taxonomies were identified, and then I tried to integrate the benefits given by existing taxonomies and cover their shortcomings. Furthermore, the taxonomy was established based on a comprehensive literature review on the use of QT&T in support of quality improvement. Finally, the proposed taxonomy was validated through expert advice of quality practitioners to ensure it was well defined and developed.

3.2 Phase II: Develop a Quality Software List

A questionnaire survey of 53 quality software companies mainly located in the USA and Canada was conducted. The software companies were selected based on the list of quality software companies compiled by Daniels (1998). The questionnaire was divided into two parts. Part one was designed to assess the companies quality software products against a list of 36 functions or techniques in a matrix format (see Appendix B). The companies were asked to mark off each function or technique their quality tools covered. I also requested the companies to provide a description of their quality software. Part two of the questionnaire was designed to validate my proposed taxonomy. The software companies were asked about their degree of agreement with the classification of the mentioned QT&T under my proposed five application domains, namely problem identification, problem analysis, problem prevention, idea generation and decision making.

3.3 Phase III: Conduct an Empirical Research on QT&T Usage

While the quality literature abounds with quality management tools and techniques and many discussions on QT&T have been presented (Crosby, 1979 and 1984; Deming, 1986; Juran, 1986; Lascelles and Dale, 1990; McQuater, *et al.*, 1994, McQuater, *et al.*, 1995), only a very few attempts of empirical research into the prescriptions of quality management and QT&T have been undertaken. In this study, an exploratory study into the use of QT&T and the influencing factors was conducted in order to evaluate and investigate the impact of the influencing factors on the use of QT&T in organisations. The two influencing factors examined are understanding of QT&T and training and education in the use of QT&T. Hypothesis testing was then performed to assess the association between these two influencing factors and the use of QT&T.

To collect data for testing the hypotheses, a survey instrument was developed. The procedures and methods employed for instrument development will be addressed. To understand the association between the two influencing factors and the use of QT&T in organisations, an exploratory analysis of how often different industries utilise QT&T was performed. It is generally accepted that different industries employ different QT&T, and that the frequency of QT&T usage would differ among industries. For the provision of empirical data, chapter four will address the association analysis of the use of QT&T as well as the exploratory research on the pattern of employing QT&T by different industries. An analysis of the discovery of which training approaches can provide effective and efficient means for learning the use of QT&T will also be presented.

3.4 Survey Design and Execution

3.4.1 Instrument Development

For survey instrument development, measurement issues related to reliability and validity are particularly weak (Flynn, *et al.*, 1994). The instrument development is a very sophisticated and complicated process. However, rigorous development methods have been developed for constructing instruments to measure social variables (Likert, 1967; Nunnally, 1967; Sellitz, *et al.*, 1976). In the quality literature, Hours (1989), Saraph, *et al.*, (1989), Flynn, *et al.*, (1994), and McCahon, *et al.*, (1996) provided instruments for measuring "training and education", and "understanding". There were eight steps involved in developing the instrument for this study. The first step was to define the critical factors, which affect the use of QT&T. In this case, I identified training and education of the use of QT&T, and understanding of QT&T as the influencing factors. The next step was to generate an item pool. The selection of items was based on exhaustive reviews of empirical research in the quality management field. The third step was to determine the format of the survey. Typically the researchers use a five-point scale because it allows a central "neutral" response. The fourth step was to consider what kind of demographic questions should be included. In many cases, the demographics contained in the survey were different according to different backgrounds of the respondents. In the fifth step, I selected and determined the items and scale respectively, where the initial items had to be reviewed thoroughly by experts in quality management or operation management. In the sixth step, a pilot test was conducted to enhance the readability for the respondents and eliminate ambiguity. The seventh step was to refine the items and finalise the questionnaire according to comments from the pilot test. The eighth step was to determine the internal consistency for each factor. The internal consistency of a set of measurement items refers to the degree to which the items in the set are homogeneous. It can be estimated using a reliability coefficient such as Cronbach's alpha (Cronbach, 1951; Nunnally, 1967; Sellitz, 1976). The instrument development process is depicted in Figure 3-1.

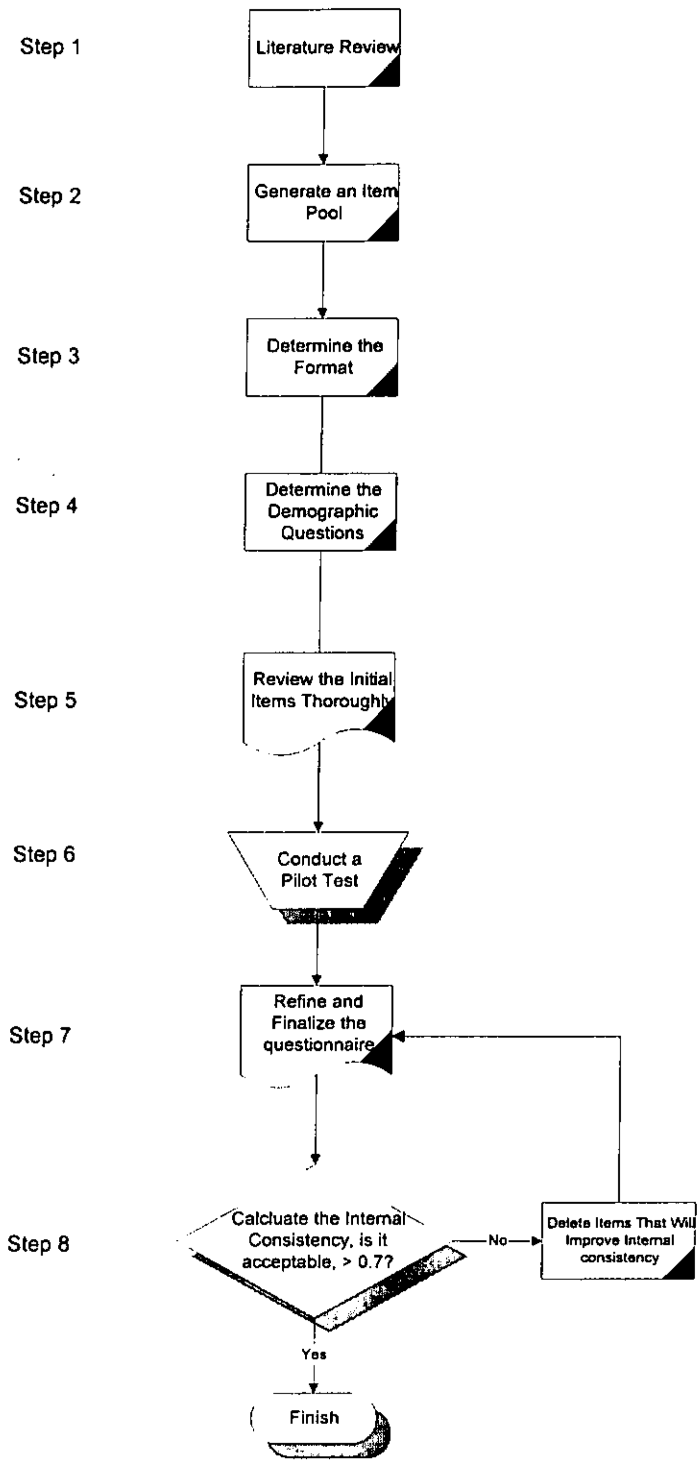


Figure 3-1 The Instrument Development Process

Steps 1 and 2: Literature Review and Item Pool Generation

Use of Quality Tools and Techniques Factor

The primary interest is the use of the quality tools and techniques. The survey instrument was designed based on how often different QT&T were employed.

Respondents were asked to indicate, using a five-point scale, how frequently they used the 31 QT&T ranging from 5 = "daily use" to 1 = "never use". However, according to comments made in the pilot test, which I will discuss later, a reduction in the number of QT&T would create an easier survey questionnaire for the respondent to fill in (shown in Table 3-1). Therefore, particular QT&T were grouped as the 7 basic quality tools, new 7 management tools, and advanced techniques.

Table 3-1 First Part of Instrument: Frequency of QT&T Usage

Quality Tools and Techniques	Daily (5)	No more than several times every week (< daily) (4)	No more than once every 2 weeks (3)	No more than once every month (2)	Never Use (1)
7 Basic Quality Tools[1]	☐	☐	☐	☐	☐
New 7 Management Tools[2]	☐	☐	☐	☐	☐
Advanced Techniques[3]	☐	☐	☐	☐	☐
Acceptance Sampling	☐	☐	☐	☐	☐
Benchmarking	☐	☐	☐	☐	☐
...	☐	☐	☐	☐	☐
(Cont.')	☐	☐	☐	☐	☐

1. Cause-effect Diagram, Charts (Bar, Pie, Run, and Spider), Check Sheets, Control Charts, Flowchart, Pareto Analysis and Scatter Diagram.
2. Activity Network Diagram, Affinity Diagram/KJ Method, Interrelationship Diagram, Matrix Data Analysis, Matrix Diagram, Process Decision Program Chart and Tree Diagram.
3. Design of Experiment (DOE), Quality Function Deployment (QFD), Failure Mode Effect and Criticality Analysis (FMECA) and Taguchi Method.

Training and Education of the QT&T Factor

The paper presented by Saraph, *et al.* (1989) discusses the development of an instrument for measuring the critical factors of quality management. According to them, the factors were derived from thorough identification and synthesis from literature reviews prescribed by quality practitioners and academics. Based on their study the content validity was established by a critical review of the items by professors in the operation management field at the University of Minnesota. The items used for measuring training are listed as follows:

1. Specific work-skills training (technical and vocational) given to hourly employees throughout the division.
2. Quality-related training given to hourly employees throughout the division.
3. Quality-related training given to managers and supervisor throughout the division.
4. Training in the "total quality concept" (i.e., philosophy of company-wide responsibility for quality) throughout the division.
5. Training in the basic statistical techniques (such as histograms and control charts) in the division as a whole.
6. Training in advanced statistical techniques (such as design of experiments and regression analysis) in the division as a whole.
7. Commitment of the divisional top management to employee training.
8. Availability of resources for employee training in the division.

Chaudhry, *et al.* (1997) conducted a survey to investigate the impact of quality control processes on the food industry. A survey instrument was developed regarding the management style, employee training, organisational structure, etc. The training part of the survey is indicated below:

1. Additional quality control training of hourly employees would allow the use of more advanced quality control procedures.
2. Further quality control training of supervisors would improve the accuracy of implementing quality control procedures.
3. Employees not directly involved in quality control procedures should be trained in quality-related matters.

Unfortunately, DeVellis (1991) pointed out that each of the above three items contained two questions. Because of these questions, these three items were avoided. An example is in item 1: "Additional quality control training of hourly employees would allow the use of more advanced quality control procedures." Additional quality control training of hourly employees is one question, while allowing the use of more advanced quality control procedures is another question. For this reason, I did not consider these items as part of my survey instrument.

Training Method Performance

In McCahon, *et al.* 's study (1996), they aimed to investigate the effectiveness of training methods used in quality programmes by comparing the performance of six training methods including lecture, workshop, videotape, role playing, self-tutorial (workbook), and self-tutorial (computer). These training methods are shown in Table 3-2.

Table 3-2 Training content part of McCahon's (1996) survey instrument.

Which training technique does your company use to teach specific steps to the seven-step problem-solving process? (Place an "X" in the appropriate block)

Process step	Training techniques					
	Lecture	Video tape	Role playing	Workshop	Self-tutorial (workbook)	Self-tutorial (computer)
Forming a team						
Identifying the problem						
Analysing the problem						
Generating a solution						
Evaluating the solution						
Implementation						
Final evaluation						

For this research, the survey instrument should contain the comparison of training methods because the recognition of effective training methods needs to be identified in order to assist in the attainment of quality improvement. Therefore, to obtain data which indicate the performance of training methods, I have modified McCahon's (1996) survey instrument to create the instrument for this study.

Appendix D shows the instrument that measures the performance of training methods.

Understanding of the Use of QT&T Factor

The extant literature makes no attempt to clarify the understanding of the use of QT&T. Hours (1989) developed an instrument to measure understanding of Crosby's (1979) quality management program. The maturity grid (depicted on Table 3-4) was established based on a theory propounded by Crosby (1979). He advocated four key principles of quality management:

1. Quality denotes conformance to requirements
2. Defect prevention, rather than inspection, is the way to attain quality
3. A standard of zero defects is the only acceptable quality standard
4. The cost of poor quality can amount to 40% of operating costs in a service agency

The principles were then expanded to embrace the concept of quality management maturity. The concept includes a progressive movement through several developmental stages, through which an organisation passes in their quest for a fully developed program of quality management. According to Crosby (1979), quality maturity has five stages on a continuum from least desirable to most desirable:

1. Uncertainty. Problems are dealt with as they occur. No one is able to identify why there are problems.
2. Awakening. A quality assurance team is established. Management begins to ask why they do not have quality.

3. Enlightenment. Corrective action and communications are established. Management becomes committed to quality.
4. Wisdom. Problems are identified early through employee feedback and quality control. Everyone is open to suggestions for improvement and prevention becomes routine.
5. Certainty. Problems are prevented except in unusual circumstances.

Table 3-3 Crosby's Quality Management Maturity Grid (1979)

Quality Management Maturity Grid					
Measurement Categories	Stage I: Uncertainty	Stage II: Awakening	Stage III: Enlightenment	State IV: Wisdom	Stage V: Certainty
Management understanding and attitude	No comprehension of quality as a management tool. Tend to blame quality department for "quality problems".	Recognizing that quality management may be of value but not willing to provide money or time to make it all happen.	While going through quality improvement program learn more about quality management; becoming supportive and helpful.	Participating. Understand absolutes of quality management. Recognize their personal role in continuing emphasis.	Consider quality management an essential part of company system.
Quality organisation status	Quality is hidden in manufacturing or engineering departments. Inspection probably not part of organisation. Emphasis on appraisal and sorting.	A stronger quality leader is appointed but main emphasis is still on appraisal and moving the product. Still part of manufacturing or other.	Quality department reports to top management, all appraisal is incorporated and manager has role in management of company.	Quality manager is an officer of company; effective status reporting and preventive action. Involved with consumer affairs and special assignments.	Quality manager on board of directors. Prevention is main concern. Quality is a thought leader.
Problem handling	Problems are fought as they occur; no resolution; inadequate definition; lots of yelling and accusations.	Teams are set up to attack major problems. Long-range solutions are not solicited.	Corrective action communication established. Problems are faced openly and resolved in an orderly way.	Problems are identified early in their development. All functions are open to suggestion and improvement.	Except in the most unusual cases, problems are prevented.
Cost of quality as % of sales	Reported: unknown Actual: 20%	Reported: 3% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported: 2.5% Actual: 2.5%
Quality improvement actions	No organized activities. No understanding of such activities.	Trying obvious "motivational" short-range efforts.	Implementation of the 13-step program with thorough understanding and establishment of each step.	Continuing the 13-step program and starting. Make certain.	Quality improvement is a normal and continued activity.
Summation of company quality posture	"We don't know why we have problems with quality."	"Is it absolutely necessary to always have problems with quality?"	"Through management commitment and quality improvement we are identifying and resolving our problems."	"Defect prevention is a routine part of our operation."	"We know why we do not have problems with quality."

As it can be seen, the above five stages are in ascending order of maturity or understanding of a quality training program. Therefore, the modification was made to the "use of QT&T" instead of to the "quality program" itself. An adaptation of the original survey instrument enables a measurement of the understanding of the use of QT&T. For modifying the measurement items of understanding of the use of QT&T for the whole organisation, there were six items originally. Three items were retained in my instrument because they are related to how the organisations implement quality programs and the degree of understanding quality. Item 1 was to evaluate management's understanding and attitude on quality program. Item 5 was to evaluate the degree of quality improvement action taken in the organisation. Finally, item 6 was a summation of the company quality posture. I modified the term "quality program" to be "use of QT&T". Item 2 was to evaluate quality status such as the existence of a quality department or a quality manager in the organisation. Item 3 concerned the problem of handling. Item 4 was about the ratio of the cost of quality of sales as a percentage. Therefore, items 2, 3 and 4 were not related to my required instrument, leaving only 3 items captured for measuring understanding of the use of QT&T for the whole organisation. The modified measurement items are shown at Appendix D.

To create a more comprehensive measurement, personnel understanding should be taken into account. The measurement items for the personnel would be set up as Table 3-4:

Table 3-4 Measurement Items for Personnel Understanding

1.	I can use the appropriate 7 basic quality tools to tackle the problems easily.
2.	I can use the appropriate new 7 management tools to tackle the problems easily.
3.	I can use the appropriate advanced quality techniques to tackle the problem easily.

The above measurement items are simple and unambiguous. If the respondents can use the appropriate QT&T to tackle the problem easily, that means they can understand how to use it. Including the first 3 items on measuring the understanding of the use of QT&T for the whole organisation, there would be a total of 6 items for understanding of the use of QT&T.

Steps 3 and 4: Format Determination - Scale Development, and Demographic Questions

In many cases, the questions are set out on a five-point scale which is known as the Likert scale, ranging from 5 = "Strongly Agree" to 1 = "Strongly Disagree" with the median value as "Neutral" or "No Opinion".

Demographic questions included information regarding the respondent's educational level, current position, company's business natures, main ownership of the company, and size of the company. The reason to include this information is because there may be relations between company's business natures, ownership of the company, and size of the company to the primary interest of this survey. Categories of the business natures were classified according to the Hong Kong Trade and Industrial Organisation (1998).

Steps 5, 6 and 7: Items Revision, Pilot Test, and Survey Refinement and Finalisation

To increase the readability and to ensure that all respondents have the same perception on the surveys, I conducted a pilot test before mailing the questionnaires.

The questionnaires were distributed to 12 students taking the Master of Science in quality management program of The Hong Kong Polytechnic University.

The result of the pilot test indicates that the respondents encountered two main difficulties in answering the questionnaire.

1. Part D question 3 – the ranking part was the most difficult to fill in because the matrix was too big and too many items needed to be filled in.
2. Some items (QT&T) the respondents did not know or were not familiar with.

To solve these difficulties, for problem 1, I grouped charts (bar, pie and spider), cause and effect diagram, control charts, check sheets, flowcharts, pareto analysis, and scatter diagram into the 7 basic quality tools; activity network diagram, affinity diagram, interrelations diagram, matrix data analysis diagram, matrix diagram, process decision program charts (PDPC), and tree diagram into the new 7 management tools; QFD, FMECA, and Taguchi Method as advanced techniques. This minimised items and matrix complexity. For problem 2, if respondents did not fill some items they were treated as missing values.

Step 8: Reliability Test

There are four methods to assess the reliability of empirical measurements:

1. retest method
2. alternative form method
3. split-halve method
4. internal consistency method

According to Saraph, *et al.* (1989), the first three methods have major limitations, which require two independent administrations of the instrument on the same group of people or two alternate forms of the measuring instrument. On the other hand, the internal consistency method works well in field studies and also provides the most general form of reliability estimation. Internal consistency describes the degree to which items in the set are homogeneous. It can be estimated by using a reliability coefficient such as Cronbach's alpha (Cronbach, 1951; Nunnally, 1967; Sellitz, 1976) and can be computed after data collection.

3.4.2 Survey Frame and Procedures

The objective of the survey is to investigate the impact of training and education, and understanding on the use of the quality tools and techniques in HK's service and manufacturing companies. A random sample of 600 companies' addresses was drawn from the following sources:

- Directory of ISO 9000 certified companies in Hong Kong (1998), and
- Directory of members / Chinese General Chamber of Commerce, Hong Kong (1997)

The questionnaire was sent randomly, together with a letter regarding the purpose and confidentiality of the research and a self-addressed stamped envelope. To identify respondents, a code number was given on the back of each return envelope. Phone calls were made to non-respondents to remind them three weeks after the questionnaires were mailed. Twenty-five company replies were received, achieving a response rate of 4.2%. This return rate was poor for a survey. Therefore another 100 questionnaires were distributed to the following sources:

- Students of the Master of Science in operation management program of The Hong Kong Polytechnic University

- Students of the Master of Science in quality management program of The Hong Kong Polytechnic University
- Students of Master of Business Administration in operation management program of The Hong Kong Polytechnic University

As a result, seventy-five out of a hundred data were valid. Therefore, the total number of surveys returned was 100. Data were entered into a computer for analysis using the SPSS software.

3.5 Phase IV: Develop a Multimedia Advisory System

The MBAQ system was used to assist the user in identifying appropriate QT&T, according to the natures of problems. The MBAQ system can be used to diagnose the problem by selecting an appropriate QT&T, with regards the problem solving approach. Comparing with Tables 2-4 and 2-5, the multimedia-based advisory system would be the most comprehensive and user-friendly among them. Firstly, MBAQ can assist the quality practitioners for quality diagnosis and improvement in both the manufacturing and service industries, while the mentioned software tools are for the manufacturing industry only. Secondly, the problem solving approach contains 5 phases: problem identification, problem analysis, problem prevention, idea generation and decision making. This is my proposed taxonomy problem solving approach. Thirdly, the system is multimedia-based. As a consequence, it allows the quality practitioners to learn and use the system in a most convenient way.

There are numerous multimedia software programs, which can be used for multimedia development. The most popular multimedia software are Marcomedia

Director, and Marcomedia Authorware Attain. The former aims at animation more while the latter aims at both animation and navigation. Further, Marcomedia Authorware Attain is more user friendly according to experts in the Multimedia Innovation Centre of The Hong Kong Polytechnic University. Therefore, it was selected as a tool for the development of the MBAQ system under the Microsoft Windows 95 or 98 platform.

3.6 Summary

In this chapter, the research methodology of this study has been presented.

Phase I: Propose a taxonomy for classifying QT&T

The proper use of quality tools and techniques is vital for the success of quality improvement efforts. The approach to develop a taxonomy for classifying QT&T was to examine existing taxonomies and evaluating their features.

Phase II: Develop a quality software list

A questionnaire survey of 53 quality software companies mainly located in the USA and Canada was conducted. The questionnaire was divided into two parts. Part one was designed to assess quality software products of these companies. Part two of the questionnaire was designed to validate my proposed taxonomy.

Phase III: Conduct an empirical research

In this study, exploratory research on the use of QT&T and the influencing factors was conducted in order to evaluate and investigate the impact of the influencing factors on the use of QT&T in organisations. The two influencing factors examined were understanding of QT&T and training and education in the use of QT&T. Hypothesis testing was then conducted to analyse the association between these two influencing factors and the use of QT&T. In developing the hypotheses for testing, a survey instrument was developed. The instrument was developed following a rigorous procedure using eight steps. 100 survey questionnaires were returned for data analysis and hypothesis testing.

Phase IV: Develop MBAQ system

The development approach of MBAQ has been described. The benefits of MBAQ compared with other existing training systems for QT&T have been highlighted and discussed.

4. RESULTS OF DATA ANALYSIS

4.1 Data Analysis I: A Taxonomy and Quality Software Tools List

The taxonomy classifies 25 popular QT&T into five application domains, namely problem identification, problem analysis, problem prevention, ideas generation and decision making. Problem identification refers to gaining an understanding of the current situation of a business process and formulating the existing problem to be amenable to relevant QT&T. Problem analysis is concerned with revealing the root causes of the problem. Problem prevention deals with eliminating the possibility of problem recurrence. Idea generation is concerned with adopting innovative approaches to tackle the existing problem and make improvement on the current business processes. Decision-making means taking actions based on the overall conclusion inferred from the analysis.

As shown in Figure 4-1, the proposed taxonomy provides a step-by-step procedure for selecting QT&T, focusing on problem solving and process improvement. The procedure starts with problem identification, going through each step sequentially and finishes with decision-making. Beginning with identifying the problem will help in the understanding of the current situation and help to clarify the existing problem. Having identified the problem, the next step should be to analyse it so as to reveal the root causes. Once the causes underlying the problem are identified, preventive measures should then be taken to eliminate the possibility of problem recurrence. New ideas should be formulated to tackle the existing problem and to improve the current situation. Finally, decision-making should take corrective actions based on the overall conclusion from the analysis. It is an endless loop and therefore it can facilitate continuous improvement.

To assist quality practitioners to use and understand QT&T in depth, I have collected a comprehensive list of quality software available by conducting a survey. The implication is that the application of QT&T can be aided by the use of computers and data storage, retrieval and transfer data can be greatly enhanced via computer power.

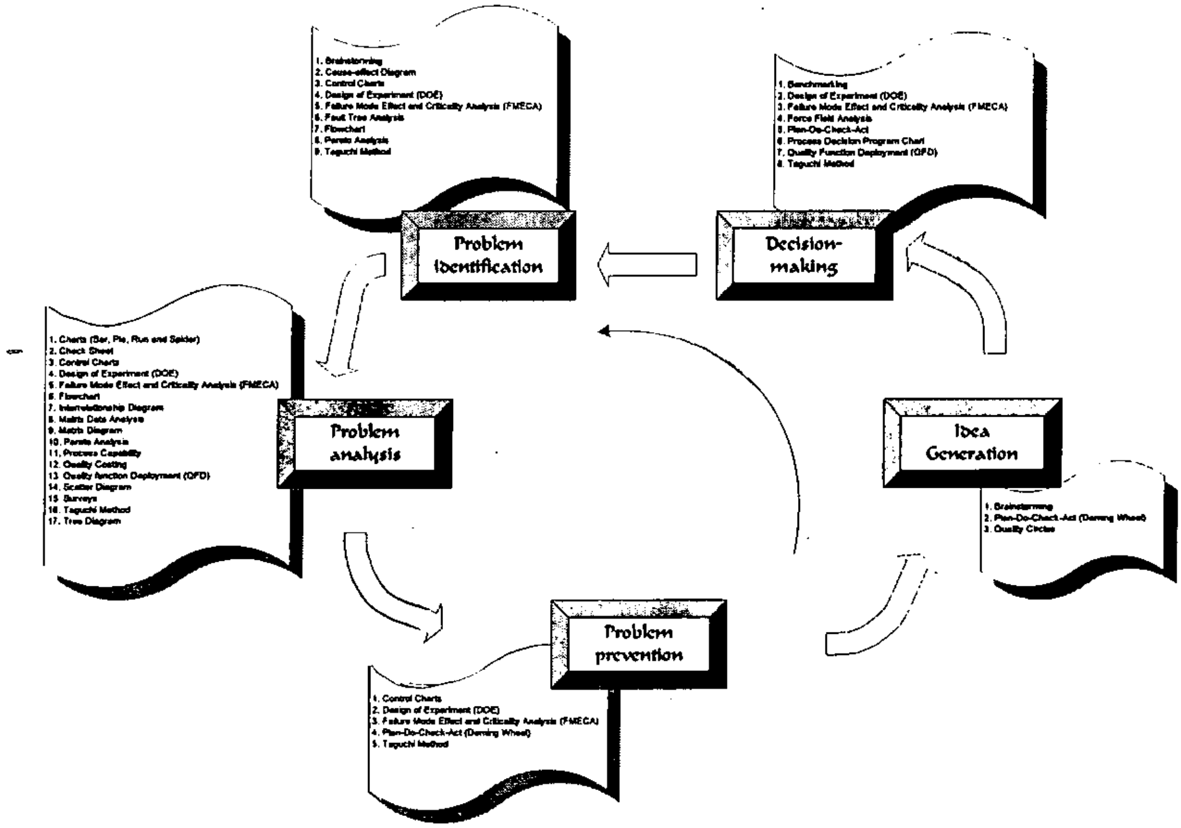


Figure 4-1 The Proposed Taxonomy

In order to validate the proposed taxonomy, I have conducted a survey to seek the opinion of quality experts in quality software companies on its validity. Questionnaires were mailed to 53 quality software companies and a total of 20 were returned, achieving a response rate of 37.7%. The respondents were asked to fill in part one by checking an 'X' in the appropriate box(es) of the matrix questionnaire, according to the functions or techniques provided by their products. 47 different quality software products were identified and their functions or techniques were noted (as shown in Table 4-1). The quality software products for which responses were received are outlined at Appendix C together with references for each product. 16 out of 20 respondents filled in part two. The survey results in Table 4-2 show that 75% of the respondents agree on the classification of the mentioned QT&T under "problem identification", while 72% of the respondents agree on the classification of the mentioned QT&T under "problem analysis". Referring to the classification of the QT&T under "problem prevention, 75% of the respondents agree that they should be classified as such. In addition, 71% of the respondents agree on the classification of the mentioned QT&T under "idea generation". Referring to the categorisation of QT&T under "decision-making", 60% of the respondents agree with their classification. Based on the survey results, it can be seen that majority of the experts surveyed agree with the proposed taxonomy.

