Development of a TQM model for improving business performance based on surveys conducted in Hong Kong, Japan and the UK

A thesis submitted for the degree of Doctor of Philosophy

by

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April, 1996

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I declare that all the work described in this dissertation was produced by myself and that none of this work has been previously submitted for any academic degree. All sources of quoted information have been acknowledged by means of references.

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Development of a TQM Model for Improving Business Performance based on Surveys Conducted in the UK, Hong Kong and Japan

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ABSTRACT

This thesis begins by reviewing the literature on TQM. It is found that in the past, the TQM theories by quality gurus have given pictures of TQM from different angles but there is little discussion of the implementation steps for company to follow. Also, there is hardly any mention on what companies that have already achieved some form of improvement, like ISO 9000 or its equivalent, should do next.

With this scenario in mind, a model called TQMEX standing for Total Quality Management EXcellence model has been developed based on sound TQM practices. It aims at providing companies with a step-by-step approach to achieving TQM.

In order to prove the validity of the TQMEX model, the author undertook intensive questionnaire survey and field survey in the UK, Hong Kong and Japan during 94/95. About 400 valid questionnaire replies have been received and analysed. 35 case studies from the three countries were also studied. Action and longitudinal research have been carried out in a major construction company in HK. Findings were further validated by comparing with two similar size UK and Japanese construction firms.

The main finding from companies of the three countries is that TQM is an essential requirement for their business success. This can be achieved by good organisation, working environment, operations management systems, quality circle practices, quality management system, and preventive maintenance measures. They form the base for the TQMEX model.

Then, surveys in the three countries were carried out and their findings provide the knowledge for the development of an advisory service called TQMEXAS. The TQMEXAS consists of the Internet Program and the Expert System, which also incorporates a case-study bank and implementation plans (http://www.dmu.ac.uk/dept/schools/business/corporate/tqmex/abs).

Both the Internet Program and Expert System have been validated and further improved. The experimenters find them useful in assisting companies to implement TQM and benchmark with successful cases. Moreover, the TQMEX model can be of value to other companies contemplating the TQM goal. A marketing plan has been suggested to launch the TQMEXAS so that it can become more easily available. Finally, recommendations are made on the effective use of the advisory service and for further development. On reflection, this research has a number of important points on originality and contributions to knowledge.

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ABBREVIATIONS

5-S	Five Japanese words: *Seiri, Seiton, Seiso, Seiketsu and Shitsuke*
ANOVA	ANalysis Of VAriance
APO	Asian Productivity Organization
ASS	Advisory Service System
BPR	Business Process Re-engineering
BSI	British Standards Institution
CEO	Chief Executive Officer
CWQC	Company Wide Quality Control
CIRIA	Construction Industry Research and Information Association
EFQM	European Foundation for Quality Management
EQA	European Quality Award
ES	Expert System
HTML	Hypertext mark-up language
ICOT	Institute for New Generation Computer Technology
IKBS	Intelligent Knowledge Based System
ISO	International Organization for Standardization
IT	Information Technology
JIT	Just-In-Time (Production System)
JIPE	Japan Institute of Plant Engineers
JUSE	Japan Union of Scientists and Engineers
Kaizen	The Japanese word for 'Continuous Improvement'
LCL	Lower Control Limit
MBNQA	Malcolm Baldrige National Quality Award
PDCA	Plan-Do-Check-Act Cycle (Deming Cycle)
PDSA	Plan-Do-Study-Act Cycle (Revised Deming Cycle)
QAT	Quality Action Team
QC	Quality Control
QCC	Quality Control Circle
QI	Quality Improvement
QLG	Quality Liaison Group
QMS	Quality Management System
QSC	Quality Steering Committee
Servqual	Service Quality Model (by Parasuraman A.)
TPM	Total Productive Maintenance
TQ	Total Quality
TQM	Total Quality Management
TQMar	Total Quality Marketing
TQMEX	TQM EXcellence Model used in this book
TQMEXAS	Total Quality Management Excellence Model Advisory Service
TQPur	Total Quality Purchasing
UCL	Upper Control Limit
WWW	World Wide Web
ZD	Zero Defects

Chapter 1

Introduction

CHAPTER 1

INTRODUCTION

PROLOGUE

This chapter introduces the basic concepts of Total Quality Management (TQM) which forms the basis of the research. It also explores and defines the aim and objectives of the thesis. The structure of the thesis is summarised at the end of the chapter.

Introduction

- TQM
- The History of TQM
- The TQM Theme
- Aim and Objectives
- Scope of Research
- Structure of Thesis

1.1 GENERAL

Much has been published regarding the theories and implementation on the subject of Total Quality Management (TQM). TQM should be tailored to an organisation's needs. However, there is little research done to identify the implementation steps that should be considered when planning a TQM journey. Among the many quality practitioners who have stated that TQM needs to be tailored to the organisation. Coulson [1991] finds out that every organisation has to develop its own and unique way, because organisations differ in history, markets, style of leadership and cultural environment. Despite these there are little guidelines on how to develop a tailor-made system for organisation wishing to achieve TQM and what to do next for companies that have achieved some kind of quality achievement, such as ISO 9000. Furthermore, there are few step-by-step approaches to assist companies in achieving TQM. Patel [1993] suggests, based on his survey, that many consultants provide a good service on what TQM is, but fail on the mechanics of clearly identifying how the businesses should implement the philosophy.

This submission arises partly out of the above issues and partly from the interest of the researcher's experience in the construction industry on the problems which companies have in transforming from ISO 9000 to TQM. The research is directed towards identifying and developing a step-by-step model for firms committed to improving total customer satisfaction through TQM. Many companies work very hard to produce high standard goods and services. Quality is a vital issue in contemporary business and is becoming a distinctive competitive advantage. Each company that has chosen the path of total quality towards excellence has its own approach. This research is therefore focusing on identifying the best quality practices coming together in a sequential model called TQMEX, which stands for TQM EXcellence model. It can be used as a step-by-step guideline for the companies wanting to achieve TQM.

Fig.1.1 shows the sequence and structure of the TQMEX model. The various terminology and important terms used in the present research are explained in section (S.1.2.1). Research by Dale and Lascelles [1990] has indicated the difficulty of such research. They investigated whether companies use techniques in any order or whether there is an ideal order in which to apply techniques. Through their studies they concluded that "because of the variety of starting points and motivations for quality improvement it is not possible to identify an implementation plan detailing the order in which techniques should be used". While this is understood, flexibility of the model has also been taken into consideration to minimise the variation when implementation takes place in the business processes (see S.4.2.).

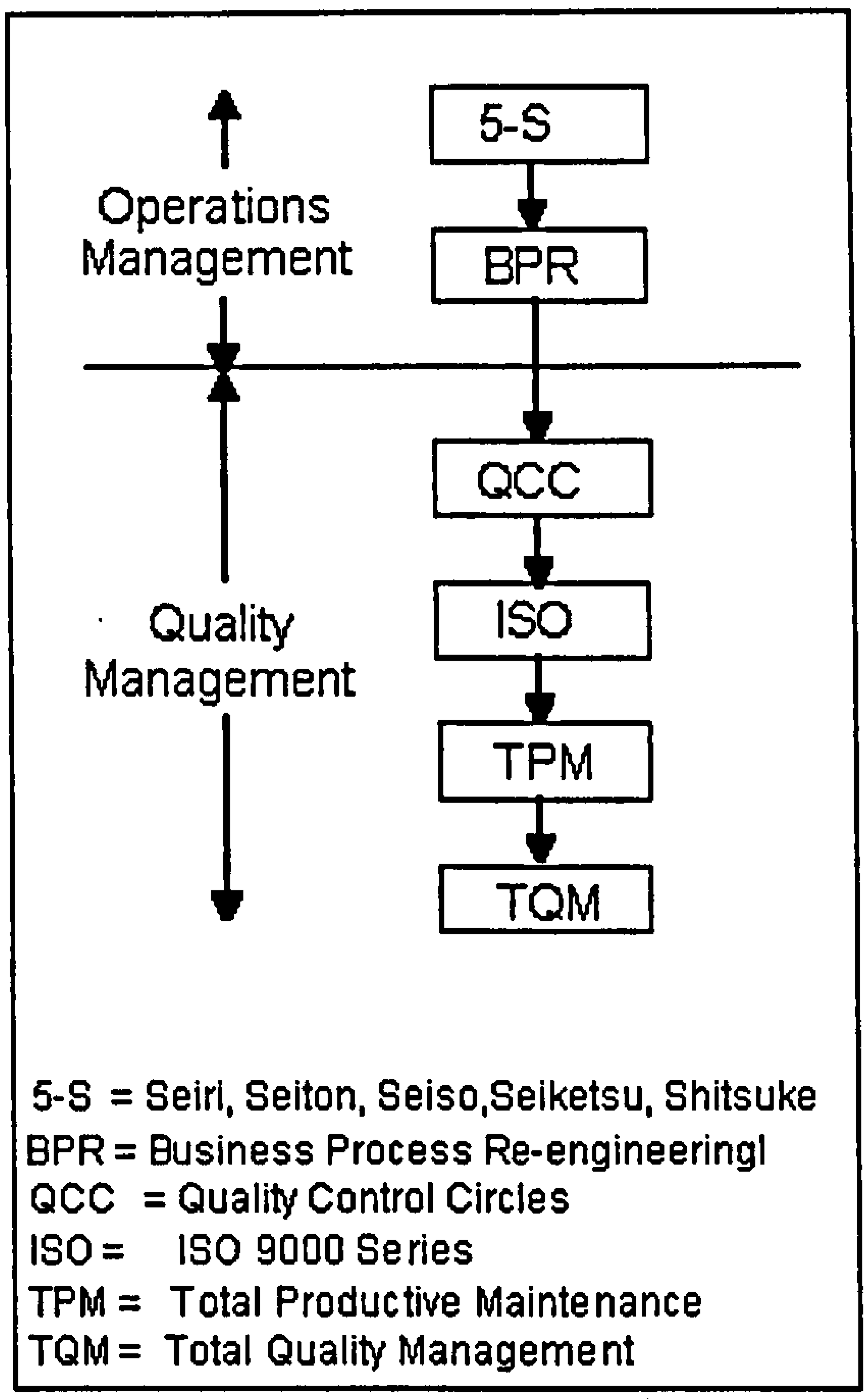


Figure 1.1 TQMEX Model

1.1.1 Definition of Quality

Despite being in use for nearly 50 years, the term 'quality' still poses problems of definition for writers on quality, and consequently often becomes a rather abstract term. There are a number of well-known quality definitions. ISO 8402 [1986] defines quality as "the totality of features and characteristics of a product or service that bears on its ability to meet a stated or implied need". Crosby [1979] defines quality as "conformance to requirement". Juran [1988] defines quality as "fitness for use". Japanese companies found the old definition of quality "the degree of conformance to a standard" too narrow and consequently have started to use a new definition of quality as "user satisfaction" Wayne [1983]. Table 1.1 summarises the definitions of quality from the point of view of different quality professionals and provides a basis for the discussion of TQM. This can be classified in three sections: Customer-based, Manufacturing & Service-based, and Value-based definitions.

Quality Definition	
Customer-based Definition	
• Edwards [1968]	Quality consists of the capacity to satisfy wants...
• Gilmore [1974]	Quality is the degree to which a specific product satisfies the wants of a specific consumer.
• Kuehn & Day [1962]	In the final analysis of the marketplace, the quality of a product depends on how well it fits patterns of consumer preferences.
• Juran [1988]	Quality is fitness for use.
• Oakland [1989]	The core of a total quality approach is to identify and meet the requirements of both internal and external customers.
Manufacturing & Service-based	
• Crosby [1979]	Quality [means] conformance to requirements.
• Price [1985]	Do it right first time.
Value-based	
• Broh [1982]	Quality is the degree of excellence at an acceptable price and the control of variablity at an acceptable cost.
• Feigenbaum [1983]	Quality is the degree to which a specific product conforms to a design or specification.
• Newell & Dale [1991]	Quality must be achieved in five basic areas: people, equipment, methods, materials and the environment to ensure customer's needs are met.
• Kanji [1990]	Quality is to satisfy customers' requirements continually; TQM is to achieve quality at low cost by involving everyone's daily commitment.

Table 1.1 Quality Definition

1.1.2 Definition of TQM

TQM is a necessity. It is a journey. It will never end. It makes Japanese industry a miracle. It is the way to survive and succeed. TQM is the totally integrated effort for gaining competitive advantage by continuously improving every facet of an organisation's activities. If we synthesise the meaning of each word,

TQM can be defined as:

Total	-	Everyone associated with the company is involved in continuous improvement (including its customers and suppliers if feasible),
Quality	-	Customers' expressed and implied requirements are met fully,
Management	-	Executives are fully committed.

TQM provides the overall concept that fosters continuous improvement in an organisation. The TQM philosophy stresses a systematic, integrated, consistent, organisation-wide perspective involving everyone and everything. It focuses primarily on total satisfaction for both the internal and external customers, within a management environment that seeks continuous improvement of all systems and processes.

TQM emphasises the use of all people, usually in multifunctional teams, to bring about improvement from within the organisation. It stresses optimal life cycle costs and uses measurement within a disciplined methodology in achieving improvements. The key aspects of TQM are the prevention of defects and emphasis on continuous quality improvement.

1.1.3 Relationship between TQM and Corporate Strategy

Broadly speaking corporate strategy consists of three key phases. The first phase is the determination of a corporate mission statement which sets the common value for everyone in the organisation. This mission statement or vision of the firm should sustain the challenge of time and should remain unchanged for a decade or more. The second phase is defining the strategic options and choosing the optimum one. Normally, this will become the three to five year plan for the organisation. The third phase is the strategic implementation which is also known as operations management

Many companies think that TQM should be linked to operations management. This is by no means a coincidence because before the Japanese developed TQM, they started with industrial engineering, quality control, company wide quality control, and value engineering. Unfortunately, it is not always obvious that during the evolution of TQM, the concept of quality awareness has filtered up the organisational hierarchy. Today, many companies (Dow Chemicals, Matsushita electric, Hewlett-Packard, etc.)are so concerned about quality that it has long become their mission. Consequently, in their strategic formulation process, they have used quality as their key mission statement and strategic option. When it comes to strategic implementation, quality has become a routine. The relationship between TQM and corporate strategy is illustrated in Figure 1.2. This approach adds totality to quality, as it is communicated throughout the organisation and spanned over its long term plan.

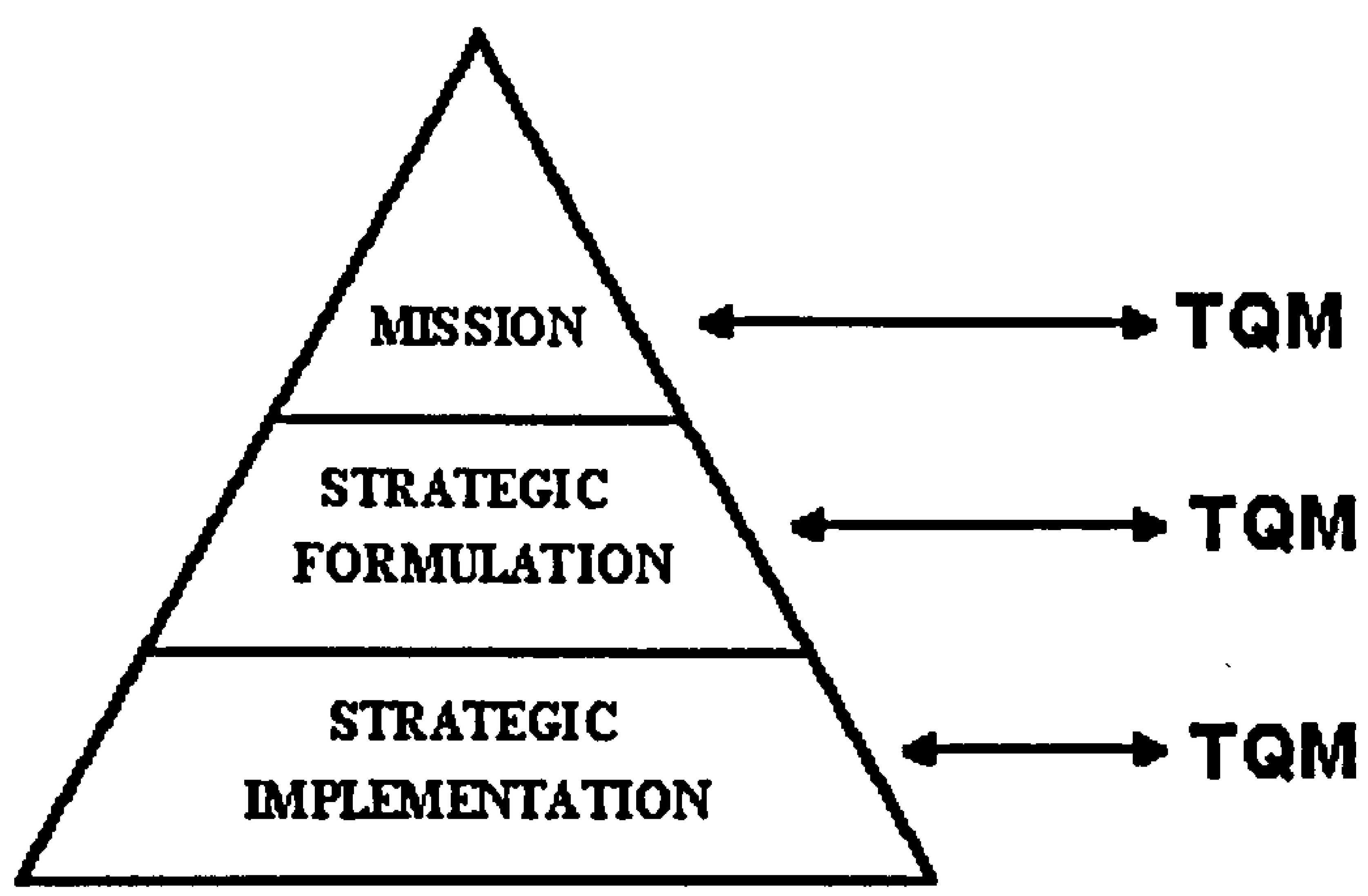


Figure 1.2 The relationship between corporate strategy and TQM

1.2 THE HISTORY OF TQM

There are two stages in the historical development of quality philosophy. The first stage is the period before the industrial revolution. This was the age of the craftsman when the need for quality was self evident and was contained within pride of workmanship. The interface with the customer was virtually one for one. For example, if you were a carpenter making table and the product did not live up to the customer's expectations, you would very soon be made aware of it. Since the second stage, with the onset of the industrial revolution, all this has been changed. In the interests of efficiency, production work was divided into specialist functions and the customer-supplier relationship was lost. So too was the pride of workmanship, which was so much a part of the craftsman. Taylor, the father of so called Scientific Management, changed the methods of work. With the accent on output, labour efficiency and the introduction of Work Study & Work Measurement, quality was treated as an afterthought. Taylor's answer to poor quality of output was the rigorous application of more and more inspectors, who in themselves were seen as specialists.

Shewhart [1933] realised that inspection after the event was not a good way of ensuring quality. He developed the idea of Statistical Process Control (SPC) and was the first to mention quality and control in the same context. Following Shewhart came Dr Deming and Juran. Deming has been referred to as the father of the Third Industrial Revolution. In early 1950's the two Americans, Dr Juran and Deming, were sent to Japan to revitalise Japanese industry, which was at that time concentrating on mass production of cheap goods. They pioneered the idea that upper management should be responsible for quality to revitalise post-war economics in Japan. By 1970s the Japanese had turned their weaknesses in quality into strengths. By pursuing quality, variety, customisation, and speed in getting to the market, they had not only become more productive but also found new ways of production.

In 1980, the National Broadcasting Corporation programme, "If the Japanese Can, Why Can't we...?", resulted in a resurgence in the USA on the topic of quality. Deming and Juran were rediscovered at home in the USA. As a result of the "white paper", Motorola was one of the first US companies to take action. The culminating result of the 1980s has been TQM with its customer requirements, quality process, production and service focus. There was also an emphasis on new Quality Management System (QMS) such as ISO 9000 intending to inform customers and third parties that a particular organisation is working according to customers' specified requirements.

In the 90's, quality is an essential requirement without which an organisation cannot survive. A company can not beat the competitors just with better products, facilities, or equipment. In mature markets with such free access to information globally, a competitive edge in these areas tends to be a short-lived illusion. Competitive strength is now derived from the ability to deliver quality, variety, customisation, and convenience in the shortest possible time.

1.3 THE TQM THEME

It is established from the history of TQM above that TQM is the theme for excellence for companies to survive and grow in the 90's. This section will explore the literature of the key processes of TQM and investigate the best practices in achieving success in each of the key components which form the basis of the model of excellence. Common terms used in the present research will also be explained.

From various literature [Ishikawa, 86], [Mizuno, 88], [DTI, 89], [Osada, 91], [Senju, 92], and [Ho, 93], the processes for excellence for enterprises can be summarised as follows:-

1.3.1 The Japanese 5-S Practice (5-S)

The 5-S practice is a technique used to establish and maintain quality environment in an organisation. The name derives from the five Japanese words: *Seiri, Seiton, Seiso, Seiketsu and Shitsuke* [Osada, 1991]. The English equivalent, their meanings and typical examples are shown in the Table 1.2.

JAPANESE	ENGLISH	MEANING	TYPICAL EXAMPLE
Seiri	Structurise	Organisation	Throw away rubbish
Seiton	Systematise	Neatness	30-second retrieval of a document
Seiso	Sanitise	Cleaning	Individual cleaning responsibility
Seiketsu	Standardise	Standardisation	Transparency of storage
Shitsuke	Self-discipline	Discipline	Do 5-S daily

Table 1.2 5-S Interpretation

The 5-S framework has been around a long time, and there is nothing new about it. However people have not been that aware of it until now. So when we look around, there is a lot of room for improvement.

The reason why 5-S framework needs to be implemented at work is because there are many things that people do without thinking. The 5-S can help improve everything we do. It is like a mirror reflecting our attitudes and behavioural patterns. Even so, we all too often avert our eyes and prefer not to look at what we see there. Many of the everyday problems that we encounter would be cleared up if only we paid more attention to the 5-S framework. Not observing the 5-S is a mark of a lazy mind and a slothful attitude.

Before management and supervisors embark on the 5-S principles, they need to take stock of the organisation and see if they really understand why themselves.

1.3.2 Business Process Re-engineering (BPR)

BPR is a management process used to re-define the mission statement, analyse the critical success factors, re-design the organisational structure and re-engineer the critical processes in order to improve customer satisfaction [Hammer & Champy, 1993]. BPR challenges managers to rethink their traditional methods of doing work and commit themselves to a customer-focused process. Many outstanding organisations have achieved and maintained their leadership through BPR [Oakland, 1995]. Companies using these techniques have reported significant bottom-line results, including better customer relations, reductions in cycle time to the market, increased productivity, fewer defects/errors and increased profitability. BPR uses recognised techniques for improving business results and questions the effectiveness of the traditional organisational structure. Defining, measuring, analysing and re-engineering work processes to improve customer satisfaction pays off in many different ways.

1.3.3 Quality Control Circles (QCC)

A QCC is a small group of staff working together to contribute to the improvement of the enterprise, to respect humanity and to build a cheerful workgroup through the development of the staff's infinite potential. A quality control circle (QCC) team of people usually come from the same work area and voluntarily meet on a regular basis to identify, investigate, analyse and solve their work-related problems.

It has been the Japanese experience that 95% of the problems in the workshop can be solved with simple Quality Control (QC) methods such as the 7 tools of QC [Ishikawa, 1985]. In addition to Ishikawa's statistical techniques, there are seven new tools [Barker, 1989]. These techniques are thought to have been developed for the purpose of "creative output" or "quality thinking". and are summarised in Table 1.3.

Ishikawa Seven QC Tools	The 7 New tools of quality
Pareto diagrams	Relations diagram method
Cause-and-effect diagrams	KJ method: affinity diagram
Stratification	Systematic diagram
Check sheets	The matrix diagram method
Histograms	Matrix data analysis
Scatter diagrams	PDPC (Process Decision Programme Chart) Method
Graphs and Control charts.	Arrow diagram method

Table 1.3 The Seven new and old tools for quality improvement

These tools will help QCC to carry out systematic brain-storming and analyse the problems critically. Then through logical thinking and experience, most problems can be solved without pain.

1.3.4 ISO 9000 Quality Management System (ISO9000)

The ISO 9000 series is a family of quality management and quality assurance standards developed by the International Organisation for Standardisation.

ISO 9001 is the *Quality systems -- Model for quality assurance in design, development, production, installation and servicing.* It is the most comprehensive model of quality systems offered by ISO.

As quoted from the **Scope** of the ISO 9001:1994, this International Standard specifies quality system requirements for use where a supplier's capability to design and supply conforming product needs to be demonstrated. The requirements specified are aimed *primarily at achieving customer satisfaction by preventing nonconformity at all stages from design through to servicing.* This International Standard is applicable in situations when

a) design is required and the product requirements are stated principally in performance terms, or they need to be established; and

b) confidence in product conformance can be attained by adequate demonstration of a supplier's capabilities in design, development, production, installation and servicing.

ISO 9002 and ISO 9003 are sub-sets of ISO 9001. Most of the registered firms are registered under ISO 9001 or ISO 9002. Therefore, **ISO 9001:1994** will be used as the framework for quality management system in TQMEX.

ISO 9004-4:1993 is the Quality management and quality system elements -- Part 4: Guidelines for quality improvement. It gives suggestions for effective quality management, helps organisations in building their quality systems, so that they can develop quality improvement practices for TQM.

1.3.5 Total Productive Maintenance (TPM)

In 1971, the Japan Institute of Plant Maintenance (JIPM) defined TPM as a system of maintenance covering the entire life of the equipment in every division, including planning, manufacturing, maintenance, and all other divisions, involving everyone from the top executives to the shop floor workers and promoting productive maintenance through morale-building management and small-group activities in an effort to maximise equipment efficiency. Because of its targeted achievement, the term TPM is sometimes also known as Total Productivity Management. [Senju, 1992]

1.3.6 Quality Function Deployment (QFD)

QFD was first introduced in Japan by some Japanese companies such as Toyota about two decades ago. It is a powerful planning tool for use upstream, off-line, to ensure that the customer's needs are first understood; then deployed into design requirements and subsequently through the manufacturing chain of critical part characteristics and key process requirements; and finally deployed to operational specifications.

Note: Although QFD is a recognised practice, it is not used in the present research as its benefits are found in other techniques such as BPR and ISO.

1.3.7 Statistical Process Control (SPC)

Statistical Process Control is a generic name for a range of statistic tools and techniques that improve the performance of a process by reducing its variability. It is a means for achieving the prevention of defects by highlighting situations when the output of the process is drifting outside acceptable limits.

1.3.8 Critical Success Factor (CSF)

CSFs are the few key areas of business activity in which favourable results are absolutely necessary for business to reach its goals. Because these areas of activity are critical, the manager should have the appropriate information to allow him to decide whether events are proceeding sufficiently well in each area. CSFs are of such importance that these key areas of activities should receive constant and careful attention from management. The current status of performance in each area should be continually measured and status information should be made accessible for management's use.

1.3.9 Internet

The Internet is often referred to as the network of networks. It is a communication medium made possible by computers and networks. This allows all kinds of information exchange on the Internet. Research and information pass back and forth endlessly. It is a fluid and dynamic environment with no definite boundaries, its limitations imposed only by available software and hardware technology. It has been used exhaustively by the scientific and academic communities for a number of years. With the recent surge in interest by business and government, the Internet will be of major importance to today's and tomorrow's world. In order to dissimulate the present research knowledge effectively, the author has made use of this powerful communication system to provide an interactive graphic forum for those who want to know the contemporary development in TQM and to identify the steps that are of particular importance to TQM implementation. In order to achieve these, the Internet System will be based on the TQMEX model.

1.3.10 Expert System (ES)

Once the background and applications of TQMEX are understood via rigorous questionnaire and field surveys, it is possible to transplant the knowledge developed into an ES. A large part of this research is dedicated to this ES and it is intended that the key research findings are incorporated into it. This will then act as an informative guide to companies wishing to initiate TQM with the aim at business excellence. The TQMEX Expert System (TQMEX ES) will be a PC-based system which assists management in developing or improving existing quality systems within the organisation. The main task of this ES is to carry out an audit into the quality-related activities of the company with a view to provide a clear guidance to management on how to implement and assure quality.

1.4 AIM AND OBJECTIVES

In order to promote and implementation TQM more effectively, there needs to be a rigourous research to identify a sound approach and its applicability at corporate levels through questionnaire surveys, field surveys and case studies. Therefore, the present research proposal fits well into the place towards developing a step-by-step implementation model for TQM. Furthermore, this can be carried out more effectively if knowledge can be planted into an ES. With these in mind, the aim and objectives of the research are stated as follows.

1.4.1 Aim

To develop a TQM Model to optimise business performance, to validate the TQM model through the surveys conducted in the UK, Hong Kong and Japan and consequently to develop an advisory service system to assist companies in implementing TQM.

1.4.2 Objectives

1. Review the constituents of TQM and establish a hypothesis for a TQM excellence model.
2. Identify factors critical to the successful implementation of TQM based on literature review and the review of relevant cases.
3. Discuss the various established research methodologies, identify those relevant ones for the present research, and plan research project management.
4. Evaluate the TQMEX model.
5. Identify factors critical to the successful TQM implementation based on intensive questionnaire and field surveys on companies from Hong Kong, Japan and the UK.
6. Conduct action research based on the TQMEX model.
7. Validate the TQMEX model.

8. Produce implementation guidelines, in the form of an Advisory Service System which consists of an Internet Program and an Expert System, in order to offer guidance to management on how to implement TQM.
9. Evaluate the contributions of the ES to knowledge in TQM.

A thorough and comprehensive achievement of the objectives will result in meeting the aim of the research.

1.5 SCOPE OF RESEARCH

The present research was based on the companies in the UK, Japan, and Hong Kong. This portfolio of countries enables the comparison of applications across cultural and geographical differences to be carried out. An activity-time (Gantt) chart is used to control of the project progress.

1.5.1 Research Plan

The PhD research has two phases: the first phase concentrates on developing and testing the model in the UK, while the second phase repeats the research for firms from Japan and Hong Kong.

First Stage (from Jan 94 to Jan 95)

1. Review the literature on
   a) TQM, its definitions, critical success factors and measurement.
   b) Research methodologies and techniques.
   c) Expert System.
2. Develop theoretical model of TQM based on intensive literature research.
3. Conduct questionnaire survey and interviews in the UK.
4. Use statistical analysis method based on software packages (SPSS & Excel) to test the validity of results.
5. Conduct action and longitudinal research in a major construction company in Hong Kong. Findings are to be used to compare with two similar size construction companies in the UK and Japan.

Second Stage (from Jan 95 to April 96)

6. Widen scope of questionnaire survey to include industrialised Southeast Asian countries such as Japan, and Hong Kong. This mix of Asian countries enables a comparison of applications across cultural and geographical differences to be made with the UK findings.
7. Extend the depth of research by undertaking in-depth case studies to companies across three countries through field interviews of selected firms.
8. Evaluate the TQMEX model based on the questionnaire and field survey results.
9. Develop and test an Advisory Service System (Internet Program and Expert System) based on the validated model.
10. Evaluate the contributions of the Internet Program and the Expert System to the knowledge of TQM for different businesses, and also to good management practices in general.

1.6 STRUCTURE OF THESIS

The structure of the research follows the objectives in section (S.1.4.2) closely. It can be summarised in Table 1.4.

STRUCTURE	CHAPTER
Introduction	1
Literature Survey	2
Research Methodology	3
Development of the TQMEX model	4
Survey Result & Analysis	5
Action Research (TQMEX applied to the Construction Industry)	6
Advisory Service System	7
Validation	8
Conclusions & Recommendations	9

Table 1.4 Summary of the structure of research

Chapter 1 identifies and discusses the fundamentals of TQM. After the introduction to why present work is done, the aim, objectives and the scope of the study are established. This is followed by a plan of the chapters to be developed.

Chapter 2 describes a comprehensive literature survey based on the pertinent publications and on-line search facilities. The important teachings of the quality gurus are summarised. Different models of TQM are also reviewed.

Chapter 3 critically reviews the common research methodologies and identifies those which are relevant to the present research. An effective research project management plan is developed based on sound project management principles. Sufficient time was allowed for the survey, field work, action research, longitudinal survey, and validation.

Chapter 4 explains how TQMEX is developed and each element of the TQMEX is discussed in depth. The principles of the TQMEX model are then used to benchmark against some of the guru's ideas, the McKinsey's 7-S model and Porter's five competitive forces.

Chapter 5 develops the principles of effective TQM implementation based on questionnaire and field surveys. The questionnaire surveys were conducted in the UK, HK and Japan. The results were validated based on statistical analysis. The field surveys were also carried out on companies from the three countries. With this spread of experience across countries, experiences amongst nations of different technological and cultural backgrounds are taped and cross-referenced. This enables conclusions to be drawn from the results of the research based on different countries. Furthermore, successful experience from other countries can be shared.

Chapter 6 is an in-depth field survey in three construction companies, one from each country. This enabled similarities and differences in the perception on the TQMEX model to be compared. Action research was also carried out in a major construction company in Hong Kong. Findings were used to compare with the other two similar size construction companies in the UK and Japan.

Chapter 7 describes the development of the advisory service system based on the knowledge developed in the questionnaire and field surveys. Internet programming and the Expert System language are used for its development. The advisory service systems are supported with clear instructions and are prepared to ensure user-friendliness and effectiveness on their use.

Chapter 8 describes the validation of the advisory service system by Internet users and individuals who want to know the contemporary development in TQM. The validation was further enhanced by the longitudinal research carried out over a period of one year in a construction company in HK. The model is also mapped onto the European Quality Award criteria. The final product is a ES package that has the essential features and expertise for commercialisation.