The survey results of part one indicate that there are 23 software products that can be used for pareto analysis, 21 for process capability, 19 for control charts, 17 for charts (e.g. bar, pie, run and spider), and 13 for scatter diagram and design of experiments (DOE). It can be seen that the seven basic quality tools are available in most of the listed quality software products, which may imply that they are very popular and are frequently used for quality improvement. It is somewhat surprising to note that there are several quality software products for advanced quality tools and techniques, ten for Taguchi method and six for QFD. With the aid of quality software to apply quality tools and techniques, quality improvement efforts can be undertaken quite easily. This, therefore, removes the difficulties associated with the advanced quality tools and techniques and helps promote their usage.

Table 4-1 Some Quality Software in available for Continuous Improvement

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
	4TQFlow+	4TQLink	allCLEAR	CARD	CATS	Design of Experiments (DoE) - Matrex for Excel 5.0	DESIGN-EASE	DESIGN-EXPERT	JMP	Milestones, Etc.	MINITAB	NCSS 97	PathMaker	PFT for Windows	PFT Pro Ed. Advanced for Windows	PFT Pro Ed. for Windows	Process Charter	Project KickStart	Project Scheduler 7.5	QC-PRO	QFD Designer	QFD/Capture Profession Edition	QFD/Capture Standard Edition	QFD Scope for Windows	QI Analyst DB	Qualitek 4	Relex FMEA/FMECA	SAS/QC Software	SPSS	SQCpack for Windows	STATGRAPHICS Plus for Windows	STATISTICA Industrial System	Statistical Process Control	Survey Genie	Survey Select	Survey Solutions for the Web	Synergy Gold	Synergy Maestro	TE Sampling Programs	TimeSaver for Windows	TimeSaver Gold	TimeSaver Maestro	VarTran	Visio
Acceptance Sampling																												X			X	X						X	X	X	X	X		
Affinity Diagram		X											X	X	X	X								X																				
Benchmarking			X										X									X	X																					
Brainstorming		X	X										X	X	X	X								X		X		X																
Brainwriting			X																																									
Cause-effect Diagrams		X								X		X	X	X	X												X			X													X
Charts (Bar, Pie, Run and Spider)		X							X		X	X	X		X	X				X		X	X		X	X		X	X	X	X	X												
Check Sheets		X																																										
Control Charts		X								X	X	X		X	X				X					X			X	X	X	X	X	X				X	X		X	X	X		
Deployment Chart			X																		X	X																					X
Design of Experiments (DOE)				X		X	X	X	X		X	X			X					X						X		X			X	X												
Failure Mode Effect and Criticality Analysis (FMECA)																											X																	
Fault Tree Analysis													X	X		X																												
Flowchart	X		X										X		X		X																											X
Force Field Analysis													X																															X
Gantt Chart										X			X	X	X	X		X	X									X																X
How-How Diagram														X	X	X						X	X																					
Interrelationship Diagram			X										X	X	X	X						X	X																					
Matrix Data Analysis				X								X		X	X	X						X	X						X		X	X												
Matrix Diagram											X			X	X	X						X	X	X								X												
Pareto Analysis		X			X				X		X	X	X		X	X				X		X	X	X	X			X		X	X	X					X	X		X	X	X	X	
Plan-Do-Check-Act (Deming Wheel)		X									X		X																															
Process Capability		X	X						X		X	X	X		X	X				X					X	X		X		X	X	X	X				X	X		X	X	X		
Process Decision Program Chart													X	X	X	X												X															X	
Quality Circles													X																															
Quality Function Deployment (QFD)			X																		X	X	X	X				X																
Scatter Diagram		X							X		X	X	X		X	X						X			X			X	X		X	X												
Surveys																						X							X			X		X	X	X								
Taguchi Method			X			X					X	X								X						X		X			X	X											X	
Tree Diagram			X										X	X	X	X						X		X				X				X												X
Why-Why Diagram			X																																									
WorkFlow Diagram	X		X														X																											X

Table 4-2 Survey Results

Problem Identification	% Agreed	% Disagreed	% of No Idea
Brainstorming	75	6	19
Cause-effect Diagram	88	6	6
Control Charts	75	13	13
Design of Experiments (DOE)	81	13	6
Failure Mode Effect and Criticality Analysis (FMECA)	63	13	25
Fault Tree Analysis	75	6	19
Flowchart	63	6	31
Pareto Analysis	88	6	6
Taguchi Method	63	13	25
Average	**75**	**9**	**17**

Problem Prevention	% Agreed	% Disagreed	% of No Idea
Control Charts	88	6	6
Design of Experiments (DOE)	69	25	6
Failure Mode Effect and Criticality Analysis (FMECA)	81	6	13
Plan-Do-Check-Act (Deming Wheel)	69	0	31
Taguchi Method	69	6	25
Average	**75**	**9**	**16**

Problem Analysis	% Agreed	% Disagreed	% of No Idea
Charts (Bar, Pie, Run and Spider)	94	6	0
Check Sheet	50	19	31
Control Charts	69	19	13
Design of Experiments (DOE)	100	0	0
Failure Mode Effect and Criticality Analysis (FMECA)	75	0	25
Flowchart	69	13	19
Interrelationship Diagram	69	6	25
Matrix Data Analysis	63	0	38
Matrix Diagram	56	0	44
Pareto Analysis	75	6	19
Process Capability	63	19	19
Quality Costing	50	19	31
Quality function Deployment (QFD)	56	13	31
Scatter Diagram	94	6	0
Surveys	69	6	25
Taguchi Method	88	0	13
Tree Diagram	81	6	13
Average	**72**	**8**	**20**

Idea Generation	% Agreed	% Disagreed	% of No Idea
Brainstorming	94	0	6
Plan-Do-Check-Act (Deming Wheel)	44	25	31
Quality Circles	75	0	25
Average	**71**	**8**	**21**

Decision Making	% Agreed	% Disagreed	% of No Idea
Benchmarking	63	19	19
Design of Experiments (DOE)	88	0	13
Failure Mode Effect and Criticality Analysis (FMECA)	56	13	31
Force Field Analysis	50	0	50
Plan-Do-Check-Act	56	19	25
Process Decision Program Chart	50	0	50
Quality Function Deployment (QFD)	63	13	25
Taguchi Method	56	13	31
Average	**60**	**10**	**30**

4.2 Data Analysis II: Empirical Research

In this section, four aspects will be discussed: preliminary findings, hypotheses testing results, correspondence analysis and performance of training approaches. The purpose of the preliminary findings is to give an overview of the frequency of the QT&T usage obtained from the companies. The aim of hypotheses testing is to examine the association between the use of QT&T and training and education, and understanding of QT&T. Correspondence analysis reveals the relation between different kinds of business natures to the frequency of QT&T usage. Finally, the performance of training methods for QT&T will be evaluated and discussed.

4.2.1 Preliminary Findings

Out of the 100 company responses, the mean frequency of QT&T usage ranged from 2.9 to 1.59 with a median of 2.23 (See Table 4-3). This suggests that the companies normally employed QT&T from once every 2 weeks to once every month (ranging from 2.9 – 1.59). The 7 basic quality tools, acceptance sampling and brainstorming were the most commonly used. To categorise the usage by industry, Table 4-4 shows that the manufacturing industry used the 7 basic quality tools, acceptance sampling and process capability more often than the service industry. In contrast, the service industry used benchmarking, gantt chart and quality circles more frequently.

Table 4-3 Mean Response of the Use of QT&T

7 Basic Quality Tools	**New 7 Manageme nt Tools**	**Advanced Techniques**	**Acceptance Sampling**	**Bench -marking**	**Brain-storming**	**Deployment Chart**	**Faulty Tree Analysis**
2.65	1.77	1.69	2.86	2.39	2.90	1.92	1.83
Force Field Analysis	**Gantt Chart**	**Plan-Do-Check-Act (Deming Wheel)**	**Pokayoke (Foolproof)**	**Process Capability**	**Quality Circles**	**Quality Costing**	**Surveys**
1.59	2.27	2.38	1.83	2.37	2.24	1.98	2.22

Table 4-4 Difference of the Use of QT&T compared with MFG Industry and Service Industry

	Number of Company	7 Basic Quality Tools	Acceptance Sampling	Bench-marking	Brain-storming	Gantt Chart	Plan-Do-Check-Act (Deming Wheel)	Process Capability	Quality Circles
MFG	63	2.90	1.88	0.72	1.24	1.38	1.07	1.36	0.91
SER	37	2.22	1.38	1.08	1.18	1.51	1.01	1.18	1.03

4.2.2 Hypotheses Testing

In the research hypotheses, the primary interest is the use of QT&T. The purpose of this study is to examine whether there exists any association between the use of QT&T and the two influencing factors: training and education, and understanding of QT&T. The testable model is shown in Figure 4-2. The null hypothesis is a proposition that states a definitive, exact relationship between two variables. That is, it states that the population correlation between two variables is equal to zero or that the difference in the means of two groups in the population is equal to zero (or some definite number). In general, the null statement is expressed as no (significant) relationship between two variables or no (significant) difference between two groups. The alternate hypothesis, which is the converse of the null, is a statement expressing a relationship between two variables or indicating differences between groups. The study was to examine the following hypotheses:

$H_0 1$: Training and education of the use of QT&T is not associated with the use of QT&T

$H_1 1$: Training and education of the use of QT&T is associated with the use of QT&T

$H_0 2$: Understanding of QT&T is not associated with the use of QT&T

$H_1 2$: Understanding of QT&T is associated with the use of QT&T

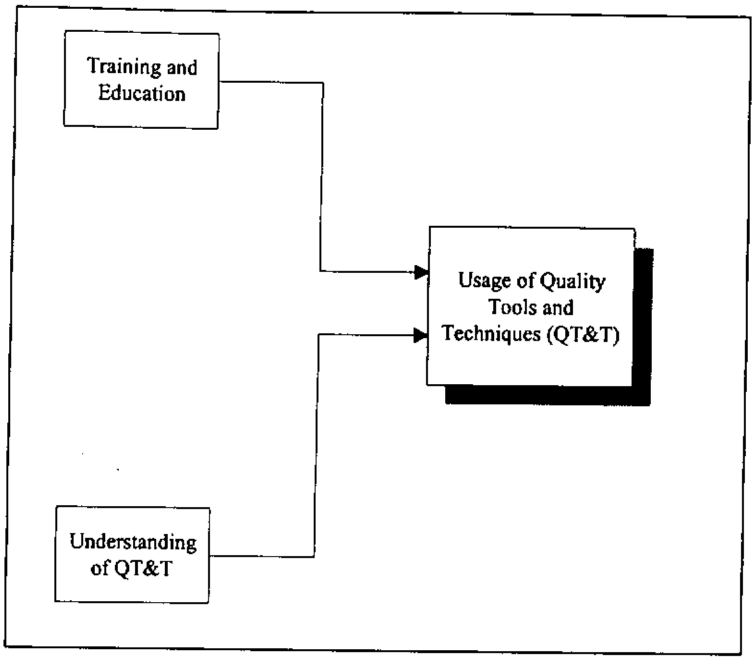


Figure 4-2 Testable Model

Since the variable of "training and education" is ordinal, and variables of "use of QT&T" and "understanding of QT&T" can be treated as either "interval" or "ordinal", a chi-square test (χ^2) was used. It examines if there is a relationship between two nominal variables or whether they are independent of each other. χ^2 is a nonparametric test that is used when normality of distributions cannot be assumed as in nominal or ordinal data. The χ^2 test compares the expected frequency (based on probability and the observed frequency), and the χ^2 statistic is obtained by the formula:

$$\chi^2 = \sum \frac{(O_i - E_i)^2}{E_i},$$

where χ^2 is the chi-square statistic; O_i is the observed frequency of the ith cell; and E_i is the expected frequency. The χ^2 statistic with its level of significance can be obtained for any set of nominal data through computer analysis.

Thus, in testing for differences in relationships among nominally scaled variables, the χ^2 statistic comes in handy. The null hypothesis would be set to state that there is no significant relationship between two variables (use of QT&T and training and education, and use of QT&T and understanding), and the alternative hypothesis would be that there would be a significant relationship. The χ^2 test of significance thus helps us to see whether or not two nominal variables are related (Sekaran, 2000). The results indicate that "Training and education of the use of QT&T" is associated with the use of QT&T with χ^2 = 0.093 at 0.1 level of significance. And "Understanding of QT&T" is associated with the use of QT&T with χ^2 =0.002 at 0.01 level of significance.

4.2.3 Reliability Test Results

By using the SPSS program, an internal consistency analysis was performed separately for the items of each variable. Table 4-5 reports the reliability analysis of each variable. It shows that the 16 items of the frequency of QT&T usage achieves a very high reliability coefficient of 0.92, and nine items for training and education accomplishes a very high reliability coefficient of 0.92. It also shows that six items for understanding achieve a satisfied reliability coefficient of 0.88. Both reliability coefficients are well over the threshold 0.7 and are thus considered adequate (Cronbach, 1951; Nunnally, 1967; Scott, 1981).

Table 4-5 Reliability Analysis – Scale (Alpha)

Variables	Number of Items	Alpha
Use of QT&T	16	0.9206
Training and Education	9	0.9236
Understanding	6	0.8797

4.2.4 Correspondence Analysis and Homogeneity Analysis

In this survey study, an exploratory research of the relationship between types of business natures and the use of QT&T was conducted because probably different business natures would employ different types of QT&T and that have differing frequencies of usage. Therefore, it would be a novelty to figure out the pattern of usage according to different business natures. Principal components analysis and correspondence analysis (Lebart, *et al.*, 1984; Ngai and Cheng, 1997) are two common multivariate statistical techniques (Hair, *et al.*, 1995; Stevens, 1992) that can be used to analyse interrelationships among a couple of variables. Principal components analysis is used for tables consisting of continuous measurements. In other words, the type of measurement scale employed by the variables is metric (quantitative or numerical). Correspondence analysis is applied for the type of variable that is non-metric (qualitative or categorical). Correspondence analysis is a technique used to summarise the information in a two-way contingency table. The row and column variables of the two-way table are assumed to be measured at the nominal level of measurement. Therefore, the values of the row and column variables represent unordered categories. It provides a graphical summary in the form of plots that show the relationships between categories of the two variables. It also allows for examination of the relationship between two nominal variables graphically in a multidimensional space. Categories that are similar appear close to each other in the plots. In this way, it is easy to see which categories of a variable are similar to each other or which categories of the two variables are related (SPSS, 1994).

The purpose of the analysis is to explore the pattern of usage of quality tools and techniques:

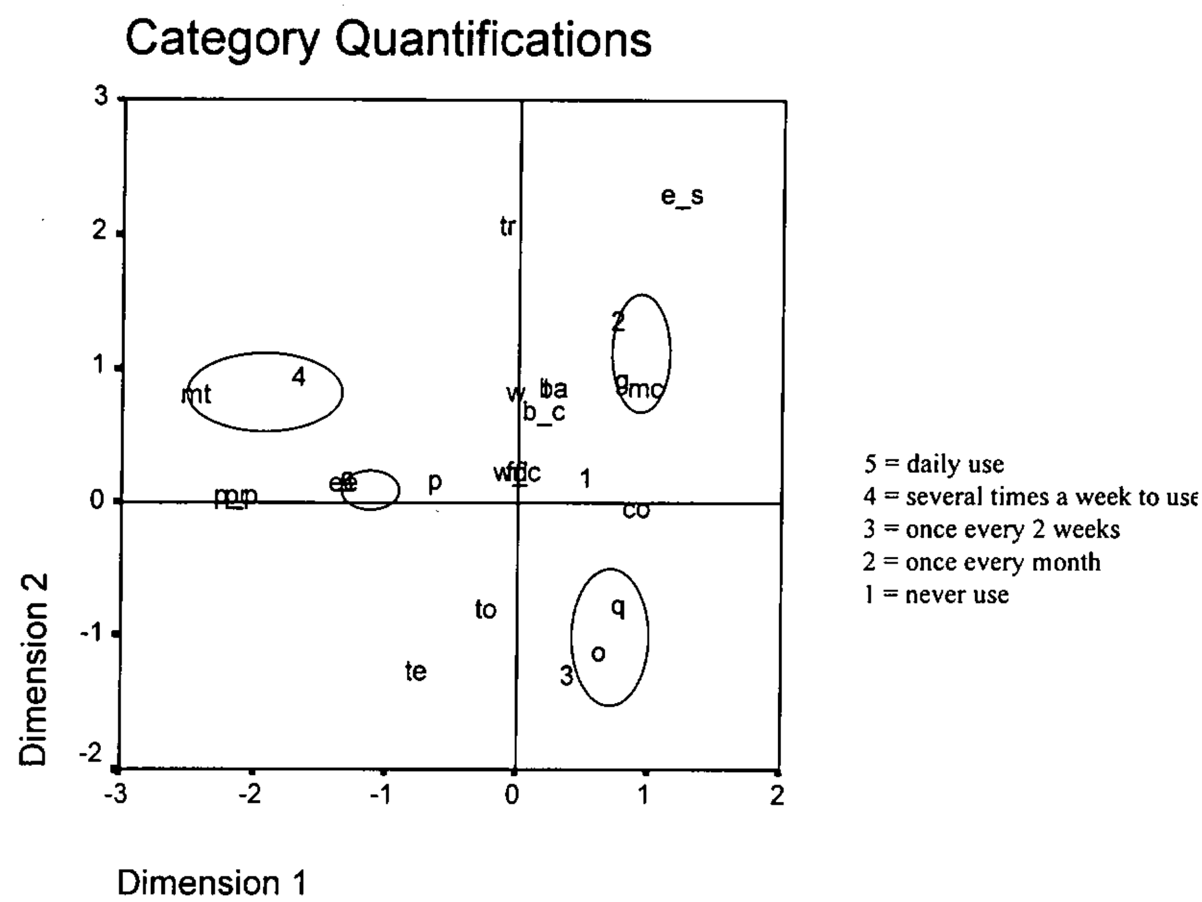
- The similarities and differences among the business natures with respect to the use of quality tools and techniques

- The relationships among the patterns of usage of quality tools and techniques and the business natures

Since the variables were 16 kinds of QT&T with 5 ordinal scales of QT&T usage, homogeneity analysis was performed. Homogeneity analysis is known as multiple correspondence analysis. Unlike correspondence analysis, homogeneity analysis is not limited to two variables (SPSS, 1994). Homogeneity analysis can compute a solution for several dimensions. A one-, two- or three-dimensional solution in homogeneity analysis is very common because a smaller number of dimensions is easier to interpret. The two dimensions together provide an interpretation in terms of distances. Objects in the same category will be close to each other, i.e. they should have similar scores.

In this exploratory study, I will individually interpret the 7 basic quality tools, the new 7 management tools, the advanced techniques, acceptance sampling, and benchmarking against different kinds of business natures.

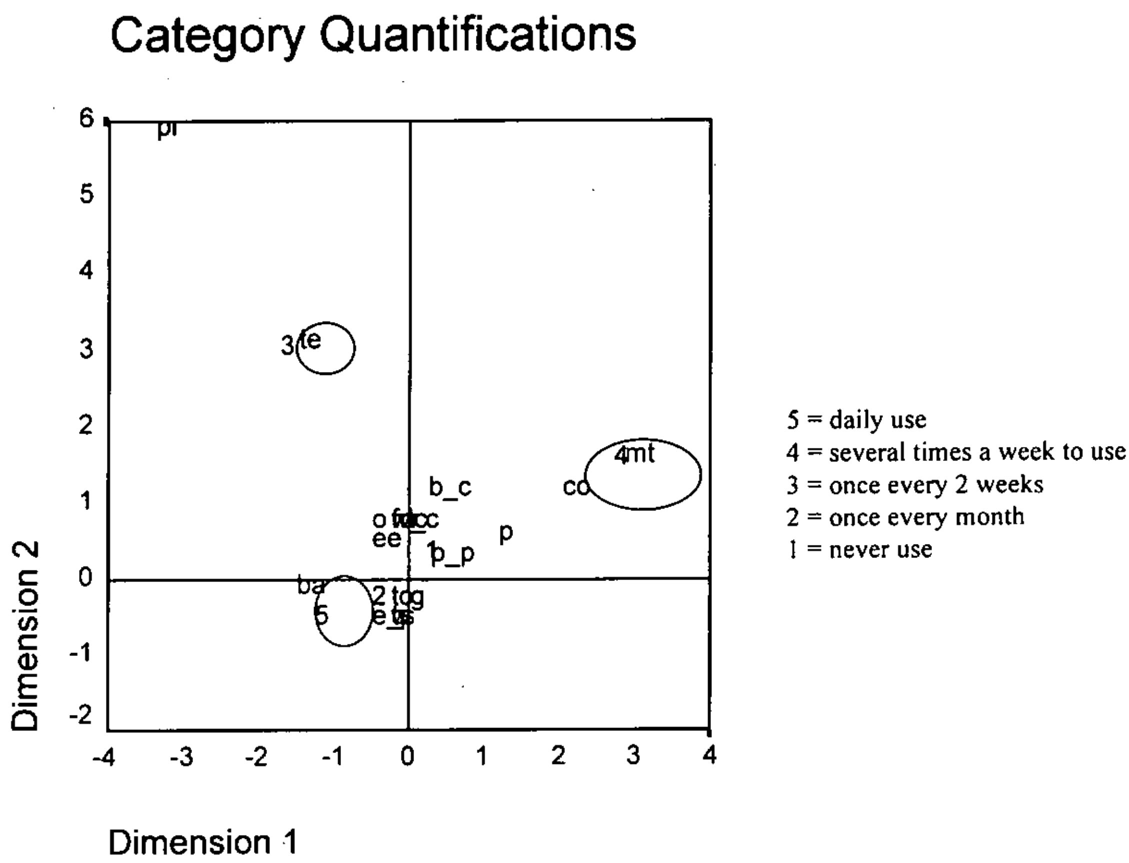
Figure 4-3 is the perceptual map that shows the relative position of the frequency of the 7 basic quality tools usage and the different kinds of business natures. Although the perceptual map does not indicate the type of correlation relationship, it does show an intuitively appealing picture. Further, it gives an indication of which business natures are particularly associated with which frequency of the 7 basic quality tools usage. From the plot of Figure 4-3, the relations between row and column dimensions can be studied. Dimension 1 displays high positive values on "environmental services" and high negative values on "metal". The business natures of "quality, industrial testing and inspection service" and "others" are associated with a "once every 2 weeks" use of the 7 basic quality tools. Further, "machinery" and "government funded/statutory organisation" are associated with "once every month" use of the 7 basic quality tools. Dimension 2 places high positive values on "environmental services" and high negative values on "textile". Dimension 2 suggests that "metal" is associated with a "several times a week" use of the 7 basic quality tools. The perceptual map suggests that "electronic and electrical products and related products" is most associated with a "daily" use of the 7 basic quality tools.



For Business Natures, the abbreviation: Bank = (ba); Building and Construction = (b_c); Computer and Related Services = (co); Electronics = (ee); Environmental services = (e_s); Financial = (f); Foodstuff = (fd); Government = (g); Machinery = (mc); Metal = (mt); Paper and Packaging products = (p_p); Plastics = (p); Printing = (pr); Quality, Industrial Testing = (q); Real Estate = (r); Telecommunications = (t); Textile = (te); Toys and Games = (to); Transport = (tr); Watches and Clocks = (w_c); Wholesale and Retail = (w); Others = (o)

Figure 4-3 Perceptual Map of the 7 Basic Quality Tools

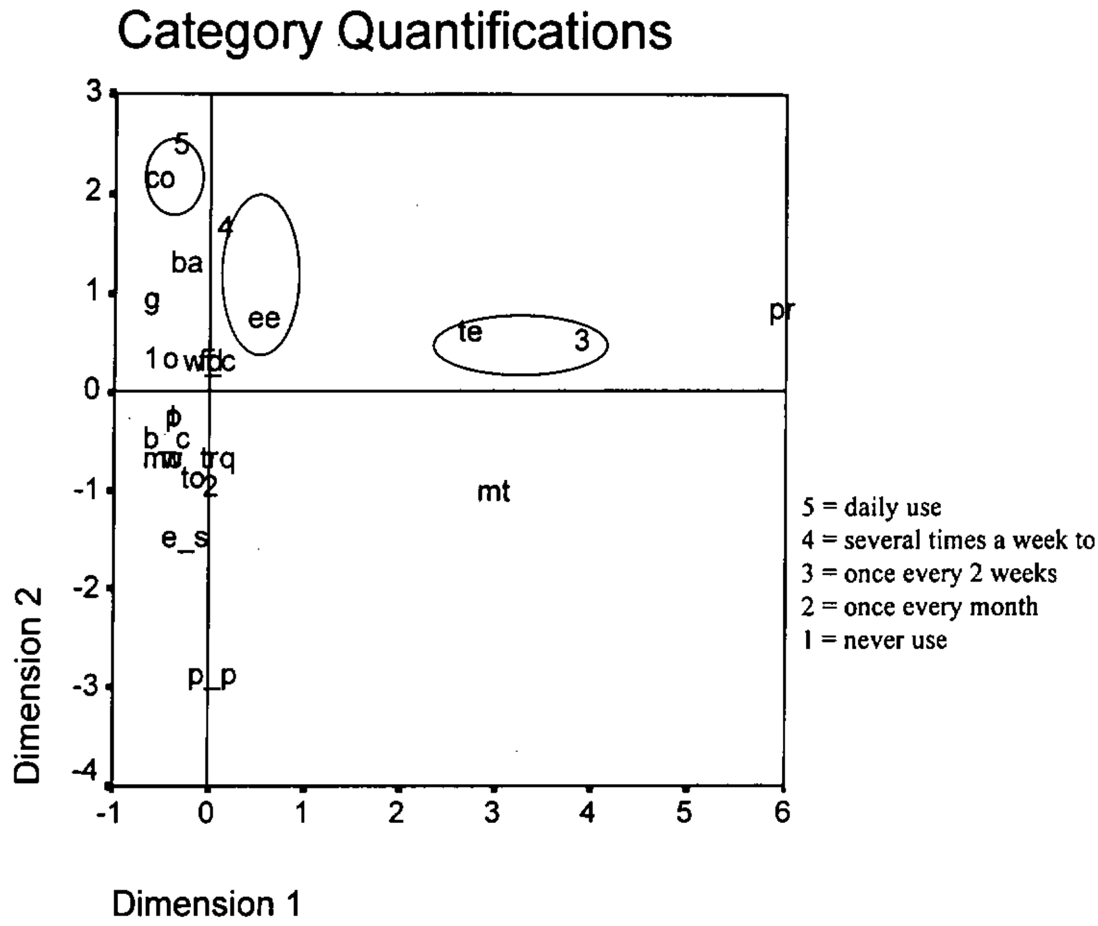
Figure 4-4 is the perceptual map that shows the relative position of the frequency of the new 7 management tools usage and the different kinds of business natures. Figure 4-4 indicates the association of the business natures groups to the frequency of the new 7 management tools usage. Dimension 1 assigns high positive values on "metal" and high negative values on "printing and publishing". Dimension 1 suggests that "banking" is highly associated with a "daily" use of the new 7 management tools. In contrast, "printing and publishing" is most isolated with the frequency of the new 7 management tools usage. Dimension 2 places "printing and publishing" as high positive values while placing high negative values on "wholesale and retail". Dimension 2 suggests that "textile" is associated with a "once every 2 weeks" use of the new 7 management tools. Further, "metal" and "computer and related services" are highly associated with a "several times a week" use of new 7 management tools.



For Business Natures, the abbreviation: Bank = (ba); Building and Construction = (b_c); Computer and Related Services = (co); Electronics = (ee); Environmental services = (e_s); Financial = (f); Foodstuff = (fd); Government = (g); Machinery = (mc); Metal = (mt); Paper and Packaging products = (p_p); Plastics = (p); Printing = (pr); Quality, Industrial Testing = (q); Real Estate = (r); Telecommunications = (t); Textile = (te); Toys and Games = (to); Transport = (tr); Watches and Clocks = (w_c); Wholesale and Retail = (w); Others = (o)

Figure 4-4 Perceptual Map of the New 7 Management Tools

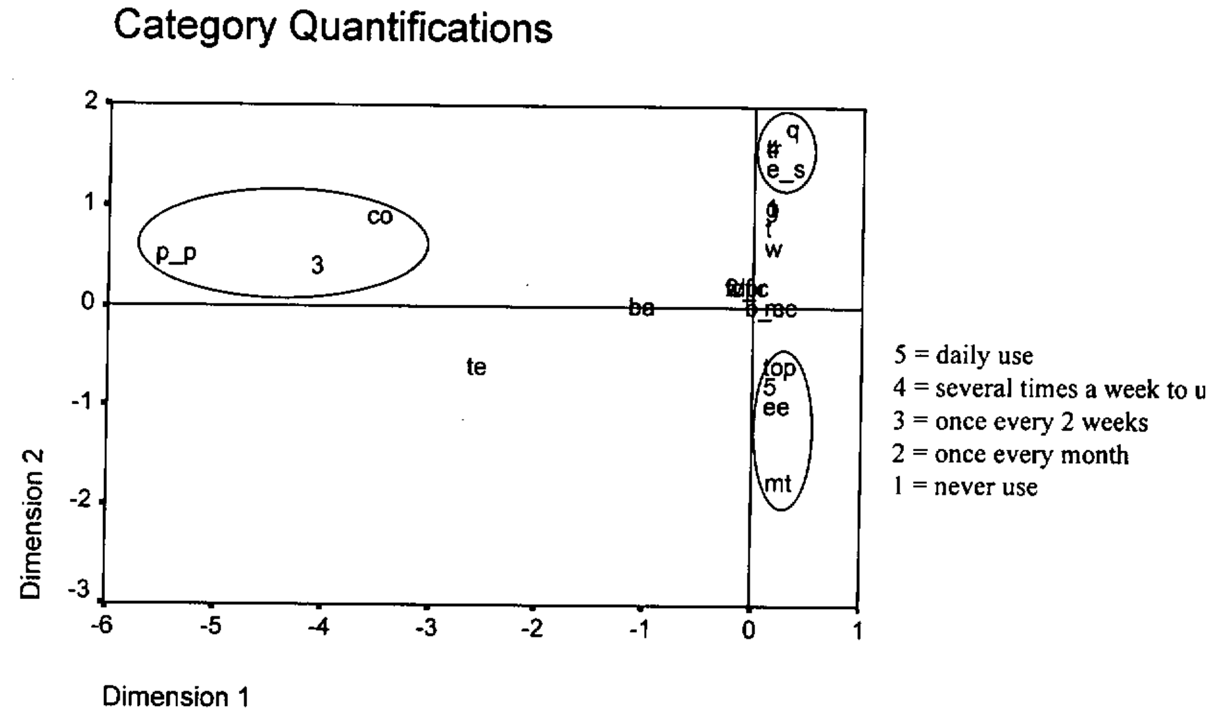
Figure 4-5 shows the relations between the frequency of the advanced techniques usage and different types of business natures. Dimension 1 posts high positive values on "printing and publishing" and high negative values on "computer and related services". It is not surprising to see that "electronic and electrical products and related services" is associated with a "several times a week" use of the advanced techniques. In contrast, dimension 2 gives high positive values on "computer and related services" and high negative values on "paper and packaging products". For dimension 2, it suggests that "textile" is associated with a "once every 2 weeks" use of the advanced techniques. It depicts the "computer and related services" as being more associated with a "daily" use of the advanced techniques.



For Business Natures, the abbreviation: Bank = (ba); Building and Construction = (b_c); Computer and Related Services = (co); Electronics = (ee); Environmental services = (e_s); Financial = (f); Foodstuff = (fd); Government = (g); Machinery = (mc); Metal = (mt); Paper and Packaging products = (p_p); Plastics = (p); Printing = (pr); Quality, Industrial Testing = (q); Real Estate = (r); Telecommunications = (t); Textile = (te); Toys and Games = (to); Transport = (tr); Watches and Clocks = (w_c); Wholesale and Retail = (w); Others = (o)

Figure 4-5 Perceptual Map of the Advanced Techniques

Figure 4-6 is the perceptual map that shows the relative position of the frequency of acceptance sampling usage. From the plot of Figure 4-6, dimension 1 gives high positive values on "quality, industrial testing and inspection services" and high negative values on "paper and packaging products". Dimension 1 suggests that "quality, industrial testing and inspection services", "transport", and "environmental services" are more associated with a "several times a week" use of acceptance sampling. "Electrical and electronic products and related services", "metal", "toys and games", and "plastics" are more associated with a "daily" use of acceptance sampling. Dimension 2 places high positive values on "quality, industrial testing and inspection services" and high negative values on "metal". Dimension 2 assigns "paper and packaging products" and "computer and related services" to a "once every 2 weeks" use of QT&T.

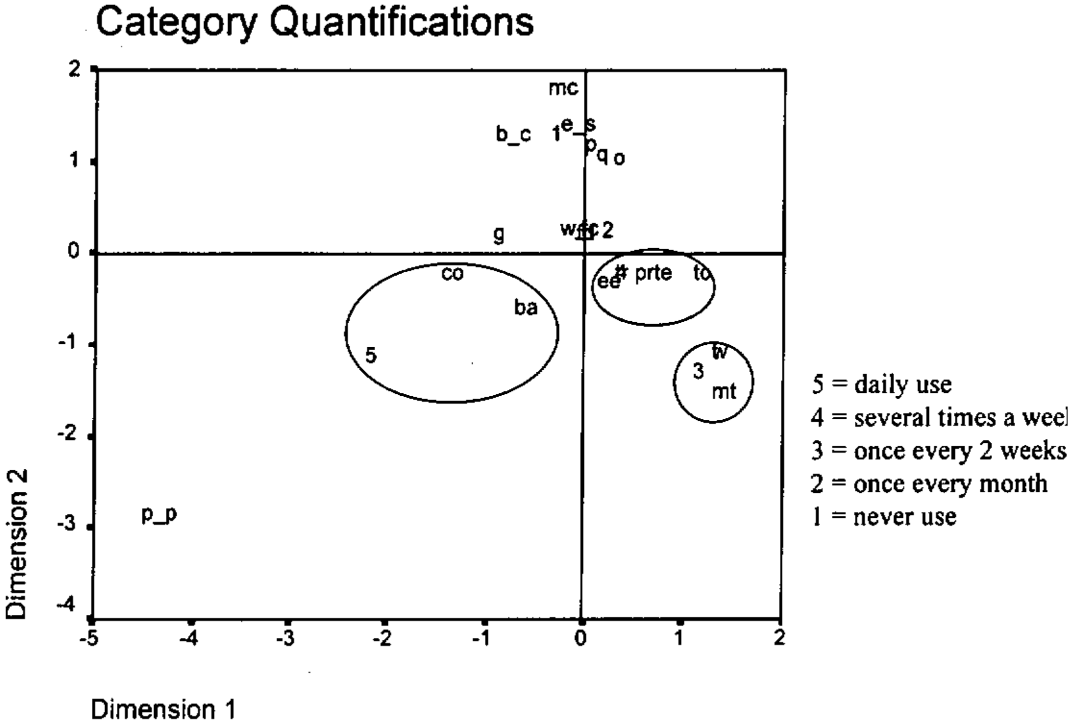


For Business Natures, the abbreviation: Bank = (ba); Building and Construction = (b_c); Computer and Related Services = (co); Electronics = (ee); Environmental services = (e_s); Financial = (f); Foodstuff = (fd); Government = (g); Machinery = (mc); Metal = (mt); Paper and Packaging products = (p_p); Plastics = (p); Printing = (pr); Quality, Industrial Testing = (q); Real Estate = (r); Telecommunications = (t); Textile = (te); Toys and Games = (to); Transport = (tr); Watches and Clocks = (w_c); Wholesale and Retail = (w); Others = (o)

Figure 4-6 Perceptual Map of Acceptance Sampling

Figure 4-7 is a perceptual map that shows the relative position of the frequency of benchmarking usage and the different kinds of business natures. From the plot of Figure 4-7, dimension 1 assigns high positive values to "metal" and high negative values to "paper and packaging products". Dimension 1 suggests that "metal", "telecommunications", "wholesale and retail" are associated with "once every 2 weeks". Dimension 2 assigns high positive values to "machinery" and high negative values to "paper and packaging products. In contrast, "banking" and "computer and related services" are associated with a "daily" use of benchmarking.

"Transport", "printing and publishing", "textile" and "toys and games" and "electrical and electronic products and related services" are highly associated with a "several times a week". In this perceptual map, it is found that most of the service industry employs benchmarking more frequently than the manufacturing industry does.



For Business Natures, the abbreviation: Bank = (ba); Building and Construction = (b_c); Computer and Related Services = (co); Electronics = (ee); Environmental services = (e_s); Financial = (f); Foodstuff = (fd); Government = (g); Machinery = (mc); Metal = (mt); Paper and Packaging products = (p_p); Plastics = (p); Printing = (pr); Quality, Industrial Testing = (q); Real Estate = (r); Telecommunications = (t); Textile = (te); Toys and Games = (to); Transport = (tr); Watches and Clocks = (w_c); Wholesale and Retail = (w); Others = (o)

Figure 4.7 Perceptual Map of Benchmarking

To conclude the data analysis, from the tables and figures of the homogeneity analyses, I discovered that the frequency of QT&T usage is dependent upon the business natures. I classified "banking", "computer and related services", "environmental services", "financial markets and fund management", "government funded/statutory organisations", "real estate services", "telecommunications", "transport", "wholesale and retail" as service industries. The remaining, "building and construction", electrical and electronic products and related services", "foodstuff beverage and tobacco", "machinery", "metal", "paper and packaging products", "plastics", "printing and publishing", "quality, industrial testing and inspection service", "textile, garment and footwear", "toys and games", "watches and clocks" were classified as manufacturing industries. Generally speaking, manufacturing industries (MFG) employed the 7 basic quality tools and advanced techniques more than service industries (SER) do. For the new 7 management tools, SER used them more frequently. MFG implemented acceptance sampling much more than SER do. This is understandable because acceptance sampling is for the purpose of inspecting manufactured products which are to be accepted or rejected. Therefore, SER would not implement it as often as MFG do so. SER used benchmarking and plan-do-check-act (PDCA) more frequently owing to their business target and the fact that their purpose is different from MFG. MFG used gantt chart, pokayoke, process capability, quality costing and surveys more frequently than SER did. Pokayoke is for product design purpose and process capability is for inspection purpose. Therefore, both QT&T are definitely important to MFG. Both MFG and SER implemented brainstorming, force field analysis, deployment chart and quality circle more or less frequently.

4.2.5 Performance of Training Methods for QT&T

Performance of training methods will be analysed because the recognition that effective training methods should be identified to assist in the attainment of quality improvement. In the survey, the respondents were asked to rank from 5 = "most effective and efficient" to 1 = "least effective and efficient" which training approach(es) can facilitate the learning of QT&T. Table 4-6 shows the results by summarising each ranking score. From the results (Table 4-6), for the 7 basic quality tools, 31 respondents ranked "lecture" as most effective and efficient training approach and 19 respondents ranked "workshop (experience sharing)" as most effective and efficient learning approach. For brainstorming, 36 respondents ranked "workshop (experience sharing)" as most effective and efficient learning approach.

Table 4-6 Ranking Scores of each of the Training Approaches (Only "most effective and efficient" and "the second most effective and efficient" are shown)

Rank as Most Effective and Efficient (5)	**7 Basic Quality Tools**	**New 7 Management Tools**	**Advanced Techniques**	**Acceptance Sampling**	**Bench marking**	**Brain storming**	**Deployment Chart**	**Faulty Tree Analysis**	**Force Field Analysis**	**Gantt Chart**	**Plan-Do-Check-Act (Deming Wheel)**	**Pokayoke (Foolproof)**	**Process Capability**	**Quality Circles**	**Quality Costing**	**Surveys**
Lecture	31	13	11	19	14	9	11	4	1	15	16	5	16	19	12	4
Video Tape	8	3	2	4	3	4	1	0	1	3	1	0	3	4	1	1
Workshop	19	11	8	21	25	36	7	1	0	14	21	12	14	17	11	2
Self-tutorial (workbook)	2	1	1	1	4	2	1	0	0	4	2	2	3	2	2	0
Self-tutorial (Multimedia)	3	2	1	2	2	1	0	0	0	2	0	2	3	2	2	0
Rank as the Second Most Effective and Efficient (4)																
Lecture	14	4	5	12	15	18	3	1	0	13	11	5	7	12	6	2
Video Tape	16	10	6	8	12	11	4	1	1	8	9	5	9	10	7	1
Workshop	22	6	8	13	12	6	6	1	0	5	9	1	7	11	6	3
Self-tutorial (workbook)	5	7	2	6	4	8	4	1	0	4	6	7	11	7	5	0
Self-tutorial (Multimedia)	5	2	1	7	5	7	2	1	1	8	6	2	6	4	3	1

In summary, for 11 out of 16 QT&T "lecture" was deemed to provide the most effective and efficient learning approach while for the remaining QT&T "work (experience sharing)" was deemed to provide the most effective and efficient learning approach. Overall speaking, the most effective and efficient training approaches were "lecture" and "workshop (experience sharing)", while "video-tape" and "self-tutorial (multimedia)" were average effective and efficient for learning. The least effective and efficient raining approach was "self-tutorial (workbook)". The reason for this results may be that "lecture" and "workshop (experience sharing)" are more a people-to-people interactive way of learning, and so the learners can feedback their ideas and opinions at once. For video tape and self-tutorial (multimedia), they are on another level of interactive with pictures, sound and so on to facilitate the learners to learn in their own way. The last one is "self-tutorial (workbook)", which is a somewhat vapid learning method, without any interactive response or feedback.

4.3 Summary

A survey was conducted to seek the opinion of quality experts in quality software companies about the validity of the proposed taxonomy and to collect a state-of-art review of quality software on the current market. The survey results validate the proposed taxonomy, which should provide a guideline to quality professionals as a useful means to select and apply proper QT&T for their quality improvement efforts. Based on the survey results, it can be seen that the majority (from 60% to 75%) of the experts surveyed agreed with the proposed taxonomy. The chapter also describes and provides a decent list of quality software tools available to quality practitioners for supporting their quality improvement initiatives (as shown in Table 4-1). The quality software products for which responses were received are outlined at Appendix B together with references for each product. Although this list cannot be claimed to be exhaustive, it should provide a valuable source of reference for quality practitioners in selecting quality software to aid in their quality improvement efforts.

From the data analysis of the empirical research, it reveals that training and education, and understanding have significant impact on the use of QT&T. Other than hypothesis testing, a homogeneity analysis was used to investigate the relations between the frequency of QT&T usage and the different kinds of business natures. The results reveal that the 7 basic quality tools and the advanced techniques are being used by the manufacturing industry; on the other hand, the new 7 management tools and benchmarking are used by the service industry more frequently.

This study also investigated the performance of training methods for QT&T. From the survey results, it was noted that the most effective and efficient training approach is "lecture", following "workshop (experience sharing)". The least effective and efficient training approach is "self-tutorial (workbook).

5. DESIGN AND DEVELOPMENT OF MULTIMEDIA-BASED ADVISORY SYSTEM FOR SELECTING QT&T (MBAQ)

5.1 Introduction

Considerable varieties of quality tools and techniques (QT&T) exist to cope with a multiplicity of quality improvement issues. Each QT&T is especially suitable for one or a few application objectives under particular scenarios. However, many companies have difficulties in using QT&T for quality diagnosis. There are numerous quality training software products for supporting the selection QT&T for quality practitioners (See Section 2-5, Table 2-4 and 2-5). However, these quality advisory systems for QT&T seem unable to offer sufficient capability or effective learning interface to assist the practitioners in implementing quality improvement strategies. According to the literature (Dale and Shaw, 1989; Deslandres and Pierreval, 1995), there are two major reasons for the quality practitioners' inadequacy in problem solving capability needed for successful implementation of any quality improvement necessaries. One is people lack expertise in quality diagnosis. In organisations, people concerned with quality problems do not always have the required experience. And quality experts are not always available to assist people in identifying quality problems as well as deciding what should be done to prevent the problems. The other reason is people lack knowledge about quality methods and procedures that can be used after the problems have been diagnosed. Some advanced techniques require sophisticated and complicated skills to apply. In order to facilitate quality practitioners in problem solving and quality diagnosis, a multimedia based advisory system was developed to assist them. The purpose of developing the MBAQ (Multimedia-Based Advisory System in selecting QT&T) is to assist quality practitioners in selecting the proper QT&T and correctly applying them in their business or manufacturing processes. It aims at assisting quality practitioners in using proper QT&T in problem solving approaches (problem identification, problem analysis, problem prevention, idea generation and decision making) and it allows quality practitioners to learn the procedures of each QT&T in a systematic and step-by-step way. Burns (1997) quoted from Henderson of the US Department of Commerce that quality training via multimedia systems is an extremely useful and cost-effective way of training people.

I adopted an evolutionary approach (Choi, 1995) of building a multimedia-based advisory system to support quality practitioners in the selection of QT&T based on my proposed taxonomy. The objective of the system is to assist the less experienced users or quality professionals in identifying the proper QT&T to adopt to tackle the problems they are facing. To accomplish this, MBAQ firstly identifies the situation the users face, and according to the circumstances uncovered, it proposes proper QT&T with regard to problem solving and process improvement approaches. The first stage is to design and develop the architecture of the system and to acquire expert knowledge of the methods and procedures for the use of QT&T. Stage two is the development of an early prototype and an evaluation of the MBAQ system by potential users. Stage three is an analysis of the results and making interpretations of the MBAQ evaluations.

5.2 *Stage 1: Design and Development of the System Architecture*

The system overview is depicted in Figure 5-1 that will be comprehensively described in the sequel. MBAQ was structured on the basis of three application modules: manufacturing industry module, service industry module and learning the use of QT&T database module.

The first two modules containing common manufacturing and business processes problems will conduct a quality analysis and suggest a proper QT&T against the found problems. The learning database module provides training instructions on the applications and procedures for the use of selected QT&T.

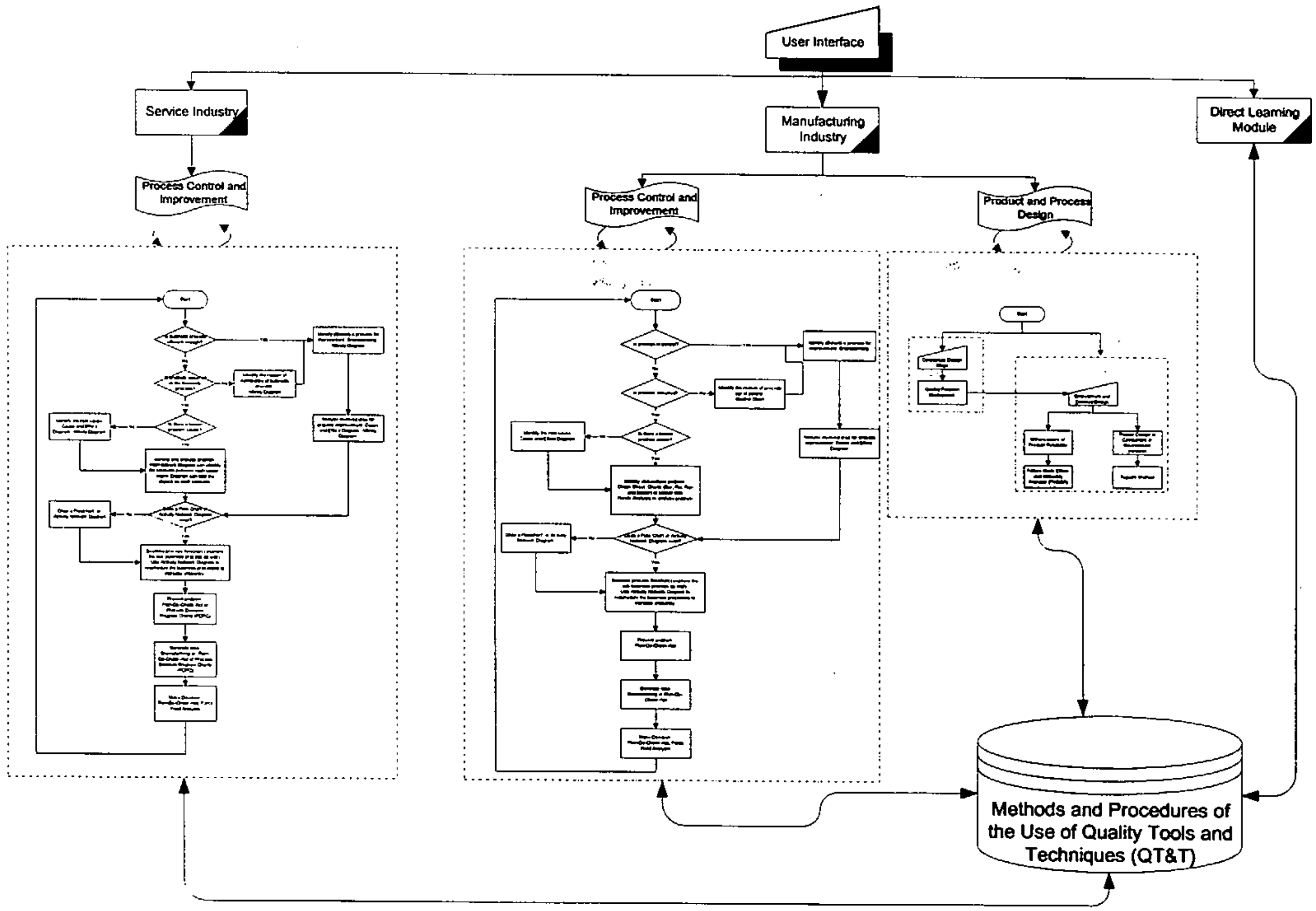


Figure 5-1 System Overview

5.2.1 Manufacturing Industry Module

Improvement Strategy

In the manufacturing industry module, two major application domains, namely product and process design strategy, and process control and improvement strategy, are provided for problem diagnosis and quality improvement. The improvement strategy (referred to Figure 5-2) of both modules for quality diagnosis consists of the following steps:

- Identification of a quality problem;
- Analysis of the found problem;
- Prevention of problem recurrence;
- Idea generation to formulate an innovative approach to deal with the problem;
- Decision-making inferred from an overall conclusion;
- Selection of appropriate QT&T;
- Facilitation of the use of QT&T.

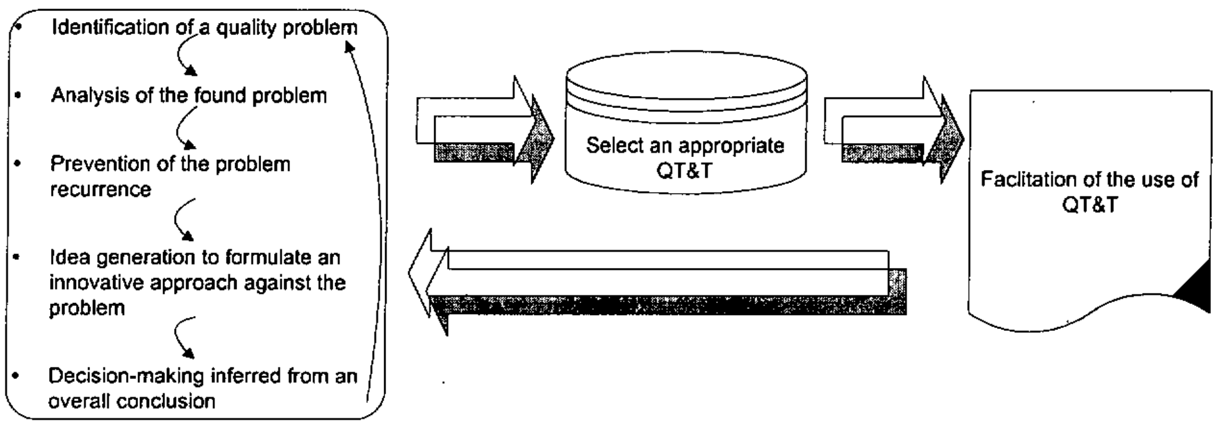


Figure 5-2 Improvement Strategy Approach

The first step attempts to identify the underlying quality problems in which the quality practitioner is involved. At the problem identification stage, the system will suggest an appropriate QT&T by asking a series of interactive questions. Once the quality problem is identified, quality analysis is embarked upon. At the quality analysis stage, the quality practitioner is asked to employ an appropriate QT&T to collect information and allocate the area for process analysis. After quality analysis, it requires the quality practitioner to construct a flow chart according to his or her business processes. The business process flowchart should be obtained for examination of the process in order to improve efficiency and productivity. Thereafter, efforts on prevention of problem recurrence will be undertaken. An appropriate QT&T will be employed to eliminate the possibility of problem recurrence. Idea generation will be carried out to formulate an innovative approach to deal with the problem that the quality practitioner faces. Finally, the system will suggest the quality practitioner to make a decision in accordance with an overall inference from the analysis. In learning the use of QT&T module, 20 most commonly used QT&T are provided with an example illustrating how they work. They are classified into four groups including the 7 basic quality tools, new 7 management tools, advanced techniques, and other commonly used QT&T for the quality practitioner to choose.