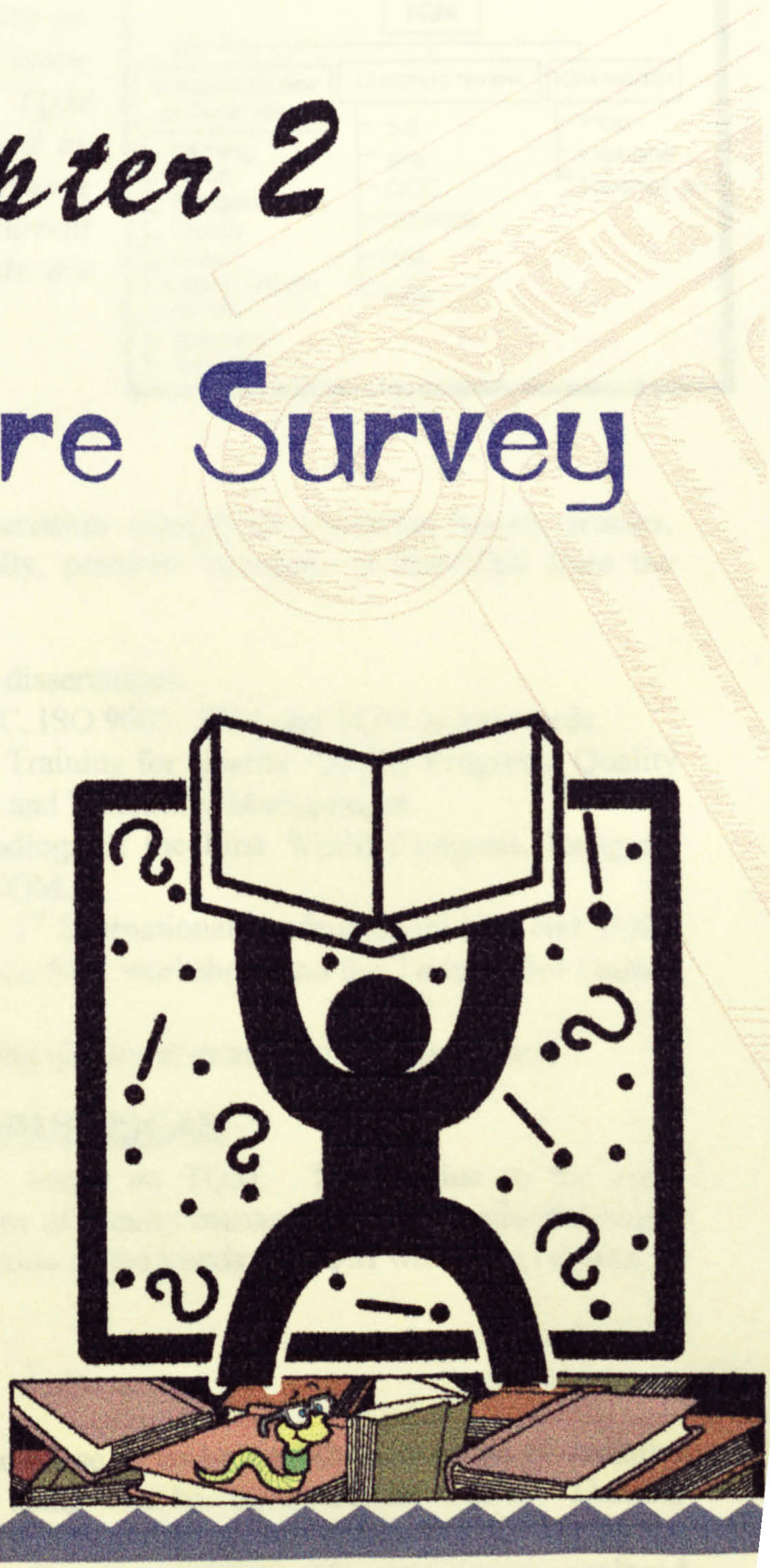
Chapter 9 presents the conclusions and recommendations for further work. The conclusions reveal that companies could make effective use of TQM if they follow the TQMEX model and exercise good managerial skill based on the pre-requisites for TQMEX in its implementation.

EPILOGUE

This chapter sets the scene and defines the aim and objectives of the research. The scope and structure of the research are also discussed. This leads to the identification of the scope of literature survey in the next chapter.

Chapter 2

Literature Survey

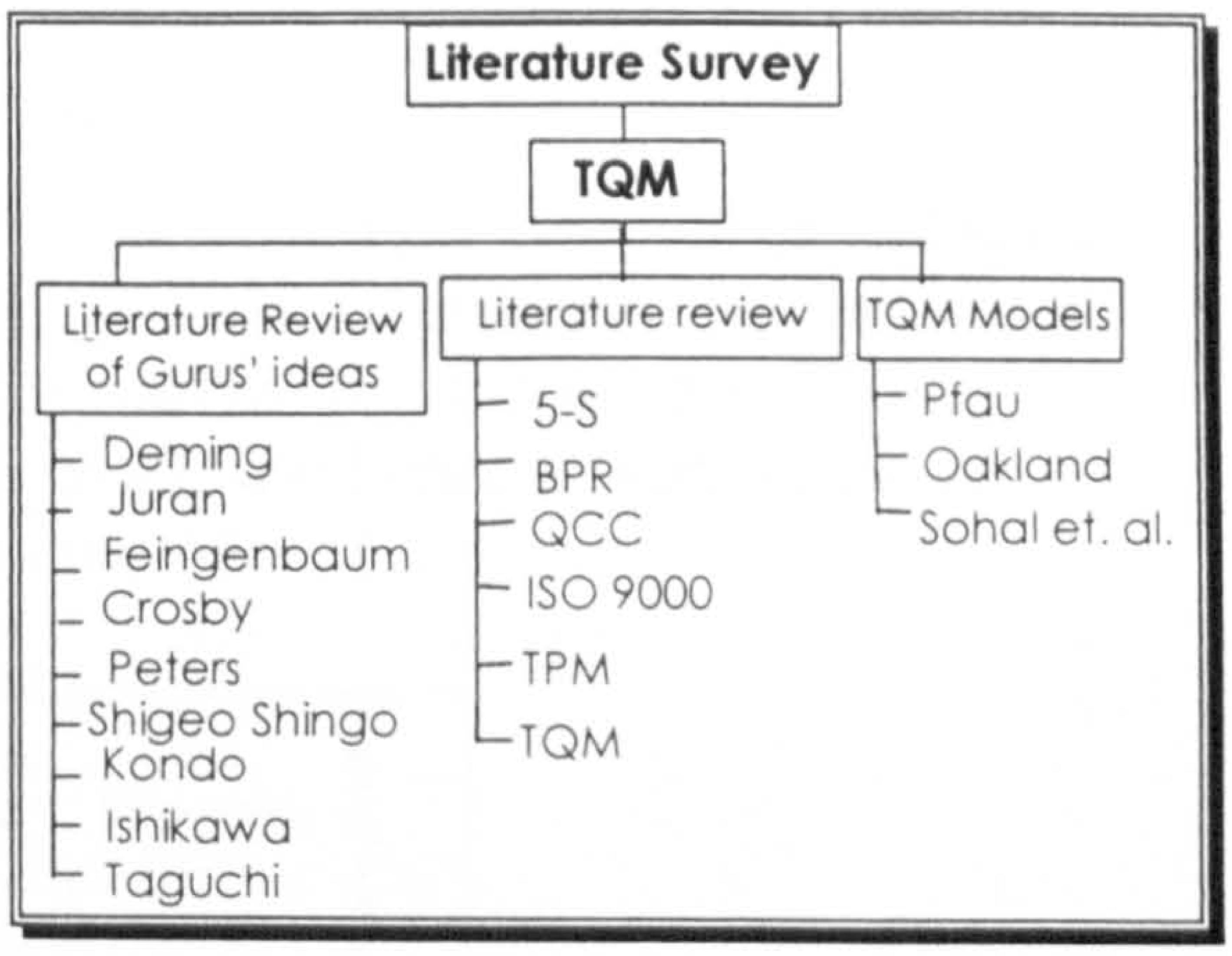


CHAPTER 2

LITERATURE SURVEY

PROLOGUE

This Chapter reviews the pertinent literature on TQM. They are classified under Literature review of gurus' idea, literature review and TQM models. Books are reviewed first, followed by published articles. Comments on their relevance are included in book reviews. The current thinking and development of TQM Models are also evaluated.



2.1 LITERATURE SURVEY

The review of the literature for this dissertation consists of reviewing books, articles, working papers, and journals. Specifically, pertinent literature is identified from the following main sources:

- Bibliographies from related books, and dissertations.
- CD-ROM searches using 5S, BPR, QCC, ISO 9000, TPM and TQM as keywords.
- Quality journals, e.g., TQM Magazine, Training for Quality, Quality Progress, Quality World, International Journal of Quality and Reliability Management.
- Conference Proceedings, e.g., Proceedings of the First World Congress, Inaugural Internet Conference on ISO 9000 and TQM.
- Attending relevant meetings, e.g., The 1st International conference on ISO and TQM, The Midland British Deming Association SPC workshop, and the Training for Quality Editorial Board Meeting.
- Attending relevant courses, e.g., Auditing quality systems lead assessor course.

2.2 LITERATURE REVIEW OF GURUS' IDEAS

There are many new text and reference books on TQM. This is due to the rapid development of the principles and practices of quality management. The relevant books are reviewed here in order to build up a picture of the trends on TQM which are relevant to the present research.

2.2.1 W. Edwards Deming [1986]

Deming encouraged the Americans and Japanese to go beyond the utilisation of statistics and strive for continuous improvement by using what has been referred to as the "Deming Cycle" or Plan-Do-Check-Act (Figure 2.1). Deming, however, referred to this as the Shewhart Cycle, named after his teacher Shewhart [1933]. He subsequently replaced "Check" by "study", as that word reflects the actual meaning more accurately. Therefore an alternative abbreviation for the Deming Cycle is PDSA Cycle.

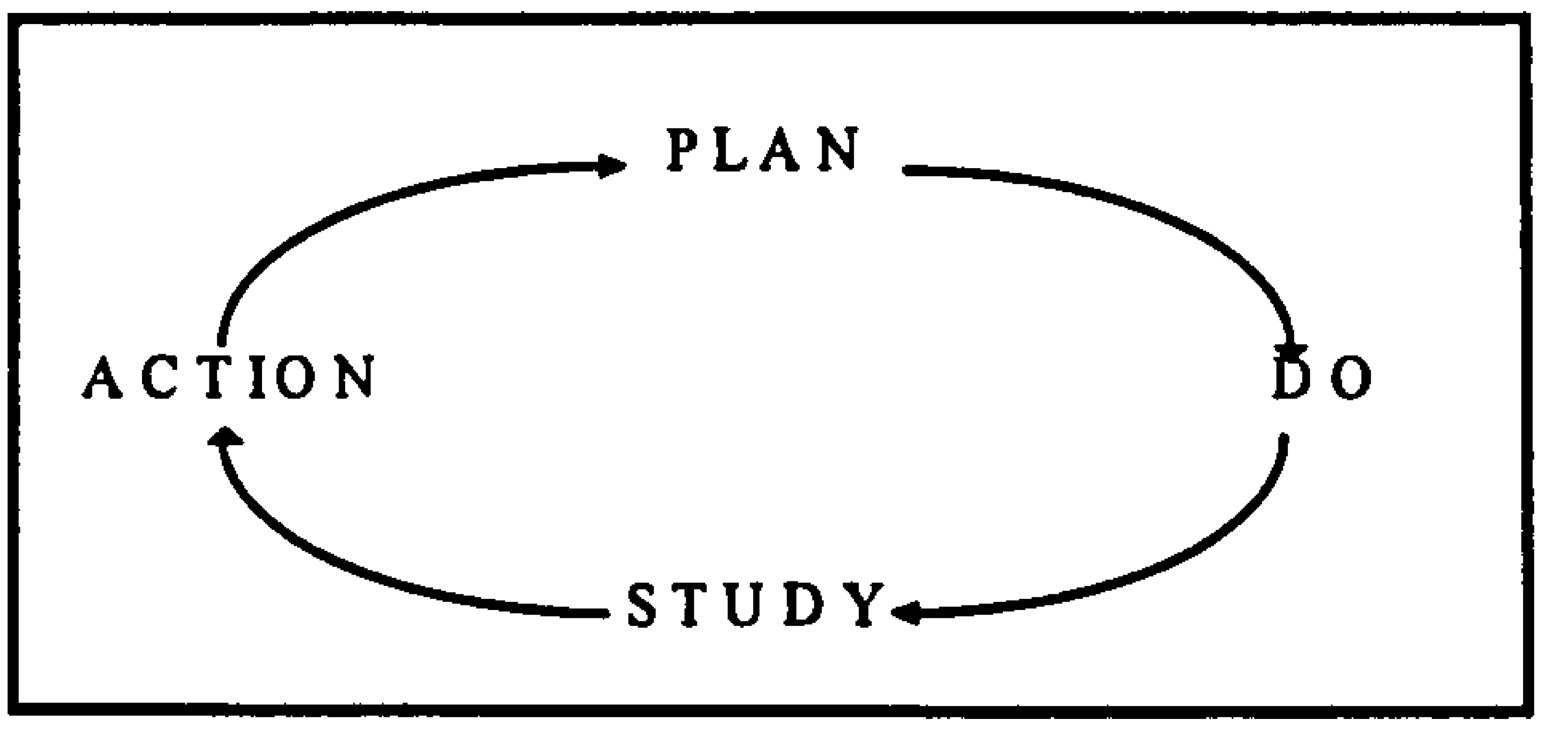


Figure 2. 1 Deming Cycle

Deming also addressed the real meaning of "quality". The Deming chain reaction in Figure 2.2 [Deming, 1986] highlights the fact that cost reductions, business success, and increased profitability are natural consequences of the improvement in quality. This in the broad sense, can also lead to improvement of productivity, and hence to survival, success, expansion of the business and multiplier effects on the community.

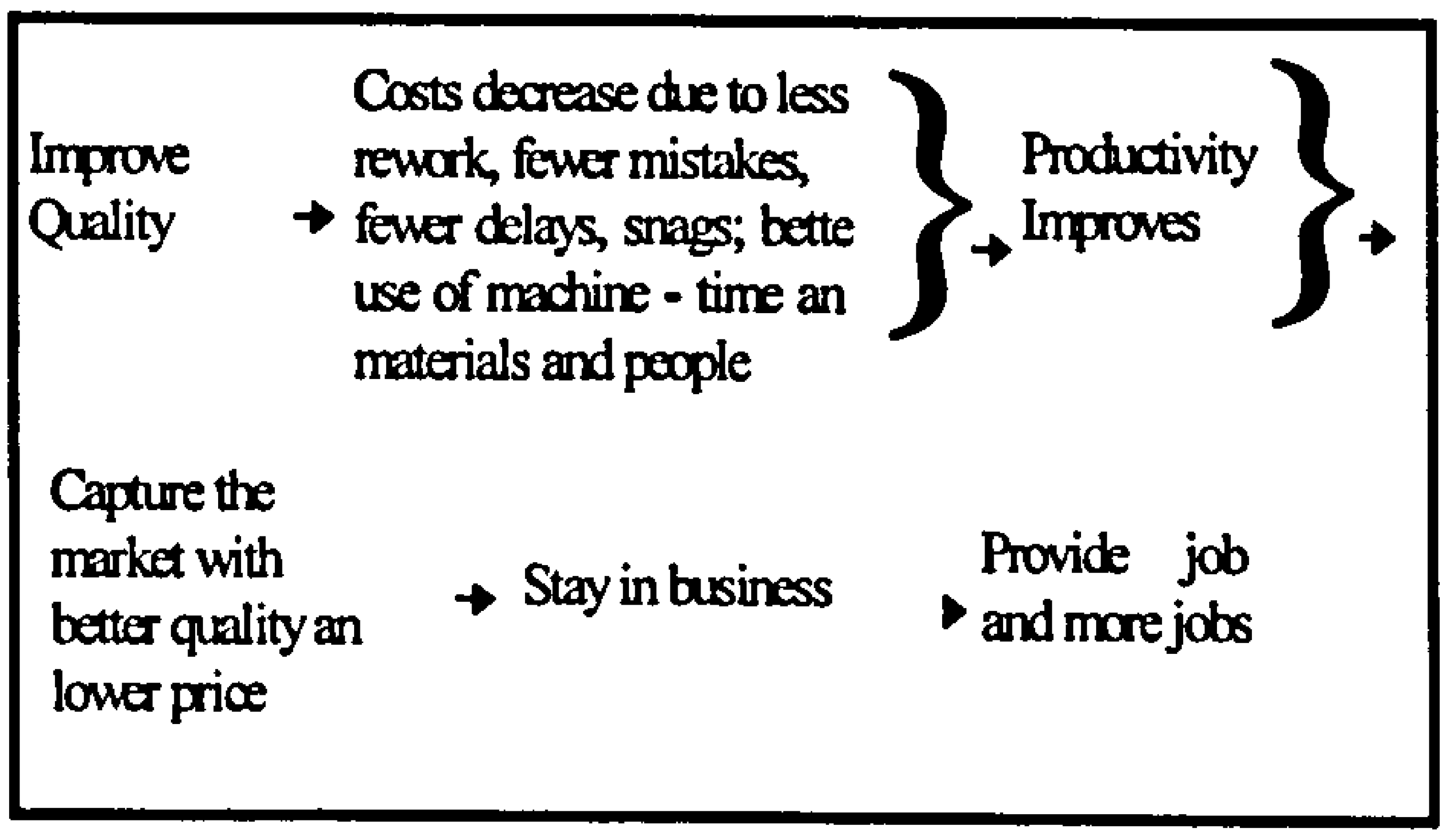


Figure 2. 2 Deming Chain Reaction

His greatest contribution to the Japanese was the message regarding a typical business system (Figure 2.3). It explains that the consumers are the most important part of a production line. Meeting and exceeding the customers' requirements are the tasks that everyone within an organisation needs to accomplish. Furthermore, the management system has to enable everyone to be responsible for the quality of his output to his internal customers.

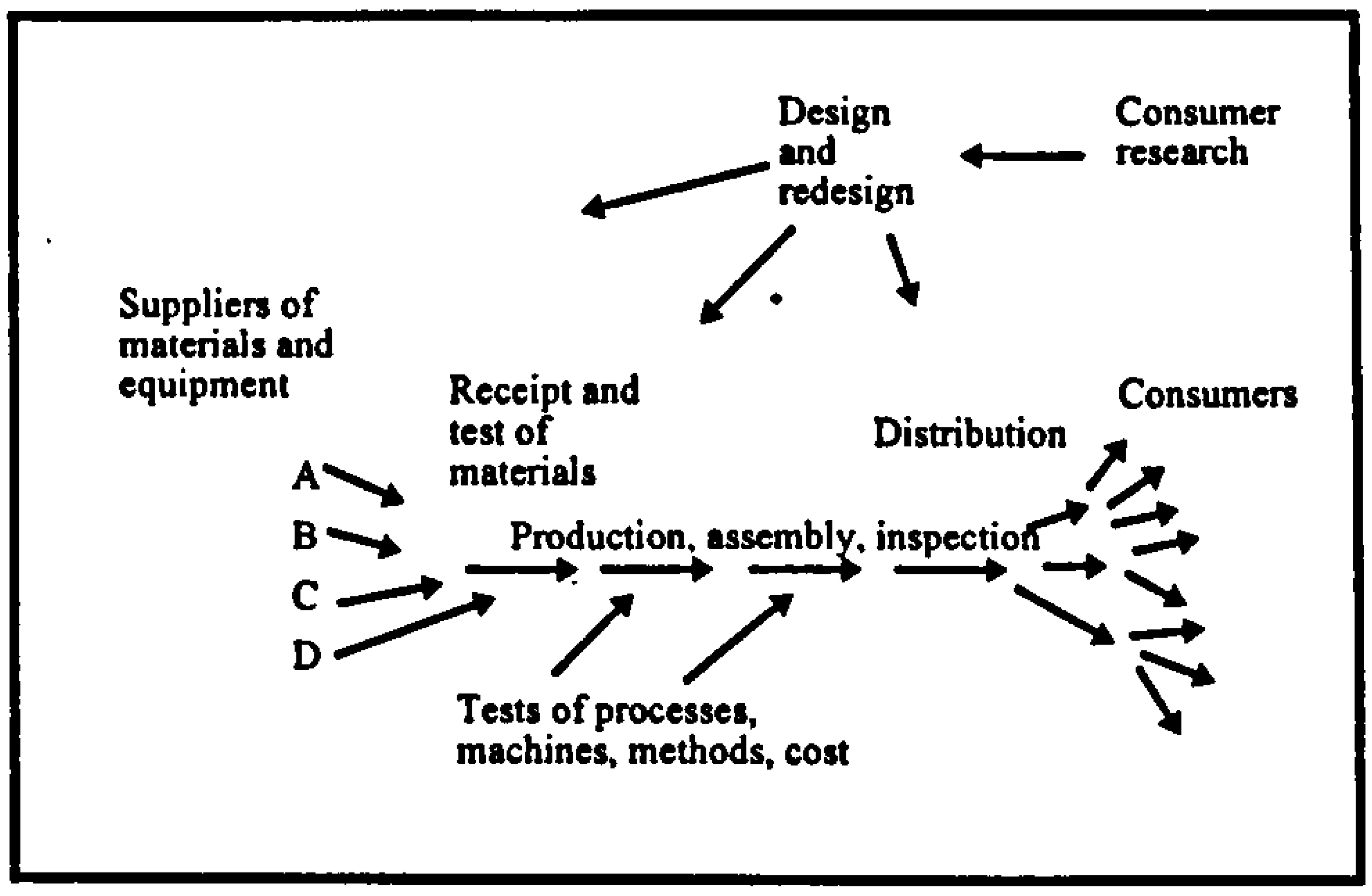


Figure 2.3 A Typical Business System

Relevance: The book gives an in-depth knowledge of the management principles and practices of TQM. These provide valuable and important basis for developing the TQMEX model. More importantly the concept of PDCA Cycle should be used in implementing the TQMEX model. If some areas of improvement are spotted, there should be a good "Plan" to implement it. Then, there should be a pilot test to "Do" the work.. The results of the pilot test are further "Checked" so that a more effective implementation scheme can be drawn up. Finally, the scheme comprises "Action" accordingly, ready to feedback for the next stage of development.

2.2.2 W. Edwards Deming [1993]

This book offers a perspective of Deming's thinking before his death, which can best be expressed as Management by Positive Co-operation. He talks about the **New Climate** (organisational culture) which consists of three elements.

- Joy in Work,
- Innovation, and
- Co-operation.

He has referred to this New Climate as 'Win: Win', as opposed to the 'I Win: You Lose' attitude engendered by competition. In order to help people understand and implement the necessary transformation, Deming [1989] produced his 14 points for management (App.2.1). He also said that the adoption of and actions on the 14 points are signals that management intends to stay in business. These apply to both small and large organisations, and to service industries as well as to manufacturing.

Relevance: The book appeals to practitioners of how quality can be applied to a range of business decisions. Since the 14 points are very important guidance for companies to be successful in their TQM journey, the TQMEX model has to incorporate most of the Deming's 14 points. Therefore, it will be used as a set of guiding principles for the TQMEX model as shown in Table 4.4 (S4.2.5). However, they are not used as a check-list or instructions. They are used as a vehicle for opening up the mind to new thinking, to the possibility that there are radically different and better ways of organising businesses and working with people.

Critical Comment: The 14 points identify some important principles for management to consider. However, it gives very few guidelines about implementation steps which a company should follow. There may be a danger in simply obeying the words without studying and developing deep understanding of why, how and in what situation the 14 points should be implemented. Indeed, some adjustments to 14 points have been made during the decade, reflecting the way that the world is changing and the changing needs of the people. Therefore, it is important to understand quality through the implementation of the first five stages of the TQMEX model. This provides the company with information about its environment, people, teamwork, resources, etc (S.4.2). The company will then be able to create a new environment which is consistent with the principles of TQM.

2.2.3 Henry Neave on Deming's System of Profound Knowledge [1990]

The book summarised Deming 70 years' vision and experience. It explains why the prevailing system of management has led companies into the decline and the transformation that must occur for survival take place under the leadership of the top management. Most importantly it will be necessary to learn and to practise *the Deming's System of Profound Knowledge.* It encompasses four interrelated dimensions (App.2.2):

- Appreciation for a system
- Knowledge of statistical theory
- Theory of knowledge
- Knowledge of psychology

<u>**Relevance:**</u> Deming's system of profound knowledge provides a comprehensive description and contains essential ingredients of achieving TQM. These ideas could also be used by every individuals and organisations as their values are tremendous. Therefore, it is of direct relevance in the development of the TQMEX model. The application of Deming's system profound knowledge to TQMEX model will be discussed in [S.4.2.3].

2.2.4 Joseph M. Juran [1988]

Juran's approach to quality control and management comprises two elements:

1. The role of senior managers in providing leadership, required resources, in encouraging awareness, participation and in developing system of policy, goals, plans, measures and control for quality. These lead to three aspects of company-wide quality strategy which termed as "**quality trilogy**" (App.2.3).
2. Companies' mission in terms of fitness for use by providing products and services which conform to customer specifications plus issues of reliability, availability, maintainability, customer service, etc. that reflects the interplay between the various stages of organizational activities before meeting customer demands. This process which Juran termed as "**the spiral of progress**" (Figure 2.4).

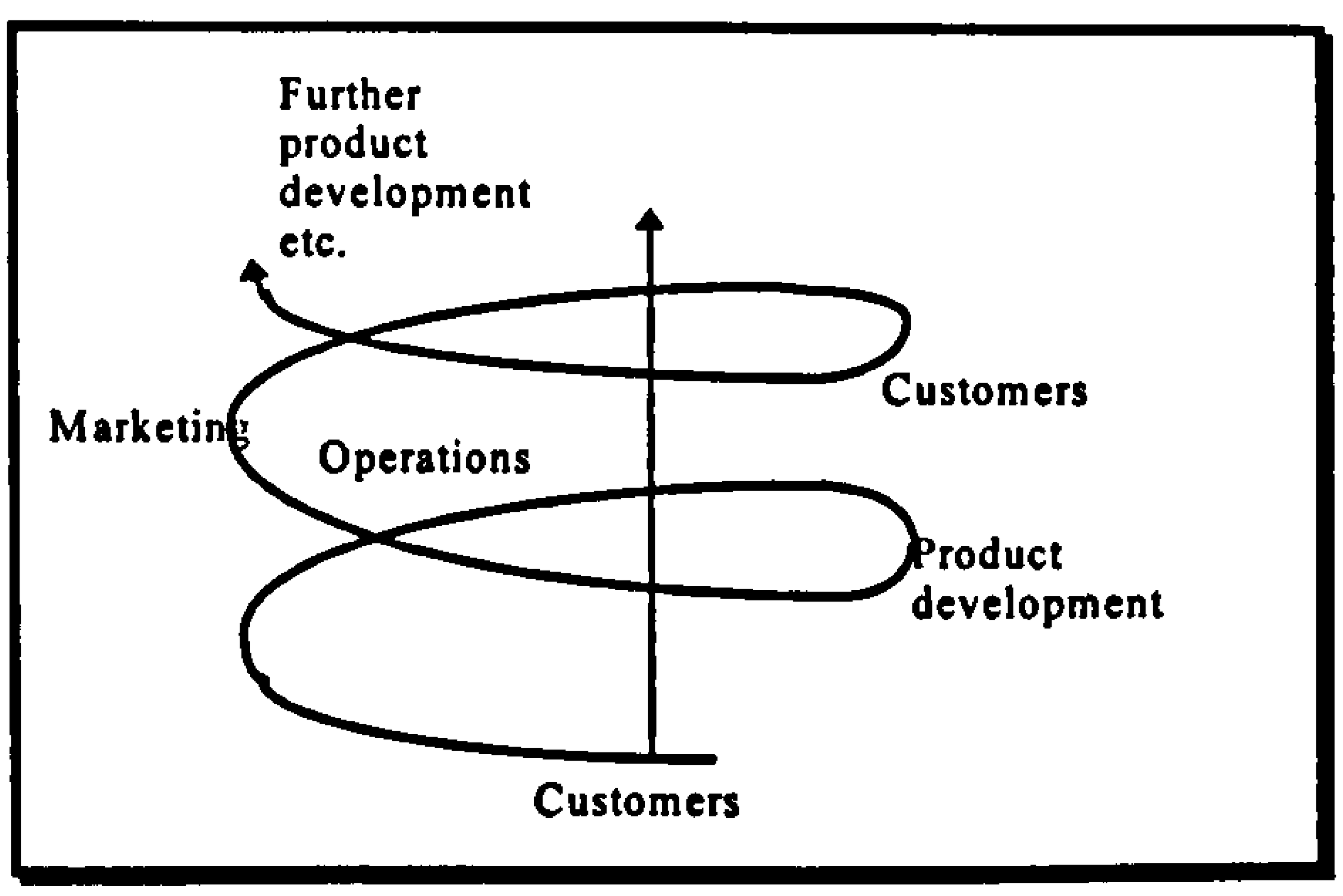


Figure 2.4 Spiral of Progress

Relevance: Juran's work emphasises the need for specialist knowledge and tools for successful conduct of the quality function. He emphasises the need for continuous awareness of the customer in all functions. His formula for achieving success in a quality campaign is to:

- Establish specific goals to be reached.
- Establish plans for reaching the goals.
- Assign clear responsibility for meeting the goals.
- Base the rewards on results achieved.

The book is very well illustrated text for beginners and professionals in the field. Therefore, it will be used as a key source of reference in the advisory services.

2.2.5 Armand V. Feingenbaum [1983]

Feingenbaum argued that the contribution of manufacturing function in isolation is not enough for the production of high quality products. He concludes that:

"The underlying principle of the total quality view, and its basic difference from all other concepts, is that to provide genuine effectiveness, control must start with identification of customer quality requirements and end only when the product has been place in the hands of a customer who remains satisfied. Total quality control guides the co-ordinated actions of people, machines, and information to achieve this goal. The first principle to recognise is that quality is everybody's job"

The new 40th Anniversary edition of Dr Feigenbaum's book, "Total Quality Control", now further defines TQC for the 1990s in the form of ten crucial benchmarks for total quality success. These are that:

1. Quality is companywide process.
2. Quality is what the customer says it is.
3. Quality and cost are a sum, not a difference.
4. Quality requires both individual and team enthusiasm
5. Quality is a way of managing.
6. Quality and innovation are mutually dependent.
7. Quality is an ethic.
8. Quality requires continuous improvement.
9. Quality is the most cost-effective, least capital-intensive route to productivity.
10. Quality is implemented with a total system connected with customers and suppliers.

Relevance: The ten benchmarks enable the company to focus quality towards both internal and external customers. Most importantly, they provide the company with foundations for successful implementation of quality leadership. Feigenbaum also emphasises that there are three keys to achieving quality competitive leadership.

1. A Clear understanding of international markets
2. A thorough grasp of a total quality strategy
3. Hands-on management know-how

Feigenbaum consistently emphasises that total quality programmes are perhaps the single most powerful change agent for companies today. The coverage of this book is very broad and includes the state-of-the-art development in the field of quality. Furthermore, there are many practical applications from business and management. Therefore, it will be used as a key reference for the development and implementation of the TQMEX model. Feigenbaum's ten crucial benchmarks for total quality success will be used as a set of guiding principles for the TQMEX model as shown in Table 4.4 (S4.2.5).

2.2.6 Philip B. Crosby [1979]

Crosby's name is best known in relations to the concepts of ***"Do It Right First time"*** and ***"Zero Defects"***. He considers traditional quality control, acceptable quality limits and waivers of sub-standard products to represent failure rather than assurance of success. He views quality improvement as an ongoing process since the work 'programme' implies a temporary situation. Crosby's Quality Improvement Process is based upon the "Four Absolutes of Quality Management" (Table 2.1).

Quality means conformance to the requirements: The setting of requirements is management responsibility as are the communication devices and their effectiveness. Crosby argues that if management wants people to "do things right first time" they have to define what the task is;
Quality comes from prevention: The first absolute was to understand the processes of producing products/services. The second is about identifying and eliminating all chances for error to occur;
Quality performance standard is zero defects: This is conformance to the requirements and should be the personal performance standard of everyone in the organisation according to Crosby and will come from a change in attitudes.
Quality measurement is the price of non-conformance: According to Crosby manufacturing companies spend 25% of sales doing things wrong and service companies spend about 40% of their operating costs on the same wasteful actions.

Table 2.1 Four Absolutes of Quality Management

Crosby identifies additional quality-building tools, including the Quality Management Maturity Grid which enables a company to measure its present quality position. He also classifies Cost of Quality into three categories: prevention cost, appraisal cost, and failure costs (App.2.4-1). Crosby also proposes a checklist with fourteen points which could facilitate the introduction of continuous improvement (App.2.4-2).

<u>Relevance:</u> The Crosby approach to total quality is to change the culture and attitudes within organisations to implement zero defect. This approach is therefore more management-oriented than technique-oriented since it does not refer to the control of quality by the use of various statistical techniques. The focus of the book is on quality improvement which is spread by creating a core of quality specialists within the company. There is a strong emphasis on the top-down approach, since he believes that senior management is entirely responsible for quality. Since the TQMEX also emphasise the top-down approach to TQM, the ideas in this book are also relevant to the development of the effective model of TQM. Crosby's fourteen points will be used as a checklist for the TQMEX model as shown in Table 4.4 (S4.2.5).

Critical Comment: Zero defects is only useful in terms of driving force behind continuous improvement. However using zero defect as conformance, requirement can have an adverse effect. This is because there are few tasks for which it is possible to judge immediately whether things have in fact been done right first time. This could discourage workers for further improvement because they fail to meet the target.

2.2.7 Kaoru Ishikawa [1976]

Ishikawa's contribution is in simplifying statistical techniques for quality control in industry. At the simplest level, his work has emphasised good data collection and presentation, the use of Pareto diagrams to prioritise quality improvements and Ishikawa diagrams. Through his experience, he identifies a set of tools which can be used by teams and individuals to interpret the data fully and derive the maximum information out from it. These are seven effective methods which will offer any organisation means of collecting, presenting, and analysing most of its data and problems. *They are: process flowchart, check sheet, histogram, Pareto analysis, cause & effect analysis, scatter diagram and control charts.* Since their applications are so wide, they are also known as the **seven tools for QCCs.**

Relevance: The book is directed towards the usefulness of QCCs and quality control tools in solving a wide variety of business-related problems. The Japanese experience of quality circles provides an insight into the problems of implementation in the West, usually because of management's lack of interest or excessive intervention. Adoption of QCCs has been varied and has achieved different levels of effectiveness and success. Therefore, QCCs cannot be implemented naively, their use has to be carefully planned. The principles of QCCs are sound and will be able to contribute to the implementation framework of the TQMEX model

2.2.8 Genichi Taguchi [1986]

Taguchi's methods incorporate the use of statistical techniques. They are primarily intended for designers and engineers to optimise the settings so that products are robust. He defines the quality of a product as the loss imparted by the product to the society from the time the product is shipped. Taguchi breaks down off-line quality control into three stages:

- System design
- Parameter design
- Tolerance design

Relevance: Taguchi sees quality from a different view point than the other gurus, because he emphasises quality loss rather than quality. Although the book is not directly relevant to the TQMEX development, it is a good reference for the understanding of the use of statistical techniques for problem solving in the early stages of the product development cycle.

2.2.9 Shigeo Shingo[1986]

Shingo has pioneered the area of "zero quality control" by asking similar questions to those asked by Taguchi. Shingo argues that the effort put into tightening tolerances does not necessarily raise production costs significantly as is widely believed. He believes that quality should be controlled at the source of the problem rather than after the problem has manifested itself. Consequently he recommends that inspection should be incorporated within the process where the problem has been identified and where it should be eliminated. He went on to developed his own concept called "Poka-Yoke" (or foolproofing). Poka-Yoke means that checklists for each operation are provided so that human error is completely eliminated. Shingo recommends the following guidelines for the implementation of Poka-Yoke (Table 2.2).