Manufacturing Application Domain

In the manufacturing application domain, there is evidence suggesting that for quality diagnosis, a great variety of knowledge needs to be acquired for the selection process, which encompass as: (Deslandres and Pierreval, 1997)

- Knowledge about the proper use of QT&T for manufacturing processes – both product design/process design, and process control and improvement

- Decision making on the selection of appropriate QT&T suitable for the underlying manufacturing processes

Knowledge of the Proper Use of QT&T for Manufacturing Process

For quality improvement purposes, the application domain of QT&T for manufacturing process as can be partitioned into two aspects:

- Product design/process design; and
- Process control and improvement

For product design/process design, it makes contributions to the three major business outcomes of quality, cost and time to market (timeliness) (Fleischer and Liker, 1992). It is typically used in the engineering and product design phases, and represents the most mature of the evolutionary phases (Jayaram, *et al.*, 1997). An in-depth review (Asimow, 1962; Watts, 1966; Krick, 1969; Pahl and Beitz, 1971, 1996; French, 1971; Pugh, 1990; VDI 2221 (quoted by Cross, 1991); Hubka, 1992) of the design phases or stages shows that a majority of their procedural steps is with regard to conceptual design, embodiment design and detailed design.

For process control, it is required for the stability and reliability of the manufacturing process; on the other hand, process improvement is the logical next step after process control (Jayaram, *et al.*, 1997).

Decision Making Method of Selection of the Appropriate QT&T

1. Product Design Process Strategy

In the aspect of product design/process design, three major quality techniques, namely quality function deployment (QFD) (Fortuna, 1988; Garvin, 1988; Chang, 1989; Adams, 1991; Bossert, 1991; Lynch and Cross, 1991; Maddux, *et al.*, 1991; Zuccheilli, 1992, Zairi and youssef, 1995; Vonderembse, *et al.*, 1997), failure mode effect and criticality analysis (FEMCA) (Dale and Shaw, 1990; Aldridge, *et al.*, 1991; Teng and Ho, 1995) and Taguchi method (Swift and Allen, 1992; Disney and Bendell, 1994; Dooley, 1996) are currently employed in order to satisfy product design/process design. Unfortunately, these advanced techniques are insufficiently used due to quality practitioners' lack of knowledge or understanding about their methods, procedures and targets for problem diagnosis. For this reason, a selection system based on the proposed taxonomy was designed and developed. For quality practitioners, concepts using advanced quality techniques for product or process design are specified in the designing stage. As mentioned before, strategies for design phases or stages are conceptual design, embodiment and detailed design (depicted in Figure 5-3).

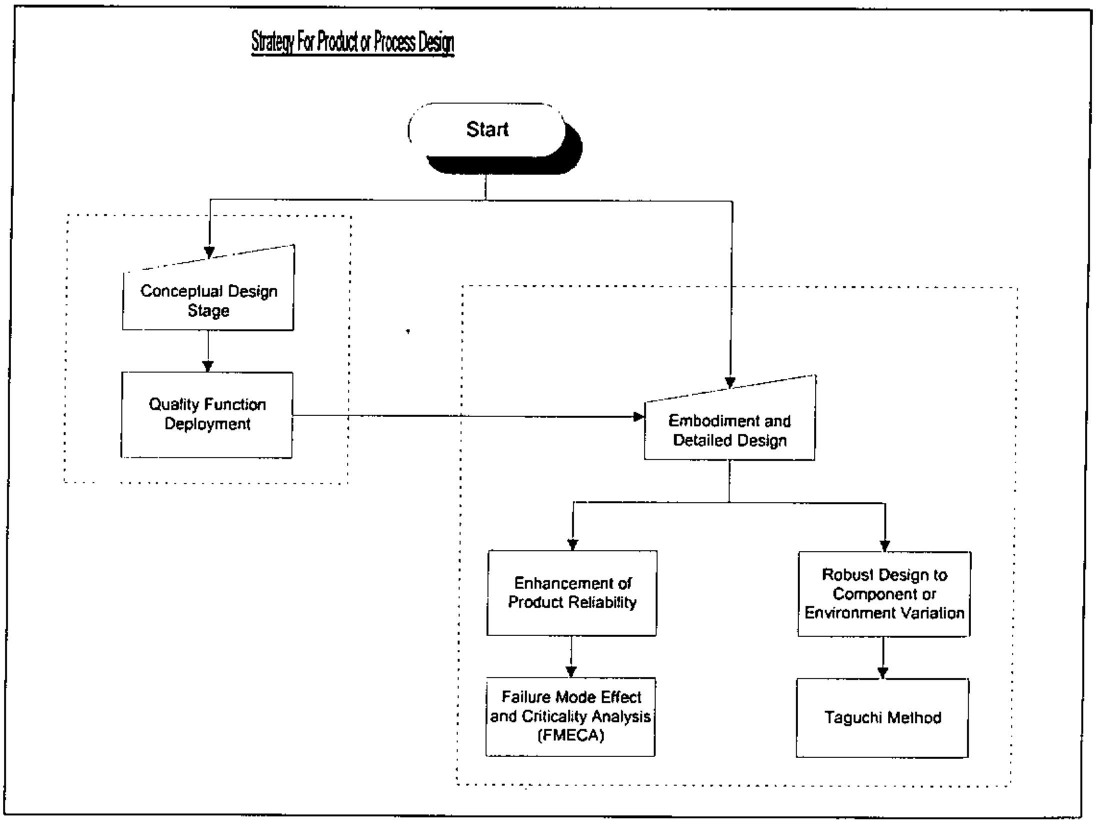


Figure 5-3 Strategy for product design.

Conceptual Design Stage. The preliminary stage is to define or design products and to link up customer's voice with engineering specifications to evaluate concepts of the product (shown in Figure 5-4). In the conceptual design stage, customer requirements obtained from the market are important information for the design team. From those requirements, the design team will understand the design problem and plan for the project. The design concept will be reviewed so that design concepts can be generated. Eventually, the evaluation of the concepts will be taken into account for revision.

Embodiment and Detailed Design Stage. After the product is defined, this stage becomes a critical quality issue because the product's reliability or robustness is crucial to satisfy customer expectations (referred to Figure 5-5). Referring to the strategy for embodiment and detailed design, the product will be generated and evaluated after the conceptual design stage. Design records, therefore, will be generated for revision.

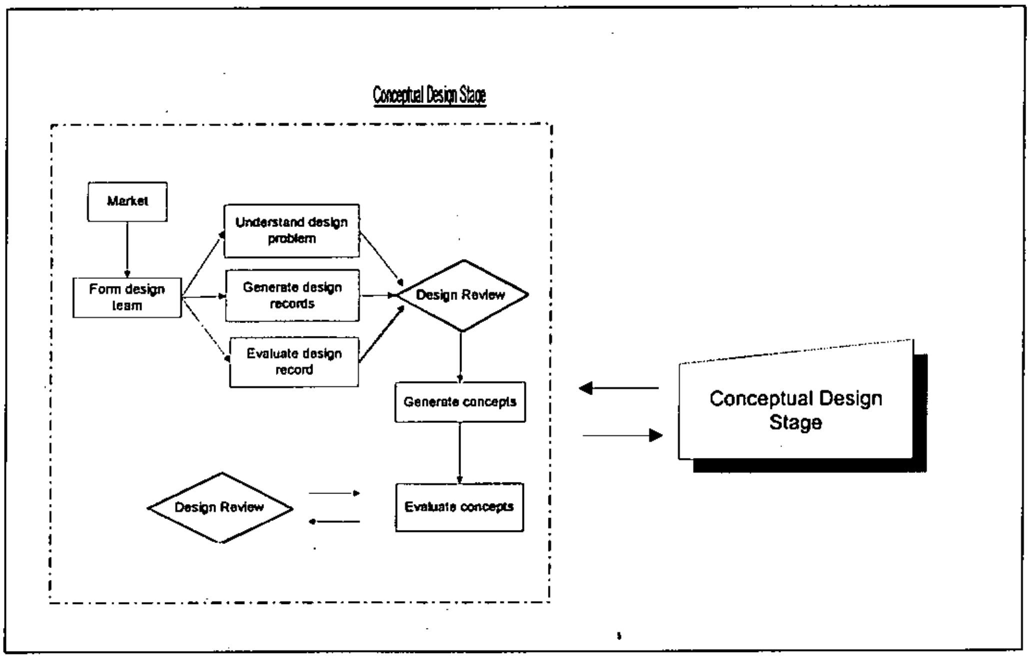


Figure 5-4 Conceptual Design Strategy

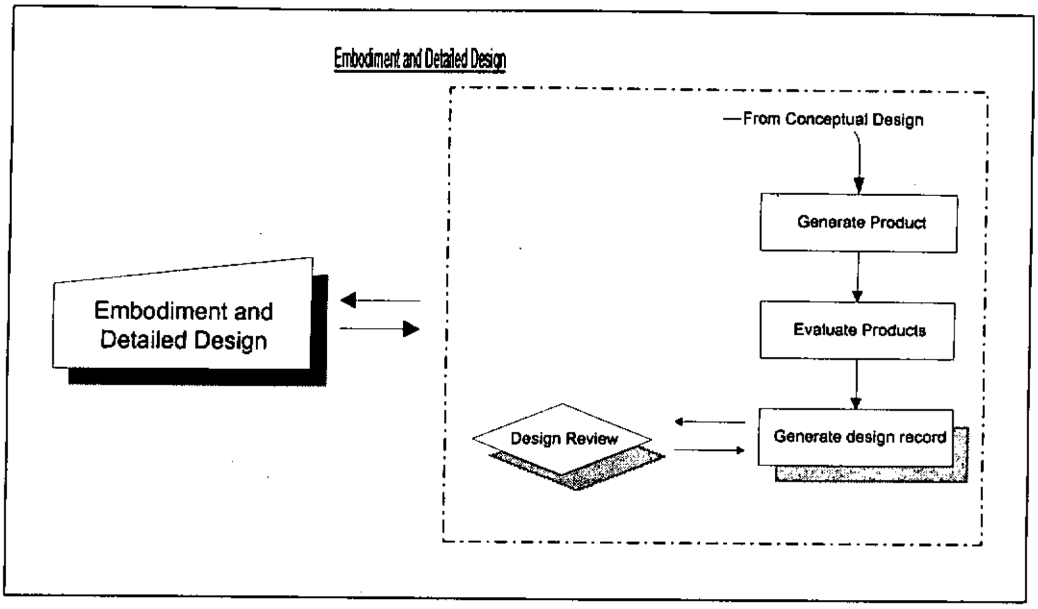


Figure 5-5 Embodiment and Detailed Design Strategy

It is generally accepted that QFD can be beneficially employed for conceptual design. It can facilitate the definition and ranking of customer requirements and thus should be applied in the conceptual design stage (Swift and Allen, 1992; Dooley, 1996). It is a process that brings together the lifecycle of a product from its conception, through design, manufacture, distribution and use. One of the characteristics of QFD is aiming at comparing with competitive products. It can identify the true voice of customer and help in producing what the engineer/design believes the customer will buy and what the company can manufacture. Also, it can ensure product designs translated into component designs, manufacturing processes and assembly operations, and improved effectiveness will ensure higher profitability. Under QFD, customer information is obtained and presented as a series of chart cascading from concepts to manufacturing details (Burn, 1994). Hence, it can be concluded that QFD is the most appropriate advanced technique for conceptual design.

In the detailed product design stage, FMEA/FMECA or Taguchi method will be considered depending on users' focus. FMEA/FMECA can identify potential failure of a product and product reliability can be highly heightened with obvious reduction in production cost (Teng and Ho, 1995). It is a systematic and analytical quality planning tool for identifying, at the product, service and process design stages, what potentially could go wrong either with a product during its manufacture or end-use by the customer or with the provision of a service (Aldridge and Dale, 1994)

The potential failure mode may be caused by an incorrect material choice, part geometry or inappropriate dimensional specification. It requires a good working knowledge of the process or design. Design and product engineers need to work with a project team that at least includes customers, reliability engineers and manufacturing engineers to identify the potential quality and reliability failures in the design process (Teng and Ho, 1995). For design purposes, design FMEA is a procedure to identify that the right materials are being used, to conform to customer specifications, and to ensure that government regulations are being met, before finalising the product design. Process FMEA deals with manufacturing and assembly processes. Process FMEA identifies the potential process failures and determines possible causes in the manufacturing and assembly operations.

Taguchi method is a means to minimise the number of changes required to each variable in achieving an optimum outcome. It selects robust elements to avoid the effect of "noises" experienced during manufacturing (Swift and Allen, 1992; Dooley, 1996). Taguchi defines the quality of a product as 'the (minimum) loss imparted by the product to society from the time the product is shipped. This loss includes not only the loss to the company through costs of reworking or scarping, maintenance costs, downtime due to equipment failure and warranty claims, but also the costs to the customer through poor product performance and unreliability. Taguchi method is applied as off-line quality control in the design stage (Disney and Bendell, 1994)

The 3 stages of off-line quality control are described as follows:

System design. Parts and materials are selected and possible product parameter levels for product design are determined. System design is best achieved by a brainstorming session involving engineers and designers.

Parameter design. The nominal factor levels selected by system design are tested and the combination of product parameter levels or process-operating levels least sensitive to changes in environmental conditions and other uncontrollable (noise) factors is determined.

Tolerance design. It is employed to reduce variations further if required, by tightening the tolerances on those factors shown to have a large impact on variations.

2. *Process control and improvement*

For process control and improvement, a vast number of QT&T (Oakland, 1993; Dale and Oakland, 1994; Nayatani, *et al.*, 1994; Mears, 1995; Swanson, 1995) are employed such as the seven quality tools for problem diagnosis. However, there are a lot of claims (Dale and Lightburn, 1992; McQuater, *et al.*, 1996) on the difficulties or ineffective and inefficient use of them. To alleviate this problem, a strategy (see Figure 5-6) based on the proposed taxonomy is adopted. It is modified and improved based on the work of Oakland (1989). The strategy for process control and improvement provides a means for a systematic approach to tackle problems based on the proposed taxonomy of "problem identification", "problem analysis", "problem prevention", "idea generation", and "decision-making". From the first decision dialog box – "Is process in control?", by answering "yes" or "no", it will direct the strategy to tackle either process control or process improvement. If the process is out of control, MBAQ will remind the user if any problem occurred. If the problem area is unknown, it will suggest the user to use cause and effect diagram to check which areas or processes are involved in causing those problems. After the root causes of the problem have been identified, check sheet, and charts are recommended to collect data and the analysis is conducted via pareto analysis. The existence of a flowchart for a particular manufacturing process is for critical review. The quality practitioner can examine the manufacturing sub-processes or a particular production line to detect which part has potential failure. Furthermore, the quality practitioner can reschedule the manufacturing processes in order to improve productivity and reduce manufacturing costs by using activity network diagrams. Therefore, MBAQ will recommend the practitioner to construct flowcharts or activity network diagrams for particular processes. For total quality improvement, problem prevention is a critical step. It deals with eliminating the possibility of problem recurrence. Plan-do-check-act is suggested to be employed for problem prevention as it allows the users to diagnose dysfunctional quality improvement successes and prevent problems. The next step is to generate new ideas by adopting innovative approaches to tackle the existing problem and make improvement on current processes. Again, plan-do-check-act and brainstorming are generally employed for this purpose. Eventually, decision making should be taken based on the overall conclusion inferred from the analysis. Plan-do-check-act and force field analysis are recommended in the MBAQ system. As it can be seen, MBAQ suggests appropriate tools or techniques in each phase or stage as a means to ensure continuous process improvement.

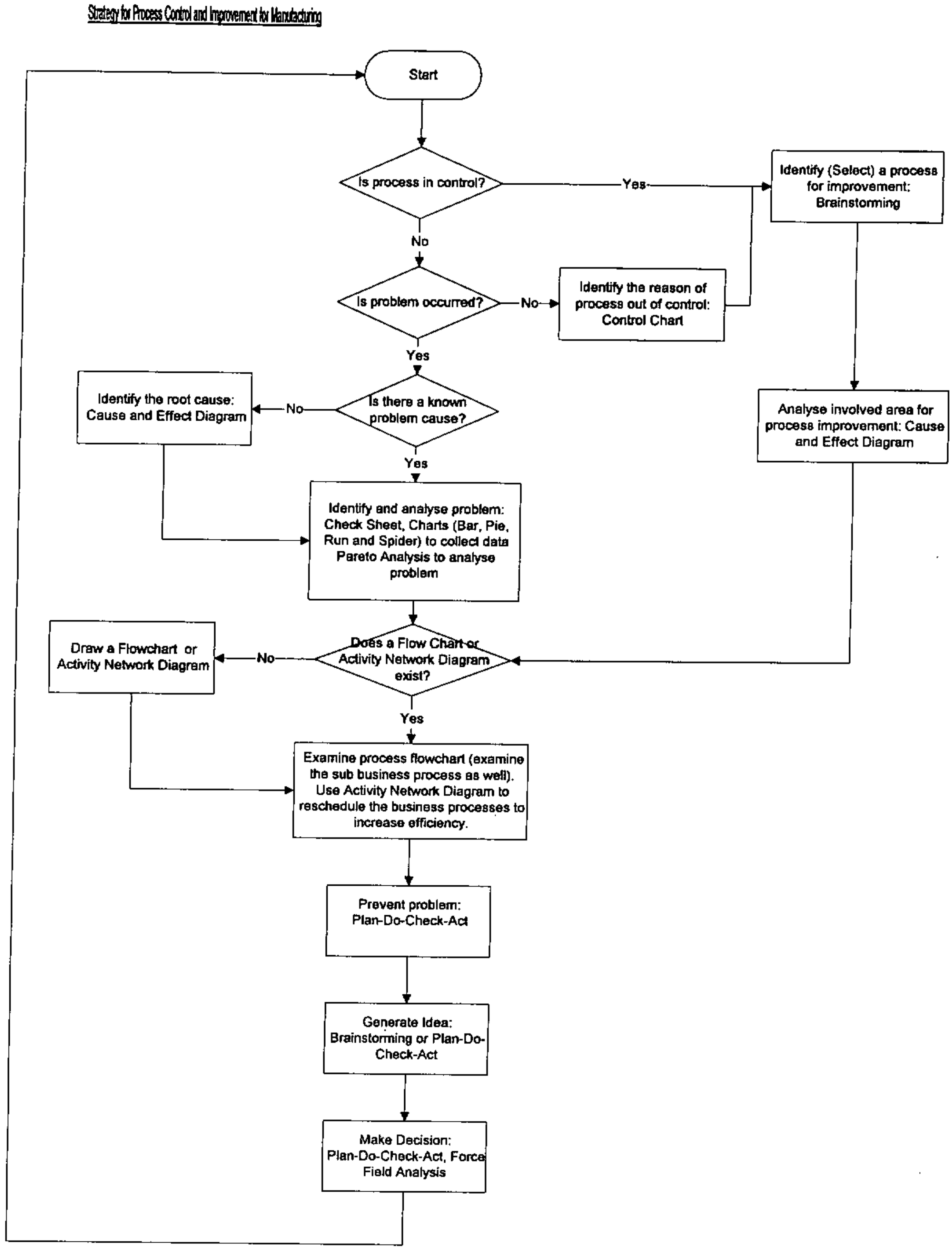


Figure 5-6 Strategy for Process Control and Improvement

5.2.2 Service Industry Module

Improvement Strategy

In the service industry module, business process control and improvement strategies are available. Figure 5-7 shows the strategy for process control and improvement for the service industry. A systematic approach leads to the use of factual information, collected and presented by means of proven techniques similar to the previously mentioned strategies for the manufacturing industry, and appropriate tools will be selected for quality services diagnosis. As a consequence, continuous improvement in the quality of products, services, and processes can often be obtained with major capital investment, if an organisation marshals its resources, through an understanding and breakdown of its processes in this way (Oakland, 1993). The strategy for process control and improvement for the service industry also provides a systematic approach to tackle the problem based on the proposed taxonomy of "problem identification", "problem analysis", "problem prevention", "idea generation", and "decision-making". From the first decision dialog box – "Is business process efficient enough?", by answering "yes" or "no", it will direct the strategy to improve the business process efficiency or process improvement. If the process is efficient enough, the user is suggested to identify a business process for improvement by using brainstorming or affinity diagrams; otherwise, the user is reminded if any problem occurred that resulted in the business process inefficient. If the problem area is unknown, the user is suggested to use cause and effect diagrams or affinity diagrams to check which areas or processes are involved in causing those problems. After the root causes of the problem have been identified, interrelations diagrams are recommended to identify the relations between each cause. Then, matrix diagrams can be used to test the impact on each relation. The existence of flow charts or activity network diagrams for any business process is very critical for evaluation and further process improvement. Therefore, MBAQ will recommend the practitioner to construct flowcharts or activity network diagrams for particular processes. The practitioner can examine business processes as well as his sub-processes by the flowcharts and reformulate the business processes to increase efficiency by using activity network diagrams. For total quality improvement in the service industry, problem prevention again is a critical step. It deals with eliminating the possibility of problem recurrence. Plan-do-check-act and process decision program charts (PDPC) are suggested to be employed for problem prevention as they allow the users to diagnose dysfunctional quality improvement means and prevent problems. PDPC is a tool for preventing problem occurrence and achieving a desired objective (Nayatani, *et al.*, 1994). The next step is to generate new ideas by adopting innovative approaches to tackle the existing problem and make improvement on current processes. Again, plan-do-check-act, PDPC, and brainstorming are generally employed for this purpose. Eventually, decision making should be taken based on the overall conclusion inferred from the analysis. Plan-do-check-act and force field analysis are recommended in the MBAQ system. Similar to the manufacturing application domain, MBAQ suggests appropriate tools or techniques in each phase or stage in order to ensure continuous process improvement.

Strategy for Process Control and Improvement for Service Industry

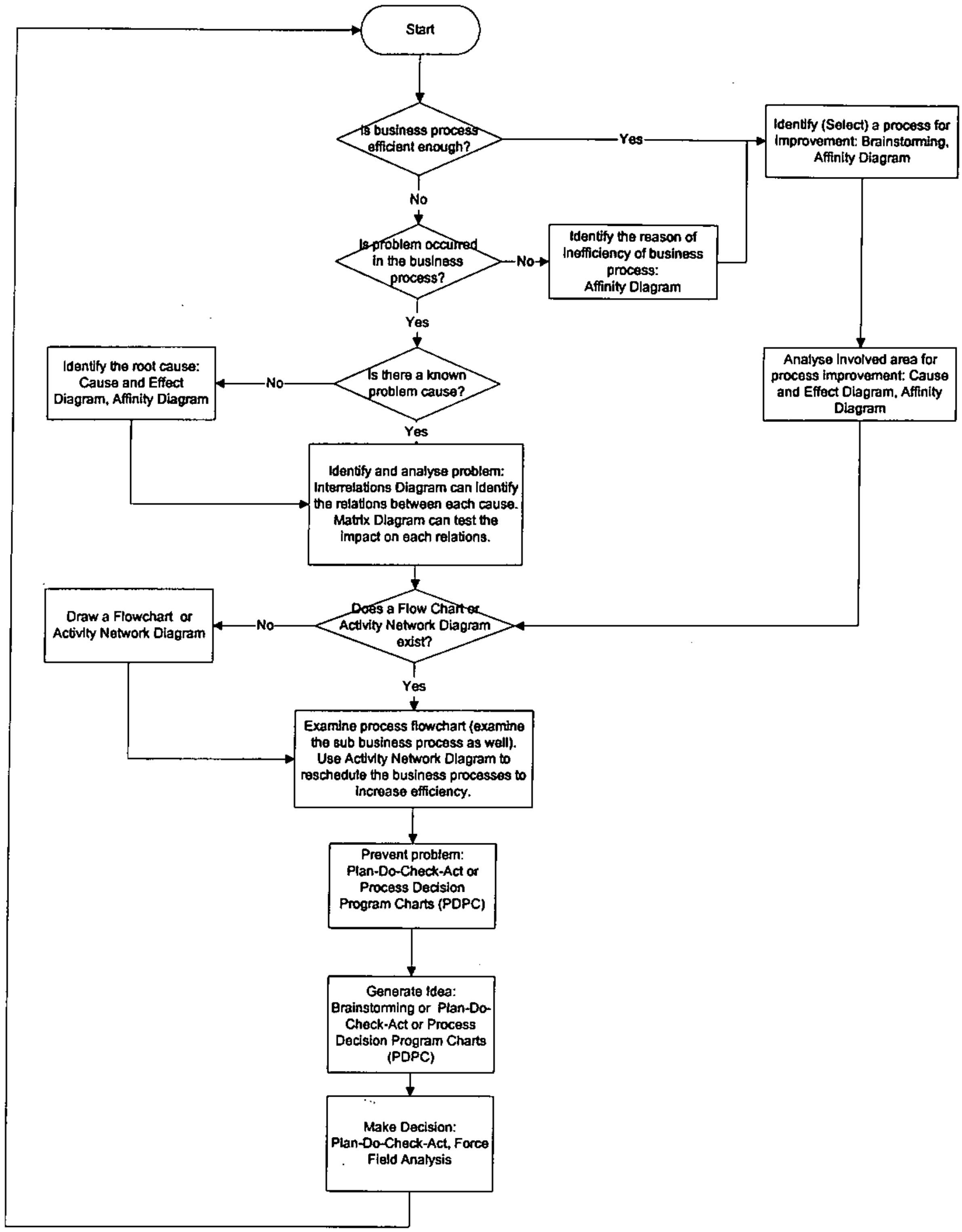


Figure 5-7 Strategy for Process Control and Improvement in Service Industry

5.3 *Stage 2: Development of Early Prototype*

5.3.1 An Illustrative Session

Figure 5-8 shows the beginning page of the system. On the left-hand side of the screen, there are navigational buttons to forward and backward the pages (i.e. previous page and next page), and functional buttons to "bookmark", "help", "find", and "quit" the program. "Bookmark" is to help the user to navigate the bookmarked page. The "help" function is to provide a means for the functional buttons. "Find" is for facilitating the quality practitioners to allocate the pages or content with the matched key words. "Quit" is used to exit the program, and it will require the user to reconfirm to exit the program or not.

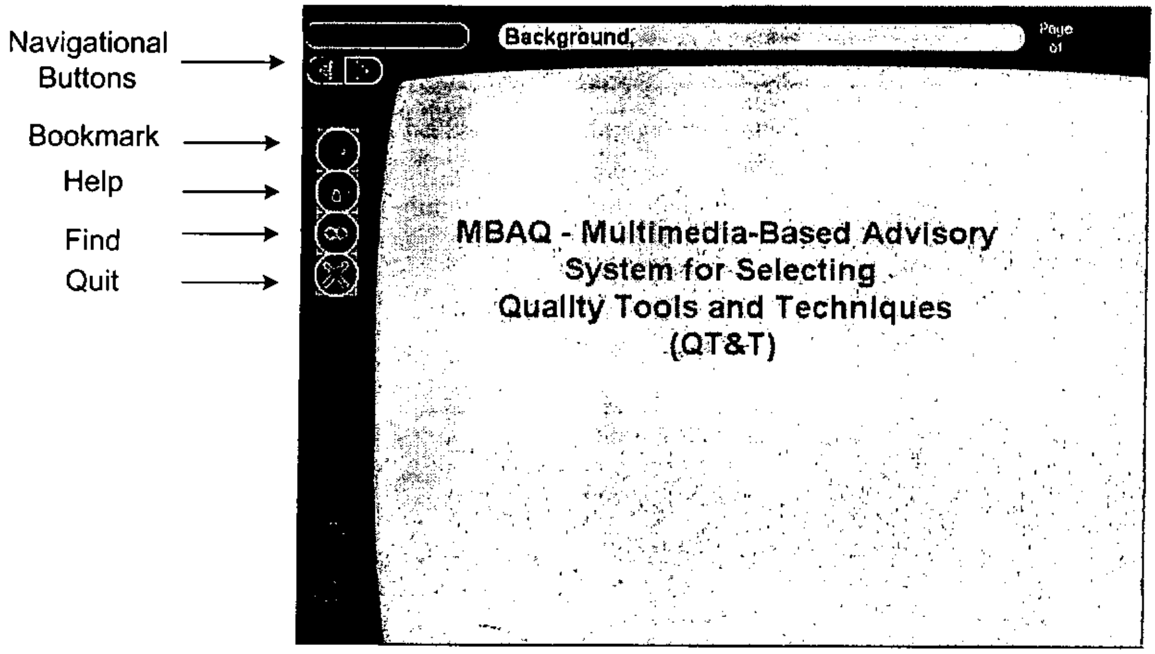


Figure 5-8 Beginning Page of the Program

The "find" function allows the user to have an immediate search of what they key in at any time. The "find" function will show pages with the matched keywords and the user just selects the page topic and click "Go to Page", then the system will jump to the relevant page immediately (See Figure 5-9).

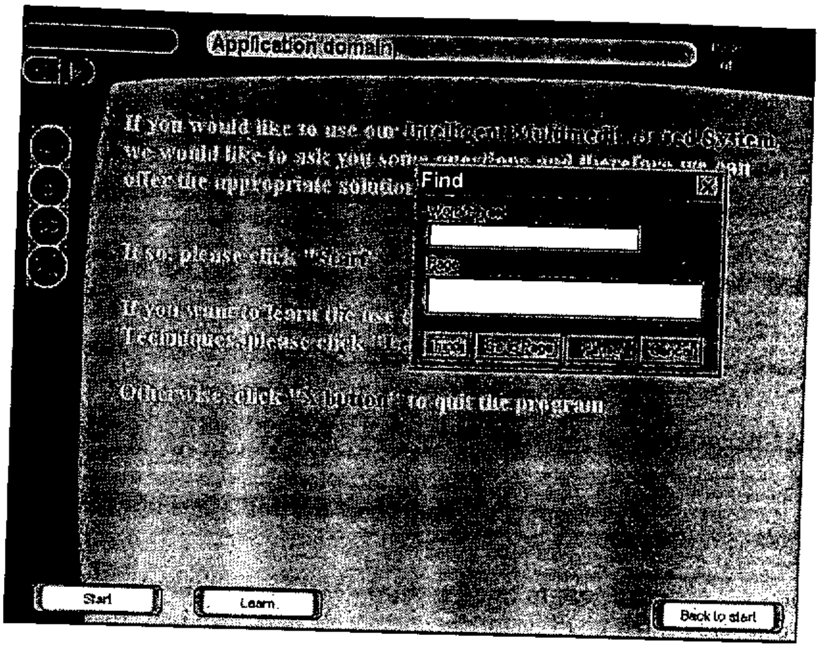


Figure 5-9 Interface of the "Find" function

The following page is an introduction of the program, in which it describes to the quality practitioner on what are embedded. It tells the quality practitioner MBAQ consists of two main flows: 1) advisory system with both the manufacturing and service industries, 2) useful guidelines on how to use the QT&T with sound, pictures, texts and so on (see Figure 5-10).

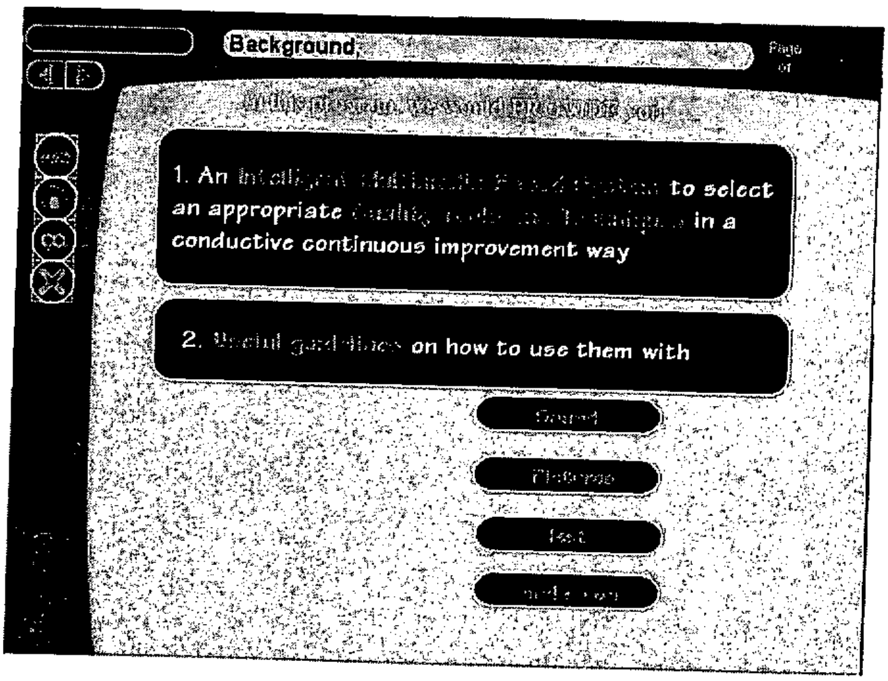


Figure 5-10 Introduction of the Program

After the introduction of the program, it comes to the selection page (see Figure 5-11) in which there are two alternatives – "start" or "learn" for the quality practitioner to select. Start" means to start the advisory system while "learn" means to learn the means of QT&T. To start the advisory system, the user can click the "start" button in the selection menu. After entering the advisory system, they can select their application domains – either manufacturing or service according to their business natures or needs. At the right bottom end, there is a functional button "back to start", which is for the user to return to the beginning page at any time.

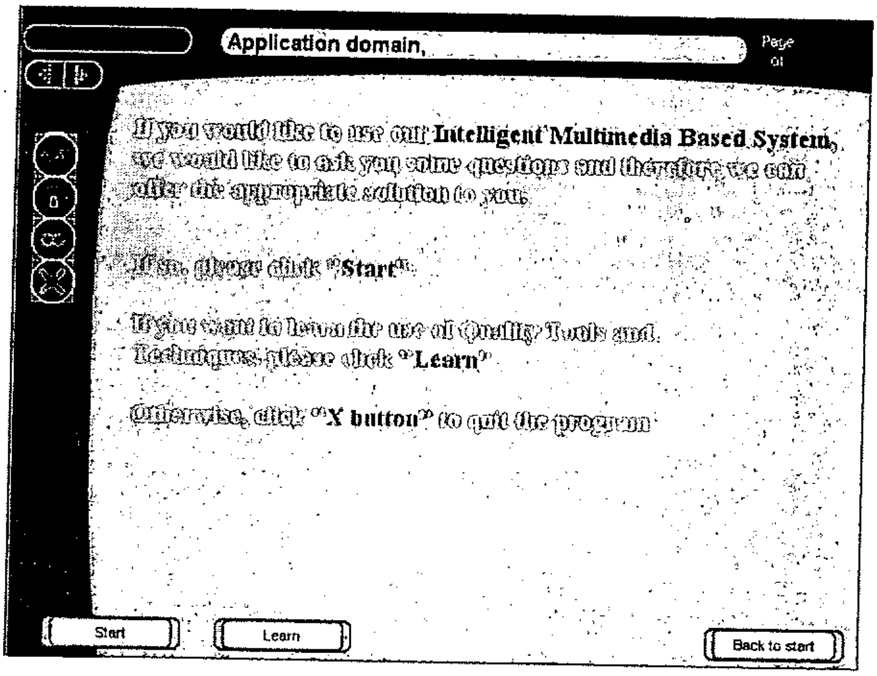


Figure 5-11 Interface of the Advisory System

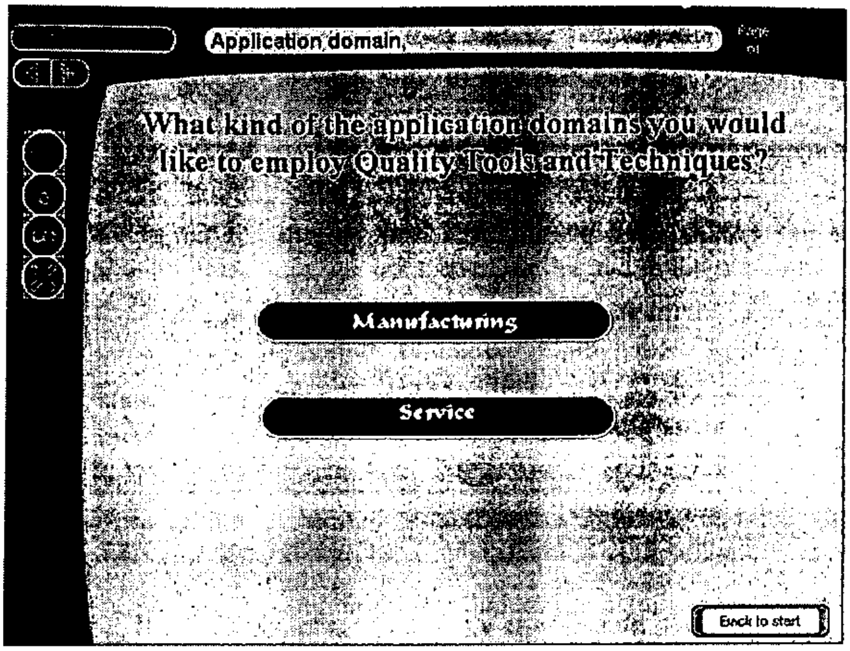


Figure 5-12 Interface of the Application Domains

For instance, the quality practitioner can click on "manufacturing" as his application domain (see Figure 5-12), then it will come to the page of manufacturing processes (See Figure 5-13). In the proposed system, two manufacturing processes – "product design or process design", and "process control or process improvement" – are included.

Figure 5-13 Interface of the Manufacturing Processes

After the practitioner selects "process control and process improvement", he will be asked to answer a series of questions and hence the system can provide him an appropriate QT&T to fix his quality problem. Figure 5-14 shows the start of the series of question for process control and process improvement. The first question "in your company, is manufacturing process in control?", by answering "yes" or "no", the system will provide different suggestions and QT&T to alleviate the problems. In this case, by answering "no", the system will jump to Figure 5-15 and it is about to guide the quality practitioner to investigate the root causes of the problem.

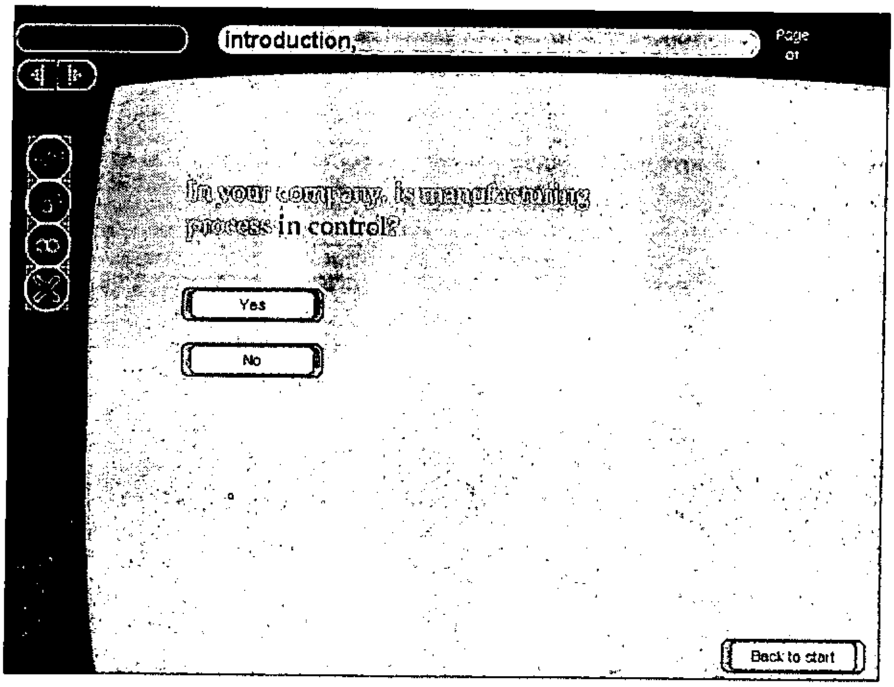


Figure 5-14 Interface of the First Step of Quality Improvement Strategy for Process Control and Improvement

From Figure 5-15, the quality practitioner is asked "If the manufacturing process is out of control, is there any problems or detects occurred?". If he answers "yes", that means there is a problem that occurred in the manufacturing process, the system will jump to Figure 5-16 and it will guide him to investigate what the problem area is.

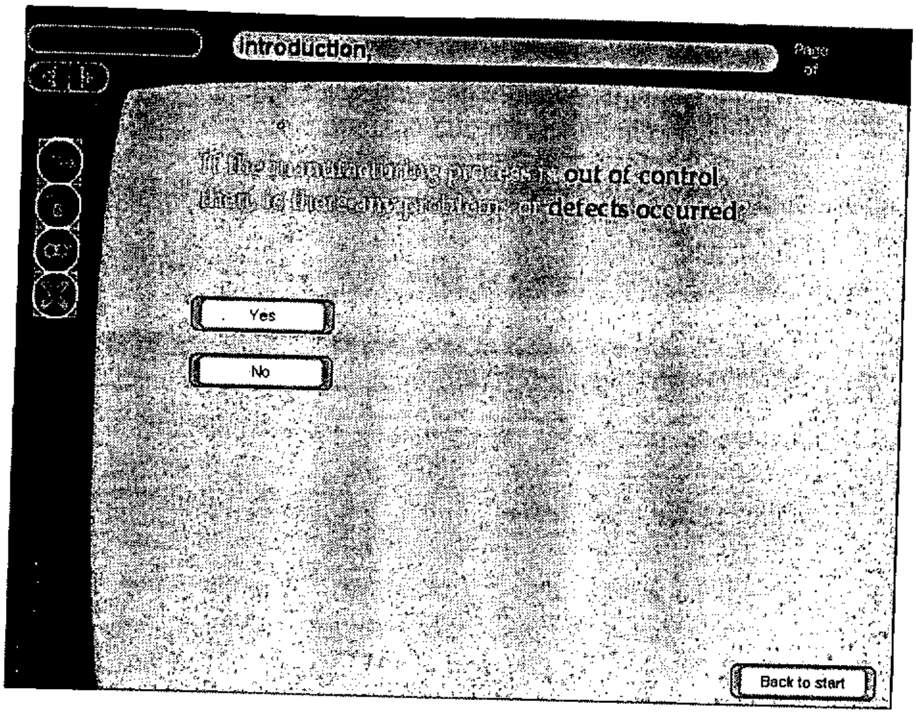


Figure 5-15 Interface of Second Step of Quality Improvement Strategy for Process Control and Improvement

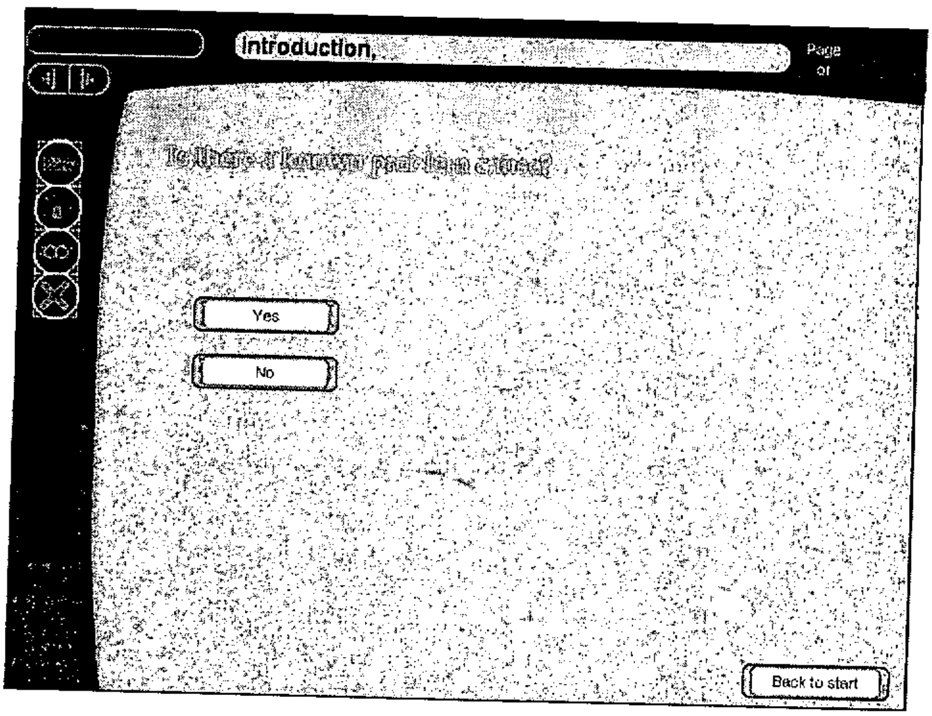


Figure 5-16 Interface of Third Step of Quality Improvement Strategy for Process Control and Improvement

Referring to Figure 5-16, if the quality practitioner does not know what the problem area is by answering "no", then the system will suggest the quality practitioner to employ cause and effect diagrams to identify what the problem root causes are (see Figure 5-17).

Generally speaking, cause and effect diagrams can help the user to generate ideas and identify the root causes in order to reach a understanding of the problem. The main feature of my proposed system is to provide a typical example and step-by-step procedures for the use of a particular QT&T in a systematic way. The practitioner just simply clicks the word "cause and effect diagram" which is underlined, and the system will navigate the practitioner to the learning database module with regard to the use of "cause and effect diagram" (see Figure 5-18 and Figure 5-19). After the quality practitioner learns the use of QT&T, he can go back to the quality improvement strategy module at any time.

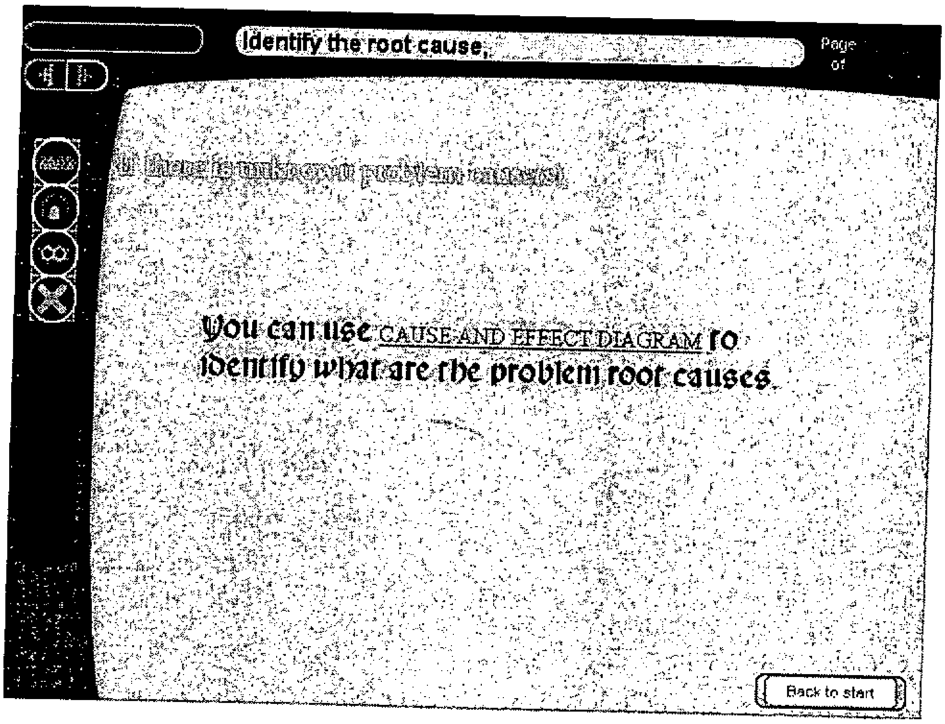


Figure 5-17 Interface of Forth Step of Quality Improvement Strategy for Process Control and Improvement

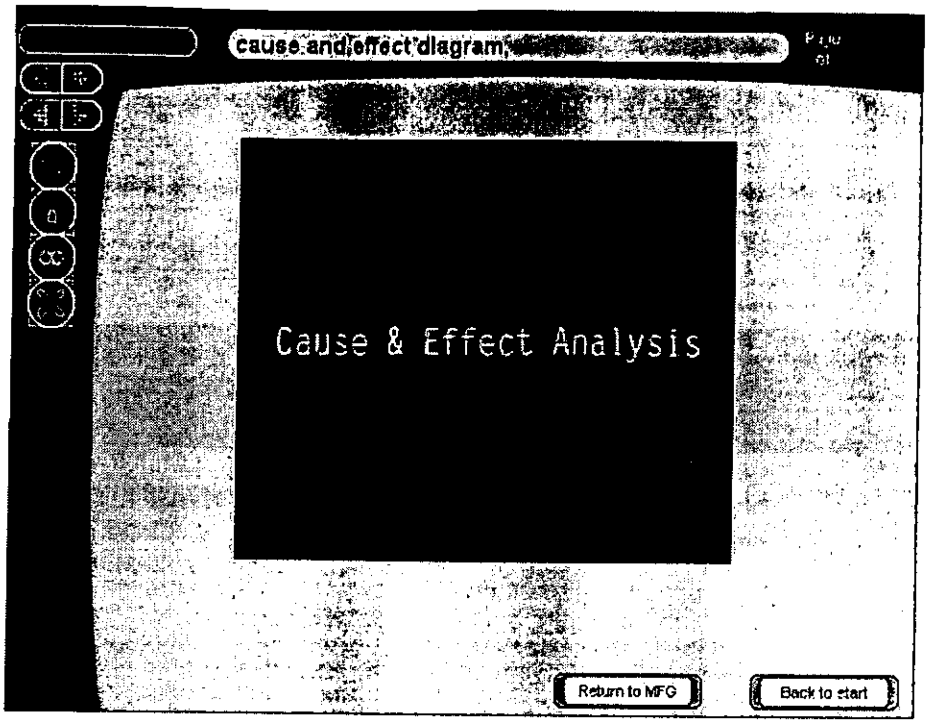


Figure 5-18 Interface of the Procedure of the Use of Cause and Effect Diagram

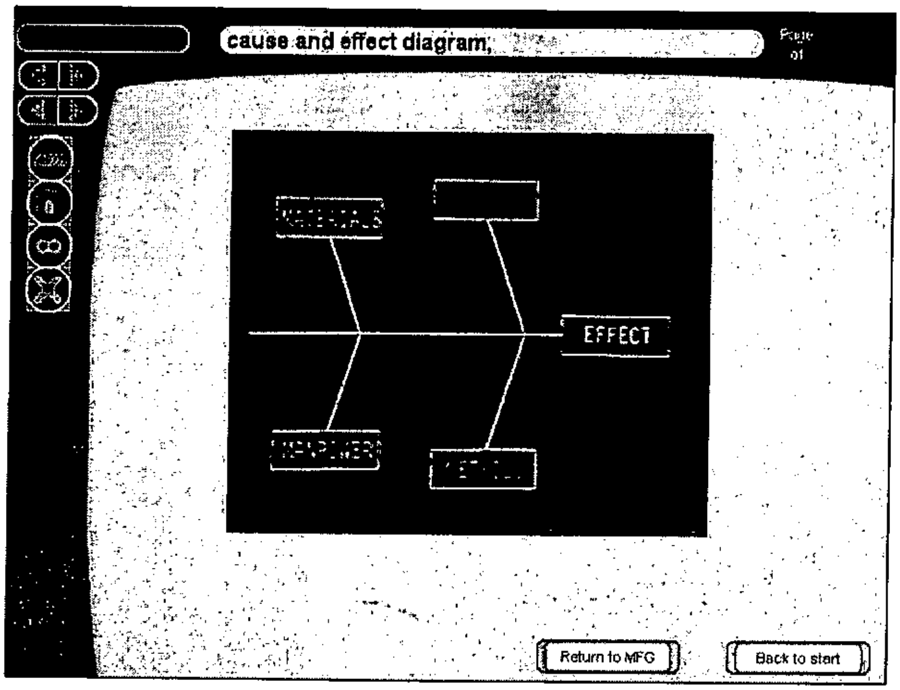


Figure 5-19 Interface of the Procedure of the Use of Cause and Effect Diagram (Cont.')

The system will provide information about quality software tools available in the current market. These tools are aimed at particular uses of the QT&T implemented in a computer system. In every last page (see Figure 5-20) of the learning procedures of each QT&T, there is a short introduction statement including the software company name and its web address for each of the software tools. Therefore it gives information to the quality practitioner so that he can choose the most suitable one.

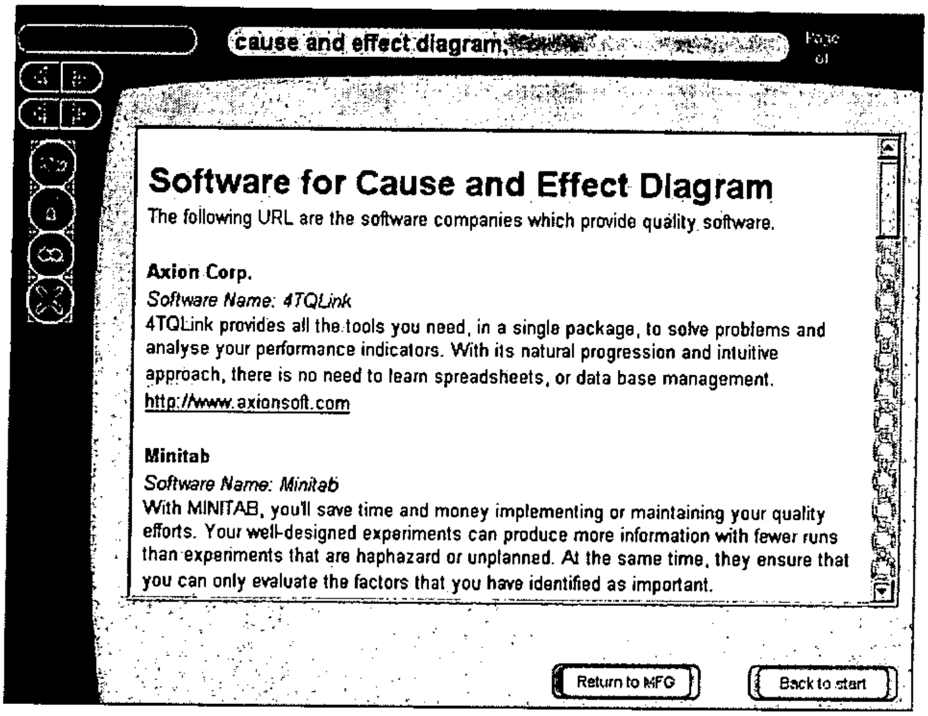


Figure 5-20 An Example of the Hyperlink of Quality Software Tools for Cause and Effect Diagram

After the quality practitioner investigates the root causes of the problems by using cause and effect diagrams, then by clicking the button "next page" in Figure 5-17, the system will suggest the practitioner to select one of the manufacturing processes for quality improvement. Seeing Figure 5-21, the quality practitioner is asked to identify a manufacturing process for quality improvement, and by using brainstorming and it can assist the practitioner to generate new innovative approaches that can help in productivity and quality improvement.