1. Control upstream, close to the source of problem, for example incorporating monitoring devices to warn on defects in materials or abnormalities within the process.
2. Establish control mechanisms to deal with different problems to enable operators to know how to deal with the problem and to solve it with minimal disruption to the operating system.
3. Take a step by step approach by taking small strides, simplifying control system and having economic viability in mind. Efficiency, technological sophistication, available skills and work methods, have all got to be carefully studied for effective usage for Poka-Yoke.
4. Do not improve by over analysing: Although many manufacturers' main objective is to achieve closeness between design manufacturability, many Poka Yoke ideas can be implemented when the problems have been identified with no cost at all to the companies concerned. Poka Yoke encourages interdepartmental co-operation and is a main vehicle for continuous improvement because it encourages continuous problem-solving activities.

Table 2.2 Guidelines for the Implementation of Poka-Yoke

It was in the period 1964-1968 that Shingo extended the ideas of proofing to the Just In Time (JIT) system. The basic idea is to stop the process whenever a defect occurs, define its cause and prevent problem the recurring.

Relevance: The book identifies the challenge that zero quality control can be achieved what may have been impossible using statistical quality control methods. Further it shows how Poka Yoke can be put to practical use in organisations. Therefore, it will be used as a key reference to the implementation of TQMEX model.

2.2.10 Yoshio Kondo [1989]

This book emphasises the interrelationship between quality and people. He sees motivation as the essence of humanity and endorses that human work should always include the following three components:

- Creativity – the joy of thinking
- Physical activity – the joy of working with sweat on the forehead
- Sociality – the joy of sharing pleasure and pain with colleagues

He advocates that making work more creative is important for motivation. He suggests four points of action in support of such a process (App.2.5):

1. When giving work instructions, clarify the true aims of the work.
2. See that people have a strong sense of responsibility towards their work.
3. Give time for the creation of ideas.
4. Nurture ideas and bring them to fruition.

Kondo concludes that only by addressing all four points will it be possible for work to be reborn as a creative activity. If ideas are created and fostered, those concerned will come to feel a real sense of self-confidence.

Relevance: This book identifies that quality is more compatible with human nature than cost and productivity. The four-point approach to motivation makes it possible for work to be reborn as a creative activity. Since the successful implementation of the TQMEX model depends on the effectiveness of people implementing it, Kondo's ideas on humanity and creativity are very important and useful for every step of the TQMEX implementation (S.4.2.1.1). Furthermore, a successful implementation should also be related to specific processes and adequate culture based on the companies' policies and strategies. That means, people empowerment must be a integrated part of the implementation programme (S.6.2).

2.2.11 Tom J. Peters & Robert H. Waterman Jr. [1981]

This book presents an overview of performance within 43 large American Companies. It discussed the idea of Mckinsey's 7-S framework which suggests that any intelligent approach to organising had to encompass, and treat as interdependent, at least seven variables: Structure, Strategy, System, Staff, Skill, Style and Shared Values. Through their experience, the 7-S can be classified into the 2-hard (Structure & Strategy) and the other 5-soft S's. They said "We had observed managers apparently getting more done because they could pay attention with seven S's instead of just two." One significant finding from their research is that in excellent companies "Tools didn't substitute for thinking. Intellect didn't overpower wisdom. Analysis didn't impede action. Rather, these companies worked hard to keep things simple in a complex world. They persisted. They insisted on top quality. They fawned on their customers. They listened to their employees and treated them like adults...."

Relevance: McKinsey's 7-S model is an important framework for organisations. More important is the distinction between the hard and soft S's. In a TQ organisation, all the 7-S are important considerations and the solution is to develop the potential of the people working in it to excel in every aspects through various quality concepts and teamworking. When the cases in the book are reviewed, it is not difficult to find that a lot of the excellent organisations are based on TQM as the pillar for their success. Therefore, this book can be used as a validation instrument for the TQM model developed in this research.

2.2.12 Tom Peters [1988]

In this book he used the term "management obsession" and considered that leaders must learn to love change in order to be proactive in a world of chaos. This book no longer appears to portray leadership, or Management By Working Around (MBWA) in particular, as the central issue. Instead, he devotes a new area "system" to the four familiar areas of customers, innovation, people and leadership.

Relevance: This book discusses several prescriptions describing tools, key strategies, and tactics for implementation of excellence. There are twelve attributes (App.2.6) concerning customer responsiveness based on shared characteristics which he has perceived amongst the successful quality implementation programmes of the top American companies. Therefore, the twelve attributes will be considered as a set of guiding principles for the TQMEX model as shown in Table 4.4 (S4.2.5.). The book will also be used as a key reference to the implementation of the TQMEX Model.

2.2.13 Joyce [1995]

This book aims to lead business to achieve world class performance by demystifing concepts such as TQM, ISO 9000 and benchmarking and provides guidelines and action planning based on proven and successful practices. It provides an overview of the organisational consideration and concerns required for building a world class culture and environment and helps managers answer questions such as:

- Why do organisations find world class performance so difficult to maintain success once they have achieved it?
- How is it that some organisations continue to be successful and build increasingly high reputations?
- What is total quality management anyway and what has it got to do with being world class?
- Can all organisations achieve continuing success and build ever higher reputations in their particular fields?

Relevance: The book identifies the necessary management, leadership, operating systems, culture and environment to become a world class company. Furthermore, it shows how such systems can be put to practical use in organisations. Therefore it will be used as a reference to the development of the model.

2.2.14 Michael Porter [1980]

In this book Porter described five forces to shape the competition in a given industry. They are buyers, substitutes goods, suppliers and the threat of potential entrants who impinge on and interact with the character of the rivalry among existing firms.

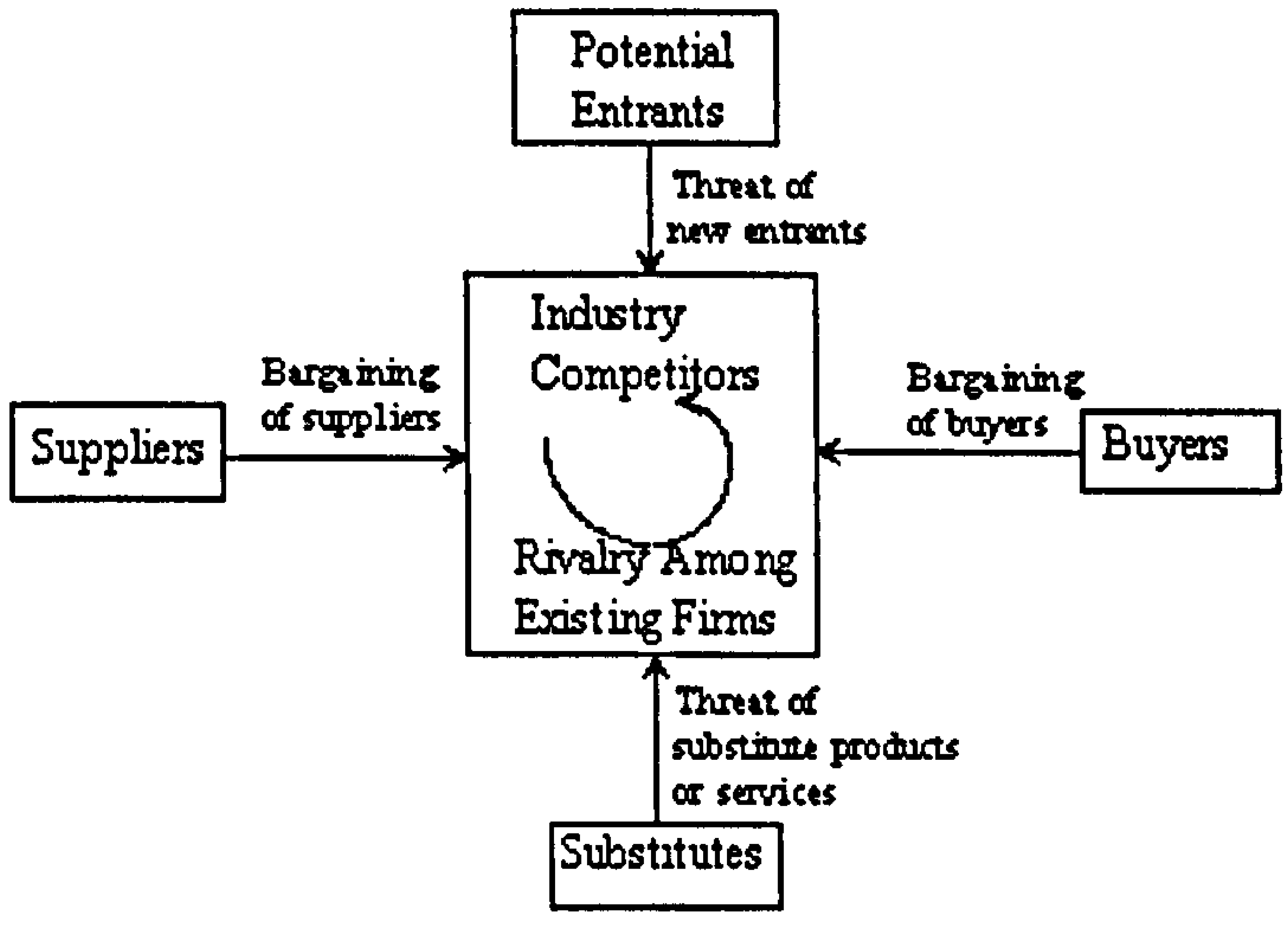


Figure 2.5 Five Forces driving industry competition

Relevance: It is important to understand the competition in any industry. In the horizontal direction, the 5-forces diagram refers to the supply chain which TQM always advocates as important. In the vertical direction, the diagram emphasises competition. TQM recognises competition right from the start, when Deming proposed his famous Deming Chain Reaction in 1950's, he recognised the fact of competition and the contribution that quality can make (i.e., by lowering cost, increasing productivity and hence remaining competitive). Porter's model will be used as a check for the effectiveness of TQM in business (S.4.2.5.2).

2.2.15 Overview of Gurus' Ideas

So far, the books which have been most relevant to the present research are identified. These are important for the present research in particular as they help to give an overview of the areas of focus in TQM. Most of the relevant books are based on the gurus' ideas. The ideas are results of their life-time understanding and experience about quality and have been tested by many organisations world-wide. Therefore, it is important to synthesise their ideas and make them integral to this research (S.4.2.5 Table 4.4). Each guru offers unique idea to the philosophy of TQM. To implement TQM successfully, one has to be able to select, sequence, and synthesise the messages from many different gurus to come to a useful conclusion. Two groups of quality gurus, American and Japanese with their ideas can be identified as follows (Table 2.3)

COUNTRY	CONTRIBUTOR	TQM PHILOSOPHY
USA	W.E. DEMING	Deming Cycle Deming Chain reaction Deming's 14 points Deming pro found knowledge
USA	J.M. JURAN	Spiral of progress in quality Juran quality trilogy
USA	A.B FEINGENBAUM	Total quality control Industrial cycle
USA	P.B. CROSBY	Zero defect Quality is free Crosby's fourteen step quality improvement programme
USA	T. PETERS	MBWA Twelve traits of a quality revolution
Japan	SHIGEO SHINGO	Zero quality control Implementation of Poka-Yoka
Japan	Y. KONDO	Four steps for making creative and quality work
Japan	K. ISHIKAWA	Simple tools, QCC Company-wide quality
Japan	G. TAGUCHI	Statistical process control Taguchi's quality imperatives

Table 2.3 Summary of Quality Gurus' ideas

Management commitment and employee awareness are essential from the early stages of TQM implementation. Deming's philosophy is possibly the most useful for encouraging these necessary attitudes.

The awareness should be backed up by facts and figures. Planning and data collection are important. Costs of Quality can be used to measure the progress of improvement. Juran has made the biggest impact in this area.

TQM programmes normally employ teamwork to facilitate improved communication and problem-solving. QCCs are particularly advocated by Ishikawa, and can be very successful if the rest of a TQM structure is in place. Ishikawa advocated simple tools for problem-solving and improvement to be used by all employees.

There are also more technical tools to control industrial design and manufacturing. Shingo's work has been associated with successful Just-in-Time systems.

Management tools should be studied to achieve quality. These include the concepts of Company Wide Quality Control and Total Quality control associated with Ishikawa and Feigenbaum respectively.

In order to move from an inspection to a prevention culture, emphasis is placed on serving the internal customers and suppliers. This customer focus has been strongly stipulated by Juran's and Deming's recent teachings.

One priority that needs emphasising is that Deming's work is so challenging that it should deserve serious consideration. Finally, of vital importance is the need to develop a company-specific quality system. It is likely that different companies will have different priorities and targets. The Quality Gurus have an important contribution to make to TQM, as almost all gurus claim, it can only be planned and driven by the senior management of the firm.

2.3 LITERATURE REVIEW

An on-line information search was done in March 94 using ABI/INFORM, ANBAR-BUSINESS INDEX, and IMID (Institute of Management Database) databases which are stored on CD-ROM. The diskette held 5 years of data dating back to Jan 89. The descriptors used were:

- 5-S
- Business Process Re-engineering
- Quality Control Circle
- ISO 9000
- Total Preventive Maintenance
- Total Quality Management

A summary of CD-ROM search is shown in Table 2.4:

	ABI /INFORM		**ANBAR**		**IMID**	
	Total	Relevant	Total	Relevant	Total	Relevant
5-S	1	1	4	2	0	0
BPR	37	12	146	21	3	3
QCC	4	3	18	8	24	15
ISO	28	11	23	6	6	4
TPM	17	4	8	3	13	5
TQM	521	22	267	25	418	32

Table 2.4 Summary of CD-ROM search showing number of abstracts

For the purpose of this research, the literature on TQM can be conveniently grouped under the followed headings which form the core of the TQMEX model:-

2.1.2.1 5-S
2.1.2.2 BPR
2.1.2.3 QCC
2.1.2.4 ISO 9000
2.1.2.5 TPM
2.1.2.6 TQM

In the following sections, the discussion begins with an overview of the above topics, followed by the summary of abstracts. The abstracts have been studied and their corresponding articles reviewed as far as possible.

2.3.1 5-S

Overview:

Surprisingly, this powerful quality tool has been a secret to the West. The western world has just recently recognised the significance of the 5-S practice although there are indications that some companies have included some aspects of the 5-S in their routines without being aware of their existence as a formalised technique. There are many examples of successful implementation of some principles of the 5-S, especially in service sector organisations, such as fast-food restaurants, supermarkets, hotels, libraries, and leisure centres.

The difference between the Japanese and Western approach lies mostly in the degree of employee involvement. By formalising the technique, the Japanese established the framework which enabled them to successfully convey the message across the organisation, achieve total participation and systematically implement the practice. The 5-S framework has become the way of doing business, not only to impress the customers but to establish effective quality processes as a pre-requisite for good products and services.

2.3.1.1 Mak [1995]

Mak believes that most companies saw elements of quality but missed the foundations of the TQM principle. Among the books on TQM, very little is mentioned about the 5-S framework: the foundation of TQM. This paper states the importance of 5-S, explains its concept and practices. He suggested that although implementing 5-S activities only take a short time, the benefits will be huge to the company. A 5-S's workplace makes staff happy, thus producing the highest quality goods and rendering the best quality services to the customers.

2.3.1.2 Ho [1996]

He reviews the 5-S technique and explores the reasons why it has been widely used in Japan as the first step towards TQM. The logic behind the 5-S practices is that organisation, neatness, cleanliness, standardisation and discipline at the workplace are basic requirements for producing high quality products and services, with little or no waste, while maintaining high level of productivity. He provides 5 steps for 5-S implementation which require commitment from both the top management and everyone in the organisation.

1. Get top management commitment and be prepared
2. Draw up a promotional campaign
3. Keeping records
4. Implement 5-S Training
5. Evaluation of the results

2.3.1.3 Ho & Fung [1995]

They determine whether the 5-S practice has a significant contribution to the successful implementation of TQM. In 1994, they carried out a questionnaire survey on 3,000 companies in the UK and 200 leading companies in Japan. The main finding was that from the 205 manufacturing companies and 106 services companies in the UK and 16 leading companies from Japan, was that the 5-S framework provides an essential total quality environment, which is an important base for implementing TQM successfully.

2.3.2 BPR

Overview:

To systematically enhance business processes today, there are some strategically important questions to be asked before initiating process improvement. They cover three areas, as follows:

1. The nature of the business.

- What business are we in?
- How fast is our business changing and why?
- What are our strengths and weakness?

2. The critical success factors

- What are the key success factors which customers look for?
- What are our current customers asking of us and other suppliers?
- Will they be asking the same in the future?

3. The processes to be improved

- Where could the competition damage our business?
- How can we effectively apply continuous process improvement?
- Which processes need re-engineering?

For examples: according to Mizuno [1988] the marketing process consists of the decision on the marketing mix - Product, Place, Promotion, and Price (4-Ps). It is more concerned with the effectiveness, (doing the right things) rather than the efficiency, (doing the things right) of a business. Therefore the success of marketing function should be the primarily objective of the firm. Unfortunately, historically, TQM does not seem to start from marketing perspective, but from production. Therefore, there is an urgent need to look closely at what marketing can offer to TQM. A contemporary concept is to apply TQM to every aspect of marketing (via the 4-Ps) which can be termed as Total Quality Marketing [Ho, 1992].

In simple terms, BPR is the radical redesign of business as a whole or individual work processes in order to maximise business effectiveness. It differs from a continuous process of improvement, in that it challenges the need for the current process in the first place. If the process is indeed needed, BPR uses the sources of variation to produce breakthroughs in process design. BPR's primary thrust is to alter processes, not to change an organisation's culture. However a climate that supports BPR, should exist before such radical efforts have been attempted. Frequently, continuous improvement and BPR occur separately. While each approach delivers benefits of its own, experience has shown that when they are carried out simultaneously, the beneficial effects are magnified [Mutton, 1995].

2.3.2.1 MacDonald [1995]

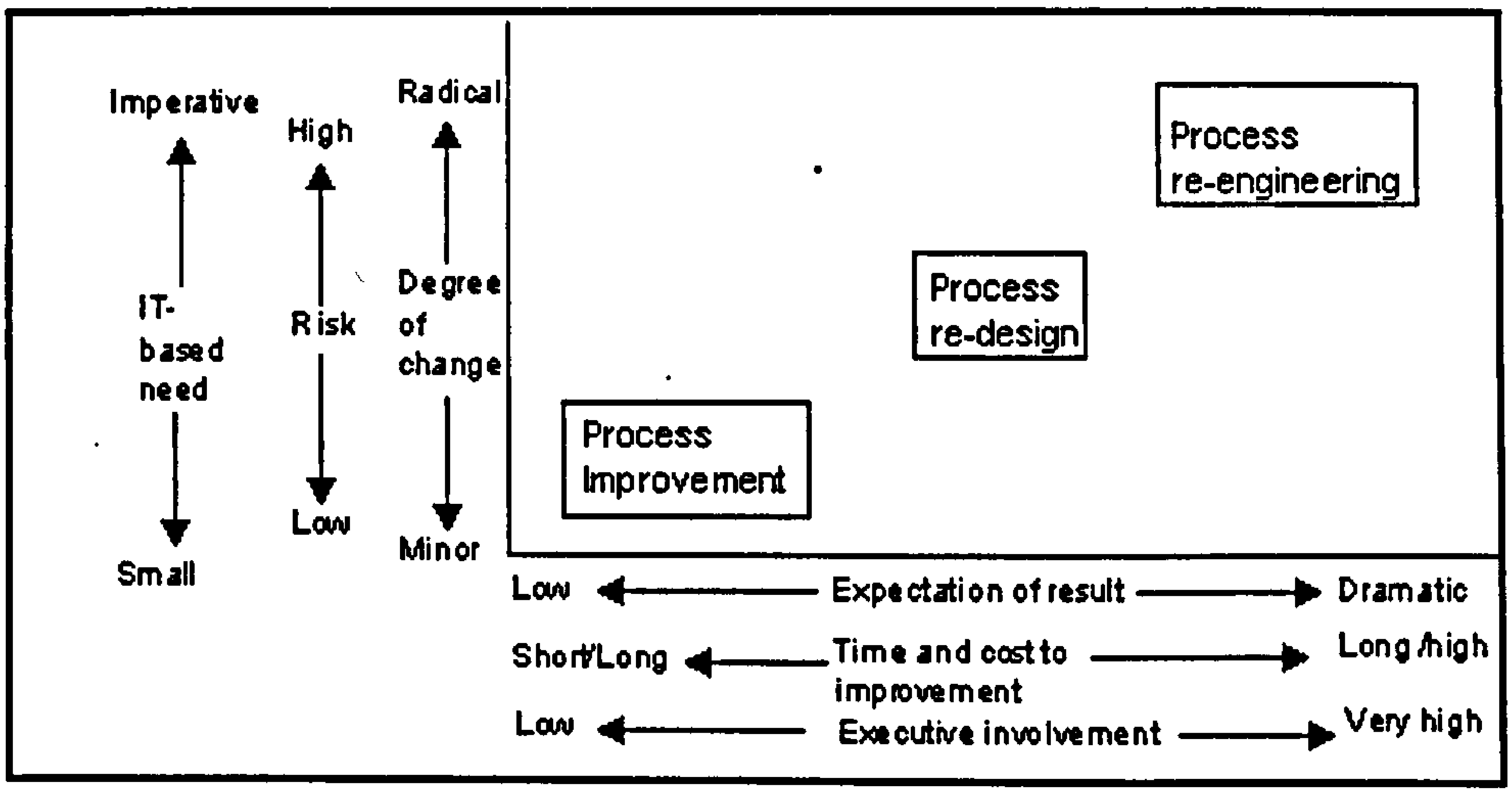


Figure 2.6 Differences between improvement, redesign and re-engineering

He believes that continuous improvement is no longer sufficient to meet customer expectations. The need is for a radical change in the way we work. He explains how to use the elements of BPR to achieve effective transformation and emphasises that BPR is complementary to TQM, but not an alternative to it. The term BPR is being used to cover three distinctly different management approaches to change, (see Figure 2.6 Differences between improvement, redesign and re-engineering). The potential benefits of BPR are enormous. They are not easy to achieve, but there is substantial evidence that it can be effective. In short, TQM and BPR are integral parts of the modern management revolution.

2.3.2.2 Brett [1995]

He describes a case study which levers a business process re-engineering effort through a traditional TQM strategy and discusses the interrelationship between TQM and BPR. The solution to the problem is by re-engineered work organisation and simplifying the relationships between the contracts section and the customer groups. This was provided through the formation of QCC to address each project as part of the TQM strategy.

2.3.2.3 Omrani [1992]

He tries to answer the question, why the sudden surge of interest in BPR. The simple but sobering reason is that most large and established business cannot cope readily with the demands and challenges of business environments of the 1990's. He then reviews the use and key steps for BPR based on a case study. The following summarises the key steps that he claims need to take when implementing a BPR programme:

1. Be clear about the objectives
2. Gain organisational commitment
3. Decide on the scope
4. Appoint process owners
5. Identify process improvement initiatives
6. Monitor processes continuously

2.3.2.4 Patching [1994]

He examines BPR in a non-partisan manner and draws out the theoretical basis of the approach by examining how it differs in principle from other initiatives that promote organisational change. He identified two fundamentally different types of re-engineering endeavours. The first category encompasses those techniques which are concerned with critically examining each process to identify bottle-necks and non-value events, leading to process improvement or process simplification. The second category, focusing on what organisations needs to achieve in business terms rather than what they currently do, thereby encouraging the development of new ways of meeting specific business criteria. The available evidence shows that process re-engineering can produce quantum leaps in performance, provided that there is the necessary commitment to face the organisational trauma that it can cause.

2.3.2.5 Parasuraman et. al. [1990]

They describe the problem of customer satisfaction as "the extent of discrepancy between customers' expectations or desires, and their perceptions of the quality of the service". The means by which customer expectations are generated include:

- word-of-mouth communication,
- personal needs,
- experience, and
- external communications that influence customers' expectations.

He also proposes a conceptual model called Service Quality (SERVQUAL). This model measures tangible and intangible service elements. It investigates discrepancies or **gaps** in the consumer-supplier chain to highlight target areas where quality may be improved. The model shows that the customer has expected service **A-B-C-D-E**, but at the end, as a result of the 5-gaps in the operations, received **A-F-G-H-I** instead!. (See Figure 2.7)

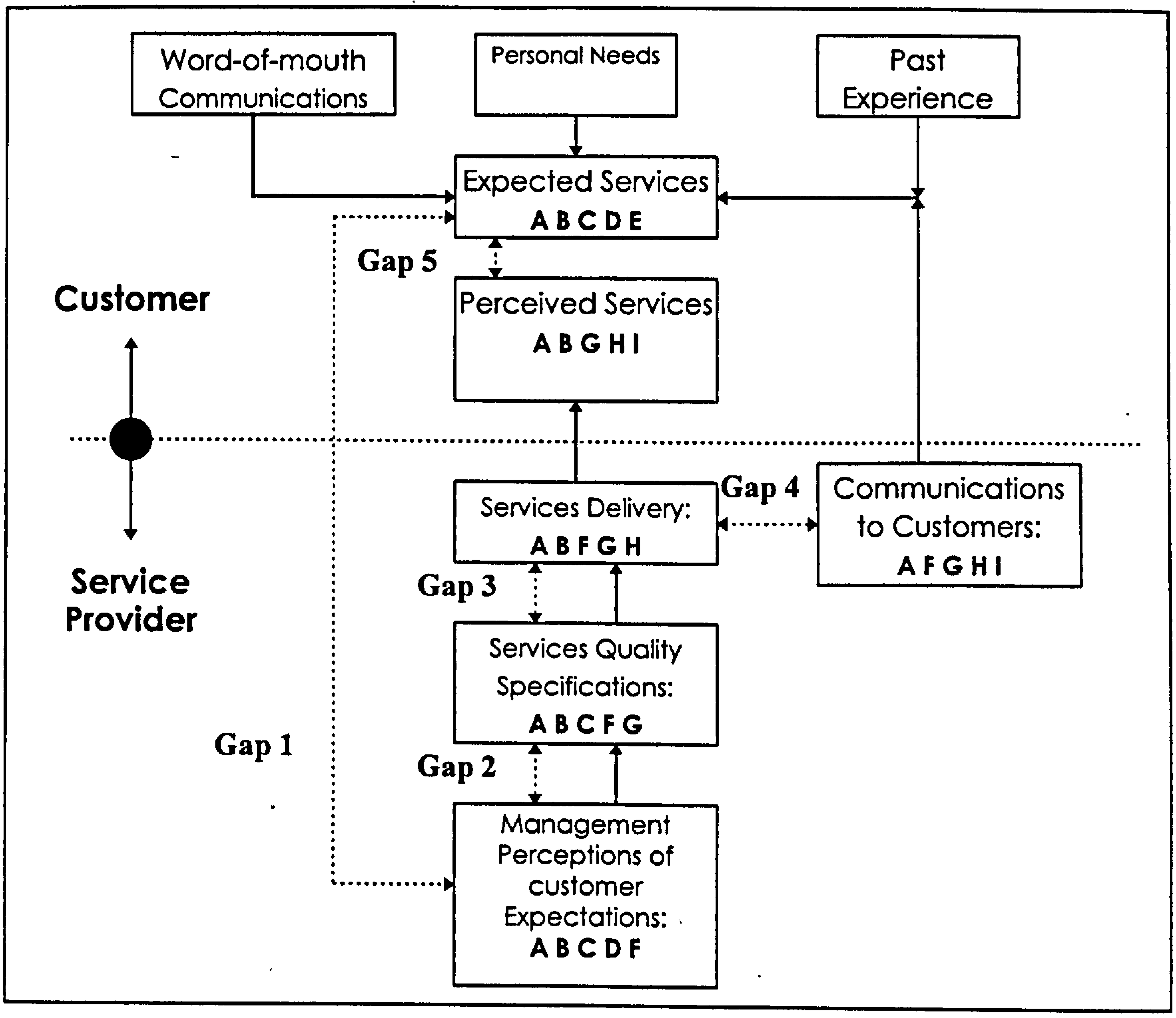


Figure 2.7 Conceptual Model of Service Quality (SERVQUAL)

2.3.2.6 Le Boeuf [1987]

He states the study on the reasons why customers quit the relationship with a particular supplier:

- 3% move away giving no reasons,
- 5% develop other supplier relationships,
- 9% leave for competitive reasons,
- 14% are dissatisfied with the product,
- 68% quit because of an attitude of indifference toward the customer by the owner, manager, or some employees.

Le Boeuf claimed that businesses spend six times more to get new customers than to keep old customers. Customer loyalty is worth ten times the price of a single purchase, in the average case.

2.3.2.7 Denning [1995]

He shows that a methodology for mapping, measuring, tracking and managing commitments in business processes is necessary to make a discipline from TQM and BPR. He illustrates a basic work-flow loop which connects a customer can be examined in four stages:

1. Customer makes a request
2. Negotiate on the conditions
3. Performer do the work
4. Customer accepts the work and declares satisfaction.

One of the common problems in the business process is the non-completion of the main loop, very often the fourth stage (satisfaction) is partially or fully missing. He discusses that the basic element of a co-ordination process is a closed loop, called a work flow, which connects the missing link and fills important gaps in TQM.

2.3.2.8 Willmott [1994]

He reviews the BPR vision of radical business process change, focusing on information and communication technologies to facilitate a move away from linear /sequential work organisation, towards parallel processing. He identifies that given the focus on business processes, it often neglects the human dimension in BPR. This shortcoming is symptomatic of the way BPR's claims and prescriptions for change are even more abstract from the practical realities of organising and managing people than earlier recipes for improving business performance, such as excellence and TQM. He concludes by suggesting that the human aspects and implications of BPR have been woefully neglected, and that these should provide a strong focus for contemporary management research.

2.3.2.9 Dixon et. al.[1994]

They summarise information on 23 re-engineering projects. These findings could be used to help managers decide which improvement approach is likely to be most effective and how to use re-engineering to steer their organisations along new improvements. The study shows that process analysis was the most common training directly applicable to the re-engineering project. The need for management commitment and appropriate training and communication of the re-engineering team's efforts were critically important. The success of re-engineering is dependent upon very active and directive leadership and a project-orientation that focuses energy on changing direction.

2.3.3 QCC

<u>Overview:</u>

QCC practices have been introduced for a variety of reasons (i.e improve communication, building cheerful workships, problem solving) but firms invariably find that the quality of product and service is improved as a result of QCC activities. QCCs can reveal all sorts of faults that prevent good practices, thus improving job satisfaction and contributing to pride in workmanship. This leads to higher quality of products, increased awareness of quality, and continuous improvement.

Another benefit is an improved two-way communication. The management becomes more concerned with the staff problems and, in turn, the staff becomes aware of the day-to-day problems of running an organisation.

Everyone's commitment to improvement imposed by a QCC programme also helps to establish customer confidence. Although some companies do not set out to achieve a pure financial return, most find that the financial benefits considerably overrun the costs. Some have experienced ten-fold savings, taking into consideration the gains cumulated year after year. The basic concepts behind QCC activities within the company-wide quality control effort are:

- Contribute to the improvement and development of the enterprise;
- To respect a better working relationship and to build worthwhile lives and cheerful workshops;
- To empower fullest rein to human capabilities and to draw out each individual's infinite potential.

2.3.3.1 Coyne[1990]

The case study presented by coyne holds that quality circles are part of an overall quality improvement process. Their quality circle programme evolved from 141 circles in 1988 to 208 in 1989. Participating members increased from 866 employees to 1352 during this time. To achieve this level of progress required the company a total of 6185 hours of training. The training included facilitators, leaders and circle member themselves. The company also introduced a competition called "Quality Circle Challenge". The criteria that applied were designed to bring quality assurance back to fundamentals, to highlight not only the importance of the solution but also the quality of the activity leading to that solution. This identifies the importance of process driven solution rather than goal driven.

2.3.3.2 Bradley & Hill [1983]

They outline the role of quality circles based on two case studies. They discuss three important assumptions which underlie quality circles:

1. All employees are capable of improving quality and efficiency;
2. Among employees there exists a reservoir of relevant knowledge about work processes, which, under conventional work practices, is difficult to tap;
3. Quality is an integral part of the entire production process.

In both the case-studies, each company the introduction of quality circles has produced efficiency gains with quantifiable financial returns. These demonstrate how arrangements internal to a firm contribute to productive efficiency and how the knowledge and skill of non-managerial employees can be significant for the design of more rational and profitable organisations. The results of these case studies show that QCC does improve communications between the workforce and management which supports the contention that quality circle programmes can promote better human relations.

2.3.3.3 DTI [1992]

The case study reviews the steps for implementation of QCC which are part of the TQM Programme. In the case study, the company have seen substantial improvements in all areas of operation since QCCs were introduced. From this the DTI conclude that in order to implement QCC successfully, the following implementation guidelines should be followed:

- Participation should be voluntary.
- Management should be supportive.
- Employee empowerment is required.
- Training is integral part of programme.
- Members should work as a team.
- Members should solve problems not just identify them.

2.3.3.4 George & Weimerskirch [1994]

The company was granted the Malcolm Baldrige National Quality Award. Its employee involvement was the key factor for their success. It all started with the change in managerial paradigm of being prepared to 'give employees control over their activities, freedom to make important decisions, and responsibility for their actions - forever'. The transition to employee involvement was a painful process for this company because they had had a long tradition of having clear divisions between management and the work force. They managed to communicate the idea of 'integration through quality' by training employees to accept responsibility, giving feed-back, and establishing criteria for rewards and recognition. In this company, managers and supervisors are trained in giving on-the-spot and monthly feedback. There is an established code of behaviours against which every employee's annual performance is evaluated and improvements result in merit pay.

2.3.4 ISO

Overview:

TQM implementation is an exercise in changing management. It is generally accepted that it involves a major cultural change, which in turn requires changes in attitude by people within the organisation. Many companies have instituted the ISO 9000 quality system with the expectation that this standardisation will bring about, assist, or substitute for, the required cultural change within the company. Other organisations have adopted the policy of obtaining such accreditation at the behest of their current customers, or with the expectation that it will gain a favourable response from future customers. For effective standardisation, the manager should encourage and assist the workers to improve their work-standards and continue to refine and revise their standards in order to meet the needs of the customers.

The ISO 9000 series sets out the methods that can be implemented in an organisation to assure that the customers' requirements are fully met. Moreover, the organisation's requirements will be met both internally and externally and at an optimum cost. This is the result of efficient utilisation of the resources available, including material, people and technology. To summarise, ISO 9000 is a:

- documented system to interpret the customers' requirements,
- commitment to meeting the customers' requirements,
- total company involvement,
- nationally accepted standard,
- 'springboard' for more effective management control.

2.3.4.1 Kume [1992]

He discusses the underlying differences between Japanese and Western quality control. He observed that Japanese quality management sits rather uneasily with a certification system based on ISO standards. This is because the ISO standards represent quality management from the purchaser's standpoint, the mainstream of Japanese quality management is from the supplier's standpoint. He suggested ISO standards are capable of making up for the weaknesses in Japanese quality management. The key is to reassessing Japanese quality management in comparison with ISO standards and reconstructing it on the firm foundation which these standards provide which could raise Japanese quality management to even higher levels internationally.