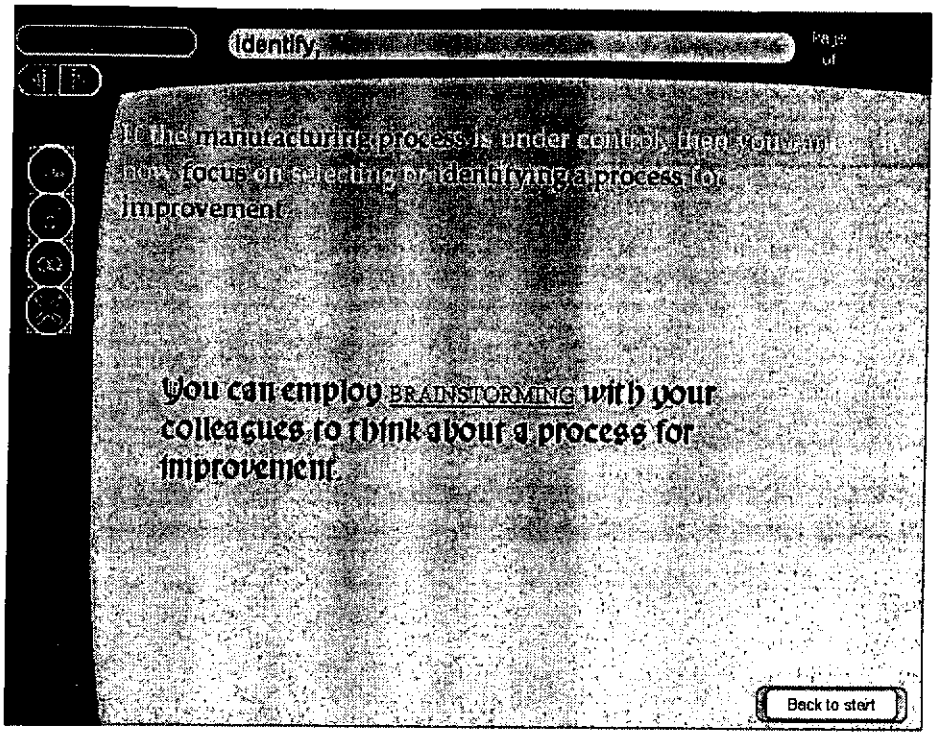


Figure 5-21 Interface of Fifth Step of Quality Improvement Strategy for Process Control and Improvement

By employing brainstorming, the quality practitioner can identify what area or which manufacturing process should be selected for process improvement. Then clicking the button "next page", it is to figure out what areas need to be involved to accomplish process improvement, and cause and effect diagrams will be preferred (refer to Figure 5-22). As mentioned before, cause and effect diagrams can assist the practitioner to generate ideas. Furthermore it can also identify the involved areas or processes in order to reach a common understanding to achieve the goal of process improvement.

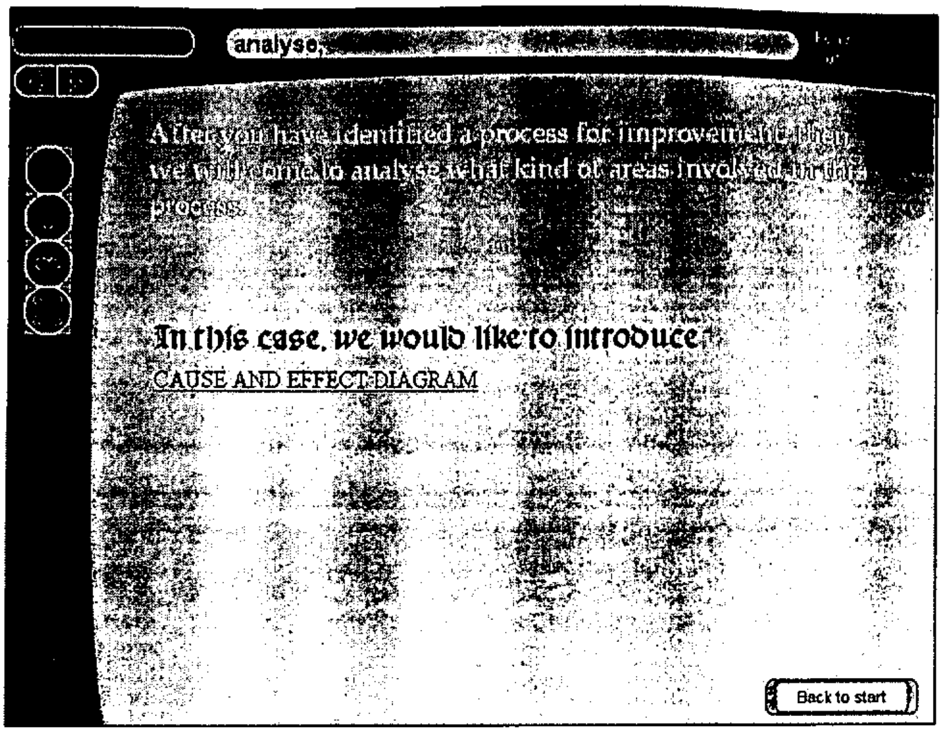


Figure 5-22 Interface of Sixth Step of Quality Improvement Strategy for Process Control and Improvement

After the practitioner has identified the area involved for manufacturing process improvement, he clicks the button “next page” and the system will ask the practitioner to check that “does a flowchart or an activity network diagram exist for particular process?” (see Figure 5-23). If the practitioner clicks “yes”, the system will suggest the quality practitioner to examine the manufacturing sub-processes or a particular production line to detect which part has potential failure. Furthermore, the quality practitioner can re-design the manufacturing processes in order to improve productivity and reduce the manufacturing costs by means of activity network diagrams (refers to Figure 5-24).

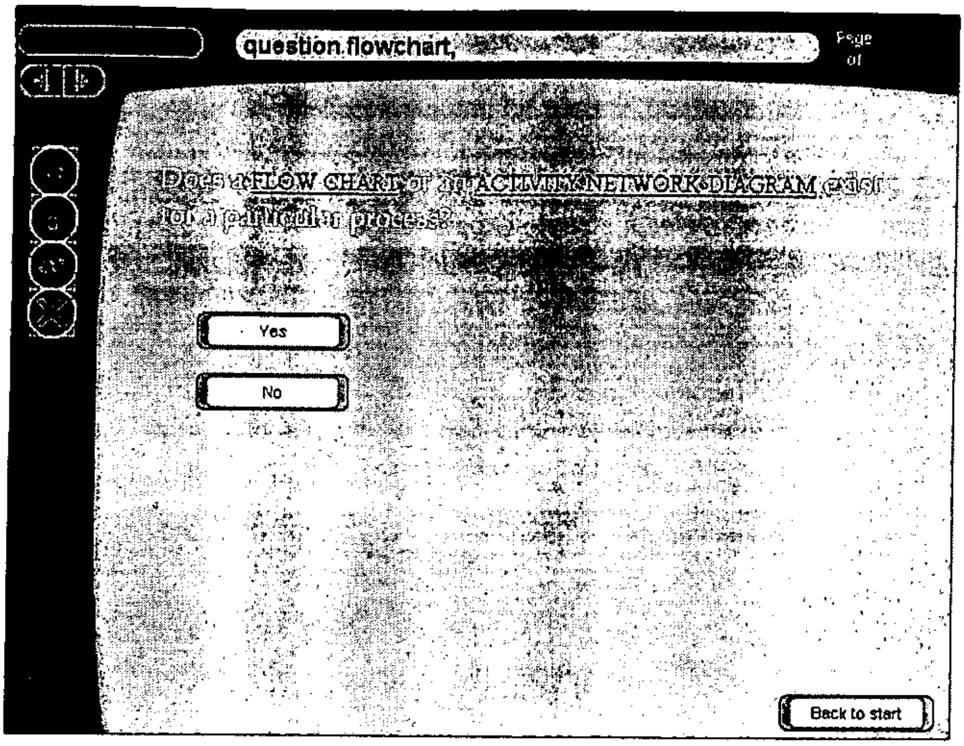


Figure 5-23 Interface of Seventh Step of Quality Improvement Strategy for Process Control and Improvement

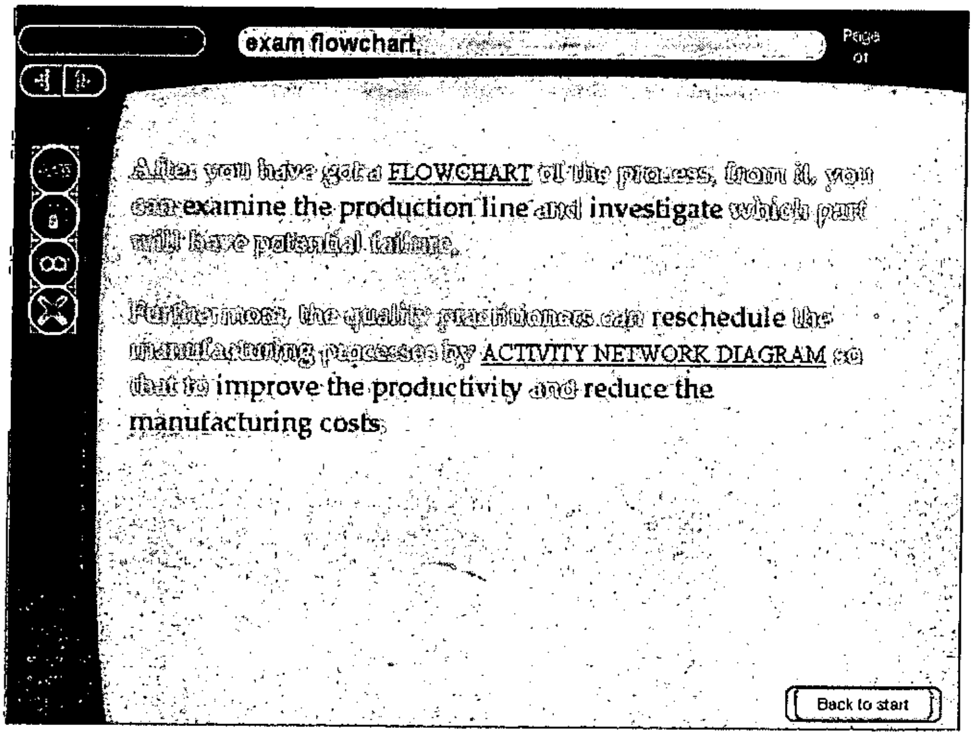


Figure 5-24 Interface of Eighth Step of Quality Improvement Strategy for Process Control and Improvement

By clicking the button "next page", further improvement will be suggested for problem prevention. Plan-do-check-act can be used to facilitate the prevention of the problem and elimination of possibility of problem recurrence (see Figure 5-25).

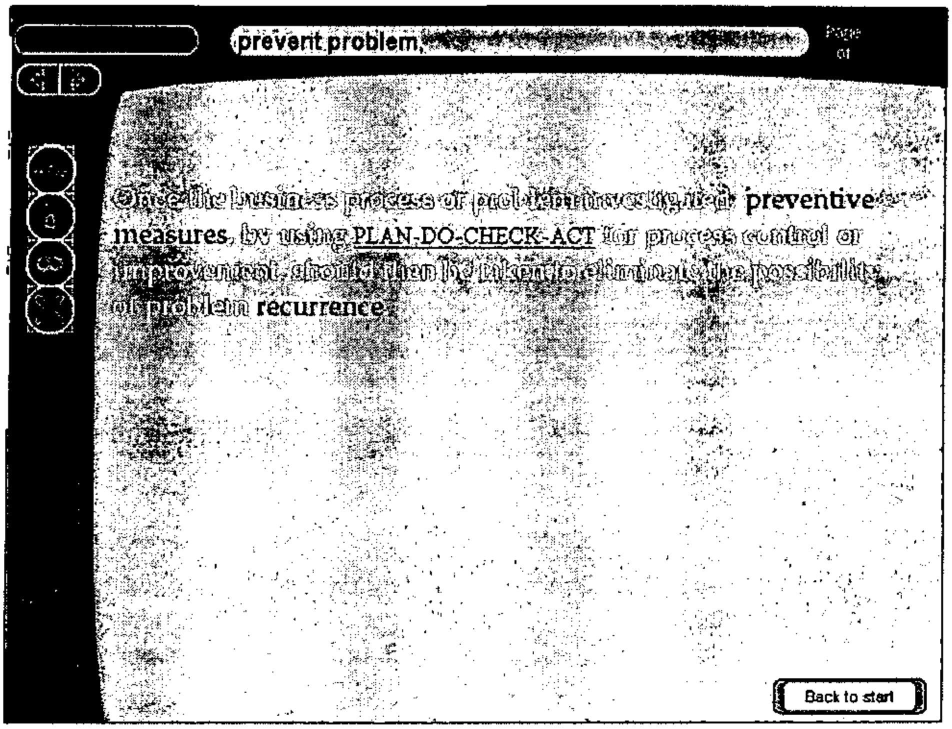


Figure 5-25 Interface of Ninth Step of Quality Improvement Strategy for Process Control and Improvement

By using plan-do-check-act, the practitioner can prevent problem recurrence in the manufacturing processes. However, for endless improvement, new ideas should be formulated to improve the current situation (by clicking the button "next page" to see Figure 5-26). By further employing plan-do-check-act, new innovative approach can be formulated. For easier manipulation, brainstorming is another kind of QT&T to generate new ideas.

From the new formulated approaches and ideas on improving the manufacturing processes, the practitioner has to consider the step-by-step approaches for making decisions in organisations. Decision-making is to take actions based on the overall conclusion inferred from the analysis. It is always a hard job because the decision involves the whole organisation. Therefore, by clicking the button "next page", the system will propose two QT&T for the quality practitioner to make decisions in a systematic and reasonable way (refer to Figure 5-27).

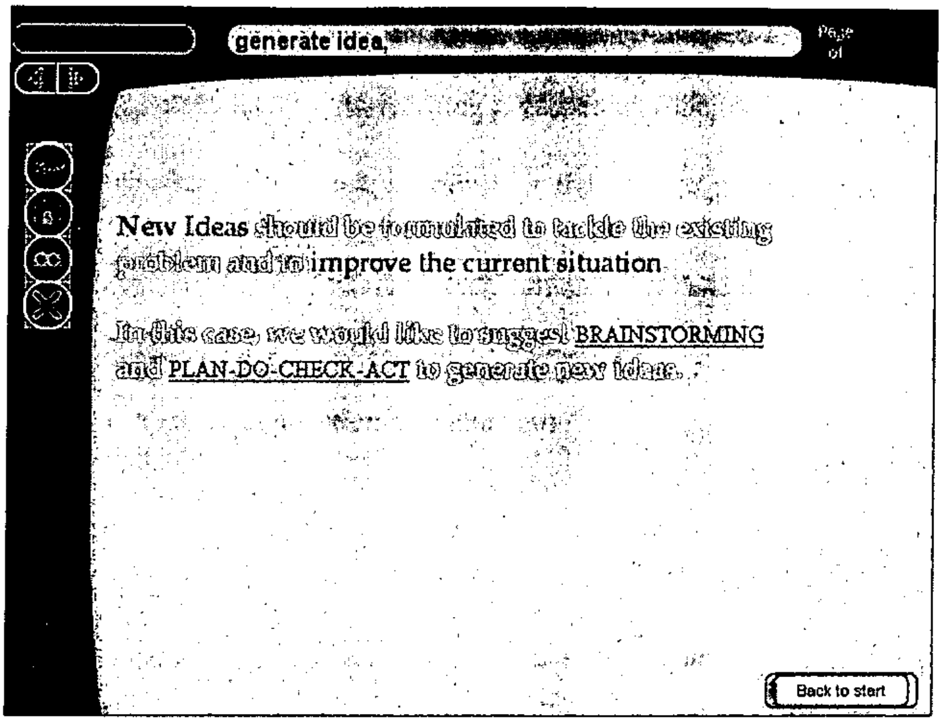


Figure 5-26 Interface of Tenth Step of Quality Improvement Strategy for Process Control and Improvement

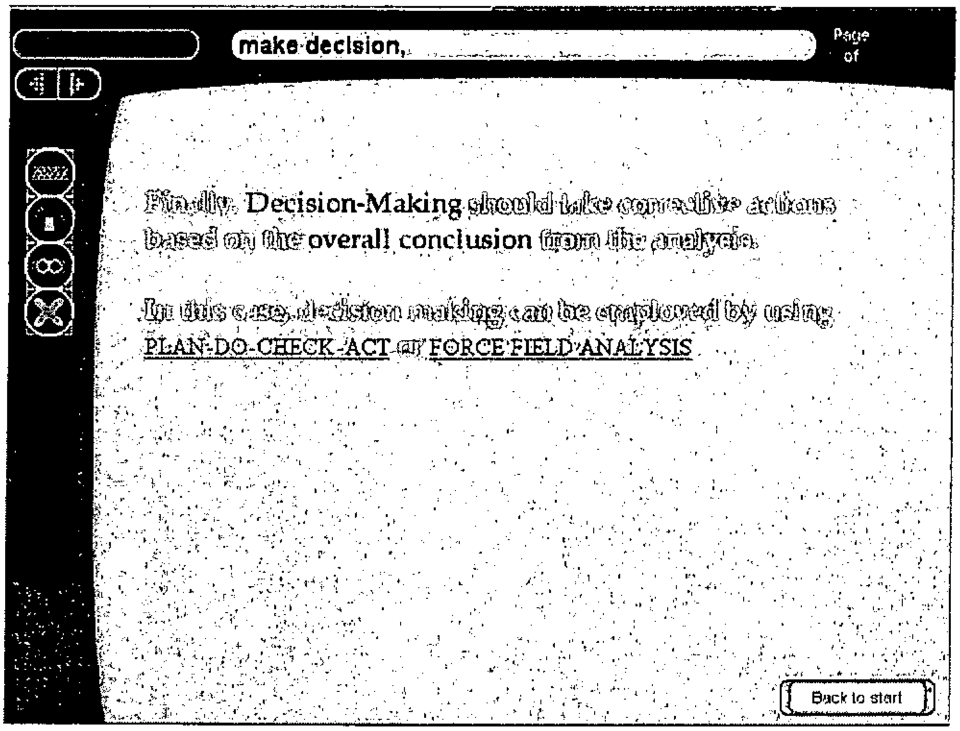


Figure 5-27 Interface of Eleventh Step of Quality Improvement Strategy for Process Control and Improvement

The above demonstration is one of the process control and improvement strategies depending on how the quality practitioner selects and answers the series of questions. When the practitioner faces a particular QT&T that he is not familiar with, he can just simply click on it and the system will navigate the practitioner to learn the use of QT&T database. In the learning database module, the practitioner can go back to the manufacturing industry module or the service industry module at any time interactively.

5.4 *Stage 3: System Evaluation and Analysis*

During the period of development of the system evaluations were conducted through informal discussions and interviews with potential user groups. Evaluations of the MBAQ system were conducted in two different stages: prototyping testing and potential user evaluation. Prototyping testing was focused on quality improvement strategy for the manufacturing and service industry modules, the capacity of learning QT&T database, user interfaces, and usability. The latter was directed at evaluating the educational aspects such as the system's effectiveness for searching and presenting, and the capability of the interactive learning methods.

5.4.1 Prototyping Testing

During the development of the MBAQ system, the prototyping testing evaluation methodology consisted of the following procedures:

1. Analysing and reviewing the capability the MBAQ System
2. Refining the structure and user-interface of the MBAQ system
3. Prototyping the MBAQ system

Analysing and Reviewing the Capability MBAQ System

The quality improvement strategy is generally for companies that would like to implement quality improvement measures by using QT&T. Of course, there will be different application methods for different companies to employ the quality improvement strategy proposed by the MBAQ system. To fulfil more companies' requirements, evaluation of the analysis capability of the MBAQ system, on-line evaluation methods were employed. Quality and production managers from different companies, research students and faculty members of The Hong Kong Polytechnic University were asked to review the MBAQ system during the development of the system with a view to enhance its capability.

Refining the Structure and User-Interface of the System

Critical reviews and feedback from the reviewers were collected. The major comment was to add some interactive quizzes and videos to enhance the users' leaning interests. The reviewers were satisfied with the quality improvement strategies in the manufacturing and service industry modules, as well as the capability of the learning QT&T database proposed by the system.

5.4.2 Potential User Evaluation

After the prototype of MBAQ was developed, another set of evaluations was performed. The main goals of this evaluation were:

1. to examine the design of the advisory and learning capability and system flow from educational and technical viewpoints;

2. to develop strategies and directions for future development of the MBAQ system.

The evaluation was conducted in a class of 26 students on the Master of Science (MSc) in quality management program of The Hong Kong Polytechnic University. In addition, ten quality managers from different companies also were invited to evaluate and use MBAQ. The evaluation of the system consisted of the following steps. First, I briefly described what this demonstration would be about. Then, I introduced the MBAQ system by showing the evaluators the applicability of the manufacturing and service industry modules and how the system can give advice to practitioners to help them to apply appropriate quality improvement and problem solving approaches by using QT&T. The demonstration of the capability of the learning the use of QT&T database was presented. The 26 MSc students and ten quality managers were therefore asked to fill in an evaluation form (see Appendix E), which included two parts. The first part was the background of the respondents regarding their experience in their current professions/industries, experience in quality management, and experience in using computers. The second part of the questionnaire included three major concerns. The first concern was the overall features and learning efficiency and effectiveness of the MBAQ system. The second concern was about the design, flexibility and user-interface of the MBAQ system. The third concern was about system clarity and sufficiency.

5.4.3 Evaluation Analysis

Tables 5-1 and 5-2 show the results of respondents' background and their evaluations respectively. As for the respondents' background, 56% of the them had at least 3-5 or more years of experience in the quality management field, while 92%

of the respondents had 3-5 or more years experience in using computers. Regarding MBAQ evaluation, 64% and 86% of the respondents agreed that MBAQ could help practitioners in selecting proper QT&T and learning the use of QT&T respectively. About 80% of the respondents agreed that MBAQ could provide an effective means to learn and provide better training to staff. The majority of the respondents deemed MBAQ could help quality practitioners in selecting the proper QT&T and provide an effective learning environment for them to learn the use of QT&T. The aspects of the design, flexibility and user-friendliness of the MBAQ system were evaluated. 83% and 89% of the respondents agreed that the system is easy to learn and use. 64% of them deemed that the use of pictures and graphs of MBAQ system is effective enough. About the information contained in the MBAQ system, 78% and 50% of the respondents agreed that it is clear and sufficient enough respectively.

Table 5-1 Results of Respondents' Background

Total Number of Respondents, n = 36	% of < ½ Year - >½-1 Year	% of >1-3 Years	% of >3-5 Years - > 5 Years
1. Number of year(s) in current profession/industry	8	17	75
2. Number of year(s) in quality management field	22	22	56
3. Number of year(s) in using computer	0	8	92

Table 5-2 Results of Evaluation

Total Number of Respondents, n = 36	% of Strongly Agree and Agree	% of Neutral	% of Disagree and Strongly Disagree
The overall Multimedia-Based Advisory prototype system of selection Quality Tools and Techniques can:			
1. help quality practitioners to select the proper quality tools and techniques	64	31	6
2. help quality practitioners to learn the use of quality tools and techniques	86	14	0
3. increase the interest of learning the use of quality tools and techniques	61	36	3
4. provide new insights of the use of quality tools and techniques	42	53	6
5. provide an effective means to learn	78	14	8
6. reduce pressure in the learning procedures	61	31	8
7. enable inexperienced user to deal with	75	22	3
8. provide better training to staff	83	14	3
9. improve learning efficiency	67	28	6
Concerning about the prototype system			
1. the system is easy to learn	83	17	0
2. the system is easy to use	89	11	0
3. the use of pictures and graphs is effective	64	33	3
4. the scenario is easy to visualize	64	33	6
The information contained in the prototype system is:			
1. clear	78	19	3
2. sufficient	50	39	11

5.5 *Summary*

The development of the MBAQ system discussed in this chapter is to assist the user in identifying the appropriate QT&T, according to the problems that quality practitioners face. Referring to MBAQ evaluation, 64% and 86% of the respondents agreed that MBAQ could help the practitioners in selecting proper QT&T and learn the use of QT&T respectively. About 80% of the respondents agreed that MBAQ could provide better training to staff as it is an effective means for learning QT&T.

6. CONCLUSIONS AND FUTURE WORK

6.1 *Conclusions*

The following conclusions are drawn with respect to the purpose of this research as stated in section 1.2.

1. A proposed taxonomy was established based on a comprehensive literature review of the use of QT&T in support of quality improvement and validated through expert advice of quality practitioners. The taxonomy classifies 25 popular QT&T into five application domains, namely problem identification, problem analysis, problem prevention, ideas generation and decision making. It can encourage quality practitioners to employ the QT&T in a step-by-step and systematic manner instead of in an isolated way.
2. In order to explore the impact of two influencing factors – training and education, and understanding – on the use of QT&T, hypothesis testing was conducted to analyse the association of the influencing factors with the use of QT&T. The results indicate that "Training and education of the use of QT&T" was associated with the use of QT&T with $\chi^2 = 0.093$ at 0.1 level significance. And "Understanding of QT&T" was associated with the use of QT&T with $\chi^2 = 0.002$ at 0.01 level of significance.
3. A Multimedia-Based Advisory system in selecting proper QT&T (MBAQ) was developed. The MBAQ system provides linking from text to graphics by clicking on icons. This kind of linkage provides a direct way to learn and is time efficient (Hillinger, 1997). Evaluation of MBAQ was conducted with 36 potential users (MSc students in quality

management program and quality practitioners in 10 different organisations). 64% and 86% of the respondents agreed that MBAQ could help the practitioners in selecting proper QT&T and learn the use of QT&T respectively. About 80% of the respondents agreed that MBAQ could provide better training to staff as it is an effective means for learning QT&T. According to the evaluation results, it can be summarised that MBAQ can facilitate the quality practitioners to learn and to be trained to use and select proper QT&T for problem solving and quality improvement efforts.

6.2 Future Work

For the MBAQ system, two main improvements are suggested as follows:

1. *Chinese Version.* Technicians and engineers work in China may not know English. Therefore, the system interface in Chinese can be added.
2. *More Examples.* At this moment, limited examples are provided. More examples will be added to facilitate users in understanding the use of QT&T.

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APPENDIX A: QUALITY TOOLS AND TECHNIQUES USAGE

Seven Basic Tools or Statistical Process Control (SPC)

It is a collection of mathematically based methods for data analysis that provide a practical means for studying process-related problems.

- Cause and Effect Diagram

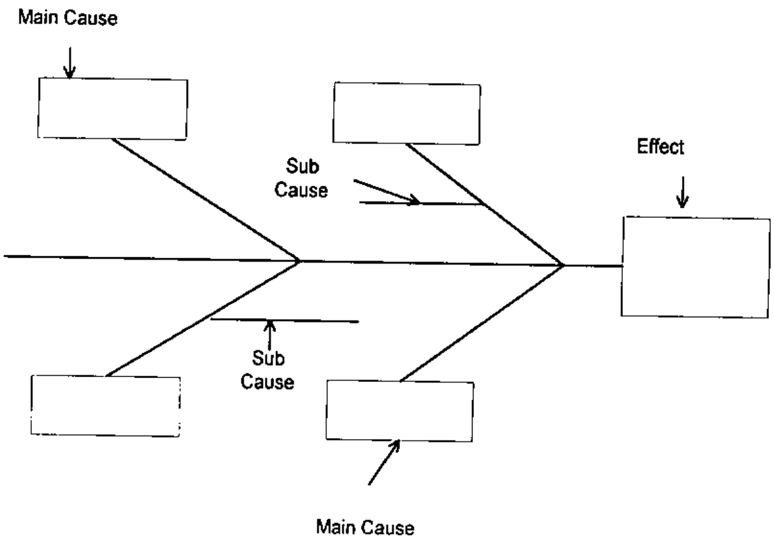
What: A cause-and-effect diagram is also called a "fishbone" diagram. It is used to show cause and effect relationships.