2.3.4.2 Whittington [1988]

He assesses the interest for organisations in implementing ISO 9000 and the difficulties they faced, discovered four different reasons for implementing the standard.

- Due to pressure from large customers,
- To maintain contracts with existing customers,
- To use the constraints of the standard to prevent scrap,
- To reduce auditing of the quality system by customers.

Failure to implement the standard for the right reason may prevent companies from gaining the potential benefits from the system. Two of the companies studied by Whittington claimed that ISO 9000 costs too much money to implement and maintain, and that their product quality is no better than before the system was implemented. He also found that there was no reduction in assessment and auditing as claimed by much of the literature. Inappropriate reasons for implementing the standard, these are:

- To make reference to the standard on company letter-head paper,
- To get the kitemark symbol on the company's product,
- To enforce discipline on employees,
- To retain existing customers.

Aside from the reasons already mentioned, the degree of commitment by top management will determine the success of the system. Top management needs to generate a conducive environment to enhance the development of the system. This can be achieved by developing a company quality policy and objectives. This will enable all the employees to work towards the same quality goal.

2.3.4.3 Irvine [1991]

He points out that many companies are now seeking registration to quality standard ISO 9000 *to demonstrate that they are in control of their business, and have proved it to a certification body.* ISO 9000 registration is a good way of measuring progress and monitoring maintenance of the standard. It brings marketing benefits, but should be regarded as the beginning of a continuous improvement process rather than the end.

2.3.4.4 West [1988]

He reports that organisations face major disagreement in interpreting the independence of the management representative, the requirement of calibration and the extent of documentation needed. Fear of change at the start of the project is among the difficulties faced by the company during the implementation.

2.3.4.5 BSI [1987]

The British Standards Institution in an effort to market ISO 9000 has published some of the claimed benefits [BSI, 1987]. They are:

1. BSI certification is a first class marketing tool. The certification marks and symbols can be used on publicity, packaging and company literature.
2. Major buyers like the Ministry of Defence and British Coal already accept BSI certification and registration as proof of quality and technical expertise.
3. Customers are much less likely to act for their own special assessments thus saving everyone's time and money.

4. Where there is a need for it, a company will improve its quality performance and as quality rises, so will company morale.
5. The cost of lost orders, reworking, extra handling, production wastage, senior executive time will all decrease once ISO 9000 is in operation.
6. Better quality performance will improve customer satisfaction which will lead to increased sales, competitiveness and profitability.
7. The confidence that comes from knowing that your quality system is under independent surveillance.
8. The company's name will appear in the BSI Buyer Guide -- an essential reference book for buyers at home and abroad; and also in the Department of Trade and Industry's National Register of Quality Assessed Companies.
9. As more British Standard becomes harmonised with international ones, BSI certification will be of increasing help to the public in export markets.

2.3.4.6 Straw [1988]

The Metal Finishing Industry has claimed tremendous benefits due to implementing the standard. Some reported benefits are:

1. Better work flow through the factory, improved efficiency which leads to better customer service.
2. Consistent standard of training of new operators.
3. Consistent reduction of reworking resulted in savings of over £10,000.
4. The work-force is much more conscious of their contribution to the quality of work and became more involved in shop floor quality improvements.
5. Better document control which leads to improved internal and external communication.
6. Fall of customer rejects to only 40% of the previous level which results in quantifiable savings, repeated businesses, and a steady increase of new contracts.
7. In-house rejection rate has been halved, savings in the consumption of chemicals such as electrolyte and electrode are well over £40,000 annually.
8. Higher quality work is noticeable as the customer return falls from 3% of sales revenue to less than 0.5%. This results in savings of more than £30,000.

2.3.5 TPM

Overview:

In the light of its contemporary context, productive maintenance cannot be an exclusive responsibility of the maintenance department. The broadened definition of productive maintenance (PM) emphasises on-site experience and calls for proactive solutions -- 'prevention is better than cure'. As a result, the maintenance department has to work with the production teams and to involve the planning department, human resources development, accounting, and more, if not all departments. TPM has evolved from being a specialist field for a small number of experts to being a generalised concern involving nearly everyone in the company, hence becoming "*total*" [Senju, 1992]. TPM involves everyone from the top executives to the shop floor workers to promote productive maintenance through morale-building management and small-group activities in an effort to maximise equipment efficiency.

2.3.5.1 Paris [1995]

He firstly identifies the growing concern of companies about reducing operation costs. Then, he discusses the pro-active type of partnering which is embedded in a TPM program and suggests ways of developing performance measures to track progress. Finally, the performance data should be gathered and the company should work with the supplier partner to develop a maintenance program tailored to the customer's needs.

2.3.5.2 Maggard and Rhyne [1992]

They provide a framework for understanding the importance of TPM. The case study is based on the company's TPM implementation program and defines why TPM is essential, what is the essence of TPM, and how TPM can be successfully introduced and sustained. A key feature of implementation of TPM has been the emphasis on continuous improvement of the production process through improved equipment reliability and maintainability. The implementation stage includes:

- Define mission.
- Develop result areas based on the mission.
- Develop performance measures to track progress.
- Implement improvements to eliminate variances between targeted and actual performances.
- Set up maintenance teams for problem-solving activities.

2.3.5.3 Ishikure [1988]

He discusses how a Japanese company changed the management system and corporate culture of a plant in the United States. After acquisition it was turned into a profitable plant. The Japanese management emphasised improvement of product quality: blue collar and white collar staff were treated equally: "management by policy" was introduced. The first step is to create a clean and tidy work place management believes that clean and tidy environment

2.3.5.4 Turbide [1995]

He believes that TPM is a way to encourage production workers to become more involved in quality and harness the tremendous power of work teams. He then explains how the company solve their problems through TPM, and as a result, the firm have improved its productivity by 130%, cut accidents by 90%, reduced defects by 95%, and increased the suggestion rate from 1.3 per employee per month to more than five suggestions per employee per month and received a TPM Award. The implementation steps can be seen as follows:

1. Training equipment operators
2. Clean up the work areas
3. Organise teams for develops improvements.
4. Carry out regular meetings to develop and review rolling 90-day plans, discuss progress, and share ideas.
5. Establish better production management system which includes improving machine and redesign process for products.
6. Automation improvements in the plant and office.

TPM provided the company a mechanism for focusing the work force's energy and creativity. TPM relies on employee teams to initiate and implement changes, most of which come from worker suggestions. The case study provided an insight into the impact and importance of TPM

2.3.5.5 Senju [1992]

He provides a framework for achieving TPM. The following points were emphasised in the TPM programme by improving process capability, eliminating all losses, and raising operating rates, to create a more productive assembly line that can turn out reliable products that will win customer trust:

1. Simplify processes so that quality is not impaired by worker reassignments.
2. Build equipment so that lower production volumes do not result in higher per-vehicle energy consumption.
3. Build flexible equipment that can be adapted to model changes with only minimum investment.
4. Improve equipment reliability and life despite the greater automation and complexity.
5. Develop production technologies that solve these problems and reduce costs at the same time.

2.3.6 TQM

Overview:

The ideas that form the foundation of TQM are deceptively simple. Most people call them common sense. The reason for failure is that they require people to relate together in their work in ways different from those to which we have been accustomed to in the past. For TQM to take root in a creative way, it is vital for management to be committed to the transformation of the organisation into one which is managed on TQM principles. Furthermore, TQM is necessary because it works. The pioneering firms in implementing TQM are American Express, IBM, Xerox, 3M, Toyota, Ricoh, Hewlett-Packard, Nissan, and many others [Smith 1988]. Evidently all these companies have provided good quality goods and services to their customer. The end results are that they will enjoy prosperity and long-term growth. A SWOT analysis of TQM has been identified, based on the following literature which contains valuable lessons for TQM practitioners to maximise the benefits of TQM.

2.3.6.1 Masaaki [1986]

He identifies some of the tangible and intangible benefits in acquiring the TQM kitemark as follows:

1. Tangible Benefits

- Increased market share
- Increased sales volume
- Increased production volume
- Successful development of new products
- Shortening of product development time
- Development of new markets
- Improved quality
- Fewer customers complaints

- Reduced defect costs
- Fewer processes
- More employee suggestions
- Fewer industrial accidents

2. Intangible Benefits

- Increased involvement in management
- Increased quality consciousness and problem consciousness
- Better communications, both horizontally and vertically
- Improved quality of work
- Improved human relations
- Improved information feedback
- Improved management skills
- Permeation of market in concept
- Clear delineation between responsibility and authority
- More confidence in new product development
- Conversion to goal-oriented thinking
- Improved standardisation
- More active use of statistical quality control

2.3.6.2 Laza & Wheaton [1990]

Like any other management practices, TQM is not without weaknesses. In fact, there are well recognised pitfalls of TQM. They include:

- Oversimplification and underestimation of the difficulty of bringing about cultural change.
- Failure to recognise that every company, and every environment, is different.
- Lack of project management and/or the management of TQM implementation as a project.
- Mass training before establishing support systems for TQM.
- Overemphasising technical tools at the expense of leadership and management issues.
- Applying tools before needs are determined and direction is established.
- Failure to provide the structure to move the program to supplier or subcontractor organisations.

2.3.6.3 Wilkinson & Witcher [1990]

They list out the activities that people deal with most of the time. They include:

- Correcting errors -- e.g. misspelled written material.
- Finding out where things are -- e.g. missing files.
- Finding why things are late -- e.g. stock shortages.
- Checking things we do not trust -- e.g. double checking research results.
- Rectifying and reworking -- e.g. modifying designs which are too difficult to produce.
- Apologising to customers -- e.g. finding mistakes and explaining to them.
- Clearing up -- e.g. scrap, returns.
- Providing after-sales service -- e.g. warranty claims, service.

2.3.6.4 Hakes [1991]

He mentions a few quality problems. He points out that companies detect defects and errors in their products and services and then congratulate themselves on taking remedial action to put them right. They continue fire-fighting and rectifying the same problems desperately week after week, month after month, and year after year! Last but not the least, all the quality gurus believe that over 80% of quality problems are caused by management and fewer than 20% are caused by workers. Crosby date also estimates that manufacturing companies spend 25% of turnover on doing things wrong or reworking.

2.3.6.5 MacDonald [1992]

He recognises nine principle reasons for disappointment. These are summarised as:

- Lack of management commitment.
- Lack of vision and planning.
- Satisfaction with the quick fix.
- The process became tool bound.
- Quality too constraining.
- Culture change versus project approach.
- Quality management has become institutionalised.
- The workforce were not really involved.
- Lack of real business measurable.

2.3.6.6 Grahn [1995]

He introduces a model called "The Five Drivers of Total Quality" adopted by The Menasha Corporation, The five drivers are:

1. People quality
2. Entrepreneurial and innovation quality
3. Information quality
4. Planning/ decision quality
5. Process/ execution quality

With the five-driver model, the whole system can be visualised so leverage points can be identified at any time. The key is to address all five of the drivers in a balanced way that considers the organisation's underlying systemic structure and how each element influences the rest. Even though all of the drivers influence each other, driver 1 has the most influence on the others, driver 2 has the next most widespread influence, and so on. The model provides Menasha a synergistic win-win-win for all: win for the customer, win for the employees and win for the business philosophy.

2.3.6.7 Duffin [1992]

He states the key to implementing cultural change lies in management's behaviour. Instead of concentrating on the organisation's culture, management should focus on educating and changing its own undesirable behaviour, thus leading the rest of the organisation into a new and desirable culture. He suggested that until TQM is very advanced in your corporation, do not worry about changing corporate culture. He provided five steps to Change managerial behaviour.

1. Define the kind of company you want to be, in terms of mission, vision and guiding principles.
2. Define the mental set behaviour and practices you want managers to exhibit throughout the corporation.
3. Develop appropriate training material, provide compulsory training, cascaded top-down, and insist that training be implemented on the job.
4. Ensure that the measurement and measurement systems promote and support the desired behaviour.
5. Provide for recognition and celebration of success.

2.3.6.8 Detoro [1995]

He highlighted importance of benchmarking which focuses on processes, practices and indicates the gap in performance, thus enabling senior managers to take action in all the areas concerned. However, some organisations have failed in their attempts to implement this concept. He provided 10 pitfalls that companies should be avoid to ensure successful benchmarking.

1. Lack of sponsorship
2. Selecting the wrong people for the team
3. Teams not fully understanding their own work
4. Teams taking on too much
5. Managers failing to understand the necessary commitment
6. Focusing on metrics rather than processes
7. Not positioning benchmarking within a larger strategy
8. Misunderstanding the organisation's mission, goals, and objectives
9. Assuming every project requires a site visit
10. Failure to inspect benchmarking

2.3.6.9 Literature Survey: Overview

Current developing case experience are best communicated in journals and magazines and are good supplement to books. Furthermore, with the easy availability of on-line search facilities like the CD-ROM, finding relevant articles in the special area of TQM can now be done more effectively.

2.3.6.10 Relevance of Literature

Much has been said about the TQM applications in the industry. On the bibliography, much attention has been given to the unique messages of all the quality gurus. Their ideas have influenced most areas of TQM, and they will be incorporated during TQMEX development, particularly in BPR, QCC and ISO.

As for published papers, the main uses of the TQMEX model elements are on specific companies or research topics. However they are largely fragmented and do not constitute a solid approach to help companies to develop their quality system. Therefore, companies cannot rely on the knowledge of these papers to act as a guide to implement TQM. Instead, the knowledge can be used as reference for specific areas where applications are similar.

The companies are finding the need to rationalise their operation by effective implementation of TQM. This means competitive edges are necessary for them, which are keys to survival and prosperity. Therefore, there is a pressing need for an effective and validated advisory service to guide companies step-by-step to develop a company-specific quality system. The current research is aiming at addressing these "gaps" of knowledge so that companies will find the results of this research of direct relevance to their needs.

2.4 THE NEED FOR A MODEL IN TQM

At the century close, the creation of the global market, international orientations of management that sweeps national boundaries, introduction of new technologies, and shift towards customer focused strategies, will make the competition stronger than ever. The criteria for success in this global, internationally oriented market have been changing rapidly. In order to expand business, enter new markets, and set realistic, competitive long-term objectives, *excellence* became imperative. Management's effort has been directed towards discovering what makes a company excellent.

To achieve excellence, companies must develop a corporate culture of treating people as their most important asset and provide a consistent level of high quality products and services in every market in which they operate. Such an environment has supported the wide acceptance of TQM which emerged recently as a new, challenging, marketable philosophy. It involves three spheres of changes in an organisation -- people, technology and structure. The role of top management in implementation of total quality is crucial and its input on people is far-reaching. TQM, therefore, should be understood as the management of a the system through systems thinking, which means understanding all the elements in the company and putting them to work together towards the common goal. A model could help to visualise all these elements and their relationship in order to achieve the company goal.

2.4.1 The TQM Models

TQM has been represented in a variety of models as a philosophy reflecting modern competitiveness and some of them have already been shown in (S.2.1.1). Since TQM is an approach for continuous improvement of goods/ services delivered through the participation of all levels and function of the organisation. It is useful to look at some TQM models from an integration point of view.

2.4.1.1 Pfau [1989]

He illustrates his model (Figure 2.7) of an integrated organisational dynamic system based on the following:

A mission to succeed by working very closely with customers and meeting their requirements with an intended commitment to better the standard and levels of service at all times;

TQM has to be driven by champions at the highest level possible. Senior management commitment is a major prerequisite for success;

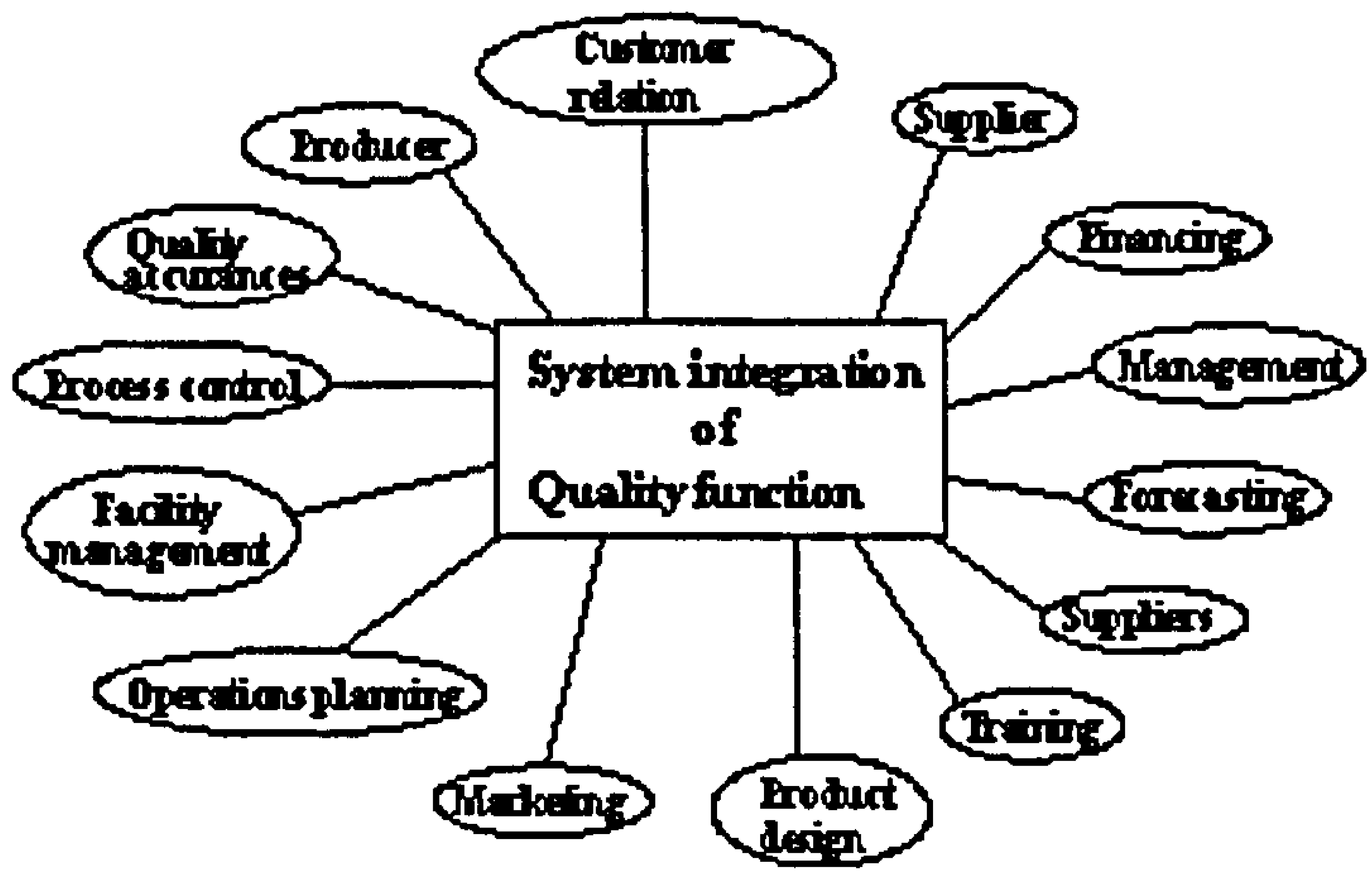


Figure 2.8 TQM an integrated organisational system

Organisations have to be lean and fit for the external battles of changes in the market place. This is achieved by quality systems which introduce discipline and monitor performance; Reliance on the human machine and people's creativity in order to succeed.

2.4.1.2 Oakland [1989]

The Oakland's TQM model (Figure 2.9A) defines TQM as a pyramid representing five distinct components. The approach will ensure the implementation of the management commitment represented in the quality policy, and provide the environment and information based on teamwork and tools for achieving TQM.

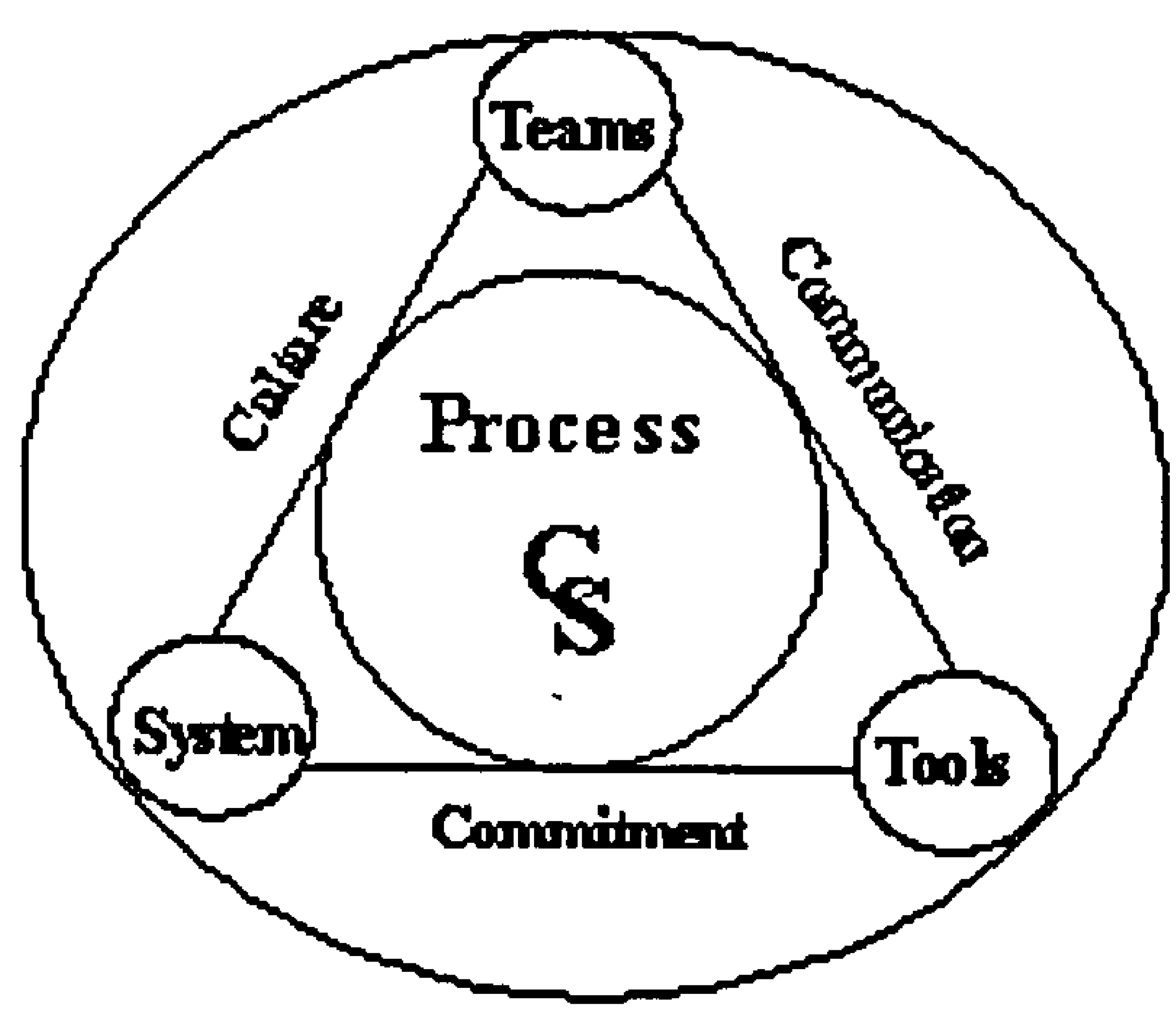


Figure 2.9A Oakland's TQM model

- Management commitment: This identifies that the role of leading and introducing change has to stem from the senior management team. Their commitment has to be reflected by the levels of investment in the required area and the amount of risk taken for the achievement of success.

- Customer-supplier chains: This component is at the heart of the Oakland pyramid. It reflects process ownership, process management and process improvement propelled throughout the chain.
- System: The approach of having documented sets of procedures and standards of doing things right first time and every time.
- SPC Tools: One of the important aspects of TQM is the need to continuously measure and control conformance to customer requirements and agreed standards and to correct quickly defective measures and keep performance on track;
- Team work: This component means that a culture based on continuous improvement has to be instigated, encouraged and implemented throughout the organisation.

The TQM model provided some essential principles in achieving TQM. In a paper by Oakland & Aldridge [1993], Oakland model was used to benchmark against a construction company based on in-depth interviews of 41 employees. The findings highlighted the problems in process, customer-supplier quality chains, quality system, tools and techniques, teamwork, culture, communication and commitment to quality, with a total of 42 bullet points. They concluded by saying that "These points are by no means sufficient, but are necessary, in every construction company to improve customer satisfaction, competitiveness, effectiveness and efficiency."

Although the above Oakland TQM model can be used as a checklist on the essential TQM principles, it is largely a conceptual model. It can not be considered as an implementation model because it does not give guideline on the process of implementation. In his recent publication he proposes a TQM Implementation Framework as shown in figure 2.9B below [Oakland, 1995]:

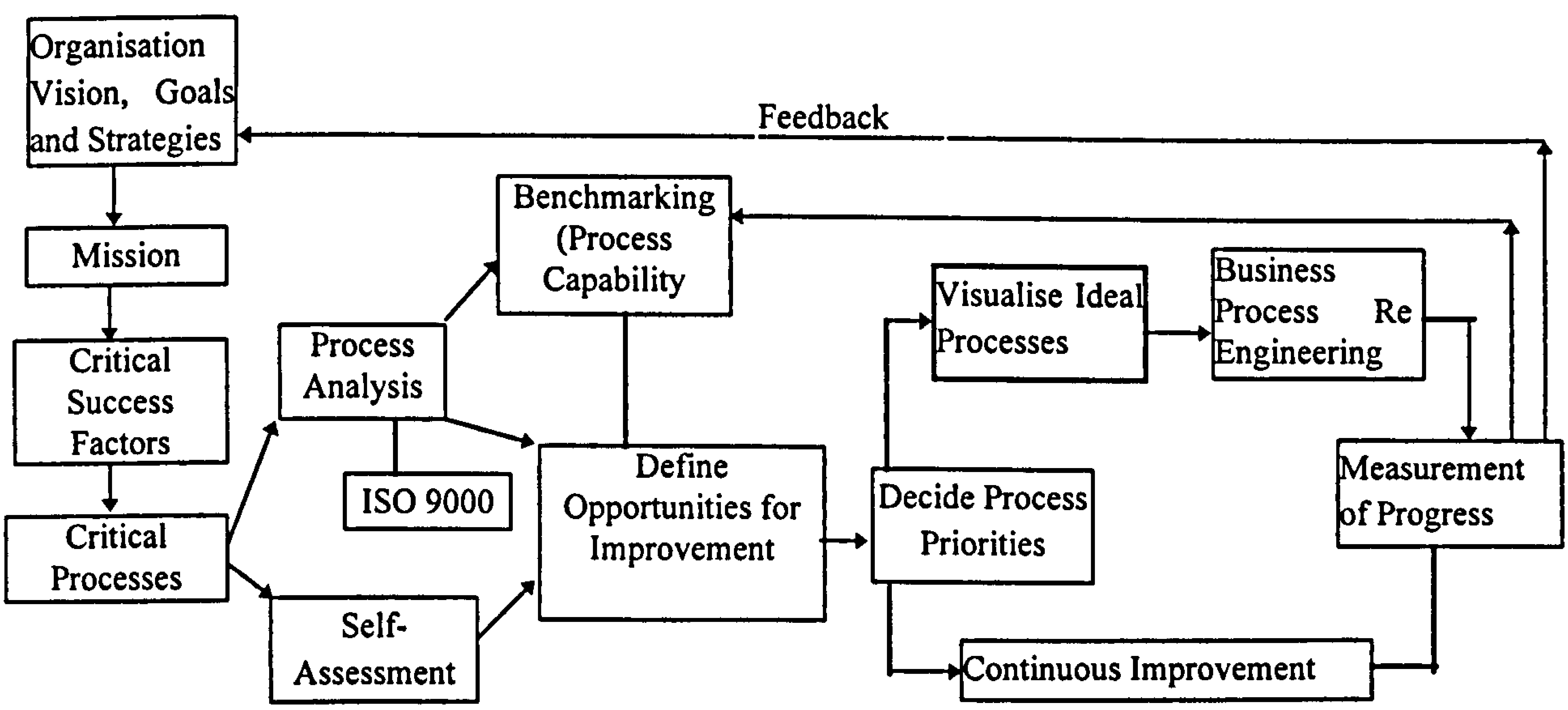


Figure 2.9B TQM Implementation Framework

According to this framework, TQM performance is based on measurement of all processes is necessary to determine progress so that the vision, goals, mission, and CSFs may be examined and reconstituted to meet new requirements for the organisation and its customers (internal and external). The interrelated approach as shown in the diagram forms the basis for the Oakland's TQM implementation framework.

2.4.1.3 Sohal & Tay & Wirth [1989]

The integrated model (Figure 2.10) proposes that continuous improvement in quality has to come from an integrated approach of controlling quality via action plans in different operations of the business cycle. The model discuss quality in terms of TQC rather than TQM but control in this instance means the management of quality at various stages of the process. There are five important elements in this model.

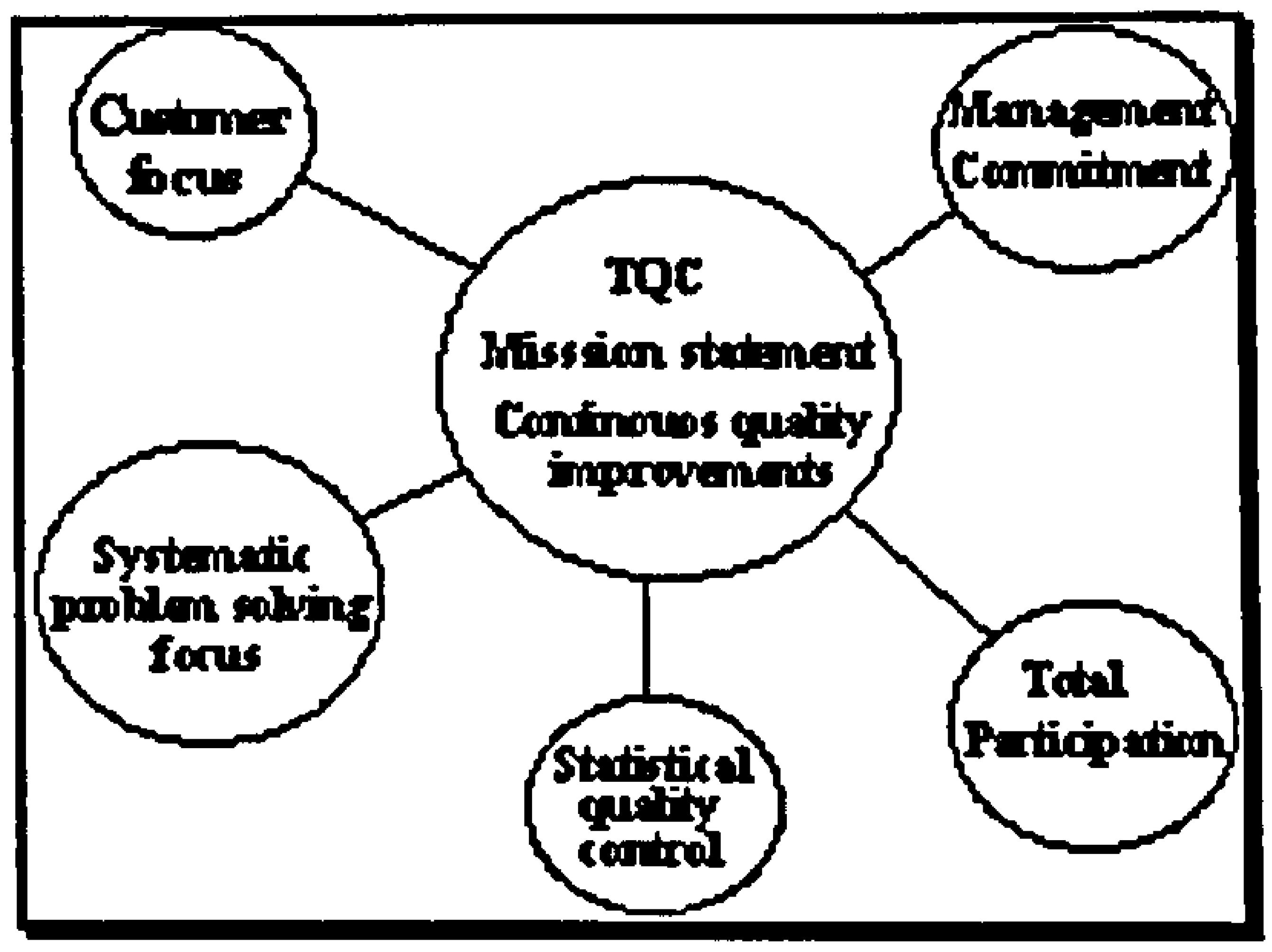


Figure 2.10 An integrated TQM model based on action approach

1. Customer focus: The customer may be the ultimate consumer external to the organisation or an internal user receiving an internal service. Customer focus therefore means that all individuals in the organisation have to focus on the quality of the process in delivering services to the customer (internal and external).
2. Management commitment: Commitment can be in the form of changing attitudes and expectations and establishing systems for quality measurement and control. Commitment can also be in the form of setting goals which are achievable and challenging to the organisation's future and in providing the right resources, skill etc.
3. Total participation: People at the grassroots level produce the goods and services that benefit the end customer. It is therefore workers who best understand the problems associated with the product delivery cycle and should be the ones to be encouraged to improve the process. Participation is also a means by which intangibles such as morale, sense of belonging and responsibility can be improved.
4. Statistical Quality Control: Use of various statistical techniques to analyse collected data and solve various problems;
5. Systematic problem-solving process: Based on the customer focus element and relies on the Plan-Do-Check-Action (PDCA) cycle to improve the whole business process. Information is also obtained from customer feedback, surveys and other information.

2.4.1.4 Kanji [1995]

Kanji proposes a leadership model for TQM implementation. According to this model, TQM provides continuous improvement by adhering to a set of general governing principles. They are delighting the customer, management by fact, people-based management and continuous improvement. These principles can be translated into practice by using two core concepts on each edge of the pyramid. These concepts are:

- Customer satisfaction
- Internal customer are real
- All work is a process
- Measurement
- Teamwork
- People make quality
- Continuous improvement cycle
- Prevention

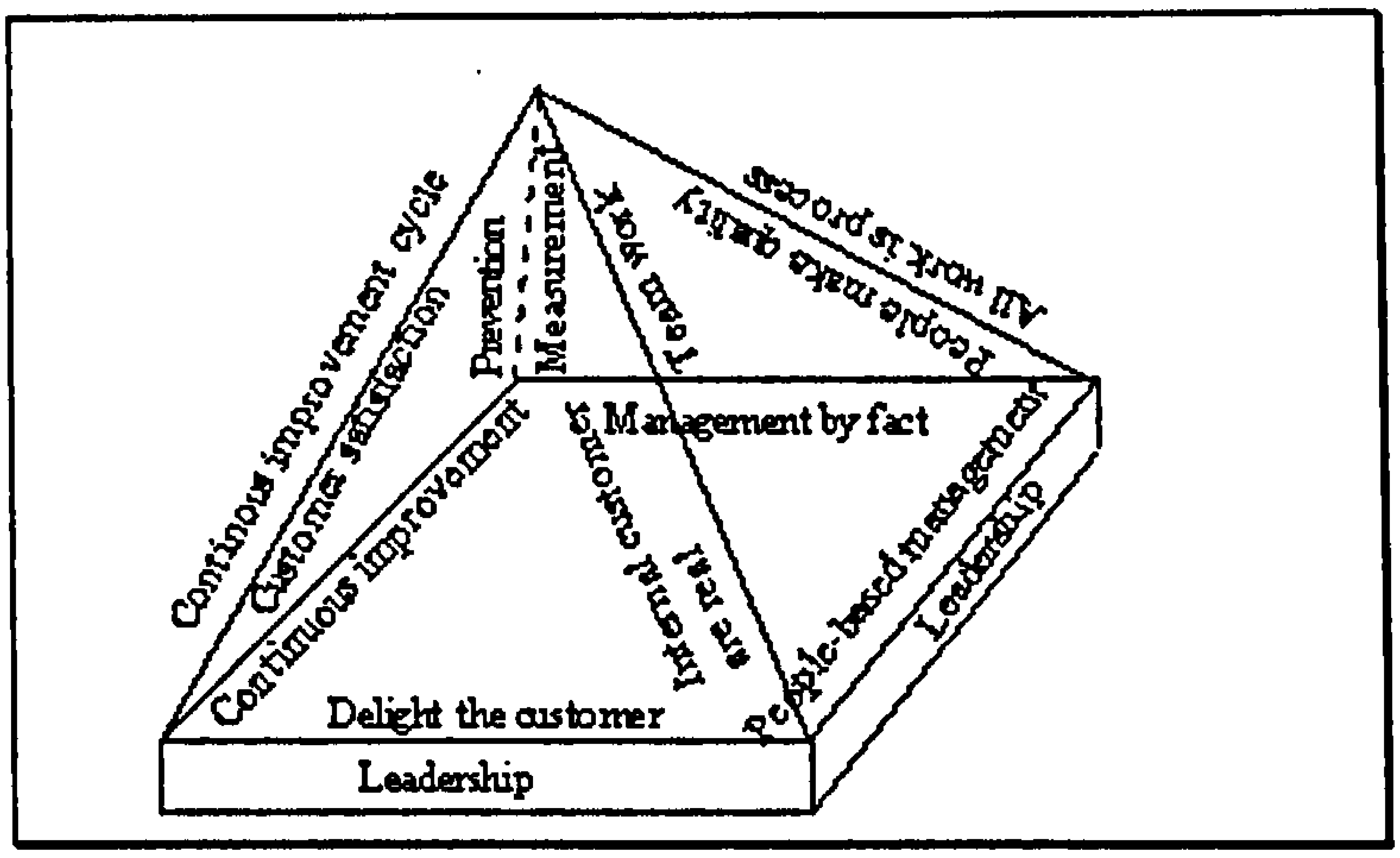


Figure 2.11 Kanji's leadership model

2.4.2 Overview of TQM Model

The Pfau model[1989] is a collection of business functions centring around the 'system integration of quality function'. In its strictest sense, this is no more than emphasising the importance of 'Total', i.e., everyone in the organisation has to practise quality. Although he mentions that the way forward is to follow a 'quality system', he makes no effort to propose what this quality system should be.

Oakland's [1995]TQM Implementation Framework addresses a number of relevant issues in TQM, including a quality mission statement, which emphasises the importance of CSFs, focusing on benchmarking as a way to set standards, and using BPR and ISO as systems of implementation. However, there is a lack of highlighting the importance of human factors in the TQM implementation process. TQM requires people to make it happen -- therefore quality environment, quality culture, teamworking and quality maintenance are vital. The other observation of the framework is that it is over-complicated with many loops and branches. This makes the implementation process very difficult to follow. Moreover, since its launch in 1995, there is no published evidence to show the validity of the implementation framework. Therefore, there is a need for a validated implementation model.

The Sohal et al. Model [1989] is very similar to the Pfau model in that it is emphasising the word 'Total'. The difference is that, instead of focusing on the business functions, the TQ concept is applied to internal and external customers in such principles as commitment, participation, problem solving and SPC.

The Kanji's TQM pyramid is highly people-oriented. It addresses the importance of leadership and human factors in TQM implementation. However, human factors are a complex and crucial factor for any TQM implementation. There may be a danger of over-simplifying the inter-relationship between human factors and implementation of TQM by limiting the relationship to delighting the customer, management by fact, people-based management and continuous improvement. Therefore, it is imperative to pose the question, "How valid is this implementation model?". This is a question which ought to be answered by the customers. The implementation model has to be assessed against certain criteria such as validity, flexibility, generality, applicability and internal logic etc. This can only be done with more empirical research on the implementation of TQM and more tests of the model in sufficient depth.

Overall, Pfau's and Sohal's models are conceptual and can not be considered as implementation models. The Oakland model is one step towards implementation but, unfortunately, is over-complicated and yet lacks the important attributes on human factor contributions to TQM.

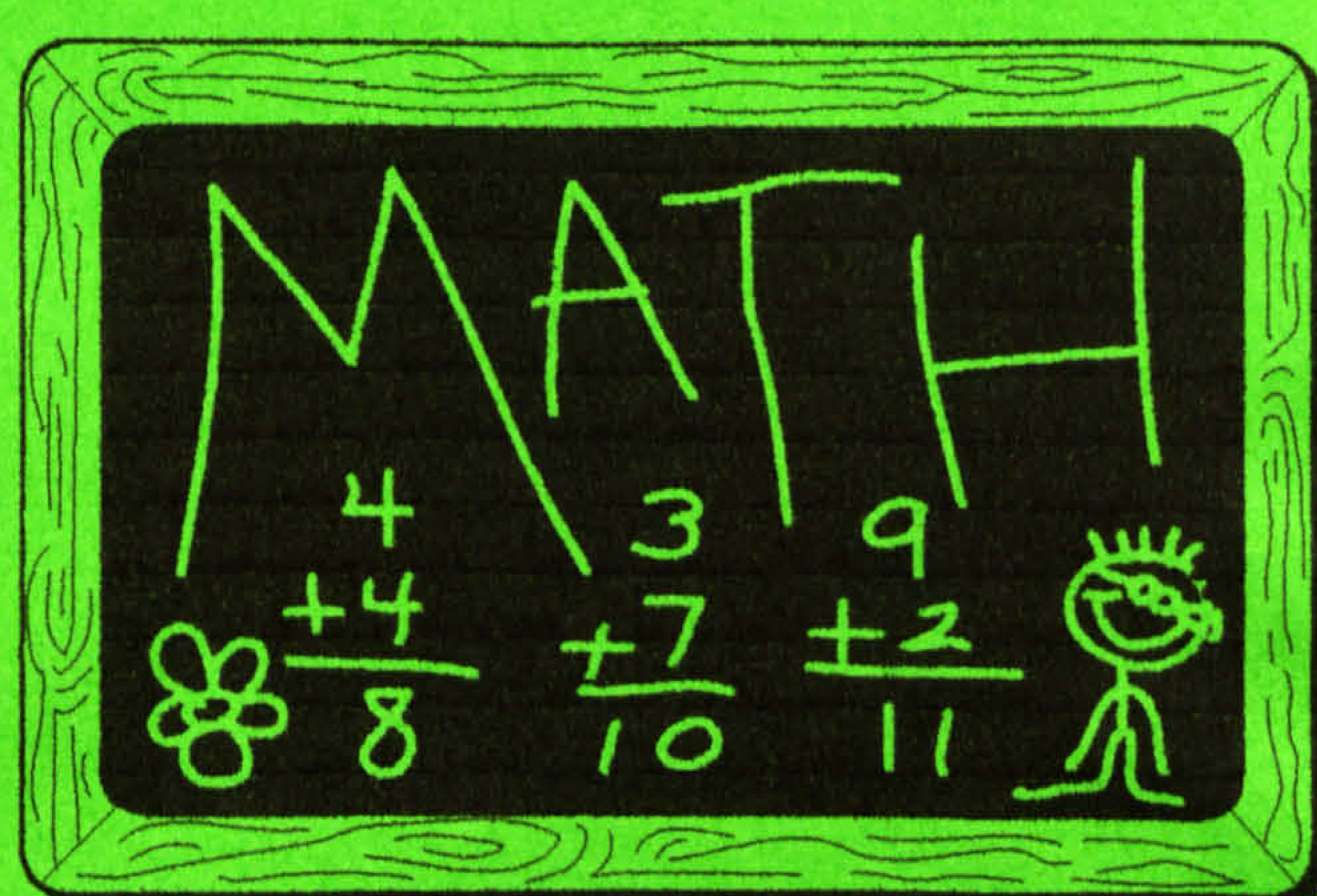
Summarising the TQM models above, there is a need to develop a sound implementation model. The model should serve as a guideline for implementation of TQM process in order to achieve the ultimate goal. The model should be simple, flexible, applicable, logical and yet comprehensive enough for successful implementation. It should also be able to sustain the changes in business environment of the new era. The knowledge from this chapter will serve as a basis for developing the TQMEX model in Chapter 4.

EPILOGUE

This Chapter has reviewed the literature relevant to the research. The general findings are that the development of TQM is very fast. The benefits are plentiful. It is therefore important for companies to develop their specific quality system that is most suitable for their organisation. Based on the literature review, there is a lack of a sound and validated TQM implementation model. Such model could help the company to visualise and understand their position in terms of quality and develop a company-specific quality system through a step by step approach.

Chapter 3

Research Methodology



CHAPTER 3

RESEARCH METHODOLOGY

PROLOGUE

It is essential that the direction is set correctly at the outset when embarking on a research project. Various methods for this research have been considered. In this Chapter, the research methods that are useful to this particular context are evaluated. Their relevance is also discussed. Finally, the project schedule has been planned to aim achieve the best results possible within the time available.

3.1 RESEARCH METHODOLOGY

There are many methods available for social research. It is important to understand the strengths and weaknesses of each method and identify those which are suitable for the this research. For those suitable methods which are suitable to this context, their relevance to the research objectives are discussed and will be used for subsequent research implementation. Figure 3.1 shows the research methods that are relevant and that will be used for various chapters of this thesis. The justifications of the chosen methods are discussed after the briefing of each of the relevant methods under the heading "Relevance".

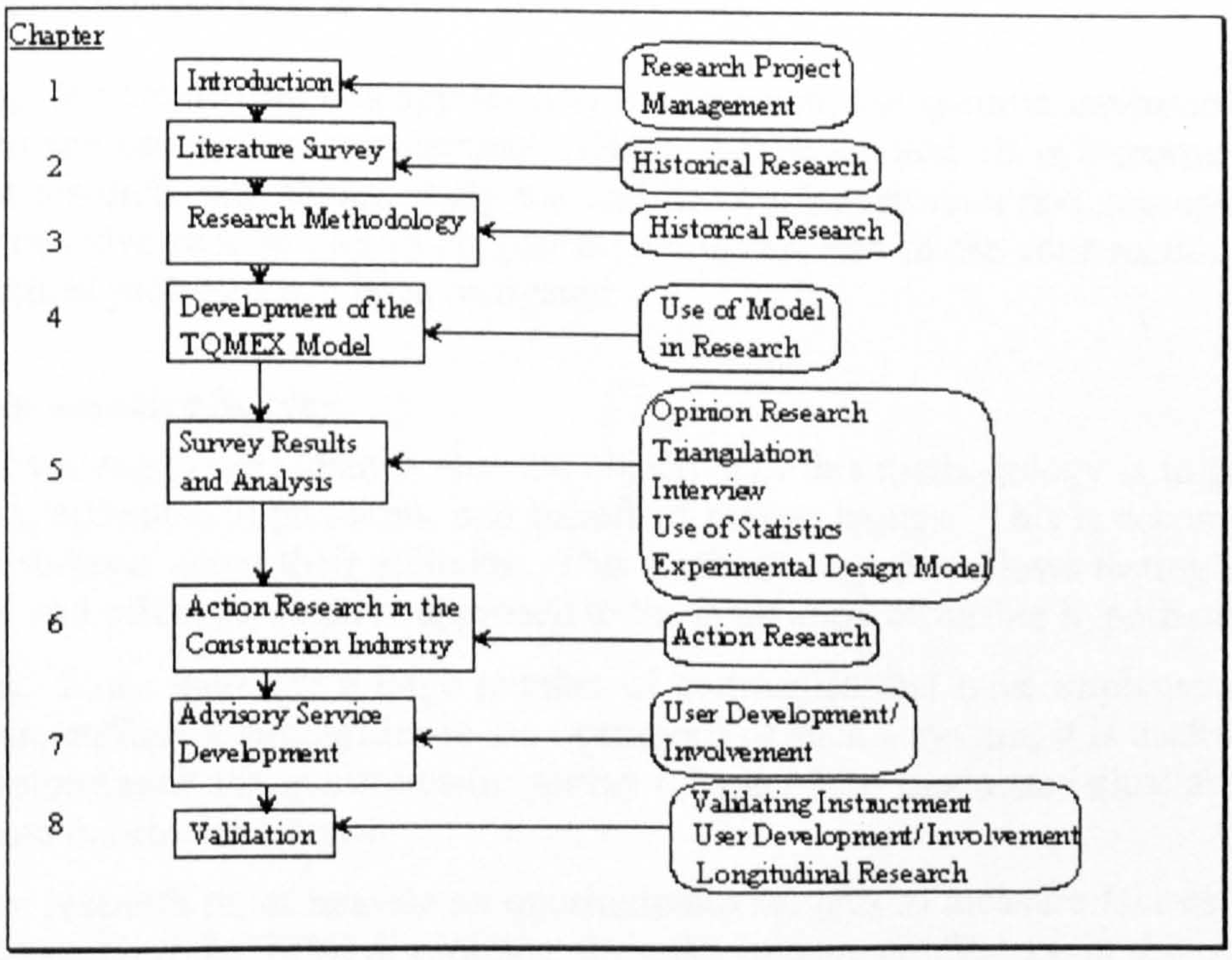


Figure 3.1 Research Methods Overview

3.1.1 Historical Research

Hammersley & Atkinson [1983] define historical research as the systematic and objective location, evaluation and synthesis of evidence in order to establish facts and draw conclusions about past events. It is an act of reconstruction undertaken in a spirit of critical enquiry designed to achieve an accurate representation of a previous age.

Diener & Crandall [1978] explains the difficulty of obtaining adequate data, which makes historical research one of the most taxing kinds of enquiry to conduct satisfactorily. When seeking data from documents and records, researchers often have to contend with inadequate information so that their reconstruction tends to be sketches rather than portraits.

Relevance: This approach is important as it enables solutions to contemporary problems to be sought about the past. In relation to this research, it can be used by understanding the relative importance of TQM and the effects of various interactions that are found by different individuals. This approach can also identify present and future trends. Thus it is important that for this research, one should study the past to predict the future, and to use the present literature to explain what has happened in the past. This gives a dual and unique quality which makes it especially useful for the present research. This theme has been used in chapter 2 (literature review) and chapter 3 (research methodology).

3.1.2 Action Research/ Case Studies

Case studies focus attention not on the total population but on an individual unit in that population. Lee [1989] explains that the classical research paradigm, drawn from the physical sciences, requires the proposal of a theory from which conclusions can be deduced and verified. The scientific method calls for control over experimental variables in order to measure their effects on outcomes. Lee argues persuasively that a case study can meet the requirements of rigorous research. Theories can be proposed that can then be tested against observed results.

Relevance: By employing this approach to the research, the specific environment under which company use quality management systems can be studied. It is important that, for the present research, one should study the real life implementation and successful use of QMS via intensive case studies in chapter 6 (action research in the construction industry) so that practical problems can be investigated.

3.1.3 Questionnaire Survey

Buckley & Chiang [1976] identify that the objective of this methodology is to gather data on attitudes, opinions, impressions, and beliefs of human beings. This is accompanied by asking the subjects about their attitudes. This methodology also allows testing of a priori hypotheses and offers an iterative approach to the generation of further hypotheses.

Relevance: Since there are a large number of companies that have implemented QMS, and there are sufficient similarities in the operations of such a system, it is useful to gather the basic information via questionnaire survey (chapter 5)so that a statistical analysis can be made, and conclusions drawn.

The present research relies heavily on questionnaire surveys to measure factors important to the understand of the TQM disciplines. In order to have confidence in the conclusions stemming from such research, care should be taken in designing and validating the research instrument.

3.1.4 User Development / Involvement

Flensburg [1985] proposes two approaches, the first is a collection of experiences in case study form, and the second is active participation in a user controlled project. Baroudi & Olson [1986] discovered through a survey that user involvement could conceivably cause improved user satisfaction, system utilisation, or both. In addition, satisfaction could cause improved utilisation, or vice versa. Barki & Hartwick [1989] found that a user becomes strongly involved when an issue carries deep psychological significance and has direct relevance on his life. By focusing on the psychological state, it may be possible to obtain better insights into how we can get more effective user involvement.

Relevance: Apart from the intensive use of case studies as stipulated in S.3.1.2 above, the current research will also be based heavily on active participation in a user controlled project. This is important so that the process and problem of implementation can be studied closely. Furthermore any results concluded from such experiment are of immediate value in advisory service development (chapter 7).

3.1.5 Triangulation

Triangulation may be defined as the use of two or more methods of data collection in the study of some aspect of human behaviour. Smith [1975] points out that as research methods act as filters through which the environment is selectively experienced, they are never theoretical or neutral in representing the world of experience. Exclusive reliance on one method, therefore, may bias or distort the researcher's picture of the particular slice of reality.

Relevance: In order to gain confidence that the questionnaire survey data generated is not simply an artefact of one specific method of collection, triangulation is used in questionnaire survey. If, for example, the results of a questionnaire survey correspond to those of a case study about the same phenomenon, it will support the accuracy of the survey findings (chapter 5).

3.1.6 Interview

Tuckman [1972] discusses some important advantages of interviews, whether structured or unstructured. It is a distinctive research technique, the interview may serve three purposes.

1. It may be used as the principal means of gathering information having direct bearing on the research objectives.
2. It may be used to test hypotheses or to suggest new ones; or as an explanatory device to help identify variables and relationships.
3. It may be used in conjunction with other methods in a research undertaking.

Relevance: It is a common but powerful method in gathering of data through direct verbal interaction between individuals. Unfortunately though, because of the complex interrelationships between different organisational characteristics, it is difficult to prove conclusively that particular quality activities are more effective in certain organisations. Owing to these difficulties it was decided that unstructured interviews would be used for opinion and longitudinal research. If the respondents are sincere and well-motivated, accurate data may be obtained. Of course all kinds of biases are liable to creep in, but with skill (establishing rapport, asking questions in an acceptable manner, etc.) these can largely be eliminated.

3.1.7 Game Approach

Duke R.D [1978] comments that there are many examples of Game/ Simulations which could satisfactorily be employed for hypothesis testing or theory generation.

Bowen K.C. [1978] states "Research games can be used to examine the interplay of information and decision in realistic simulations of situations which cannot easily, economically or safely, be observed directly." He also suggests ways in which gaming can be used as a research tool with success. The application of experimental gaming methodology enables the researcher to control the nature of the information system and detail utilised by the experimental subjects.

Relevance: The game approach is not suitable as TQM is such a vast subject area and can hardly be represented by a simulated game. Further, only a small number of subjects can enter into a game.

3.1.8 Experimental Design Model

Howard & Sharp [1983] regard the experimental design model as having considerable virtues as a conceptual model of research directed towards explanation and prediction. This is true even if no attempt is made to carry out a statistical analysis. It offers an explanatory framework which is capable of handling complex relationships between the respondent variables and factor levels along with predictions of the effect of any particular set of factor levels.

Relevance: The experimental design model assumes that the researcher can control the experiment to the extent of selecting the factors and factor levels, whose effects are to be examined. This is not always the case for a social science type of research like the present one. However, it may still be possible to approximate an experimental design by using the fact that particular variables vary between organisations, countries or over time.

3.1.9 Longitudinal Research

Pettigrew [1983] points out the dangers associated with the "prejudice" of the moment in time that the research happens to be undertaken. Time itself sets a frame of reference for what changes are seen and how those changes are explained. The more we look at present day events the easier it is to identify change. The longer we stay with an emergent process and the further back we go to disentangle its origins, the more likely we are to identify the dynamics of change and therefore the inextricable link between structure and process.

Relevance: One typical method for problem analysis is to look at "changes". By analysing changes, many strengths and weakness can be revealed. In studying QMS, it is important to understand the changes for the organisation have faced various stages of development. More important is that when results are not as desirable, these records of "changes" will be extremely useful to highlight problem areas. Thus, the present research will make use of longitudinal research (chapter 8) so that the behaviour of change can be interpreted.

3.1.10 Use of Statistics

Bryman & Cramer [1983] discuss some important issues in using statistical analysis as a research methodology. When a large volume of data is cumbersome to handle, the initial step is to summarise the data in a sensible fashion. This is an area in descriptive statistics. Normally, descriptive statistics account for three quarters of the overall statistical analysis. To test whether the statistical model is correct, data has to be collected from the real world and examined. However, this is not easy. Small sample size, and incorrect sampling methods, are two of the main obstacles towards a successful statistical analysis.

Relevance: The experiments in this research are designed in the utmost care so that the data collected will enable the relevant statistical analysis to be carried out. The statistical analysis employed includes ANOVA hypothesis testing, factor analysis and cluster analysis (chapter 5).

3.1.11 Validating Instrument

Strub & Carlson [1989] point out that in questionnaire design, questions may be misinterpreted by some of the respondents, no matter how carefully the document is constructed. In some cases the respondents may not really tell the researcher what the questionnaire is intended to reveal. They argue that too often insufficient attention is given to the validation of the research instrument. They discuss the issues involved and outline procedures to provide a higher level of confidence in research results. The procedure consists of four phases: pre-test, technical validation, pilot test and full-scale survey.

Relevance: The present research relies heavily on survey "instruments" of various kinds to measure factors important to the understanding of the TQM discipline. In order to have confidence in the conclusions stemming from such research, care needs to be taken in designing and validating the research instruments (chapter 8).

3.1.12 Use of Model in Research

Machalingasivam [1983] identifies that truth is not known to everyone and different people may interpret it in a different manner. Therefore, how one visualises truth in a specific manner will depend on how the truth is brought up. Thus in any research projects, hypothesis is stated in terms of an explicit or implicit model and attempts are made to establish their validity. The purpose of the model is to describe the manner in which a particular system operates. Note that a researcher cannot claim that only his model can reflect the laws of nature or behaviour. The reliability of a model will depend on the researcher's capability to interpret the historical facts and to make reliable forecasts.

Relevance: In order to help the reader to visualise the relationship among the different quality processes, a model can be used as a research methodology. The model serves as a guideline for implementation of a process in order to achieve the ultimate goal (chapter 4).

3.1.13 Research Project Management

Lockyer [1969] identifies the need and advantages of research project management. He believes that if a chart is used to plan a research study there is little likelihood that significant activities which need to be anticipated will be overlooked. The emphasis on rigorous planning, schedules and milestones is a notion to which students with limited time at their disposal should become accustomed. Thus, the present research will make use of the method to plan.

Relevance: Apart from the continuous planning research process, the use of project planning and the associated charts provide an excellent basis for communicating to others what activities remain to be completed, their inter relatedness, achievements to date and the proposed schedule for completion. This will form part of the research methodology.

3.1.14 Overview on Research Methodology

The above 12 selected research methods are highly relevant to the present work and include most of the effective research methodology that social research should seriously consider. More important is that these methods are complementary to one another. Therefore, in the design of experimentation for the present work, all these methodologies are reviewed to obtain the best feasible approach. In essence, they will form guidelines for the present research in order that its validity will be guaranteed.

3.2 RESEARCH PROJECT MANAGEMENT

During the PhD research period, publication of the present research idea is part of the ongoing process because it enables ideas to grow and improve. Several publications have already been accepted/published and few more have been planned. A summary of publications is shown in Table 3.1.

Date of submission	Status	Title and Name of Publication
May 94	Published	"A model of Excellence for TQM: LETQMEX", Journal of Strategic Change, UK, Oct 94
May 94	Published	"Developing a TQM Excellence Model: Part 1", TQM Magazine, MCB, UK, Dec 94
Sep 94	Published	"Developing a TQM Excellence Model: Part 2", TQM Magazine, MCB, UK, Feb 95
Feb 95	Published	"Application of ISO 9000 in the Construction Industry" Construction Professional in Hong Kong
May 95	Published	Contribution to the book "TQM an Integrated Approach", Kogan Page, UK.
Sep 95	Published	"The Japanese 5-S Practice and TQM Training" Training for Quality, MCB, UK, Vol.3, No.4, 95
April 96	Published	"A TQM Model for the Construction Industry", 1st ICIT Conference Proceedings, De Montfort Uni., UK.
May 96	Preparing	"Implementation of TQM in the Construction Industry" Chartered Builders, UK.
June 96	Preparing	"TQMEX: Case Study" Building Magazine, UK.
July 96	Future plan	Contribute to book publication "Implementing TQM through Japanese 5-S Practice and ISO 9000", 2nd Edition, Kogan Page, UK.

Table 3.1 A Summary of Publication

A research project management approach S.3.1.13 has been adopted which will serve as a basis for the control of the various stages of the projects. An overall research programme is shown in the form of a Gantt Chart in Appendix 3.1.

3.2.1 Preparation (Chapter 1, 2&3)

Concepts, research methodology, originalities, and contributions were established via literature survey, discussions, and personal experience.

3.2.2 Development of the TQMEX Model (Chapter 4)

The model was developed based on the literature review in Chapter 2. They are well established quality concepts and practices. The idea is to propose a step-by-step guideline for a company to tailor-make its specific quality system.

3.2.3 Questionnaire Survey (Chapter 5)

Before the survey, some pilot tests were carried out in order to ensure that the questions are legitimate and meaningful for subsequent analysis. All together 5500 questionnaires were sent out during the period form August 94 to January 1995. The comparisons were made between companies in the UK, HK and Japan. A total of 400 valid replies were received, 310 were from the UK, 56 from HK and 34 from Japan. The breakdowns are shown in S.5.2.6. The questionnaire was designed based on some established criteria (S.2.1.2). The results were then analysed by SPSS for Windows.

The aims of the questionnaire survey are to:

1. Identify the disparities between large enterprises and SMEs in implementing TQM.
2. Identify the key activities of TQM implementation.
3. Establish merits, drawbacks and possible improvement areas.

3.2.4 Field Survey (Chapter 5)

Field surveys were conducted in the UK and HK with the aim to:

1. Identify the factors for successful implementation as influenced by Government policies and economic environment
2. Identify commonality and disparity in the implementation of TQM amongst these companies.

3.2.5 Action Research in the UK, HK and Japan (Chapter 6)

In the section 3.1.2 of this chapter, the advantage of action research has been pointed out. One case each from UK, HK and Japanese firms were conducted based on these principles. The aim of this exercise was to assess how companies in the three countries respond to the concept and implementation of the TQMEX model. For this the construction industry was chosen, because of the author's background and contact with the companies.

3.2.6 Advisory Service System (Chapter 7)

The main task was to build the knowledge developed in chapter 5 & 6 into an advisory service system. It consists of two parts. The first part was an Internet programming. The idea is to disseminate the research findings via the Internet service, which is widely accepted as the most effective and powerful communication system available in the 1990s. The second part involved an expert system programming. The aim of this is to structure the research findings and analysis in such a manner as to assist companies to search for the most appropriate course of implementation, with reasoning and case examples included.

The Advisory Service System is an important achievement of the research. An expert system model was developed based on the analysis of the questionnaire survey and fieldwork findings. Statistical analyses were used wherever necessary to arrive at a set of statistically significant results for decision making.

3.2.7 Consolidate Longitudinal Research Findings in HK & the UK (Chapter 8)

In the Section 3.1.11 of research methodology, the advantage of longitudinal research has been pointed out. One case each in the UK and HK were reviewed basing on this principle. The aim of this exercise was to assess critically the process dynamics of changes due to the introduction of the Advisory Service System. Furthermore these cases could enhance the validity of the ES developed.

3.2.8 Validation of the Expert Systems (Chapter 8)

It is important to validate the ES before it can be used competently. The validation serves two purposes. Firstly, it provides a testing ground to the validity of the TQMEX model and knowledge developed by independent parties. Secondly, it enables the ES to be further improved and refined.

In order to present the ES effectively, an Internet System introducing the TQMEX was devised. The advantages of using Internet programming are that it is graphically oriented, interactive and can be assessed world-wide. Although this is not the main purpose of the research, it is considered as an important by-product. The ES was then developed using a powerful Windows-based Visual Basic graphic package. It was made available to Internet users through the email download path. The ES was tested by quality professionals, including those listed on the Mailbase quality-related listservers.

3.2.9 Conclusions & Recommendations (Chapter 9)

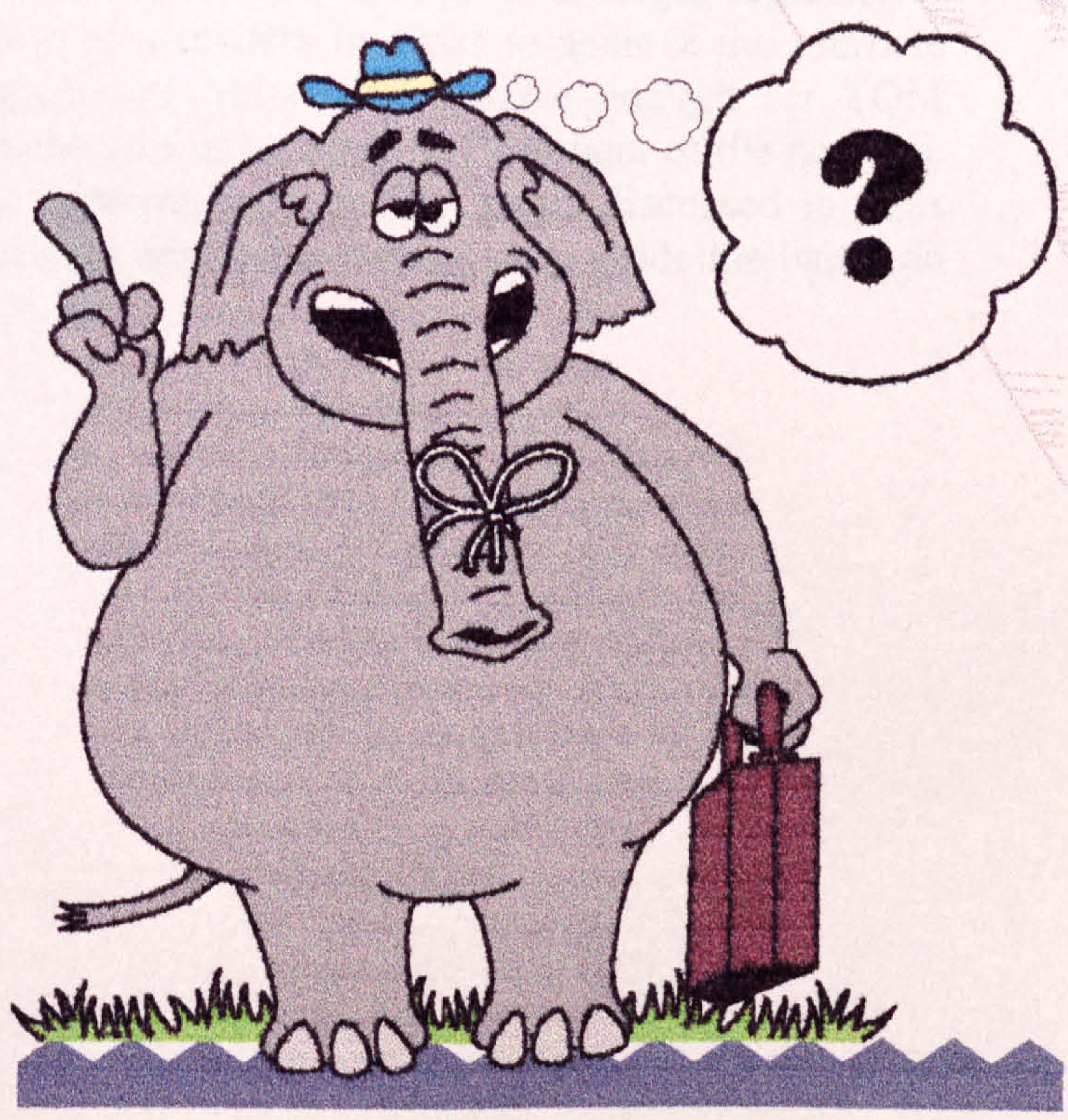
The last chapter is to conclude the findings of the research. It reflects the achievement of the aim and objectives set out at the end of Chapter 1. The useful feedback from the users was highlighted and results were summarised. Further recommendations were made for the users of the ES developed and further works were discussed for the creation of new idea and new applications of the knowledge developed.

EPILOGUE

This Chapter has reviewed the various research methodologies and selected those which are relevant for the present research. The more important ones are: questionnaire survey, statistical analysis, action research, and longitudinal research. The project schedule has also been planned in order to facilitate sound management of the research effort.

Chapter 4

Development of the TQMEX Model



CHAPTER 4

DEVELOPMENT OF THE TQMEX MODEL

PROLOGUE

This chapter, builds on the knowledge in chapters 2 and 3, and develops a TQM implementation model (TQMEX). It starts with explanations on how TQMEX is developed and the logic of each elements of the TQMEX are discussed. This will be followed by a discussion of the relationships between TQMEX and TQM gurus' ideas, together with some strategists' thinking.

Development of the TQMEX

- Introduction to TQMEX Model
- The Logic of TQMEX Model
- The Characteristics of TQMEX Model
- Applicability of TQMEX Model
- The relationship between TQMEX and Gurus' ideas

4.1 INTRODUCTION TO THE TQMEX MODEL

The TQMEX model (Figure 4.1) advocates an integrated approach in order to support the transition to systems management which is an ongoing process of continuous improvement that begins when the company commits itself to managing by quality. The Model illuminates the elements that form a base to the understanding of TQM philosophy and implementation of the process company-wide.