When To Use: To determine and breakdown the main causes of a given problem.

How: Fish's head (main activity) on right. Ribs contain major process steps.

Procedures:

1. Place the outcome or problem statement on the right side of the paper, draw a horizontal line with an arrow pointing to the outcome.
2. Determine major categories for the causes; connect them to the horizontal line with diagonal lines.
3. Note the major causes and place them under the general categories.
4. List the subcauses and place them under the main causes.
5. Evaluate the diagram.

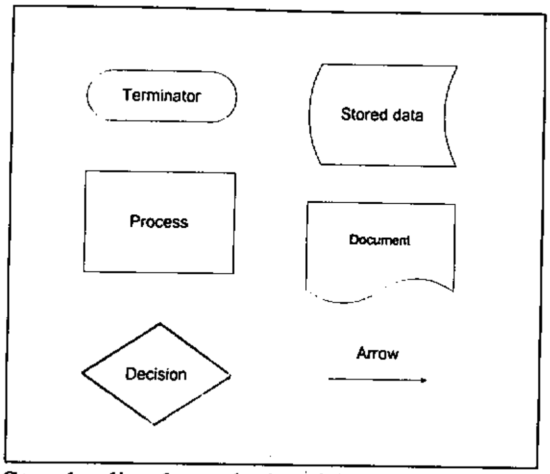


- Flowcharts

What: A flow chart is one of the most useful quality improvement tools. It depicts the sequence of steps performed in a specific process. The goal of a flowchart is to identify the actual path a process follows.

When: To document the steps of a work process either to analyze the current situation or to provide a plan to follow.

How: Layout the process steps using standardized symbols.

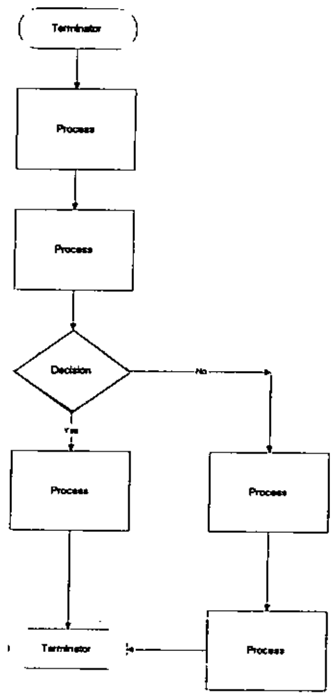


Standardized symbols of flowchart

Procedures:

1. Decide on the starting and ending points of the process.
2. Record all activities and decision points involved in process.
3. Arrange activities and decision points in sequence.
4. Create flowchart with standardized symbols.
5. Analyze flowchart.

The following is an example of a flowchart.



- Checksheet

What: A checksheet is a form on which to collect data. It tells how many times a given event occurs. A check sheet must e designed specifically for the particular process or. It will provide a clear record of the data gathered about that process.

When To Use: To simplify data collection

How: Design form for clarity and ease of data collection.

Procedures:

1. Clarify the objective(s) and decide which data should be collected.

2. Decide the period for collection.
3. Select a sample size.
4. Design a suitable check sheet format and ensure it is easy to record data.
5. Record the data.
6. Tally the check results.
7. Evaluate the check sheet.

Item \ Day	Mon	Tue	Wed	Thur	Fri	Sat
1	II	III	I	~~IIII~~	IIII	
2	I	II	~~IIII~~	II	III	II
3	II	II	III	I	III	~~IIII~~ I
4	IIII	II	II	IIII	~~IIII~~ II	I
5	I	I	III	I	I	
6	I	II	I	IIII	~~IIII~~ I	I

An example of a checksheet.

- Control Charts

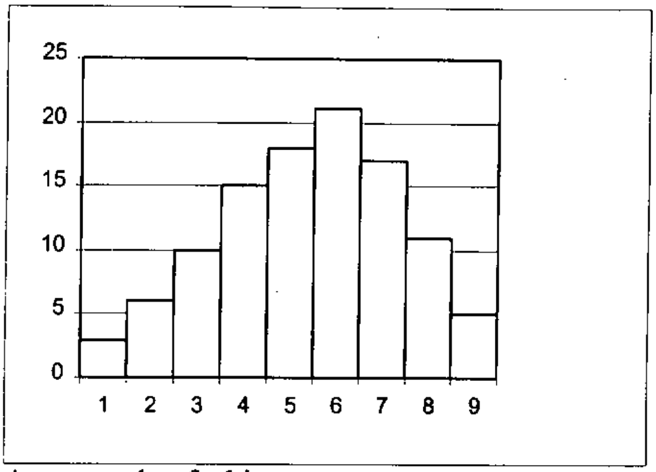
What: A control chart is the statistically oriented method that allows taking small samples at specified time intervals to record the process on a real-time basis. The data will be plotted on as a line graph with an average line and control limit lines.
When To Use: To Monitor key product variables and process parameters. Also maintain of process control and identify of special and common causes of variation.
How: Separate types of charts for continuous and discrete data.

- Histograms

What: All processes have some variation and it generally follows some pattern; there is a predictable range of variation. In most cases, the variation falls into a normal range. The histogram is a tool that shows the patterns of distribution.
When: To classify the data set into divided bars of equal width and show patterns in dispersion of continuous data or large discrete data sets.
How: Construct vertical bars showing the information of the frequency distribution for each of the classes.
Procedures:

1. Gather data.
2. Find the maximum and minimum values - Find the maximum value L and the minimum value S in the data.
3. Determine the number of classes (bars).
4. Determine the width of the section.
5. Determine the class boundaries:
    a. Take the smallest number in the data set and round it down, if necessary. This
    b. becomes the lower boundary of the first class.
    c. Add the value for the class width (W) to the lower boundary value. This is the value for the lower boundary of the next class.
    d. Continue adding the value for the class width to each lower value to determine the parameters for all the classes.

6. Construct the histogram chart placing the values for the classes on the horizontal axis and the frequency on the vertical axis.
7. Analyze the findings.



An example of a histogram.

- Pareto Analysis

What: It is for recording and analyzing information which easily enable the most significant aspects to be identified.

When To Use: To clarify and prioritize the causes of a given problem or situation.

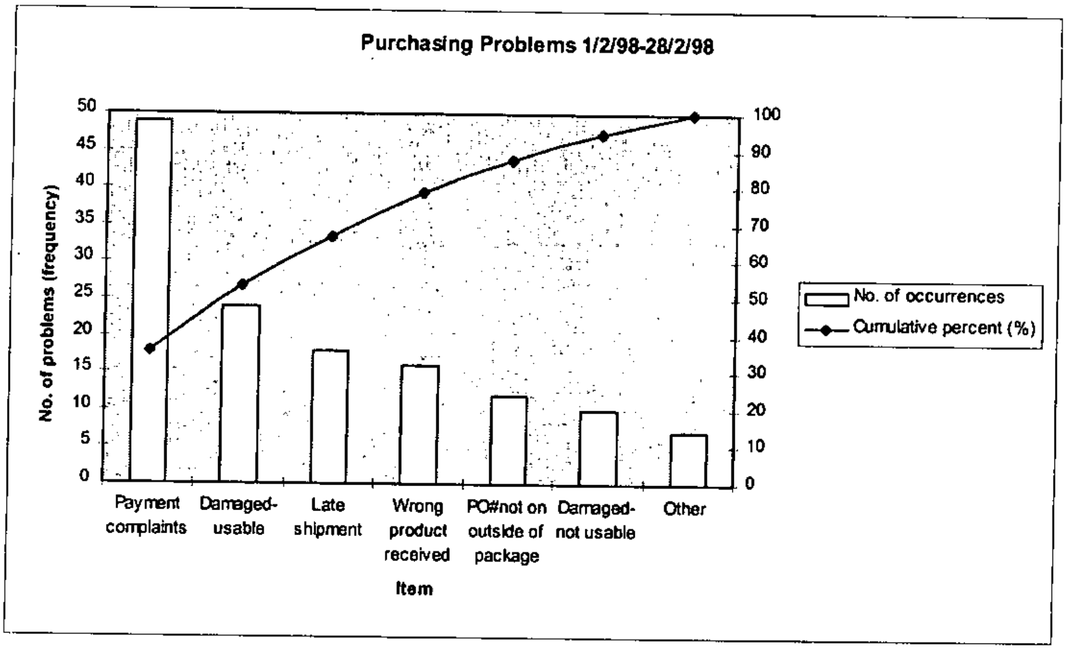
How: Construct a frequency chart in which the bars are arranged in descending order from left to right cumulatively.

Procedures:

1. Decide on the topic of study.
2. Select the type of causes or conditions to be compared.
3. Determine the standard for comparison, in many cases the standard will be the frequency.
4. Collect data.
5. Compare frequency between categories.
6. Draw the vertical axis indicating the frequency for comparison.
7. Label the horizontal axis with each factor **in descending order**.
8. Draw the bars to indicate the frequency of each factor with accumulative percentages.

Here is an example which is about the problem of purchasing. (Mears 1995)

Item	No. of occurrences	Cumulative occurrences	Cumulative percent (%)
Payment complaints	49	49	36
Damaged-usable	24	73	53.7
Late shipment	18	91	66.9
Wrong product received	16	107	78.7
PO# not on outside of package	12	119	87.5
Damaged-not usable	10	129	94.9
Other	7	136	100



- Scatter Plot

What: It is a chart where the data for x and y variables are entered as dots to see if they form a pattern.

When To Use: To identify the relationship between two variables.

How: Suspected cause should be on x axis and the effect on the y axis.

Procedures:

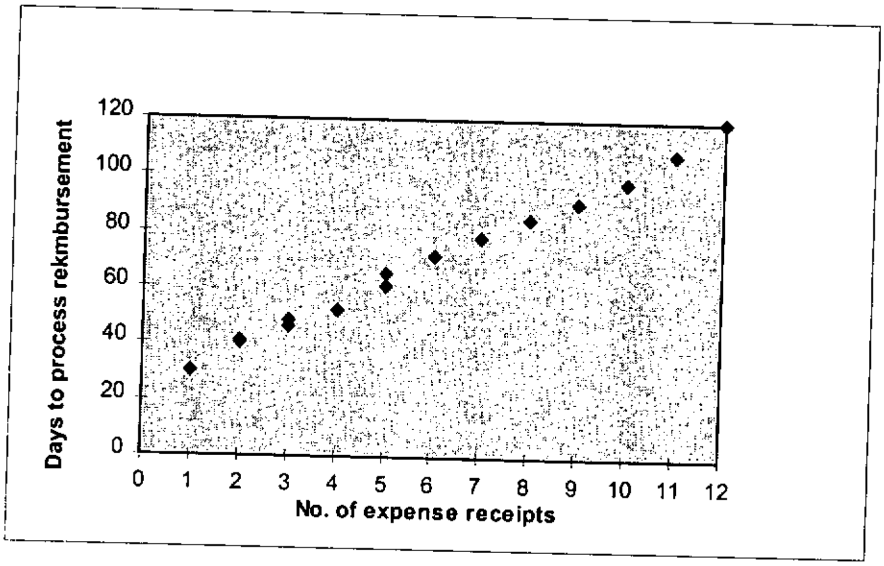
1. Decide which two variables will be tested.
2. collect approximately 50 to 100 paired samples of data and re cord them on the data sheet.
3. Draw the horizontal and vertical axes, noting which variable is represented by each, for example x can be pressure y can be time.
4. Plot the variables on the graph.
5. Interpret the completed diagram by noting the clustering of points on the graph, usually there are several kinds of appearances:

a. If points are scattered all over the diagram, the tow variables have no correlation.

b. If points cluster I an area running form lower left to upper right, the two variable shave a positive correlation.

c. If points cluster in an area running from upper left to lower right, the tow variable have a negative correlation.

Item	No. of expense receipts	Days to process reimbursement
1	1	30
2	11	108
3	7	78
4	2	40
5	10	98
6	3	48
7	2	41
8	5	61
9	4	52
10	3	46
11	12	120
12	6	72
13	8	85
14	5	65
15	9	91



Hoshin Planning Techniques (Seven Management Tools)

It is a technique that tie quality improvement activities to long-term organizational planned. It focuses on policy deployment issues including the identification of planning objectives and what action management and employees will take.

There are three detailed planning.

1. General Planning: Affinity Chart and Interrelationship Diagram
2. Intermediate Planning: Tree Diagram, Matrix Diagram and Matrix Data Analysis
3. Detailed Planning: Process Decision Program Chart and Arrow Diagram

- Affinity Chart

What: Sort related ideas into similar groupings and labels each grouping.

When To Use: There are large volumes of ideas and there is a need to identify broad issues.

Procedures:

1. Define the objective.
2. Generate ideas and write it down on a card.
3. Display the cards on the wall.
4. Classify the cards
5. Create header cards.
6. Draw the diagram.

- Interrelationship Diagram

What: Identifies cause and effect links between ideas generated.

When To Use: Root causes need to be identifies.

- Tree Diagram

What: Maps out detailed groupings of tasks that need to be accomplished.

When To Use: Broad tasks or general objectives need to be clearly divided into subtasks.

- Matrix Diagram

What: Shows relationships between activities such as people and tasks; consumer wants and system capabilities.

When To Use: relationships must be clearly shown, or when impact of demands have to be identified on system capabilities and priorities developed.

- Matrix Data Analysis

What: Shows relationships between two variables.

When To Use: Strengths of relationships must be visually shown.

- Process Decision Program Chart

What: Map out contingencies that can occur, along with countermeasures.

When To Use: countermeasures need to be "thought through" when implementing a new plan that has potential problem areas.

- Arrow Diagram (Activity Networks)

What: Detailed planning and scheduling tool that identifies time requirements and activity relationships.

When To Use: detailed planning and control is needed on complex tasks with numerous interrelationships.

Advanced Techniques

Quality Function Deployment: It is used when customer requirements must be transferred into either an organizational design or a technical product design.
How: there are six steps of QFD technique
1. Identifying the customer(s)
2. Determining customer requirements
3. Determining relative importance of requirements
4. Competition bench-marking
5. Translating customer requirements into measurable engineering requirements
6. Developing a control chart

Failure Mode Effect and Criticality Analysis (FMECA): It is a disciplined method of product or process analysis which is conducted to identify potential failures which could affect the customer's expectations of product quality or process performance. It's key application is to:
1. Identify failures which alone or in combination, have undesirable or significant effects; to determine the failures modes which may seriously affect the expected or required quality.
2. Identify safety hazard and liability problem areas.
3. Focus development testing on areas of greatest need.

Taguchi Methods: It is an experimental design method which can be used for
Designing products or processes so that they are robust to environmental conditions.
Designing or developing products so that they are robust to component variation.
minimizing variation around a target value.

There are three stages in a product's (process's) development:
1. System Design: The application of scientific engineering and technical knowledge to product a basic functional prototype design. This requires a fundamental understanding of the needs of the customer and the product environment.
2. parameter Design: The identification of the settings of product or process parameters that reduce the sensitivity of the designs to sources of variation. This requires a study of the whole process system design to achieve the most robust operational settings, in terms of tolerance to ranges of the input variables.
3. Tolerance Design: The determination of tolerances around the nominal settings identified by parameter design. This requires a trade-off between the customer's loss due to performance variation and the increase in production or operational costs.

Taguchi recommends that statistical experimental design methods can be used to find a best product or process design, where by "best" meant a product or process that is robust or insensitive to uncontrollable factors that will influence the product or process once it is in routine operation.

The quadratic loss function is basic to the understanding or Taguchi's philosophy. Any variation about a target value for a product or process parameter causes loss to the customer. The loss refers to the cost that is incurred by society when the customer uses a product whose quality characteristics differ from the nominal.

APPENDIX B: QUESTIONNAIRE

Part I: About Your Product

Your Product:____________________

Please check the appropriate box(es) if your above-mentioned product have such features/functions.

Features/Functions	"✓", if appropriate	Remarks
Acceptance Sampling	❑	
Activity Network Diagram	❑	
Affinity Diagram/KJ Method	❑	
Benchmarking	❑	
Brainstorming	❑	
Brainwriting	❑	
Cause-effect Diagrams	❑	
Charts (Bar, Pie, Run and Spider)	❑	
Check Sheets	❑	
Control Charts	❑	
Deployment Chart	❑	
Design of Experiment (DOE)	❑	
Failure Mode Effect and Critically Analysis (FMECA)	❑	
Fault Tree Analysis	❑	
Flowchart	❑	
Force Field Analysis	❑	
Gantt Chart	❑	
How-How Diagram	❑	
Interrelationship Diagram	❑	
Matrix Data Analysis	❑	
Matrix Diagram	❑	
Pareto Analysis	❑	
Plan-Do-Check-Act (Deming Wheel)	❑	
Pokayoke (Foolproof)	❑	
Process Capability	❑	
Process Decision Program Chart	❑	
Quality Circles	❑	
Quality Costing	❑	
Quality Function Deployment (QFD)	❑	
Scatter Diagram	❑	
Surveys	❑	
Taguchi Method	❑	
Tree Diagram	❑	
Why-Why Diagram	❑	
WorkFlow Diagram	❑	
Other areas, please specify:		

Another Quality Software: ________________________

Please check the appropriate box(es) if your above-mentioned product have such features/functions.

Features/Functions	"✓", if appropriate	Remarks
Acceptance Sampling	❑	
Activity Network Diagram	❑	
Affinity Diagram/KJ Method	❑	
Benchmarking	❑	
Brainstorming	❑	
Brainwriting	❑	
Cause-effect Diagrams	❑	
Charts (Bar, Pie, Run and Spider)	❑	
Check Sheets	❑	
Control Charts	❑	
Deployment Chart	❑	
Design of Experiment (DOE)	❑	
Failure Mode Effect and Critically Analysis (FMECA)	❑	
Fault Tree Analysis	❑	
Flowchart	❑	
Force Field Analysis	❑	
Gantt Chart	❑	
How-How Diagram	❑	
Interrelationship Diagram	❑	
Matrix Data Analysis	❑	
Matrix Diagram	❑	
Pareto Analysis	❑	
Plan-Do-Check-Act (Deming Wheel)	❑	
Pokayoke (Foolproof)	❑	
Process Capability	❑	
Process Decision Program Chart	❑	
Quality Circles	❑	
Quality Costing	❑	
Quality Function Deployment (QFD)	❑	
Scatter Diagram	❑	
Surveys	❑	
Taguchi Method	❑	
Tree Diagram	❑	
Why-Why Diagram	❑	
WorkFlow Diagram	❑	
Other areas, please specify:		

Please provide a leaflet describing your mentioned quality software or write a short note on the space provided below about your mentioned quality software.

Part II: About Our Proposed Structured Framework for Classifying Quality Tools/Techniques

We have developed a structured framework for quality practitioners to classify quality tools/techniques. The structured framework contains the following five major categories:

- Identify Problems
- Analyze Problems
- Prevent Problems
- Make Decision
- Generate Ideas

In order to evaluate the structured framework, we would like to seek your expertise in classifying the following list of 36 quality tools/techniques as identified in the literature.

Please check the appropriate box if you think the following quality tools/techniques can help in "**Identify Problems**".

Quality Tools/Techniques	*Agree*	*Not Agree*	*No Idea*
Brainstorming	☐	☐	☐
Cause-effect Diagrams	☐	☐	☐
Check Sheets	☐	☐	☐
Control Charts	☐	☐	☐
Deployment Chart	☐	☐	☐
Design of Experiment (DOE)	☐	☐	☐
Failure Mode Effect and Critically Analysis (FMECA)	☐	☐	☐
Fault Tree Analysis	☐	☐	☐
Flowchart	☐	☐	☐
Force Field Analysis	☐	☐	☐
Pareto Analysis	☐	☐	☐
Plan-Do-Check-Act (Deming Wheel)	☐	☐	☐
Quality Function Deployment (QFD)	☐	☐	☐
Taguchi Method	☐	☐	☐
WorkFlow Diagram	☐	☐	☐

Please check the appropriate box if you think the following quality tools/techniques can help in "**Analyze Problems**".

Quality Tools/Techniques	*Agree*	*Not Agree*	*No Idea*
Acceptance Sampling	❑	❑	❑
Affinity Diagram/KJ Method	❑	❑	❑
Charts (Bar, Pie, Run and Spider)	❑	❑	❑
Check Sheets	❑	❑	❑
Control Charts	❑	❑	❑
Design of Experiment (DOE)	❑	❑	❑
Failure Mode Effect and Critically Analysis (FMECA)	❑	❑	❑
Flowchart	❑	❑	❑
Force Field Analysis	❑	❑	❑
Interrelationship Diagram	❑	❑	❑
Matrix Data Analysis	❑	❑	❑
Matrix Diagram	❑	❑	❑
Pareto Analysis	❑	❑	❑
Process Capability	❑	❑	❑
Quality Costing	❑	❑	❑
Quality Function Deployment (QFD)	❑	❑	❑
Scatter Diagram	❑	❑	❑
Surveys	❑	❑	❑
Taguchi Method	❑	❑	❑
Tree Diagram	❑	❑	❑

Please check the appropriate box if you think the following quality tools/techniques can help in "**Prevent Problems**".

Quality Tools/Techniques	*Agree*	*Not Agree*	*No Idea*
Control Charts	❑	❑	❑
Design of Experiment (DOE)	❑	❑	❑
Failure Mode Effect and Critically Analysis (FMECA)	❑	❑	❑
Plan-Do-Check-Act (Deming Wheel)	❑	❑	❑
Pokayoke (Foolproof)	❑	❑	❑
Taguchi Method	❑	❑	❑

Please check the appropriate box if you think the following quality tools/techniques can help in "**Generate Ideas**".

Quality Tools/Techniques	*Agree*	*Not Agree*	*No Idea*
Brainstorming	❑	❑	❑
Brainwriting	❑	❑	❑
How-How Diagram	❑	❑	❑
Plan-Do-Check-Act (Deming Wheel)	❑	❑	❑
Quality Circles	❑	❑	❑
Why-Why Diagram	❑	❑	❑

Please check the appropriate box if you think the following quality tools/techniques can help in "**Make Decision**".

Quality Tools/Techniques	*Agree*	*Not Agree*	*No Idea*
Activity Network Diagram	❑	❑	❑
Benchmarking	❑	❑	❑
Design of Experiment (DOE)	❑	❑	❑
Failure Mode Effect and Critically Analysis (FMECA)	❑	❑	❑
Force Field Analysis	❑	❑	❑
Gantt Chart	❑	❑	❑
Plan-Do-Check-Act (Deming Wheel)	❑	❑	❑
Process Decision Program Chart	❑	❑	❑
Quality Function Deployment (QFD)	❑	❑	❑
Taguchi Method	❑	❑	❑
Tree Diagram	❑	❑	❑

If you have any comments/opinions on our structured framework, please feel free to write them in the space below.

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Thank you for your time and effort!

If you would like to have a copy of the summary of our investigation, please write down your name and address on the space provided **or** stick your name card below.

Name: ____________________

Address: ____________________

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Please stick your name card here

APPENDIX C: QUALITY SOFTWARE REFERENCES

4TQFlow +

4TQFlow Plus uses a flow charting interface which helps you break your business processes into tasks, decision, and process splits, prompting you to enter any additional information regarding each figure in your flow chart.
(http://www.axionsoft.com)

4TQLink

4TQLink provides all the tools you need, in a single package, to solve problems and analyze your performance indicators. With its natural progression and intuitive approach, there is no need to learn spreadsheets, or data base management.
(http://www.axionsoft.com)

allCLEAR

allCLEAR makes creating and updating diagrams, especially complex ones, easy. allCLEAR users agree - two out of three tried other products first, then switched to allCLEAR, "The Smarter Flowcharter".
(http://www.spss.com/)
(http://www.qsoftguide.com/)

CARD

CARD is a revolutionary approach to experiment design and data analysis that completely transcends general statistics program. CARD guides you through design and analysis using plan English instructions. Then it interprets your results in words that you can actually understand and use.
(http://www.qsoftguide.com/)

CATS (Corrective Action Tracking System)

The Corrective Action Tracking System (CATS) is an MS Windows multiuser database system designed to help firms track problems form identification of nonconformance, through disposition and corrective action. CATS has proven to be instrumental in helping firms achieve and maintain ISO 9000 certification. CATS is not just a static data repository, it's a dynamic workflow tool that assists you in your problem solving process.
(http://www.idscats.com/)

Design of Experiments (DoE) – Matrex for Excel 5.0

Matrex is a spreadsheet add-in for Microsoft Excel 5.0 which provides the user with a powerful environment for exploiting Design of Experiments (DoE) techniques. DoE is the essential tool for simplifying the design and analysis of complex systems. Its use in modern industry is becoming increasingly important as companies strive to optimize processes and improve product quality.
(http://www.rsd-associates.com/)

DESIGN-EASE

DESIGN-EASE software helps experimenters make breakthrough discoveries. The program sets up and analyzes two-level factorial, fractional factorial (up to 15

factors), irregular fraction factorial, and Plackett-Burman designs (up to 31 factors). DESIGN-EASE also provides simple one-way designs. Graphics simplify the analysis at every step. Purchase on approval for a no-risk trial. (Available for Macintosh or Windows).
(http://www.statease.com/)

DESIGN-EXPERT

DESIGN-EXPERT software draws 3D response surface maps that lead experimenters directly to optimal performance. For process improvement the program offers three level FACTORIALS, CENTRAL COMPOSITE AND Box-Behnken designs. For mixture experiments DESIGN-EXPERT offers simplex, extreme vertices and d-optimal designs. Mouse support allows users to interact with graphical outputs. Purchase on approval for a no-risk trial. (Windows only).
(http://www.statease.com/)

JMP

JMP (pronounced "jump") software is a highly interactive environment for statistical visualization and exploratory data analysis. JMP presents statistics in an easily understood, graphical environment. Data tables are presented clearly in spreadsheet form and are dynamically linked to related graphs and tables. JMP offers six statistical analysis platforms including a 3-D spin plot, as well as capabilities for performing univariate statistics, analysis of variance and multiple regression, nonlinear fitting, multivariate analysis, and nonparametric tests. JMP also features integrated capabilities for quality improvement and design of experiments, offering five types of classical designs for estimating the effect of one or more factors on a dependent variable. The software also provides a variety of graphical tools designed for quality control including Shewhart control charts and Pareto charts.
(http://www.sas.com/)

Milestones, Etc.