In order to have a systematic approach to TQM, it is necessary to develop a conceptual model Ho & Fung [1994]. Generally, a model is a sequence of steps arranged logically to serve as a guideline for the implementation of a process in order to achieve the ultimate goal. The model should be simple, logical and yet comprehensive enough for TQM implementation. It also has to sustain the changes in business environment of the new era. The model also reflects teachings of the contemporary quality gurus discussed in this chapter. The idea was to develop a universally applicable step-by-step guideline based on recognised practices in TQM (See Figure 4.1):

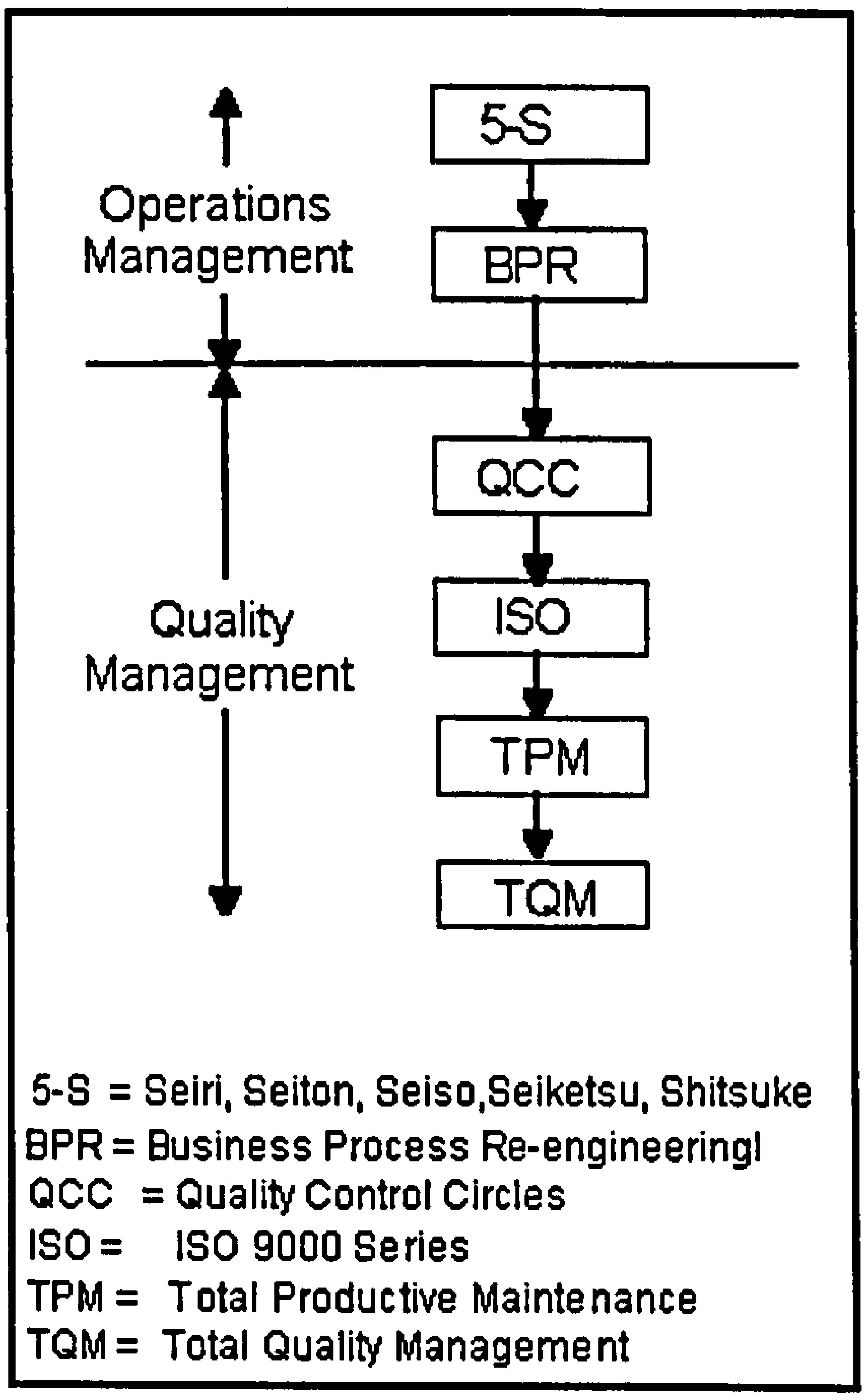


Figure 4. 1 TQMEX Model

- Japanese 5-S Practice (5-S)
- Business Process Re-engineering (BPR)
- Quality Control Circles (QCCs)
- ISO 9001/2 Quality Management System (ISO)
- Total Productive Maintenance (TPM)
- Total Quality Management (TQM)

The elements of the TQMEX model have been discussed in chapter 2.

The conceptual contribution have been developed based on the sequence of the model. Although individual steps of the TQMEX model are well-established. The development of the logical sequence of the model is unique and it offers a strong conceptual contribution by identifying the most logical combination.

4.2 THE LOGIC OF TQMEX MODEL

TQMEX is a sequential model which is easy to remember and simple to implement. This is in line with the quality principle of Keep It Short and Simple (KISS). Although there could be 120 different sequences (5x4x3x2) for 5 steps (assuming that the step 6 is TQM), there is possibly one sequence which is the most logical. As Osada [1991] ascents, 5-S is the key to total quality environment. It is a powerful tool to convince management of the impact of quality and how it can improve their business within a short space of time. This also provides a good and solid foundation for other activities to build on and therefore should be the first step. BPR is concerned with re-defining and designing your business process in order to meet the needs of your customers more effectively. It is more concerned with the business objectives and systems, which help companies to focus on the strengths in which the quality system should build on. This should follow as the second step. QCCs are concerned with encouraging the employees to participate in continuous improvement. They improve human resources capability and creativity to achieve the business objectives. Therefore, this should be the third step. ISO 9000 is implemented to develop a quality management system based on the good practices in the previous three steps. TPM is a result of applying 5-S to equipment based on a sound quality management system. In fact ISO 9001 requires procedures for process control and inspection and testing equipment which are part of TPM. Therefore TPM should be implemented in the fifth step.

If the above five steps have been implemented successfully, the organisation is already very close towards achieving TQM. This is because by then the organisation will have had a good quality environment, well-defined business objectives and processes, a good quality culture, effective quality systems in place, and good equipment supports. It is a matter of choosing an appropriate TQM framework for further improvement. Finally, although the quality gurus are not part of TQMEX, their ideas can be incorporated during TQMEX development, particularly in BPR, QCCs and ISO.

Another angle to justify TQMEX is based on the popularity of ISO 9000 QMS. ISO 9000 QMS has been implemented by over 100,000 firms world-wide and the number is growing at an unprecedented rate [Campbell, 1995]. Accredited organisations have gone through a lot of hard work to keep ISO 9000 running. However, after acquiring the ISO 9000, many organisations are wondering what they should do next. There need to be new ideas to keep the organisation alive and growing.

It has been suggested that ISO 9000 is a route to TQM. Since there are some controversial views, one need to consider four possible models of the relationship between ISO 9000 and TQM [Sallis, 1993].

Model 1: Identifies ISO 9000 as the starting point for TQM. ISO 9000 tackles the procedural infrastructure which precedes the more difficult changes of culture and attitudes. Obtaining ISO 9000 provides the institution with kitemarked confidence to go forward to deal with the larger issues associated with TQM.

Model 2: Positions ISO 9000 at the heart of TQM. In this model, ISO 9000 holds TQM in place and provides it with a solid foundation for continuous improvement.

Model 3: Considers ISO 9000 as a minor role in TQM. ISO 9000 is seen as only one element in a more important venture. Its role is little more than a useful means of assuring the operational consistency of the organisation's procedures. In this model quality is delivered by the active participation of the human resources in improvement teams and not by paper-based procedures.

Model 4: Takes a negative view of the relationship between ISO 9000 and TQM. In this model, ISO 9000 is considered as irrelevant to the pursuit of quality. ISO 9000 is viewed as a bureaucratic intrusion into the organisation's quality improvement. ISO 9000 has aroused some strong and hostile feelings. The debate is whether the extra workload and the need to work strictly to systems and procedures albeit internally generated, could damage staff morale and creativity.

The above four models are arranged in the descending order of preference for ISO 9000. However, we should not neglect the implication of Model 4. In other words, when we are developing the ISO 9000 system, we must make the quality manual short and easy to follow, and above all useful to the organisation for quality improvement rather than as document bureaucracy. Models 1, 2 and 3 confirm the value of ISO 9000 for TQM to a greater or lesser extent. These raise the important question of how can we convert an ISO 9000 system into a TQM system? In an attempt to prove the logic of TQMEX, it is useful to apply TQMEX model in the above scenario.

If an organisation has already implemented ISO 9000, it should still go back to the first step, the 5-S practices, in order to develop a total quality environment. One task of the 5-S is to throw away the rubbish, including the obsolete documents and paperwork generated from the ISO 9000 system. The 5-S framework keeps on insisting to look into the root of the problem. This helps to understand why there are so many wasteful documents created in the first instance.

BPR will then help to re-focus the business, making it more customer-oriented. This should then be built into the ISO 9000 system during management review meetings (clause 4.1.3).

QCCs will contribute continuous improvement by mobilising everybody in quality initiatives. The 5-S framework provides a good agenda for improvement. Furthermore, QCCs are good and allow organisations to review the effectiveness of the ISO 9000 system and help communicate and understand the requirements of the standard. This will lead to simplification of the quality manual.

TPM, when developed, will improve quality and productivity dramatically. This will be an important help towards achieving TQM. If you walk into an efficient factory or office with conducive environment, there is no need to look at their ISO 9000 system before you can tell whether it is a quality organisation.

Finally, TQM is a process, not a destination. As Deming said, "We have to do it forever." When TQM is built upon 5-S, BPR, QCC, ISO and TPM, it will guarantee continuous improvement and customer satisfaction, no matter how demanding that could be. The above illustration further demonstrates the logic of TQMEX model.

4.2.1 Pre-requisites for Implementing TQMEX

In order to make a good base for implementation of TQM and proactive environment there are two pre-requisites that should be installed prior to TQMEX implementation. They are the four pillars, and the 4Cs of TQM.

4.2.1.1 The Four Pillars of TQM

There is a need to review the TQMEX model from a system viewpoint. Oakland [1989] has proposed a model for TQM based on Commitment, System, People, and Tools. The proposed 4-pillar model (Figure 4.3) brings the customer's requirement into the system. This makes the approach to TQM more complete. The additional pillar -- satisfying customers -- is vital because it explicitly addresses customers requirements. Without it TQM would have no objective.

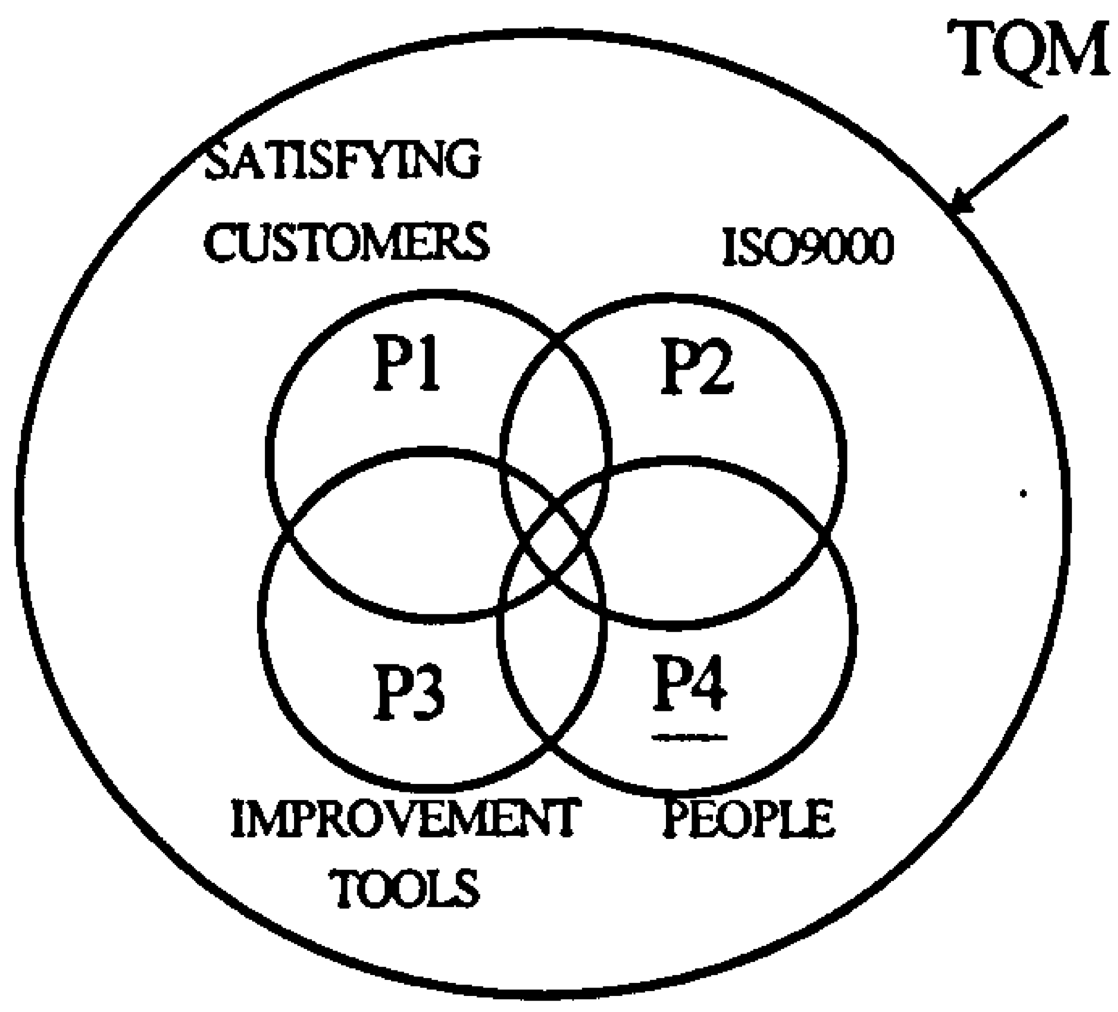


Figure 4. 2 The four pillars of TQM [Ho & Fung, 1994]

The interpretations of the 4 pillars are:

P1: Satisfying Customers -- The aim of TQM is not just to meet customer requirements (expressed needs), but it is concerned with customer satisfaction (satisfying implied needs). Companies, such as Rover Cars, use the term "extra-ordinary customer satisfaction" as their corporate mission. Customer requirements may include availability, delivery, reliability, maintainability and cost effectiveness, amongst many other features. The price of quality is therefore the continual examination of the requirements and your ability to meet them. Companies sometimes tend to neglect the needs of their employees. Only the smooth functioning of the internal customer-supply chain will ensure that the quality is built into each stage of the business for the benefit of its external customers. The importance of satisfying the internal customers' needs can never be over-emphasised.

P2: System/Process -- For many firms, the first step in creating a total quality environment is likely to be the establishment of a quality management system such as ISO 9000 series, Ford Q-101, Rover RG-2000, etc. Establishing such a **system** is the initial building block. TQM relies on an effective quality management system which ensures that preventive measures are in place, and the culture of continuous improvement exists to enable the **processes** to deliver quality products and services. *Good processes will produce good products*

P3: People -- It is vital for the management in a total quality organisation to capture the hearts and minds of everybody within the organisation, starting at the top and permeating via a chain of customer/supplier relationships throughout the whole organisation and beyond. Therefore management commitment, training, teamwork, leadership, motivation, empowerment, etc., would have a vital and complementary role to play in establishing a total quality environment. Another important aspect about people is that the management needs to develop an environment so that the people working in it can be creative. Creativity [Kondo, 1993] is the key for innovation and continuous improvement and it should be a theme for human resource development in a quality organisation.

P4: Improvement Tools -- There is no enterprise that cannot be improved. A vital part of TQM is to recognise the need for continuous improvement. The ISO 9004-4 Guideline for Quality Improvement should be a tangible help.

4.2.1.2 The 4Cs of TQM

Implementation of TQM and improvement of a company's quality system heavily relies on people. The human dimension is inevitably incorporated in each of the stages of the TQMEX model, and is the driving force behind the philosophy of total quality in business as well as in life. It begins with an individual's belief in actualisation through doing things with responsibility and pride, continuous learning, group work and contribution to common goals.

As much as any successful quality programme should be based on the Deming's cycle, the implementation of TQMEX also requires firm foundations in an organisation's human resources through a full application and integration of **4Cs of TQM: Commitment, Competence, Communication, and Continuous improvement.**

Commitment is the determined spirit of an Olympic swimmer who practises alone for hundreds and hundreds of pre-dawn hours.

Competence is the inner knowing of a well-trained pilot who uses all available knowledge -- training, instruments, and intuition -- to make quick decisions.

Communication is the critical personal contact and mutual agreement among managers and employees that makes work flow smoothly.

Continuous improvement (Kaizen in Japanese*)* is the driving force towards excellence by each individual in an organisation. Therefore, in order to implement TQMEX, you need to prepare yourself first.

4.2.2 Adequacy of the TQMEX Model

It is important at this stage to justify the adequacy of the TQMEX model for achieving TQM. An effective test is to map the elements against the 4-pillars.

	Satisfying Customer (P1)	**System (P2)**	**Improvement Tools (P3)**	**People (P4)**
5-S	✓		✓	✓
BPR	✓	✓		
QCC			✓	✓
ISO 9000	✓	✓		✓
TPM			✓	

It is seen that the mapping is sufficient, and therefore it is a good indication that the five steps of the TQMEX model will be able to support TQM implementation.

4.2.3 The Features and Characteristics of TQMEX Elements

The TQMEX model aims at continuous improvement. Table 4.1 illustrates the major implication and characteristics of TQMEX model.

Category	5-S	BPR	QCC	ISO	TPM
Aim	Continuous improvement (Kaizen)				
Applications	Better environment, better work	Clear business objectives	Small group activities	Documented quality system	Equipment and autonomous maintenance
Means of achieving aim	Integration of workplace organisation activities	Minimise input, add value to output	Identify bottle neck and problem solving	Simplify procedures	Realisation of the proper form of the equipment
Personnel training	Centred on 5-S activities	Centred on management technology (i.e. 7 new tools)	Centred on 7 QC tools and problem solving techniques	Centred on quality auditing and documenting effective procedure	Centred on maintenance technology (maintenance skills)
Problem to be dealt with	Disorganised and dirty environment	Business objectives and vision not clear	Product defects or non-value added processes	Responsibilities and procedures not clear	Machine breakdown
Traditional solution	Clean as required (fire fighting approach)	Improve sub system, not the whole system	Decision made by one or two individuals	End-of-line inspection/ sorting and reworking	Breakdown/ maintenance replacement of broken parts
Improved solution	Clean as you go/ part of daily activities	Value engineering aim at increase the whole system	Team approach	In-process inspection poka-yoke (foolproof mechanism). Design for quality improvement	Condition-based and preventative maintenance, Autonomous activities
Information for monitoring	5-S audit, good and bad examples, photographs or videos	Mission statement, business plan, process flow diagram or benchmarking	Statistical process control chart, cause and effect diagram etc.	Audit report, customers complain.	Machine trouble record/ Mean time between failure
Approaches	practise 5-S activities daily and the joy of sharing.	Involve customer (both internal and external)	Education Employee involvement "Quality is free" and the joy of thinking	Keep it simple and direct	Education employee involvement "Maintenance is free"

Table 4.1 Features and characteristics of TQMEX elements

4.2.4 Applicability of TQMEX Model in the Manufacturing and Services Industries

Quality has traditionally been related to the manufacturing industry [Parasuraman et al., 1990]. Due to the improvement in technology and automation over the last century, more and more of the workforce in both the developed and developing nations have shifted towards the service industry. As this trend is likely to continue it is therefore important to understand the special characteristic of quality as applied to the service sector. Table 4.2 illustrates the differences between manufacturing and service organisations. One primary difference is that products are tangible, and services are intangible. Another difference is that the manufacturing system is relatively closed, and the service system relatively open.

MANUFACTURING INDUSTRY	SERVICE INDUSTRY
Products are transformed from materials.	Services do not exist until they are provided at the call of the customer.
They have physical dimensions and attributes, take up space in inventory, are depreciated, and often wear out.	They take up no space, can not be inventoried, and have no shelf life.
Products can be evaluated against specifications and criteria.	Service quality is evaluated against satisfaction of the customer.

Table 4.2 Comparing Manufacturing and Service Characteristics

In order to apply TQMEX model to the service industry more effectively. BPR needs to establish a set of customer oriented business objectives. In the service sector, such objectives can be derived from the service specification. An example of this is the SERVQUAL model [Parasuraman et al., 1990](see also S.2.3.2.5). Merely closing the gaps described in the SERVQUAL model and satisfying specifications does not constitute a quality service. Quality is delighting the customer by continuously meeting and improving upon agreed requirements. Hence, flexibility should be inbuilt to exceed specifications and to respond to changes in service specification. There are five ways in which an organisation can incorporate TQMEX model into its service. (See table 4.3)

Quality Points	Application of TQMEX in Service Organisations
Design it in	BPR emphasise service re-design to meet the changing needs of customers and constant updating of service attributes.
Build it in	ISO 9000 procedures should be revised regularly to reflect the needs of the customers.
Inspect it in	ISO 9000 should provide inspection procedures for the delivery of the service. This function will minimise the risk of dissatisfying customer.
Fix it in	ISO 9000 policy must cater for total customer satisfaction.
Educate it in	QCC activities should look for innovative and new ideas to delight the heart and mind of customers.

Table 4.3 Building TQMEX into service industry

4.2.5 Relationship between Gurus' Ideas and TQMEX

At this point of development, it is worthwhile to investigate how the TQMEX model has been built upon the quality gurus' ideas. No guru has all the answers to all quality improvements. Each guru offers one unique idea to advance knowledge of solving quality-related problems. To solve real-life problems, one has to be able to understand, sequence, and synthesise the messages from different gurus to come to a useful conclusion. Thus, it is worthwhile to put the gurus' ideas and TQMEX into perspective, perhaps even more importantly, it helps companies to decide which approach is likely to be more effective and suitable for them (see Figure 4.4 for detail).

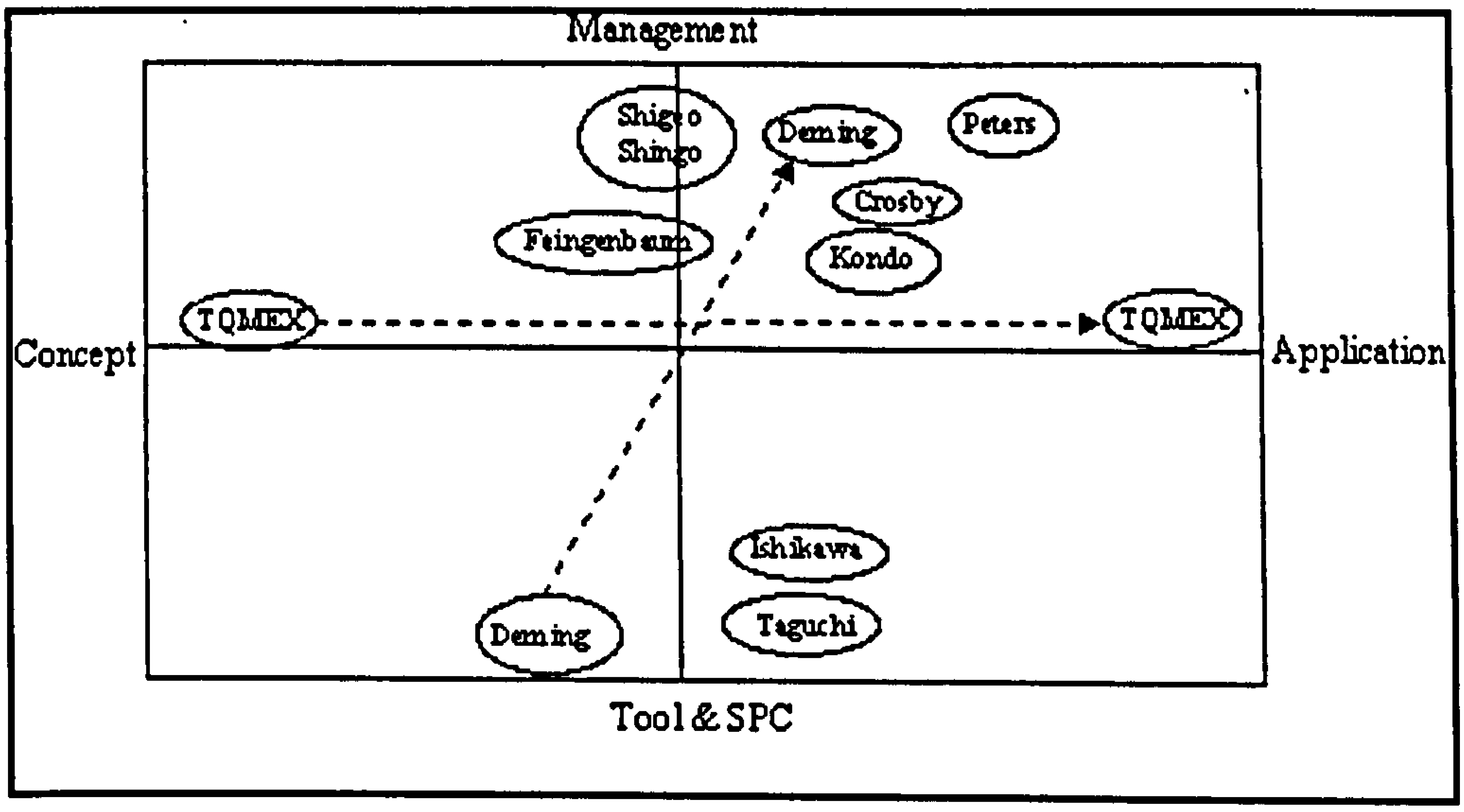


Figure 4.3 Perspective view of TQMEX and Guru's ideas

Many companies may choose to follow the teachings of only one quality guru, assuming that listening to many might confuse them. Other companies may follow the teachings of all of the gurus and continuously synthesise ideas to make them applicable to their own operations. The TQMEX model offers a highly practical oriented approach to achieve TQM based on well established concept.

Neave [1995] suggests that Deming's philosophy is a system -- thus everything in it is intimately related to much else. As he pointed out in one communication: *"That is not to say I would expect any organisation to 'do' the whole of Deming! But there is need to understand the whole as a whole. The ice will be very thin otherwise. Once that understanding is there, the proliferation of ideas, techniques, strategies from other sources may be appraised with intelligence."*

In another instance, Bajaria [1995] suggests that *"We must learn to synthesise good ideas and make them integral to business practices".* Thus, it is worthwhile to synthesise the main ideas of the quality gurus and make them an integral part of the TQMEX model. See Table 4.4 for detail.

TQM Principles used by the TQMEX Model	Crosby's 14 step quality improvement	Peters' 12 traits of quality revolution	Deming's 14 Points	Feigenbaum's 10 crucial benchmarks	Kondo's 4 factors for motivation
Leadership	Step 11	Trait 2	Points7,11	Benchmark5	Factor 1
Commitment	Step 1	Trait 1	Point 2	Benchmark 1	Factor 2
Total Customer Satisfaction				Benchmarks 2,10	
Continuous Improvement	Steps 7,9,14	Trait 12	Points 1,5	Benchmark 8	
Total Involvement	Step 5	Trait 10	Point 14	Benchmark 1	
Training and Education	Step 8	Trait 5	Point 6		Factor 4
Ownership			Points8,12		Factor 2
Reward and Recognition	Steps 10,12	Trait 4	Point 4		
Error Prevention	Step 6		Points 3,9		
Co-operation and Teamwork	Step 2	Trait 6,9	Point 13	Benchmark 4	Factor 3
Quality measurement	Steps 3,4	Trait 3,11		Benchmarks 3,9	

Table 4.4 Relationship between TQMEX and Gurus' ideas

The Table 4.4 shows a summary of some of the gurus' ideas (Crosby's 14 steps, Peters's 12 traits, Deming's 14 point, Feigenbaum's 10 benchmarks and Kondo's 4 factors) as related to the principles of TQM. Paying attention to these principles will guarantee a successful implementation of TQM.

4.2.5.1 Apply 7-S Framework to TQMEX Model

Peters and Waterman [1980] suggested that any intelligent approach to organising had to encompass, and treat as interdependent, at least seven variables as discussed in S. 2.2.11. Therefore the TQMEX model should benchmark against the 7-S framework for integrity of organisational development (See Table 4.5).

7-S Framework	Applicability of TQMEX
Structure	The central problem in organisational structuring today is not on how to divide up tasks. It is on how to make the whole organisation working as an organic unit. TQMEX model can assist companies to transform the organisational structure from mechanistic to organic by promoting cross-functional teams and teamworking.
Strategy	Strategy is about success. BPR provides a link for everyone to understand the ultimate goals (mission), the way in which success will be measured and the ways to get there.
Systems	ISO 9000 QMS, when used properly, is a good management system because it emphasises on customer-oriented. More important is that the QMS provides a universal language because every organisation in the world registered under ISO 9000 conforms to the same set of policies and procedure. This enables the management system of a registered firm to be transparent to its customers.

Style	Mintzberg [1973] has pointed out that managers do not spend their time in the neatly compartmentalised planning, organising and controlling modes of classical management theory. 5-S and QCC have an important role to play in term of changing individual's style of management.
Staff	It is important for any TQM companies to treat staff as their most valuable asset. Therefore staff are considered as part of the 4 pillars of TQM.
Skills	Skills and competence are fundamental idea in which the TQMEX model is built up. 5-S, QCC and TPM provide necessary skills for staff to become more competent and learningful in carrying out their day to day tasks.
Shared values	For organisations following the TQMEX model, the shared value is TQM. Kaizen is the key to any TQM implementation. For this to work effectively, staff must have the right attitude, sensitivity to change and self-motivation.

Table 4.5 Applicability of 7S Framework to TQMEX Model

4.2.5.2 Relationship of Porter's 5-forces with TQMEX

It has been explained in 2.2.15 that Porter's model is about supply-chain and competition. The TQMEX model has emphasised the importance of the supplier-customer relationships through both the ISO 9000 QMS and the BPR. In these steps, addressing the needs of the customers is crucial. Moreover, the suppliers should become part of the chain through such initiatives as supplier development and Just-in-time systems. In terms of the competitive forces from rivalry, new entrant and substitution, BPR and Kaizen would help by consistently insisting on improving an organisations quality standards. In this highly competitive business world, the only way to survive and grow is to become better, in some attributes, than the most fierce competition. This is sometimes called marketing niche. This can also be accomplished through the best practice benchmarking process, a critical step within the BPR process.

4.2.5.3 Apply Deming's System of Profound Knowledge to TQMEX

Summarising the analysis in Table 4.2 above management commitment, leadership, total involvement and continuous improvement are essential for all stages of TQM implementation. Deming's philosophy is possibly the most useful for encouraging these necessary attitudes and is used in the development of the TQMEX model.

In 1993, Deming summarised his 70 years' vision and experience and called it the ***System of Profound Knowledge*** [Deming, 1993]. Profound knowledge encompasses four interrelated dimensions:

- Appreciation for a system
- Knowledge of statistical theory
- Theory of knowledge
- Knowledge of psychology

4.2.5.4 Appreciation for a System

The organisation must have an aim or long term objective. Everyone must understand it and, share it. When formulating the corporate strategies, it is important to follow a set of guiding principles.

The TQMEX model provides a systematic approach towards TQM. Each of the individual processes of the TQMEX model contributes to the total system to achieve the aim by working effectively together.

4.2.5.5 Knowledge of Statistical Theory

Deming believed that managers who lacked understanding of variation, and confused the two types of variation (common and special causes) could actually make matters worse. Furthermore he estimated that management was accountable for up to **94%** of the potential improvement. No system can produce identical output every time. There are always variations in the output. Sometime the output is not able to meet the aim of the system. People working in the system need to understand how and why the output varies. They need to improve their processes continually, so that variation is reduced.

BPR and QCC can help to reveal all sorts of faults and variation that prevent good practices, thus improving job satisfaction and contributing to pride in workmanship. These contribute to the total system to increase quality awareness and achieve continuous improvement.

4.2.5.6 Theory of Knowledge

People need knowledge and understanding of the operation of their processes in order to know how to improve them. They must hypothesise and experiment. So that the company benefits from the knowledge of everyone who works within the system.

Knowledge has to be built upon facts. This can be achieved by the proper use of the seven QC tools under the QCC environment. Problems can then be solved and new ideas are created based on past experience.

4.2.5.7 Knowledge of Psychology

It is necessary to understand human interactions. Differences between people must be used for optimisation by leaders. People have intrinsic motivation to succeed in many areas. Extrinsic motivations in employment may smother intrinsic motivation. These include pay rises and performance grading. It has removed joy in work and in learning. Managers must give back to people intrinsic motivation for innovation, for improvement, for joy in work, for joy in learning. It is all too easy to inhibit co-operation. Fear is the greatest inhibitor. Also some modern practices, such as individual payment by results, can be, in reality, the abdication of management leadership and will inhibit people working together.

The TQMEX model calls for improvement in work environment (through 5-S) and develop the people's infinite potential (through QCC). These provide rewards beyond monetary motivations and will give energy to drive for continuous improvement.

EPILOGUE

This chapter reviews the rationale and development of the TQMEX model. Cross-reference is made to the gurus' ideas, and in particular, Deming's system of profound knowledge. The relationships of the TQMEX with some important strategic management thinking, such as the Mckinsey's 7-S framework and the Porter's 5-forces, are also discussed. It is identified that a company can develop a specific quality system that is most suitable for its operations. TQMEX can help the company to understand its position in terms of quality and develop a plan for further improvements. In order to develop the academic rigour of the TQMEX model, intensive questionnaire and field surveys have been conducted and will be discussed in the next Chapter.

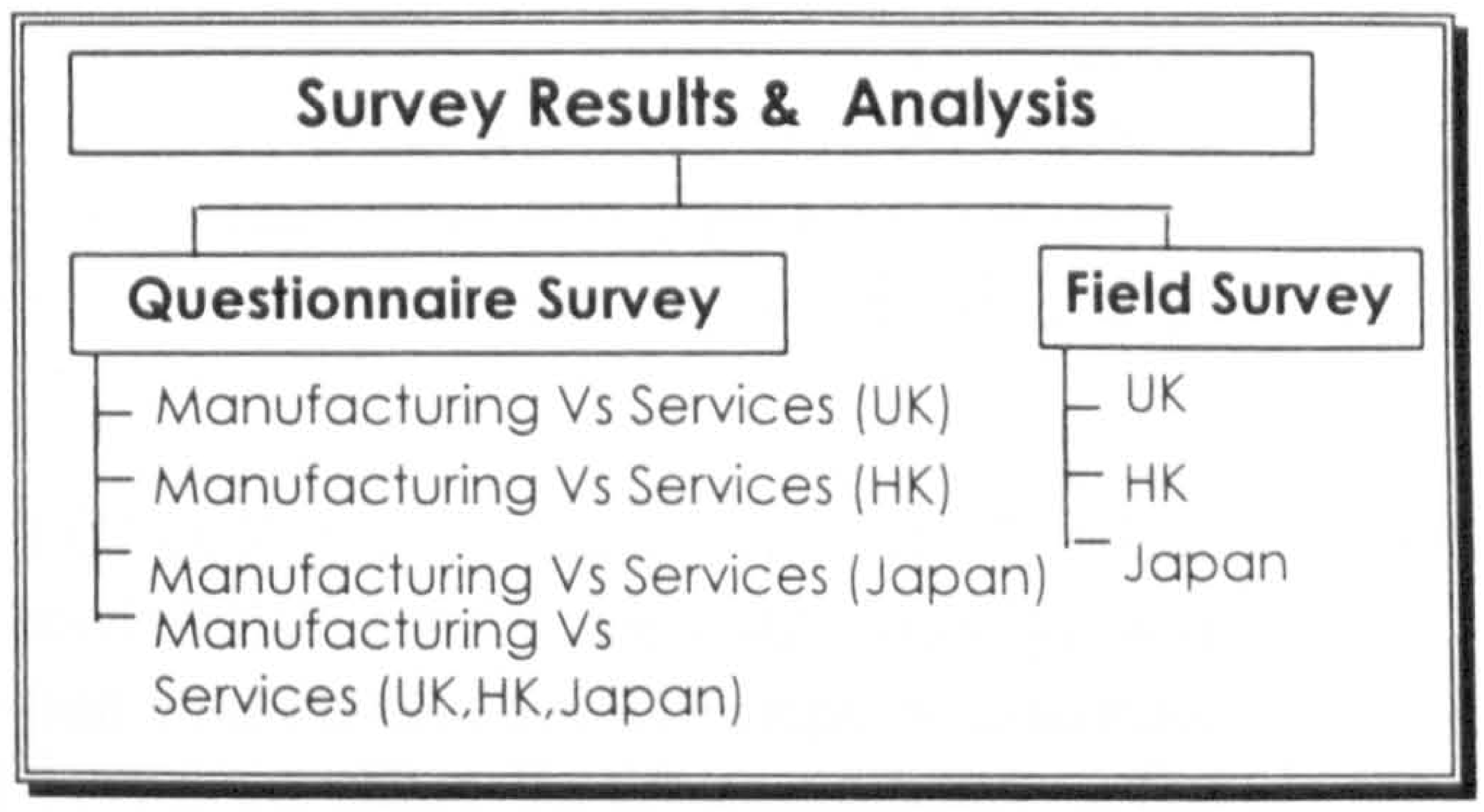
Chapter 5

Survey Results & Analysis

CHAPTER 5

SURVEY RESULTS AND ANALYSIS

PROLOGUE



The first Phase involved intensive questionnaire survey. The second phase consisted of in-depth field survey. This is necessary in order to establish a set of valid data. Further, the questionnaire survey was repeated in HK and Japan. The advantage is that differences can be explicitly shown. Field surveys were carried out on companies in HK, Japan, and the UK. This provides a good cross-sectional view of various applications of TQM for countries with differences in culture and level of TQM development.

5.1 THE USE OF QUESTIONNAIRE & FIELD SURVEY FOR TQMEX

As can be seen from the Research Methodology in S.3.1, there are several possible approaches for developing an effective TQM Model. It is worthwhile to go through them in order that the best alternative can be established for the research.

Historical Research (S.3.1.1) is important because one should employ the past knowledge in questionnaire design and apply on the present one. Action Research / Case Studies (S.3.1.2) is a good approach, except that significant amount of case studies have to be conducted. Yet, this is made possible through the effort of the research activity. Opinion Research (S.3.1.3) is suitable as TQM is a generally accepted concept. It can be obtained effectively and efficiently via questionnaire survey. User Development / Involvement (S.3.1.4) is adopted mostly in the longitudinal research cases. Triangulation (S.3.1.5) is important in validates the accuracy of the result, for example, if the outcomes of the questionnaire survey correspond to those of action Research. Game Approach (S.3.1.7) is not suitable as TQM is such a vast subject area and can hardly be represented by a simulated game. Further, only a small number of subjects can enter into a game. Longitudinal Research (S3.1.9) is good for these research, and is again adopted whenever appropriate. Statistical techniques (S3.1.10) are used to analyse the data in order to draw conclusions on hypotheses and correlation. Finally, the research results are validated (S3.1.11) in Chapter 8.

After weighing out all the above alternatives, the only one which is not suitable and therefore discarded is the Game Approach. The other 11 approaches are incorporated either into the questionnaire or field (including longitudinal) surveys.

5.2 QUESTIONNAIRE SURVEY IN THE UK, HK & JAPAN

The research approach adopted is based on Opinion Research (3.1.3). Questionnaire survey is used in order that hypotheses on the applications TQMEX model elements can be tested and improved. The aim of the questionnaire survey is to determine whether there are any differences in applications of TQM across cultural and geographical backgrounds and which factors contribute to successful TQM practices. The main finding of the research is that TQM is an essential requirement for their business success. This can be achieved by good organisation, good working environment, operations management systems, quality circle practices, quality management system, and preventive maintenance measures. The findings of the questionnaire survey have been published [Ho & Fung, 1995].

The questionnaire was designed based on the TQMEX model (App.5.1-1 & 2). The feedback of a pilot survey (100 questionnaires) carried out before the main survey, was used to ensure that the questions were legitimate and meaningful for subsequent analysis. A full scale questionnaire survey was conducted based on about 3,000 companies in the UK, 2000 companies in HK and 1000 companies in Japan. The main survey was conducted in the period from August 1994 to January 1995. Comparisons were made amongst companies in the UK, HK and Japan and between the manufacturing and services industries.

The 100 pilot questionnaires survey finding suggested that 85% of the replies are ISO 9000 registered companies. Therefore in selecting the samples for this survey, the main criterion was that the companies chosen had already adopted some good quality practices. Since ISO 9000 gives the formal certification and guarantees that the company is quality conscious, this was the yardstick in the selection process.

A limitation of this questionnaire survey was in a low coverage of 'recognised' TQM companies. There is only a limited number of the UK Quality Award winners since its launch in 1992 [Ho, 1995]. Therefore, the underlying assumption of this research is that the ISO 9000 registered firms are geared towards TQM and, therefore, the quality managers' perceptions of TQM could be considered as significant measures of the state of TQM development.

5.2.1 Methodology

In investigating which factors contribute to successful TQM practices the following terms were used: "quality process" and "quality activity".

The term quality process was used to describe a distinguishable tool or method used for quality improvement. This includes 5-S, BPR, QCC, ISO 9000, TPM and TQM. Each of the process consists of a list of quality activities.

The term quality activity was used to describe a list of factors that influences the effectiveness of a quality process. For example TQM is considered to be a quality process, which is itself composed of a list of activities i.e. leadership, commitment, customer satisfaction, continuous improvement, total involvement, training, ownership, reward and recognition, error prevention and teamwork.

This survey had three objectives:

The first was to access the TQM practices between Manufacturing and Services sector of the UK, HK and Japan (Stage 1).

The second was to compare the result between the three countries (Stage 2).

The third is to validate the TQMEX Model by conducting field survey on companies in the UK, HK and Japan that are implementing Quality Management System (Stage 3).

Stage 1

The survey on the UK companies was conducted in August 1994 on a random sample of 3000 registered firms. The addresses were obtained from the "*DTI QA Register 1994*" because it was the most comprehensive directory of quality assurance registered firms in the UK.

Survey on Japanese companies was conducted in January 1995 on a random sample of 1000 companies. They were selected from the "*Kompass 1994 Directory of the top 1000 firms in the UK and Japan*". The intention was to have a balance sample of companies.

Survey on HK companies was conducted in March 1995 on a random sample of 1500 companies. They were selected from the "*Hong Kong Business Directory*" This directory was selected because it represented a good cross-section of the firms actively in business.

Stage 2

Comparisons of the result were made between the three countries. The objective was to find out whether there were significant differences in their TQM implementation.

Stage 3

In an attempt to prove that all the TQMEX elements are good quality practices and their effectiveness. Field survey was carried out on companies from the three countries. The investigation is aimed at establishing what measures and steps are being taken by both manufacturing and service industry in pursuit of TQM.

5.2.2 Analysis of Variance and The F-Distribution

The analysis of variance, known as ANOVA, is a technique that was designed to find out the differences in means of various populations. This method takes the variability of a complex situation, as measured by the variance, and divides it into meaningful component parts. It is then necessary to test the hypotheses. The null hypothesis assumes that the groups (column data) are distributed identically in all respects. The alternative hypothesis is that the groups are not all the same. These hypotheses are tested by comparing the appropriate variance ratios with tabulated points of the F-distribution. There are two possibilities. First, If the null hypothesis is accepted because the computed F-value was smaller than the critical value from the table, then we conclude that all of the groups are identical or no differences. Second, if the null hypothesis is rejected because the computer F-value was larger than the tabled critical value, then we conclude that there are some differences from one group to another. In this case, it is useful to examine the group differences in detail and explain them.

The above discussion is for one-way ANOVA because only the columns are compared. The same argument can be applied to the different rows of data, if they carry different meanings, rather than just different numbers of samples. In this case, we have a two-way ANOVA, and the null and alternative hypotheses have to be tested for the row differences as well.

The two-way ANOVA procedure was used to test the questionnaire survey results of the three countries.

5.2.3 Questionnaire Design

The questionnaire was designed based on the following criteria:

1. It should cover the major sectors of business and industries.
2. It should include the major implementation factors modified from similar surveys conducted by Dale and Lascelles [1990] and Mann [1992]
3. It should consist of the major principles that will guarantee a successful implementation of all quality activities based on secondary research (S.2.1.2).

The final version of the questionnaire is shown in App 5.1-1 & 2.

There are two parts in the questionnaire.

Part 1 is designed to obtain background information about the company which include:

- Type of business
- Existing workforce
- Aware of Quality
- Management perception of existing quality system
- Methods used for improving quality
- Training interval on quality

Part 2 consists of seven topics related to TQMEX, i.e.,

- 5-S Practices
- Quality Control in Marketing, Production & Purchasing (BPR)
- Quality Control Circles (QCC)
- ISO 9000 quality management system (QMS)
- Total Preventive Maintenance (TPM)
- Total Quality Management (TQM)
- Overall QMS

The questionnaire is designed to obtain the key quality activities relating to the above seven topics. Seventy questions are asked. A 7-point Likert scale is used for most questions, with point 1 representing 'the least' and point 7 representing 'the most' for each question. N/A represents 'not applicable'. The questionnaire was addressed to the quality manager who was requested to enter the facts or his ideas on each question.

5.2.4 The UK Survey Results and Analysis

The main survey was conducted during August 1994 for a random sample of 3,000 companies. About 11% valid replies were obtained from the manufacturing and services industries.

The breakdown of the data for the UK questionnaire survey is:

Large Manufacturing (>300 employees)
S&M Manufacturing (=< 300 employees)
Large Service (>150 employees)
S&M Service (=< 150 employees)

5.2.4.1 Survey Results and Analysis Part 1

The data are analysed using the Excel Statistical Software. In investigating for background information of companies, a number of important factors were identified:

- Type of business
- Existing workforce
- Aware of Quality
- Management perception of existing quality system
- Methods used for improving quality
- Training interval on quality

5.2.4.1.1 Type of Business

The breakdown is as follows:

Large Manufacturing: 98
S&M Manufacturing: 104
Large Service: 67
S&M Service: 36

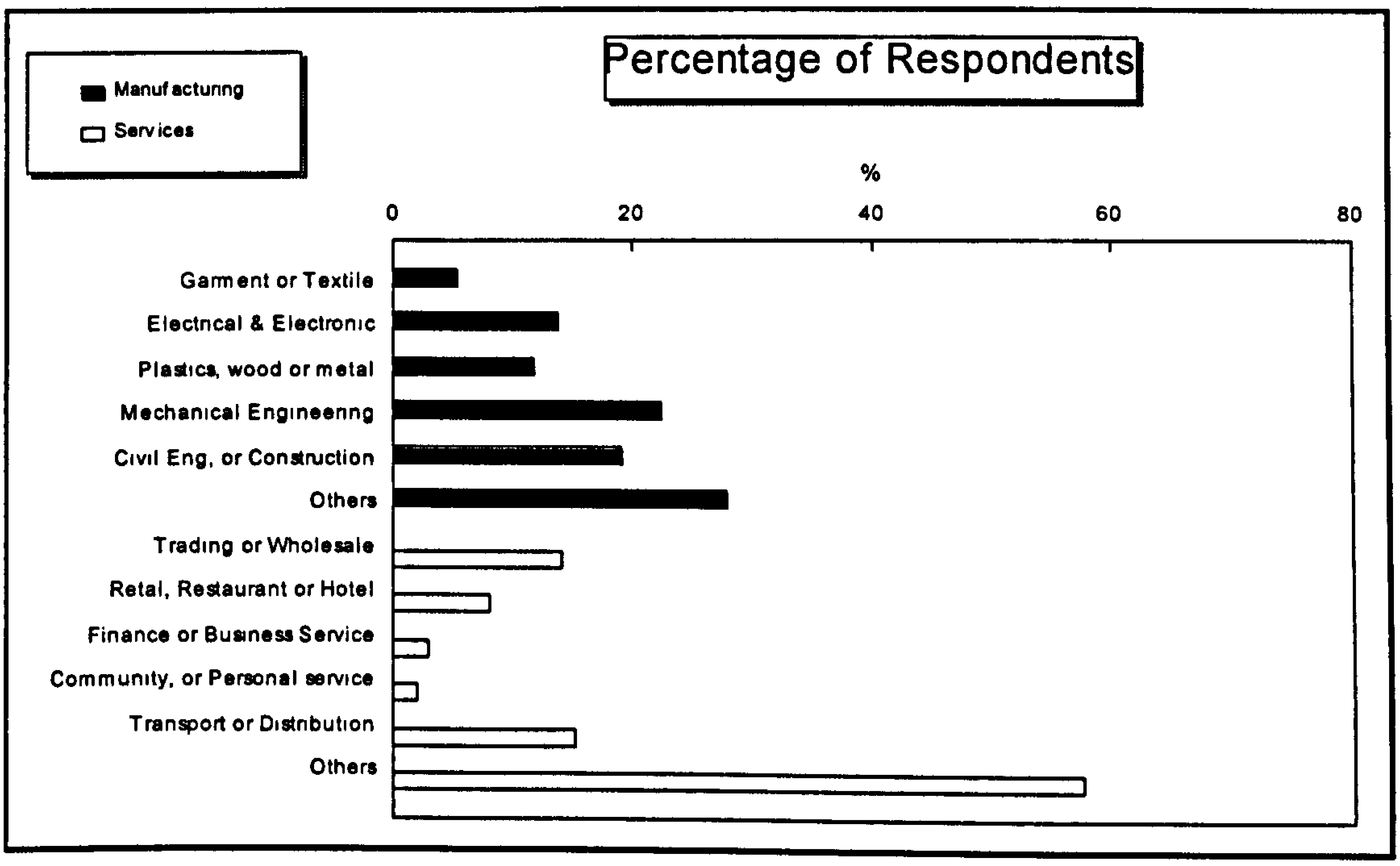


Figure 5.1 Percentage of respondents (UK)

Figure 5.1 shows the responses from 202 manufacturing and 103 services firms. The breakdown is as follows:

5.2.4.1.2 Employee Number and Company Age

The mean employee numbers are:

Large Manufacturing: 2506
S&M Manufacturing: 110
Large Service: 3887
S&M Service: 43

The mean numbers of year established are:
Large Manufacturing: 59
S&M Manufacturing: 47
Large Service: 46
S&M Service: 25

5.2.4.1.3 Awareness of Quality

The mean numbers of years for awareness of quality are:
Large Manufacturing: 59
S&M Manufacturing: 47
Large Service: 46
S&M Service: 25

	% of Industry practising TQM			
Awareness of Quality (No. of Years)	**Large Manu.**	**S&M Manu.**	**Large Service**	**S&M Service**
1-10	51	27	52	14
11-20	50	46	60	50
21-30	68	41	75	0
30+	57	13	50	0

Table 5.1 Awareness of quality (UK)

Comment: Table 5.1 reveals that certain types of company react quicker to new ideas and methods such as the implementation of TQM. The findings indicate that large manufacturing and service companies are more likely to have implemented TQM. The S&M firms do not have as much confidence in TQM as the large one. This, coupled with the fact that many S&M firms receive less-coherent training, leads to a lower standard and ability for the S&M firms in comparison with larger organisations.

5.2.4.1.4 Management Perception of Existing Quality System

Table 5.2 indicates that larger companies with a large number of employees are more likely to have implemented different quality activities.

Type of Company	Large Manu.	S&M Manu.	Large Services	S&M Services
No. of Company	98	104	67	36
% use of 5-S	8.2	2.9	1.5	7.7
% use of SPC	42.9	33.7	11.9	22.6
% using of QCC	32.7	10.6	17.9	16.1
% using of ISO 9000	95.9	98.1	82.1	83.9
% using of TPM	17.3	3.8	3	6.5
% using of TQM	55.1	31.7	53.7	19.4
% using of TQC	16.3	7.7	4.5	9.7
% using of Quality by inspection	48	46.2	16.4	19.4
% using of other methods	17	3.8	8.9	9.6

Table 5.2 Percentage use of quality process (UK)

Comment: A likely explanation for this high percentage of use of different quality activities is that often large companies seek to use different method to find out which is the best approach for their company in achieves TQM.

5.2.4.1.5 Methods Used for Improving Quality

The percentage use of quality process for quality improvement is shown in Figure 5.2:

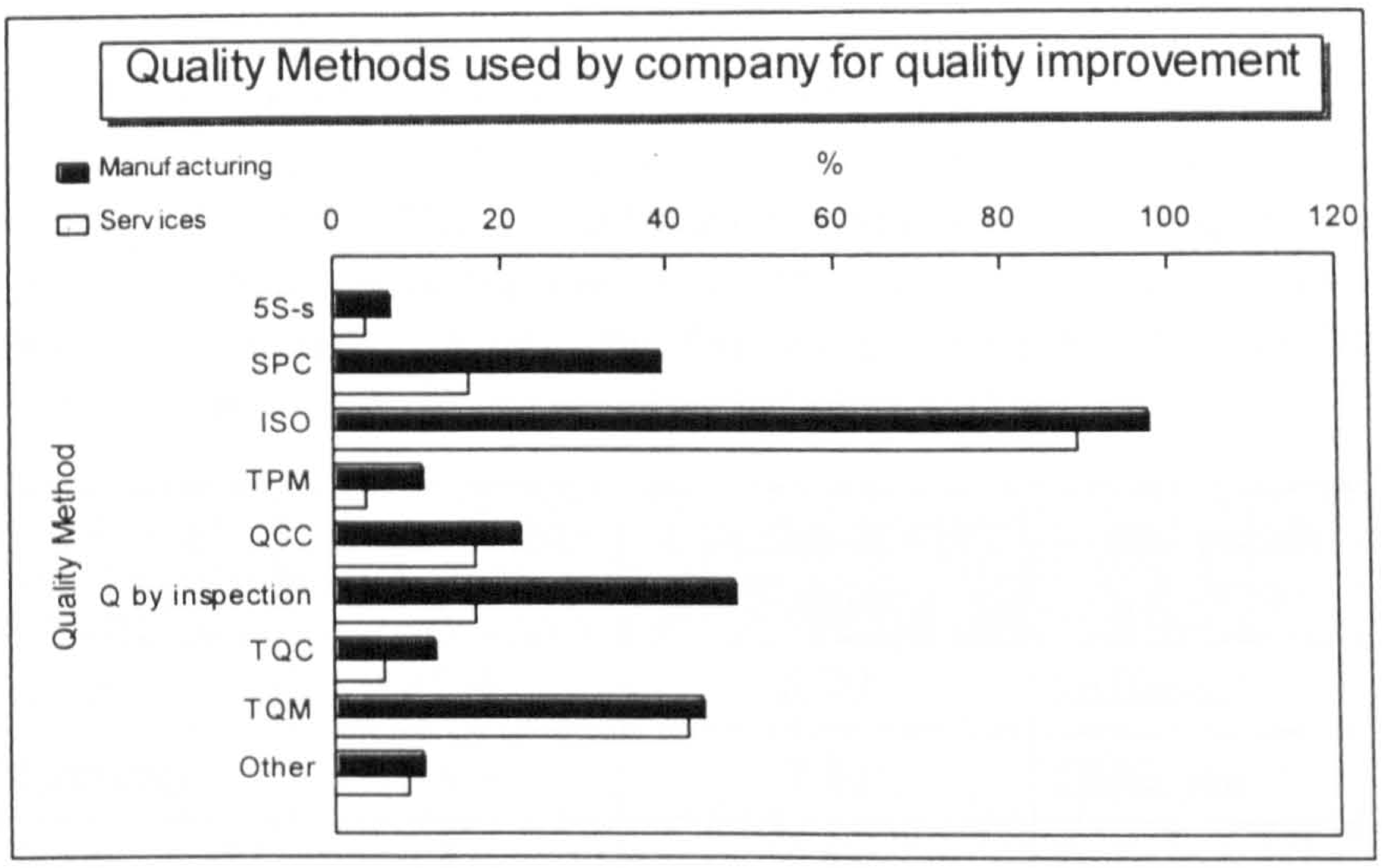


Figure 5.2 Quality processes used by company for quality improvement (UK)

Comment: Evidence from the results of the survey suggests that manufacturing company is likely have registered for ISO 9000 than service sector. Ninety six percent of manufacturing company are registered and working to ISO 9000, compared with about 20 percent of service sector. It is the most commonly known QMS that provides assurance to the customer that all products or services will reach an acceptable quality level.

5.2.4.1.6 Intervals between Quality Training

Companies were asked to indicate the frequency and intervals of training carry out on quality. Figure 5.3 shows a breakdown.

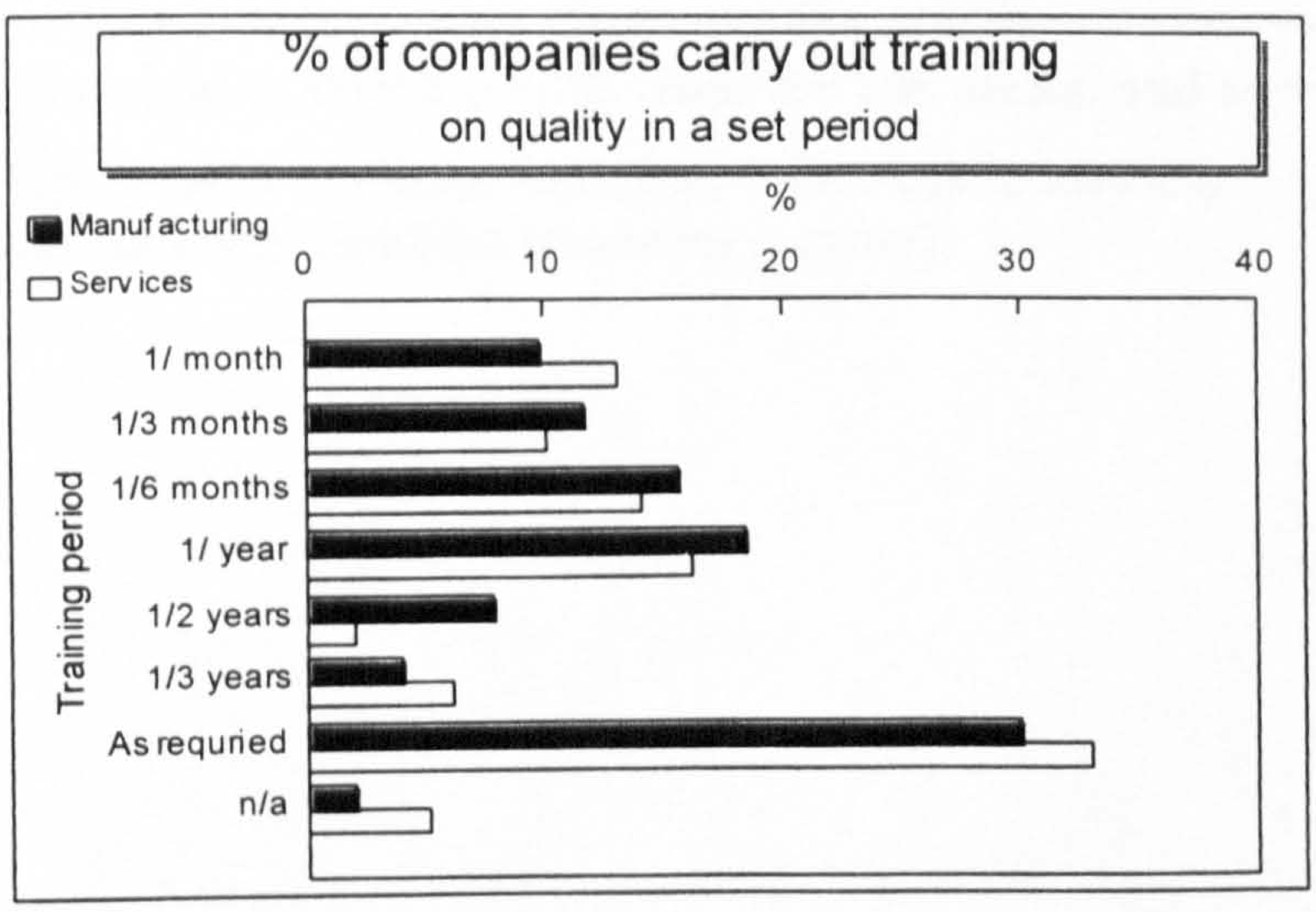


Figure 5.3 Percentage of Company carrying out training on quality in a set period (UK)

Comment: The findings indicated that while over 30% of service and manufacturing companies do not carry out training on a planned basis, about 5% have no formal training on quality.

5.2.4.2 The UK Survey Results and Analysis Part 2

The data were analysed using the ANOVA procedure (S.5.2.2) from Excel statistical software (See App.5.2.1-3). The F- test statistic was used to compare the survey results between firms in the manufacturing and services sectors. With the use of 2-way ANOVA, the differences within each set of variables were tested at 95% confidence level. A summary of the test results and conclusions is shown in table 5.3.

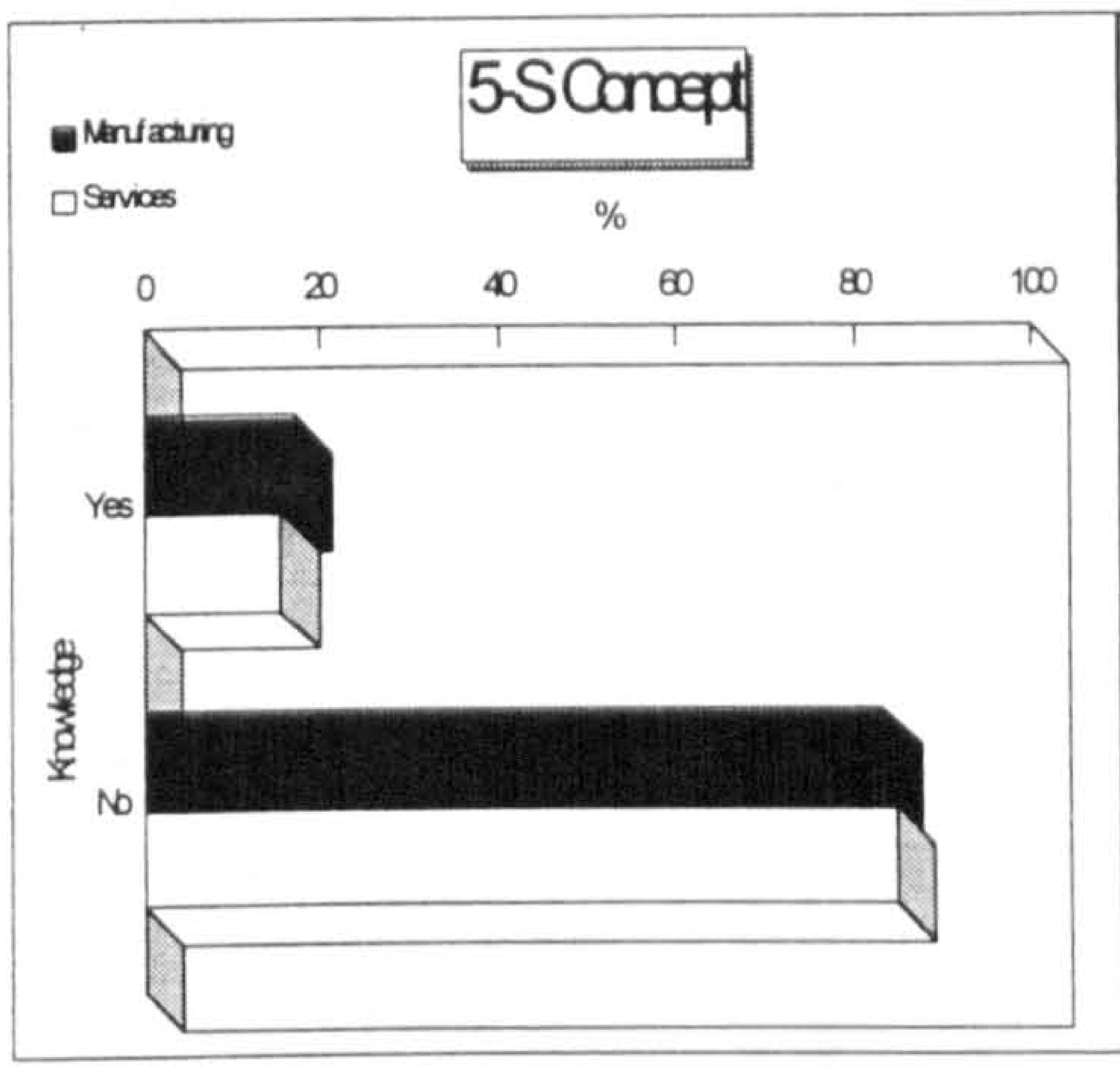
		Calculated "F" Values	**Tabulated "F" Values**	**F-test result**
5-S	Row	12.4	6.39	Different
	Column	23.3	7.71	Different
BPR	Row	17.3	6.39	Different
	Column	1.6	7.71	No difference
QCC	Row	91	19	Different
	Column	30.2	18.5	Different
ISO	Row	4.6	3.79	Different
	Column	1.7	5.59	No difference
TPM	Row	8.2	2.98	Different
	Column	10.6	4.96	Different
TQM	Row	4.7	3.18	No difference
	Column	0.9	5.12	No difference

Table 5.3 Summary of ANOVA results from the UK manu. and services industries

CM: Column Means (between Manufacturing & Services Industries)
RM: Row Means (amongst variables within each entity)

5.2.4.2.1 5-S

Figure 5.4A reveals that over 80% of the surveyed companies have not come across the 5-S concept.



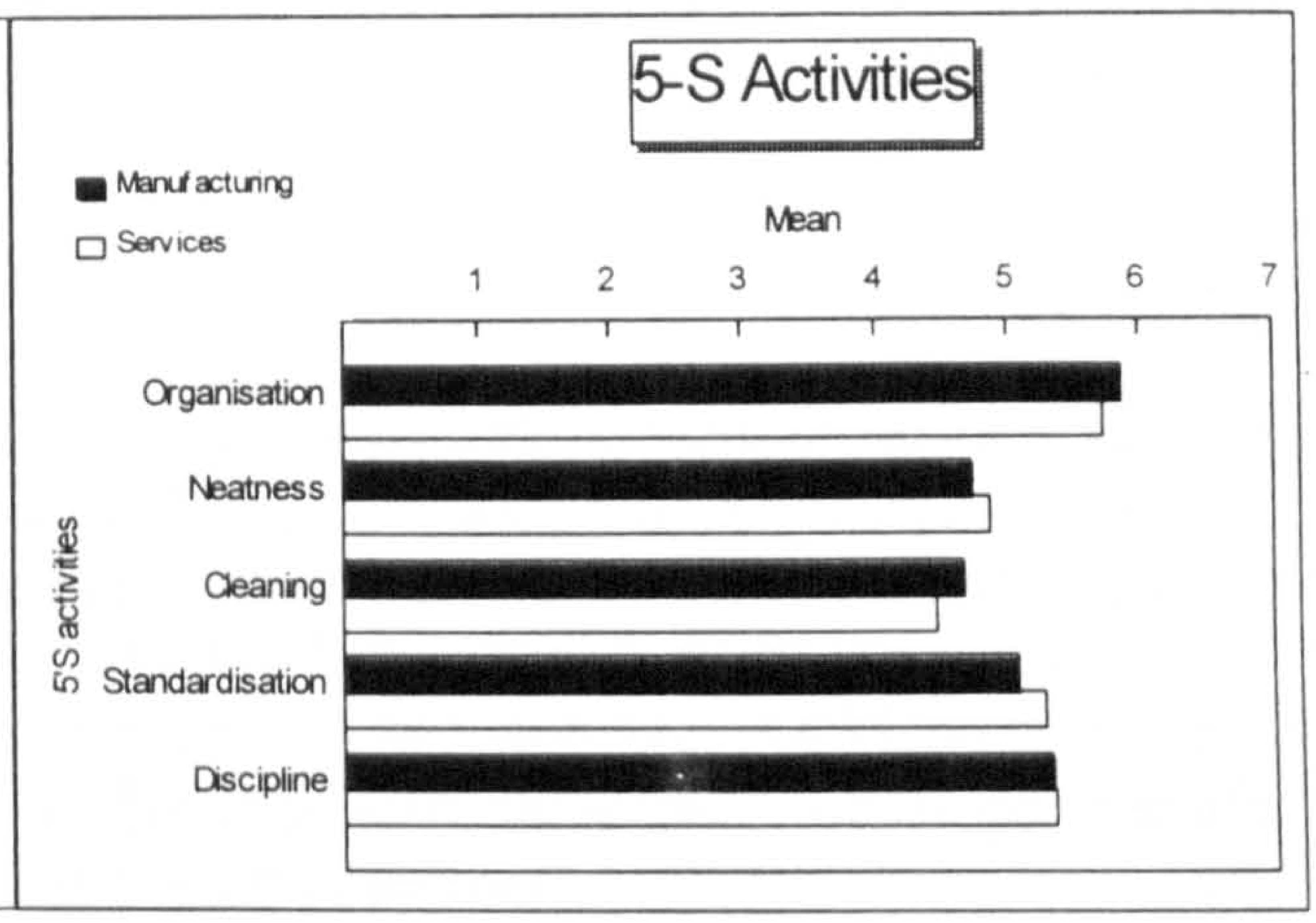


Figure 5.4A 5-S concept **Figure 5.4B 5-S activities**

Figure 5.4B shows that each of the activities has a mean between 5 and 6. When the Analysis of Variance **(ANOVA)** statistical procedure was used to test the data, it shows that services sector has a significantly greater percentage in carrying out the 5-S when compared with manufacturing. One explanation is that the majority of services have to serve their customers face to face and therefore environmental condition is important in attracting more customers. Another result from the ANOVA is that both manufacturing and services industries consider organisation as more important than cleaning and neatness.

<u>Comment:</u> From these findings, it is apparent that the majority of the UK companies practise the 5-S to some extent without realising it. It would therefore be worthwhile to formalise the 5-S practice so that more companies can implement it as a matter of course.

*5.2.4.2.2 **Business Process Re-engineering***

Figure 5.5 summarises the feedback on quality control applied to marketing, production and purchasing functions. The ANOVA results revealed that companies have put more emphasis on production/operations as the key areas for quality control, whilst paying less attention to other areas, marketing in particular. The survey finding on BPR has proved the fact the total quality marketing should require more attention by companies in the UK.