Milestones, Etc. helps you create presentation quality schedules in minutes. Select from over 40 pre-designed templates such as: budget vs. actual, shipping, development, room or meeting schedules, contract proposals, defense contractor schedules, and engineering project.
(http://www.qsoftguide.com/)

MINITAB

With MINITAB, you'll save time and money implementing or maintaining your quality efforts. Your well-designed experiments can produce more information with fewer runs than experiments that are haphazard or unplanned. At the same time, they ensure that you can only evaluate the factors that you have identified as important.
(http://www.minitab.com/)

NCSS 97

Number Crunchier Statistical System - A comprehensive and accurate, easy to learn, statistical system for Windows users.
(http://www.ncss.com/)

PathMaker

PathMaker is the perfect software for people who are working to improve processes. It is comprehensive, but easy to use... powerful but friendly. No other package offers this many tools, with this high level of functionality, flexibility and integration, at such a low price.
(http://www.qsoftguide.com/)
(http://www.skymark.com/)

PFT for Windows

A software package for planning, implementing, analyzing, and improving day-to-day business operations through Total Quality Management (TQM).
(http://www.iqd.com/)

PFT Professional Advanced for Windows

It contains PFT Professional software features plus advanced SPC tools.
(http://www.iqd.com/)

PFT Professional Edition for Windows

With the use of PFT Professional Edition for Windows, you will discover how to easily organize and important information you receive during business communications.
(http://www.iqd.com/)

Process Charter

With process Charter you can quickly diagram any business process - even if it requires parallel tasks with many branches. The interface is a delight! But Process Charter's real power lies in what it does after you draw your diagram.
(http://www.qsoftguide.com/)

Project KickStart

Project KickStart guides you step-by-step through brainstorming your project ideas, and scheduling your project plan. You will create Goals, Tasks, Obstacles, People, Assignments and even a Gantt chart, all without even opening the manual.
(http://www.qsoftguide.com/)

Project Scheduler 7.5

Project Scheduler (PS7)'s extensive on-line help, project guides, and "What's This?" help technology ensure that managers at all experience levels can quickly begin project planning and scheduling. PS7 starts with user-definable spreadsheets that work in concert with Gantt charts, network diagrams and tree charts. Data is easily entered in the spreadsheet with outlining available for fast project summaries.
(http://www.qsoftguide.com/)

QC-PRO

The software provides the key charts, calculations and reports in a clear and practical manner. It is powerful enough to fulfill the needs of the quality specialist yet simple enough to be sued by operators on the shop floor.
(http://www.pister.com/)

QFD Designer

QFD Designer easily creates a matrix that is nearly impossible to create using a general purpose software package. Input your data about customer demands, competitive analysis, and technical capabilities directly and intuitively into the QFD chart. The interrelationships between customer desires and product design rapidly become clear. Analysis is simplified using the color graphs comparing your product to your goals and to competitive products.
(http://www.qsoftguide.com/)

QFD/Capture Professional Edition

QFD/Capture Professional Edition builds on the Standard Edition to become even more of an indispensable support tool for any decision making process - from basic to complex. The software has a QFD Project focus, rather than a single matrix focus. This means that you can set up a roadmap of the lists, matrices, and documents which will be developed for each particular project. The roadmap also indicates links between the matrices. Data which changes in one matrix will cause related changes in the other linked matrices.
(http://www.iti-oh.com/)

QFD/Capture Standard Edition

QFD/Capture Standard Edition is an indispensable support tool for any decision making process - from basic to complex. The software now has a QFD Project focus, rather than a single matrix focus. This means that you can set up a roadmap of the lists, matrices, and documents which will be developed for each particular project. The roadmap also indicated links between the matrices. Data which changes in one matrix will cause related changes in the other linked matrices.
(http://www.iti-oh.com/)

QFD Scope

In QFD, you will find the tools you need assembled in one easy-to-use program to guide you through the development process, step by step. You will be able to discover new ways to translate what your customers are demanding into the design of your products. Besides customer satisfaction, you will also be able to achieve higher levels of quality than ever before.
(http://www.iqd.com/)

QI Analyst DB

QI Analyst master your processes with easy-to-learn, easy-to-use. QI Analyst has all the SPC charts, statistics and reports you need to understand your processes better, control them more easily and improve them regularly.
(http://www.spss.com/)

Qualitek-4

Qualitek-4 from Nutek, Inc. automatically design experiments based on user-indicated factors and levels. The program selects the array and assigns the factors to the appropriate column. For more complex experiments, there is a manual design option. The program also performs the three basic steps in analysis: main effect,

analysis-of-variance, and optimum studies. Analysis can be performed using standard or signal-to-noise ratios of results for smaller, bigger, nominal, or dynamic characteristics. Results can be displayed using pie charts, bar graphs, or trial-data-range graphs.
(http://www.rkroy.com/wp-q4w.html)

Relex FMEA/FMECA
Relex FMECA IS A 32-BIT Windows program that provides an organized framework for performing a variety of analyses, including Failure ode and Effects Analyses, Criticality Analyses, Safety Analyses, Damage Mode and Effects Analyses, and more. Relex FMECA is an integrated member of the Relex family of Reliability Software which includes Reliability Predictions, FMEAs, FMECAs, Maintainability Predictions, Reliability Block Diagrams, and Life Cycle Cost analyses. Analyses of any level from the piece part level up to the system level can easily be performed. A short list of Relex FMECA's many features includes interfaces to popular database, spreadsheet, and word processor packages, a powerful on-line help, and supplied libraries of standard part failure modes.
(http://www.relexsoftware.com/)

SAS/QC Software
The software offers many tools for establishing statistical quality control and reducing variability. A menu-driven environment is provided for producing Shewhart charts, performing process capability analysis, and for pinpointing manufacturing problems with Pareto and Ishikawa diagrams. For quality engineering applications, a prompt-driven environment for designing and analyzing industrial experiments is also included. A variety of designs can be constructed, including two-level fractional factorial, response surface, orthogonal array, and mixture designs. Facilities are also included for Taguchi applications, giving you ready access to state-of-the-art techniques.
(http://www.sas.com/)

SPSS
Powerful statistics offer in-depth analysis and modeling to generate reliable information fast; dynamic, interactive charts and multidimensional pivot tables help you understand and present your results more effectively; and eight types of help make data discovery easy.
SPSS 8.0 for Windows gives you more thorough answers than your spreadsheet or database. Plus, you don't have to be a statistician to use it. You'll make smarter decisions more quickly by uncovering key facts, patterns and trends in your data.
(http://www.spss.com/)

SQCpack for Windows
SQCpack for Windows combines powerful SPC techniques with the flexibility and ease of Windows. Whether you work in a manufacturing or service organization, the government, or an educational institution, it can complete your quality puzzle.
(http://www.qsoftguide.com/)
(http://www.pqsystems.com/)

STATGRAPHICS Plus for Windows

STATGRAPHICS Plus for Windows is a 32-bit program designed to run under Windows, Window 95, or Windows NT. It consists of a Base Module covering many commonly used statistical techniques and five Add-on Modules in the areas of Quality Control, Experimental Design, Time Series Analysis, Multivariate Methods, and Advanced Regression. The program contains its own spreadsheet, but it can also easily read data from Excel, Lotus, Quattro, or other spreadsheet and database programs.
(http://www.sgcorp.com/)

STATISTICA Industrial System

STATISTICA INDUSTRIAL SYSTEM that features a comprehensive selection of specialized statistical methods for industrial and engineering applications (most of which, in fact, can also be efficiently used for non-industrial data analyses and exploration of data, e.g., in social sciences, management science, biology, marketing research). The methods included in the STATISTICA INDUSTRIAL SYSTEM package are divided into four modules: Quality Control Charts, Process Analysis, Experimental Design, and Variance Components. The four modules are described in the following sections. We believe that this product offers the most comprehensive selection of methods for industrial statistics and quality improvement currently available on the market.
(http://www.statsoft.com/)

Statistical Process Control (Proceed)

Proceed is a spreadsheet add-in for Microsoft Excel 5.0 and 95 which will enable your company to exploit the potential of SPC without incurring high implementation costs. Besides cost, there are numerous other advantages to be gained from basing your SPC operations on the Excel spreadsheet. In particular, familiarity and compatibility means that minimum effort will be required to incorporate Proceed into existing systems.
(http://www.rsd-associates.com/)

Survey Genie

The Survey Genie contains everything you need to develop complete questionnaires effortlessly. Start quickly with 200 professionally developed questions which can be modified to suit your needs. The Survey Genie allows you to create exactly the questionnaire you want. You can add an introduction, produce separate questionnaire and answer sheets or a combined questionnaire/answer sheet. Export the survey to your favorite work processor to add finishing touches. Survey Genie's custom data entry screen makes data collection easy.
(http://www.qsoftguide.com/)

Survey Select

Survey Select provides you the tools to produce professional surveys. This intuitive program guides you through each step of the survey process to ensure quality results. You will appreciate the easy-to-follow language of the three sections: design, administration, and analysis.
(http://www.qsoftguide.com/)

Survey Solutions for the Web

Survey solutions is simple to master. AutoDesign wizards help create your survey using survey templates and a library of over 200 pre-written questions. Or create your survey by simply typing your questions directly or importing them from your work processor. No scripting or programming is required. You can create open-ended, single choice, multiple selection, numeric, text entry and repeated scale question. Survey Solutions formats your survey from e-mail or website distribution. (http://www.qsoftguide.com/)

Synergy Gold

Synergy Gold provides powerful flexible features in an easy-to-implement windows environment. Create files, enter data and display more than 20 types of real-time charts as fast as you can click a mouse. Charts update as data flows in, while real-time, color-coded and audible alarms alert you to out-of-spec and out-of-control conditions.

(http://www2.zontec-spc.com/zontec-spc)

Synergy Maestro

Synergy Maestro contains all the features of Synergy Gold combined with the ability to monitor a workstation, a production line, a department or the entire plant!

Synergy Maestro has three distinct levels of operation to meet the specific needs of operators, engineers, and management personnel.

(http://www2.zontec-spc.com/zontec-spc)

TE Sampling Programs

The software has the following capabilities:

Handles attribute single and double sampling plans and quick switching systems

Handles variables sampling plans with known and unknown standard deviations and both 1 and 2 specification limits.

Evaluates sampling plans including:

OC curves

AOQ curves

ASN curves

Percentiles (AQL, LTPD, RQL, LQ, UQL)

AOQL

Selects plans based on:

AQL and LTPD

AQL and AOQL

AQL and sample size

Economics

(http://www.variation.com/)

TimeSaver for Windows

TimeSaverTM for Windows provides comprehensive yet highly affordable SPC capabilities to help you collect, manage and analyze large amounts of process data easily.

The program organizes your data in database file format from a number of sources and lets you access it through spreadsheets, word processing programs and SPC charts.
(http://www2.zontec-spc.com/zontec-spc)

TimeSaver Gold
TimeSaver Gold makes it easy to access and interpret both variable and attributes data. Press one key to enter, edit, insert or withhold data from calculations. Commands are tied to the keyboard's function keys so users are never more than a few keystrokes away from any system feature. Data entry, editing and sorting takes place on the same screen to eliminate jumping back and forth to perform individual functions.
(http://www2.zontec-spc.com/zontec-spc)

TimeSaver Maestro
TimeSaver Maestro offers you all the features of TimeSaver Gold plus powerful capabilities for plantwide SPC. Create a web of operator and manager stations for efficient real-time SPC. At the Operator Level, workers gather and chart data for an unlimited number of characteristics, which allow them to detect and react to problems right on the shop floor. Data can be entered directly from multiple gages, giving immediate access to process information while reducing the chance for operator error.
(http://www2.zontec-spc.com/zontec-spc)

VarTran
VarTran is in one sense a tolerancing package. It can perform all the standard analysis including statistical tolerancing, worst-case tolerancing, and sensitivity analysis. But VarTran goes beyond the bounds of traditional tolerancing packages to address the selection of optimal targets for the inputs. This also makes VarTran a product/process optimization tool. In finding the optimal targets, VarTran considers the effects of the inputs on both the average and variation of the outputs resulting in a robust design. VarTran is also a robust design tool. In a nutshell, VarTran is a robust design, product/process optimization and tolerancing package all in one. It is a robust tolerance analysis package.
(http://www.variation.com/)

Visio
Visio Standard 5.0 helps you diagram your workflow, communicate your department's reporting structure or enhance your presentations with complete ease. It's the ideal tool for flowcharts, organizational charts, project timelines, marketing visuals and more. Plus, Visio Standard shares a common interface with your Microsoft Office tools for smooth integration with your desktop.
(http://www.qsoftguide.com/)
(http://www.visio.com/)

APPENDIX D: SURVEY FOR HYPOTHESES TESTING

Dear Business Associate, May 18th, 1999

I am a researcher in the Department of Management of The Hong Kong Polytechnic University. I am conducting a research to study the extent of the use of quality tools and techniques and their importance in local companies. I would like to ask for your favour in responding to this survey, which would take about 10-15 minutes to complete. Please try to answer all the questions.

Thank you for your time and your responses. The information you provide will help us to learn more about the use and importance of quality tools and techniques and will be used by us only for preparing statistics.

If you would like to have a copy of the summary of our investigation, please write down your name and address in the space provided **or** attach your name card below and return it by the self-addressed envelope provided **before 31st May, 99**. If you have any inquiry, please feel free to contact me at 2766 7356 or e-mail: mskyyau@

Your responses are completely CONFIDENTIAL AND ANONYMOUS.

Sincerely,

Jenny Yau

Please stick your name card here or Name: ____________________

Address: ____________________

____

____

____

Part A Personal Background Information

Please indicate your answers with a tick (✓).

1) Your Age:	☐ Under 20 ☐ 21-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-45 ☐ 46-50 ☐ 51-55 ☐ 56+		
2) Your Sex:	☐ Male	☐ Female	
3) Your education level	☐ Secondary	☐ Post Secondary	☐ Postgraduate
	☐ Bachelor's Degree	☐ Master's Degree	☐ Doctoral Degree
4) Your current position:	☐ Manager		☐ Sales Executive
	☐ Engineer		☐ Secretarial/Clerical
	☐ General Staff/Technician		☐ Others (Please specify)____________
5) What is your company's business nature?	☐ Banking	☐ Building and Construction	☐ Computer and Related Services
	☐ Electrical/Electronic Products and Related Services	☐ Environmental Services	☐ Financial Markets and Fund Management
	☐ Foodstuff, Beverage and Tobacco	☐ Government Funded/Statutory Organizations	☐ Machinery
	☐ Metal	☐ Paper and Packaging Products	☐ Plastics
	☐ Printing and Publishing	☐ Quality, Industrial Testing and Inspection Service	☐ Real Estate Services
	☐ Telecommunications	☐ Textile, Garment and Footwear	☐ Toys and Games
	☐ Transport	☐ Watches and Clocks	☐ Wholesale and Retail
	☐ Others, please specify____________		
6) What is the main ownership of your firm?	☐ American (US) ☐ Australian ☐ British ☐ Canadian ☐ German		
	☐ Hong Kong ☐ PRC ☐ Japanese ☐ Others, please specify________		
7) What is your company's size (No. of employees)?	☐ 1-10 ☐ 11-30 ☐ 31-50 ☐ 51-100 ☐ 101-500 ☐ 501+		
8) How many year(s) have you been working in this organization?	______ Year(s) ______ Month(s)		
9) How many year(s) has your company employed quality tools and techniques?	☐ Never ☐ ½-1 Year ☐ 1-3 Years ☐ 3-5 Years ☐ More than 5 Years		

Part B Use of Quality Tools and Techniques (QT&T)

1. How often does your department/company employ quality tools and techniques?
Please tick (✓) **ONLY ONE** appropriate box for **EACH ITEM**.

Quality Tools and Techniques	**Daily**	**No more than several times every week (< daily)**	**No more than once every 2 weeks**	**No more than once every month**	**Never Use**
7 Basic Quality Tools[1]	☐	☐	☐	☐	☐
New 7 Management Tools[2]	☐	☐	☐	☐	☐
Advanced Techniques[3]	☐	☐	☐	☐	☐
Acceptance Sampling	☐	☐	☐	☐	☐
Benchmarking	☐	☐	☐	☐	☐
Brainstorming	☐	☐	☐	☐	☐
Deployment Chart	☐	☐	☐	☐	☐
Fault Tree Analysis	☐	☐	☐	☐	☐
Force Field Analysis	☐	☐	☐	☐	☐
Gantt Chart	☐	☐	☐	☐	☐
Plan-Do-Check-Act (Deming Wheel)	☐	☐	☐	☐	☐
Pokayoke (Foolproof)	☐	☐	☐	☐	☐
Process Capability	☐	☐	☐	☐	☐
Quality Circles	☐	☐	☐	☐	☐
Quality Costing	☐	☐	☐	☐	☐
Surveys	☐	☐	☐	☐	☐
Other areas, please specify: ______	☐	☐	☐	☐	☐

Part C Training and Education

Please tick (✓) **ONLY ONE** appropriate box to indicate your agreement for **EACH ITEM**.

	Very Substantial	Substantial	Some	Little	Very Little
1. *Specific work skills training* (technical and vocational) given to employees throughout the division.	☐	☐	☐	☐	☐
2. Quality-related training given to the *employees* throughout the division.	☐	☐	☐	☐	☐
3. Quality-related training given to *managers and supervisors* throughout the division.	☐	☐	☐	☐	☐
4. Training in the "total quality concept" (i.e., philosophy of company-wide responsibility for quality) throughout the division.	☐	☐	☐	☐	☐
5. Training in the *7 basic quality tools*[1] in the division as a whole.	☐	☐	☐	☐	☐
6. Training in the *New 7 Management Tools*[2] in the division as a whole.					
7. Training in *advanced techniques*[3] in the division as a whole.	☐	☐	☐	☐	☐
8. *Commitment* of *top management* to employee of quality training.	☐	☐	☐	☐	☐
9. Availability of *resources* for employee of quality training in the division.	☐	☐	☐	☐	☐

1. Cause-effect Diagram, Charts (Bar, Pie, Run and Spider), Check Sheets, Control Charts, Flowchart, Pareto Analysis and Scatter Diagram.

2. Activity Network Diagram, Affinity Diagram/KJ Method, Interrelationship Diagram, Matrix Data Analysis, Matrix Diagram, Process Decision Program Chart and Tree Diagram.
3. Design of Experiment (DOE), Quality Function Deployment (QFD), Failure Mode Effect and Criticality Analysis (FMECA) and Taguchi Method.

Part D Training Content

Approximately, how many employees have been trained to use the following quality tools and techniques?

1. Please tick (✓) **ONLY ONE** appropriate box for **EACH ITEM**.

Quality Tools and Techniques	0	1-10	11-30	31-50	51-100	100+
7 Basic Quality Tools[1]	☐	☐	☐	☐	☐	☐
New 7 Management Tools[2]	☐	☐	☐	☐	☐	☐
Advanced Techniques[3]	☐	☐	☐	☐	☐	☐
Acceptance Sampling	☐	☐	☐	☐	☐	☐
Benchmarking	☐	☐	☐	☐	☐	☐
Brainstorming	☐	☐	☐	☐	☐	☐
Deployment Chart	☐	☐	☐	☐	☐	☐
Fault Tree Analysis	☐	☐	☐	☐	☐	☐
Force Field Analysis	☐	☐	☐	☐	☐	☐
Gantt Chart	☐	☐	☐	☐	☐	☐
Plan-Do-Check-Act (Deming Wheel)	☐	☐	☐	☐	☐	☐
Pokayoke (Foolproof)	☐	☐	☐	☐	☐	☐
Process Capability	☐	☐	☐	☐	☐	☐
Quality Circles	☐	☐	☐	☐	☐	☐
Quality Costing	☐	☐	☐	☐	☐	☐
Surveys	☐	☐	☐	☐	☐	☐
Other areas, please specify: ______ ______	☐	☐	☐	☐	☐	☐

2. Which of the following training approach(es) does your company predominantly adopt to teach the use of following quality tools and techniques?

Please tick (✓) the appropriate box(es); you may check **MORE THAN ONE**.

Quality Tools and Techniques	No training	Lecture	Video tape	Workshop (experience sharing)	Self-tutorial (workbook)	Self-tutorial (multimedia)
7 Basic Quality Tools[1]	☐	☐	☐	☐	☐	☐
New 7 Management Tools[2]	☐	☐	☐	☐	☐	☐
Advanced Techniques[3]	☐	☐	☐	☐	☐	☐
Acceptance Sampling	☐	☐	☐	☐	☐	☐
Benchmarking	☐	☐	☐	☐	☐	☐
Brainstorming	☐	☐	☐	☐	☐	☐
Deployment Chart	☐	☐	☐	☐	☐	☐
Fault Tree Analysis	☐	☐	☐	☐	☐	☐
Force Field Analysis	☐	☐	☐	☐	☐	☐
Gantt Chart	☐	☐	☐	☐	☐	☐
Plan-Do-Check-Act (Deming Wheel)	☐	☐	☐	☐	☐	☐
Pokayoke (Foolproof)	☐	☐	☐	☐	☐	☐
Process Capability	☐	☐	☐	☐	☐	☐
Quality Circles	☐	☐	☐	☐	☐	☐
Quality Costing	☐	☐	☐	☐	☐	☐
Surveys	☐	☐	☐	☐	☐	☐
Other areas, please specify: ______ ______	☐	☐	☐	☐	☐	☐

1. Cause-effect Diagram, Charts (Bar, Pie, Run and Spider), Check Sheets, Control Charts, Flowchart, Pareto Analysis and Scatter Diagram.

2. Activity Network Diagram, Affinity Diagram/KJ Method, Interrelationship Diagram, Matrix Data Analysis, Matrix Diagram, Process Decision Program Chart and Tree Diagram.
3. Design of Experiment (DOE), Quality Function Deployment (QFD), Failure Mode Effect and Criticality Analysis (FMECA) and Taguchi Method.

3. In your opinion, which training approach(es) can facilitate effective and efficient learning?

Please tick (✓) 2nd column to indicate the tools or techniques which you are familiar with. Then rank the training approach(es) by using 5 as the most effective and efficient and 1 as the least, 0 being not applicable.

Example

Quality Tools and Techniques	Please (✓) the tools or techniques that you familiar or you understand	Lecture	Video tape	Workshop (experience sharing)	Self-tutorial (workbook)	Self-tutorial (multimedia)
7 Basic Quality Tools[1]	✓	5	4	2	1	3
New 7 Management Tools[2]	✓	4	5	1	3	2
Advanced Techniques[3]						
Acceptance Sampling	✓	3	[illegible]	5	4	2
Benchmarking	✓	2	4	1	5	3
Brainstorming						
Force Field Analysis	✓	5	3	1	2	4
Surveys	✓	3	5	1	4	2
Other areas, please specify: ____________						

Please Fill in this Table

Quality Tools and Techniques	Please (✓) the tools or techniques that you are familiar with or you understand	Lecture	Video tape	Workshop (experience sharing)	Self-tutorial (workbook)	Self-tutorial (multimedia)
7 Basic Quality Tools[1]	☐					
New 7 Management Tools[2]	☐					
Advanced Techniques[3]	☐					
Acceptance Sampling	☐					
Benchmarking	☐					
Brainstorming	☐					
Deployment Chart	☐					
Fault Tree Analysis	☐					
Force Field Analysis	☐					
Gantt Chart	☐					
Plan-Do-Check-Act (Deming Wheel)	☐					
Pokayoke (Foolproof)	☐					
Process Capability	☐					
Quality Circles	☐					
Quality Costing	☐					
Surveys	☐					
Other areas, please specify: ____________	☐					

1. Cause-effect Diagram, Charts (Bar, Pie, Run and Spider), Check Sheets, Control Charts, Flowchart, Pareto Analysis and Scatter Diagram.
2. Activity Network Diagram, Affinity Diagram/KJ Method, Interrelationship Diagram, Matrix Data Analysis, Matrix Diagram, Process Decision Program Chart and Tree Diagram.
3. Design of Experiment (DOE), Quality Function Deployment (QFD), Failure Mode Effect and Criticality Analysis (FMECA) and Taguchi Method.

Part E Understanding of the Use of Quality Tools and Techniques (QT&T)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
1. I can use the appropriate 7 basic quality tools[1] to tackle the problems easily.	☐	☐	☐	☐	☐
2. I can use the appropriate new 7 management tools[2] to tackle the problems easily.	☐	☐	☐	☐	☐
3. I can use the appropriate advanced quality techniques[3] to tackle the problem easily.	☐	☐	☐	☐	☐

4. Please tick (✓) the most **(ONE ONLY)** appropriate box that you think best describes your company's understanding and attitude towards the use of quality tools and techniques.

	Please tick (✓) the appropriate box.
My company has *no knowledge* of the use of quality tools and techniques as a means of improving quality.	☐
My company recognizes that the use of quality tools and techniques may be of value but is *not willing* to provide money or time to make it happen.	☐
My company *is supportive and helpful* in learning more about the use of quality tools and techniques.	☐
My company *understands* of the use of quality tools and techniques.	☐
My company considers quality tools and techniques as an *essential part of the company improvement system.*	☐

5. Please tick (✓) the most **(ONE ONLY)** appropriate box that you think best describes the quality improvement actions taken in your company.

	Please tick (✓) the appropriate box.
My company does not have organized quality improvement activities and *does not understand* such activities.	☐
My company tries obvious motivational *short-range efforts*.	☐
My company implements the quality improvement program with thorough *understanding and establishment* of each step.	☐
My company *continues* the quality improvement program.	☐
My company implements quality improvement activity *normally and continuously*.	☐

6. Please tick (✓) the most **(ONE ONLY)** appropriate box that you think best describes your company's position on quality tools and techniques.

	Please tick (✓) the appropriate box.
My company *does not know* why we have problems with the use of quality tools and techniques.	☐
My company thinks that it is necessary to *always have problems* with the use of quality tools and techniques.	☐
My company thinks that through the use of quality tools and techniques, we can *identify and resolve* our problems.	☐
My company uses quality tools and techniques as a routine part of our operation to *prevent* problems.	☐
My company knows why we *do not have problems* with the use of quality tools and techniques.	☐

1. Cause-effect Diagram, Charts (Bar, Pie, Run and Spider), Check Sheets, Control Charts, Flowchart, Pareto Analysis and Scatter Diagram.

2. Activity Network Diagram, Affinity Diagram/KJ Method, Interrelationship Diagram, Matrix Data Analysis, Matrix Diagram, Process Decision Program Chart and Tree Diagram.
3. Design of Experiment (DOE), Quality Function Deployment (QFD), Failure Mode Effect and Criticality Analysis (FMECA) and Taguchi Method.

APPENDIX E: EVALUATION FORM

The following questions are related to the prototype system – Multimedia-Based Advisory System of Selection Quality Tools and Techniques.
Please indicate your answers with a tick (✓) only.

Part A Background

	< ½ Year	>½-1 Year	>1-3 Years	>3-5 Years	> 5 Years
1. Number of year(s) in current profession/industry	☐	☐	☐	☐	☐
2. Number of year(s) in quality management field	☐	☐	☐	☐	☐
3. Number of year(s) in using computer	☐	☐	☐	☐	☐

Part B Evaluation

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The overall Multimedia-Based Advisory prototype system of selection Quality Tools and Techniques can:	5	4	3	2	1
help quality practitioners to select the proper quality tools and techniques	☐	☐	☐	☐	☐
help quality practitioners to learn the use of quality tools and techniques	☐	☐	☐	☐	☐
increase the interest of learning the use of quality tools and techniques	☐	☐	☐	☐	☐
provide new insights of the use of quality tools and techniques	☐	☐	☐	☐	☐
provide an effective means to learn	☐	☐	☐	☐	☐
reduce pressure in the learning procedures	☐	☐	☐	☐	☐
enable inexperienced user to deal with	☐	☐	☐	☐	☐
provide better training to staff	☐	☐	☐	☐	☐
improve learning efficiency	☐	☐	☐	☐	☐
Concerning about the prototype system	5	4	3	2	1
the system is easy to learn	☐	☐	☐	☐	☐
the system is easy to use	☐	☐	☐	☐	☐
the use of pictures and graphs is effective	☐	☐	☐	☐	☐
the scenario is easy to visualize	☐	☐	☐	☐	☐
The information contained in the prototype system is:	5	4	3	2	1
clear	☐	☐	☐	☐	☐
sufficient	☐	☐	☐	☐	☐

Part C Your opinions

What features would you like to incorporate in the revised system?

____

____

Any other comments?

____

____