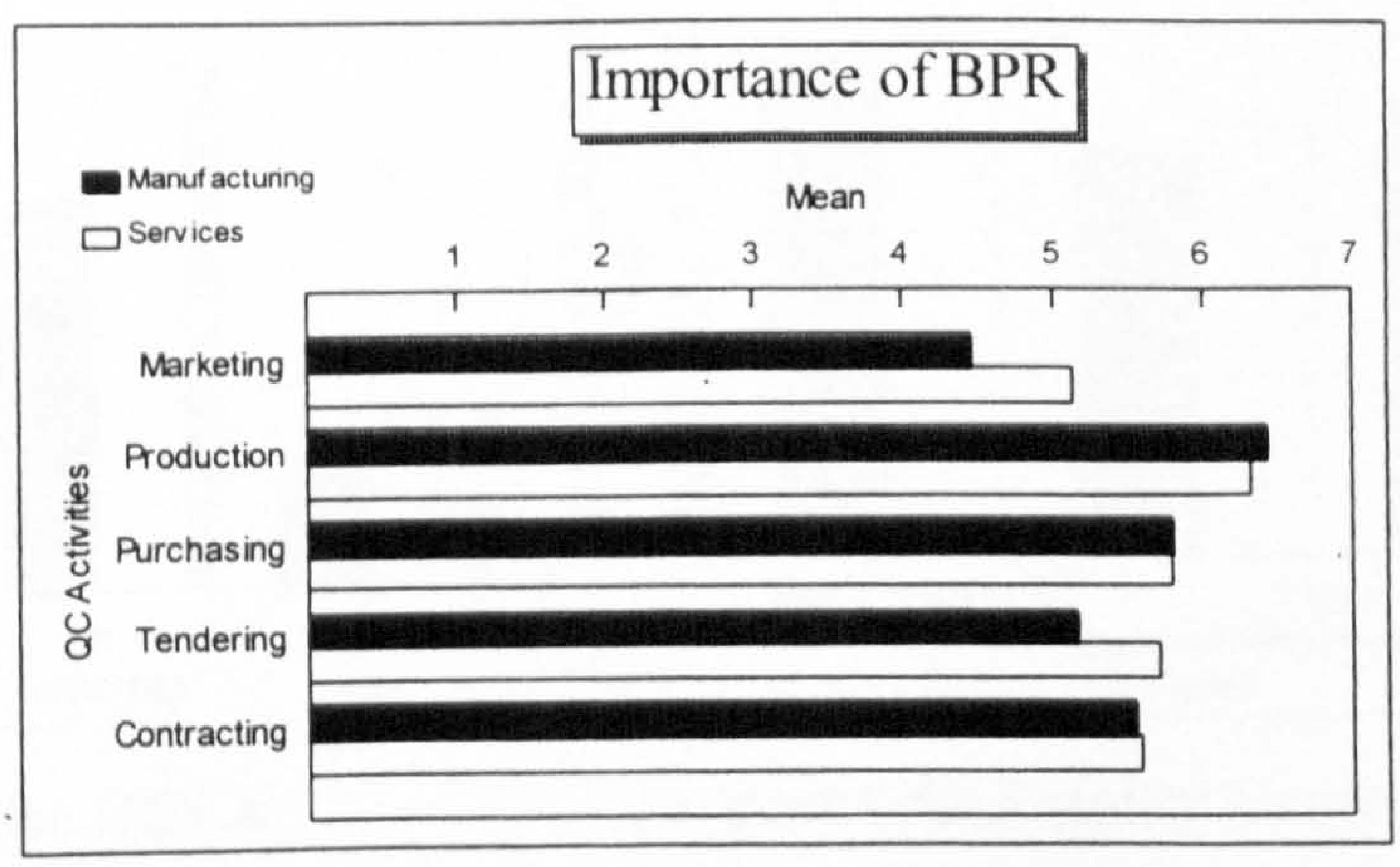


Figure 5.5 Importance of Business Process Re-engineering

Comment: There is a strong link between quality and business functions such as marketing, contracting and purchasing. In any company, the marketing and purchasing departments have the closest contact with the customers at both ends of the supply chain. Meeting the needs of the customer is what TQM is all about. Therefore it is vital for a company to review and balance their emphasis on quality control for the input (purchasing) and output (marketing) functions as well.

5.2.4.2.3 QCC

The result of the survey (Figure 5.6A) shows that 35% of manufacturing and 50% of the services companies have been practising QCCs. In half of those companies, QCCs did not make any improvement suggestions during the previous year. As for the other half, the average numbers of suggestions are 155 (in large manufacturing sector), 20 (in S&M manufacturing sector), 20 (in large services sector) and 8(in S&M services sector) per company per year (Table 5.4). The findings also indicated that large manufacturing companies have more suggestions than any other sectors.

No. of Suggestions	% of large Manu. firm practising QCC	% of S&M Manu. firm practising QCC	% of Large Service practising QCC	% of S&M Service practising QCC
0	34.4	54.5	33.3	1.9
1-50	37.5	36.4	58.3	7.5
51-100	9.4	0	8.3	0
101-150	0	9.1	0	0
151-200	6.3	0	0	0
200+	12.5	0	0	0
Mean no. of suggestion	154.5	20.8	20.6	8.4

Table 5.4 Number of suggestions generated during the last year (UK)

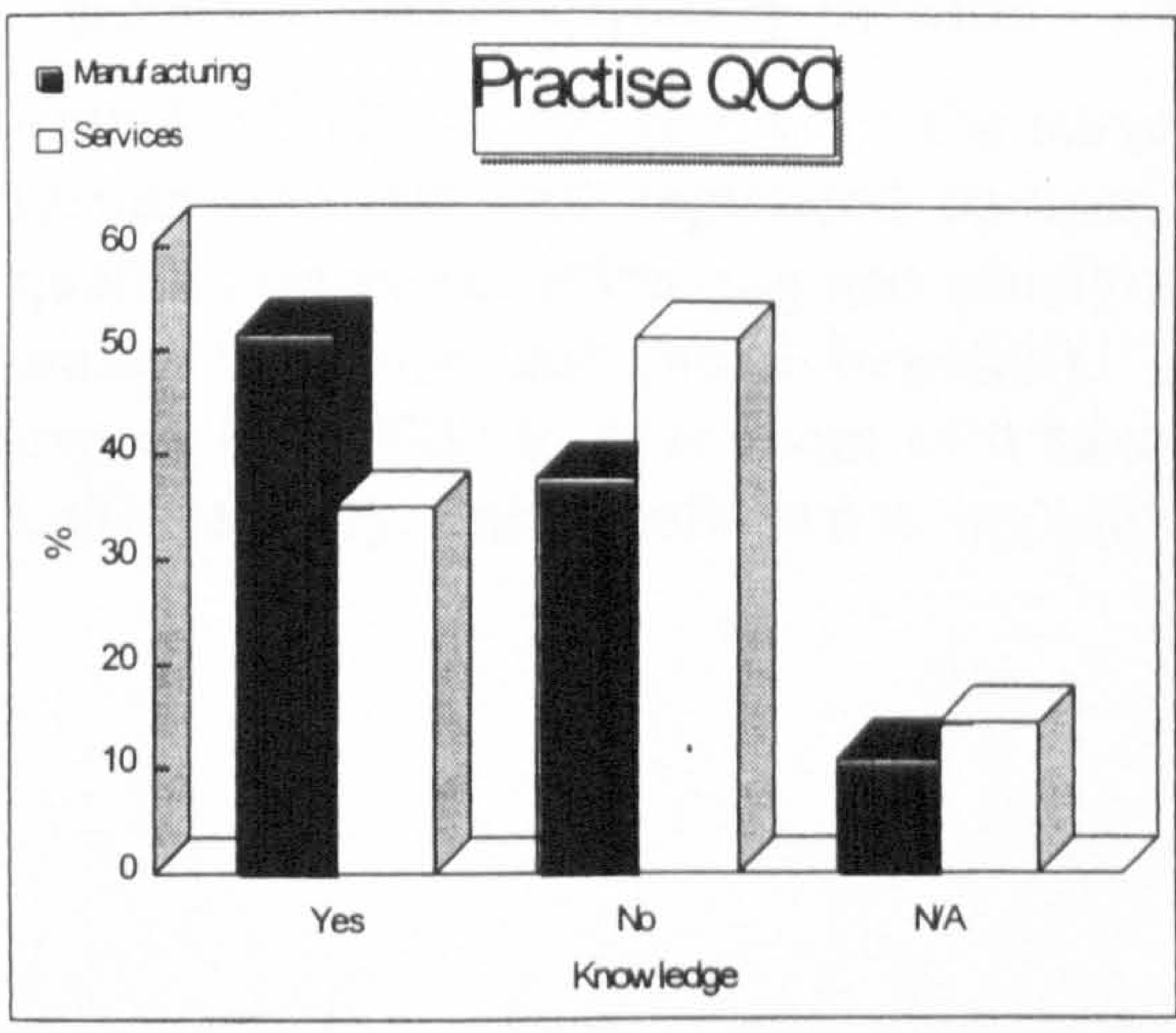


Figure 5.6A Practise QCCs

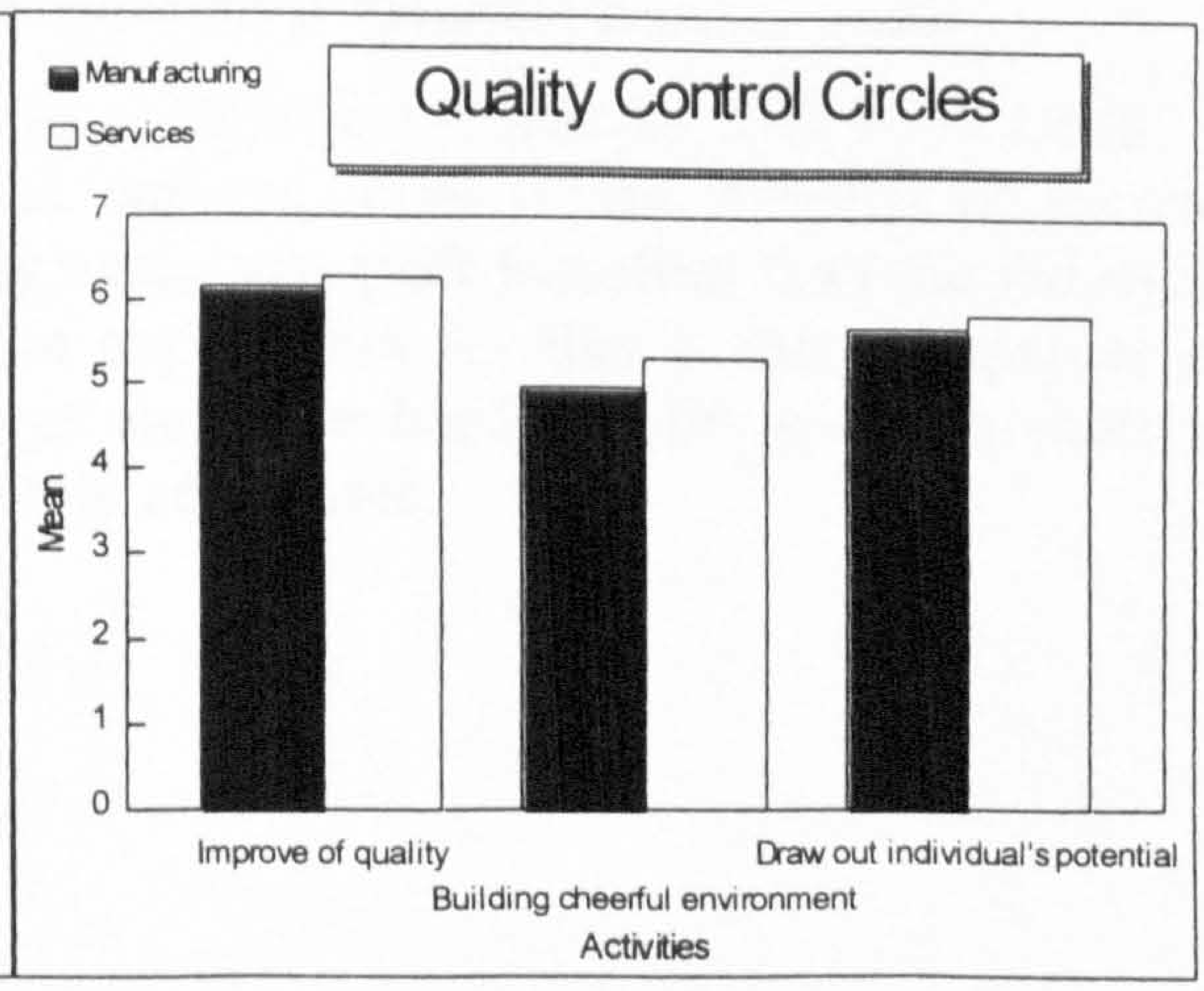


Figure 5.6B Quality Control Circles

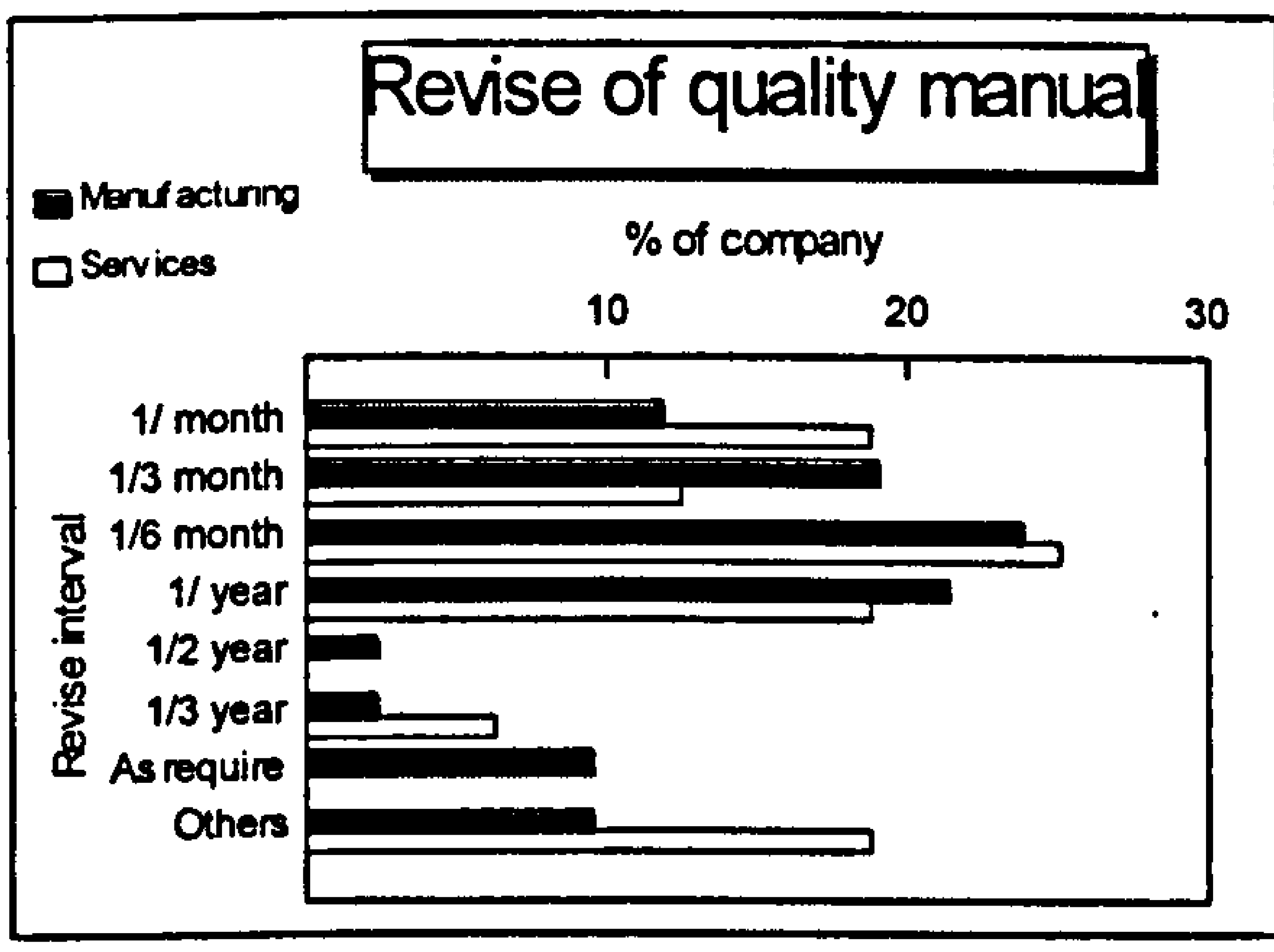
The result of the survey Figure 5.6A shows that there is a significant difference in appreciation of QCCs between the manufacturing and services sectors. The service sector views QCCs as more important because they believe that QCCs can help them to improve their service quality directly. Nevertheless, manufacturing sector sees QCC as an important tool, though somewhat less than the service sector. The ANOVA also reveals that 'improving quality' is seen as more important than 'building cheerful environment'.

According to the General Manager of an ISO 9000 registered manufacturing company, without the participation of top and middle management, QCC activities cannot be sustained. To encourage participation of all departments, the company has introduced a reward scheme for any circle that comes up with the best solutions.

<u>**Comment:**</u> Although useful to improve quality, QCCs are not widely practised in the UK. QCCs can bring about cultural change and motivate the staff to contribute to the improvement of their work. Therefore, they should deserve more attention from management and be promoted throughout the organisation.

5.2.4.2.4 ISO 9000

Figure 5.7A and 5.7B show the interval in which companies revise the quality manual and carry out internal quality audit respectively.



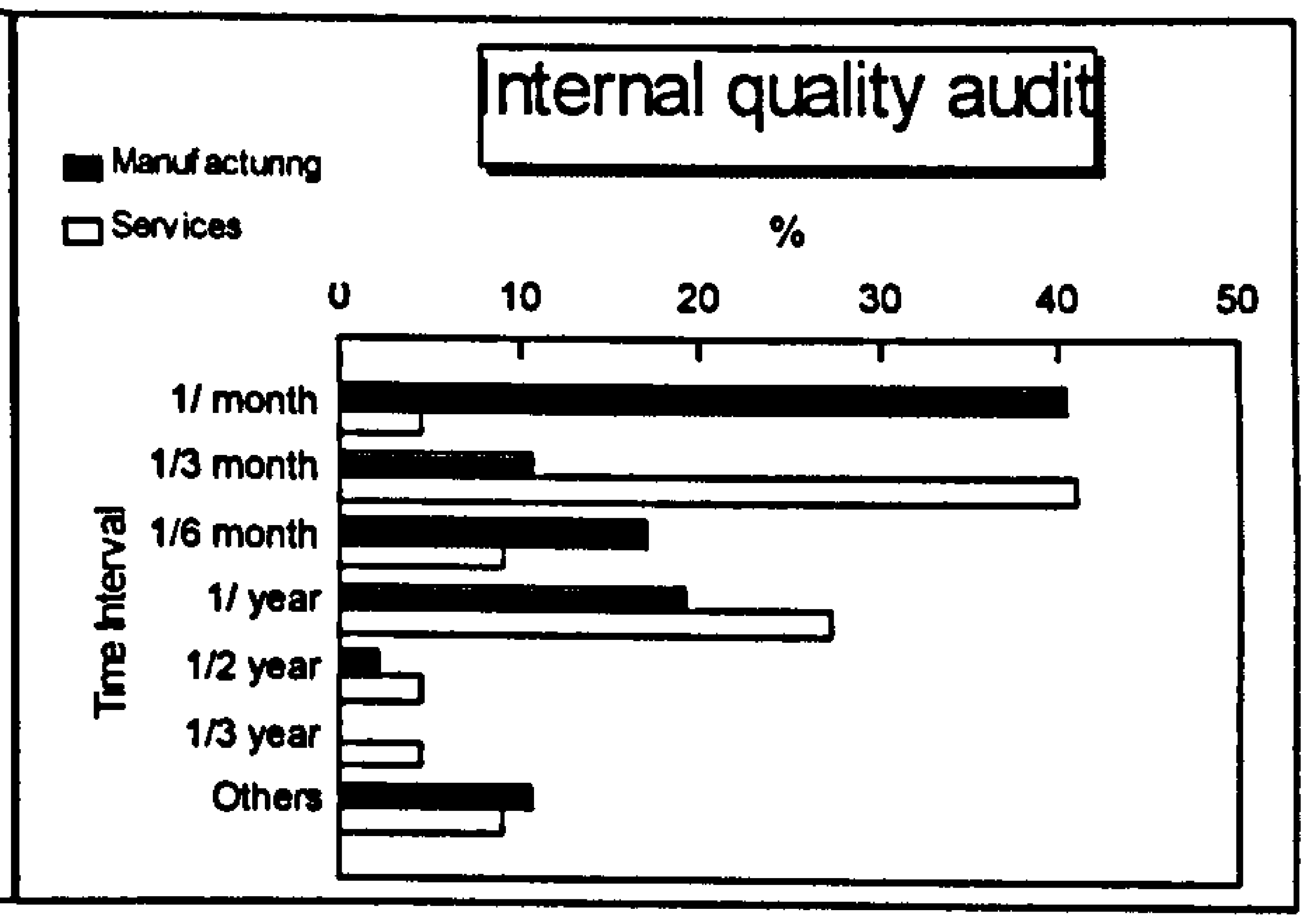


Figure 5.7A Revise quality manual **Figure 5.7B Internal quality audit**

Figure 5.8 shows the results of the survey on the effectiveness of ISO 9000 QMS. The results revealed that registered companies enjoyed more of the benefits of increasing quality awareness, attracting and satisfying customers **(soft benefits)** than the reduction of waste, time and cost **(hard benefits)**. An explanation for this is that companies often expect ISO 9000 to give them cost savings and other hard benefits within a short time. Unfortunately, this benefit is not immediately achievable.

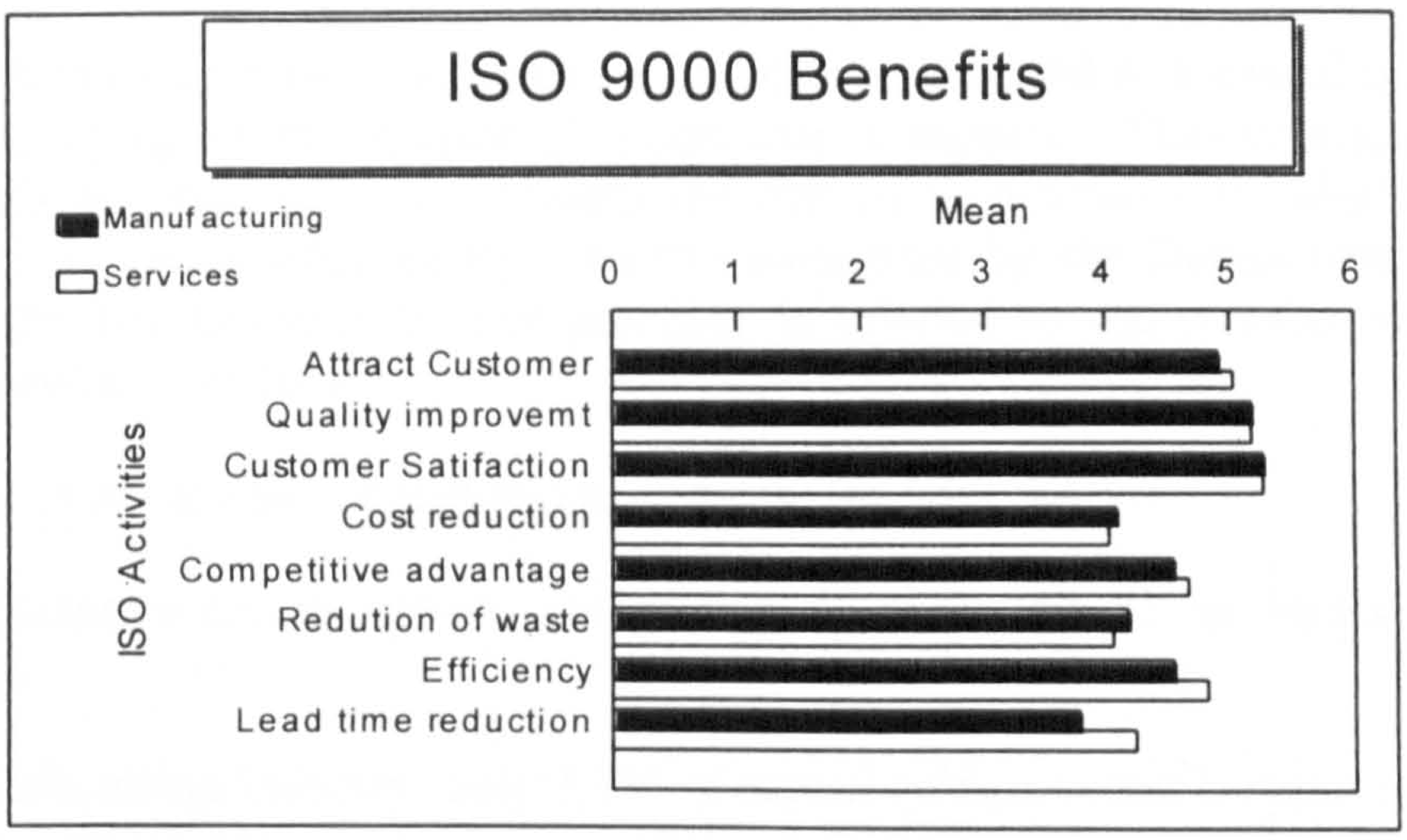
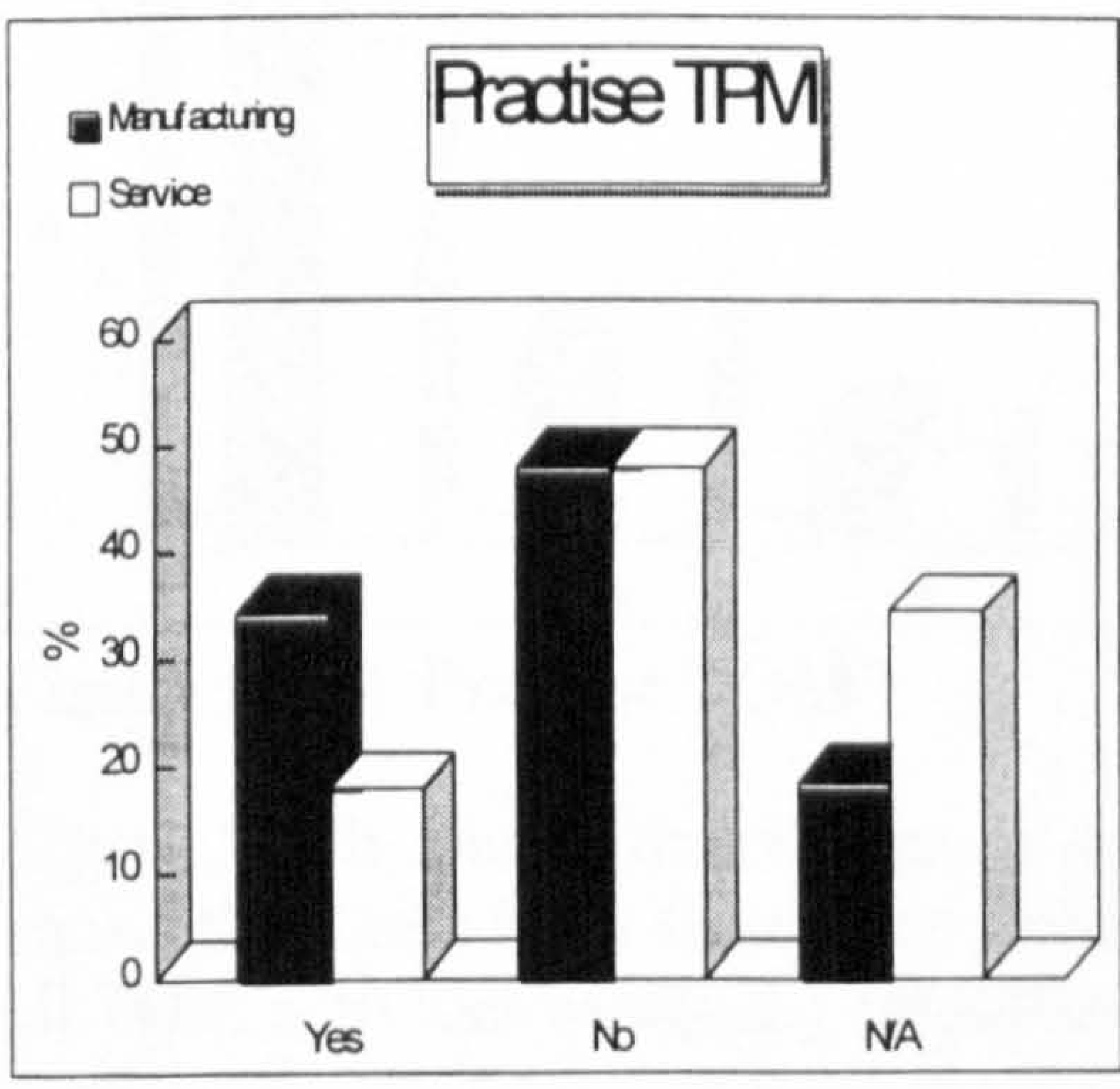


Figure 5.8 ISO 9000 Benefits

__Comment:__ In order to measure the hard benefits, suitable measuring systems, such as progress measurement, error-cause analysis, waste measurement, etc., have to be built in. In practice, companies should put the objective of satisfying customers (soft benefits) as their first priority. Then, monetary (hard) benefits will follow as a matter of course.

5.2.4.2.5 TPM

Figure 5.9A shows that about 60--70% of the companies from both manufacturing and services sectors have not practised TPM. A likely reason for this is that companies often do not know what benefits TPM could bring to them. More TPM training is therefore necessary.



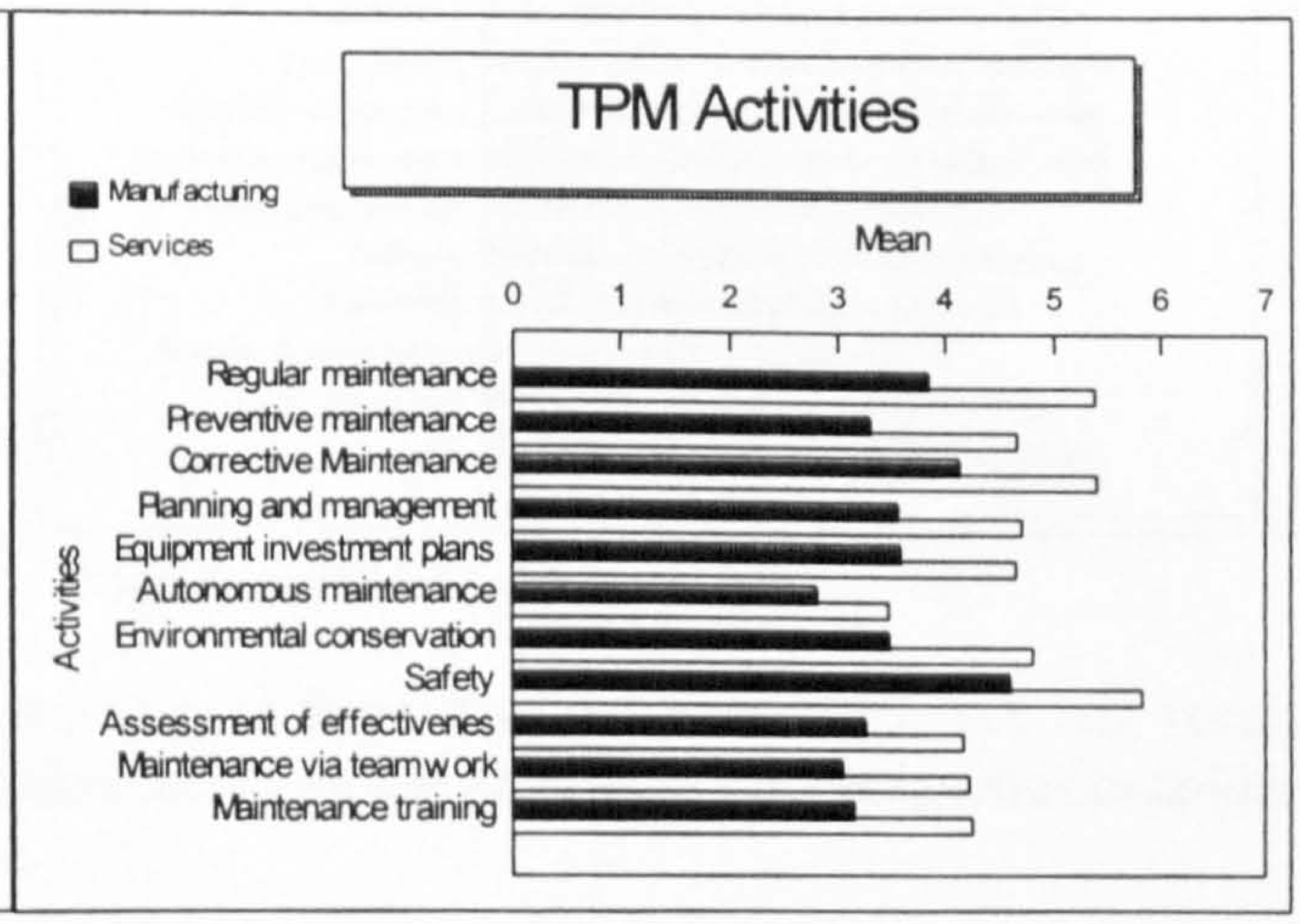


Figure 5.9A Practise TPM **Figure 5.9 B TPM activities**

Figure 5.9 B shows that there is a significant difference in the use of TPM between manufacturing and services sectors. Manufacturing employs more TPM techniques than their services counterpart. This agrees with the fact that a lot more of the services firms do not know about TPM at all. The survey results show that on average, 70% of maintenance time are spent on emergencies (fire fighting), 15% on non-critical repairs and only 15% on planned preventative maintenance.

Comment: It is evident that maintenance has been conducted in a casual manner without real effort in trying to incorporate all maintenance aspects. This is mainly due to the management's negative attitudes towards the role of maintenance in relation to business operations. This was confirmed by a survey conducted by the Department of Trade and Industry in the UK to establish best practices in relation to maintenance which came up with the following conclusions:

Maintenance is not always considered at company executive level;

Most companies seem to ignore the real cost of downtime in terms of lost sales opportunities

Within manufacturing industry, only 3.7% of annual sales revenue is spent on maintenance of operations equipment;

The survey has also concluded that with good maintenance management the above costs can be drastically reduced and plant availability increased to lead up to 30% increase in profitability.

5.2.4.2.6 TQM

Figure 5.10A shows that 70% of manufacturing and 50% of services recognised a need for TQM, apart from being registered to ISO 9000.

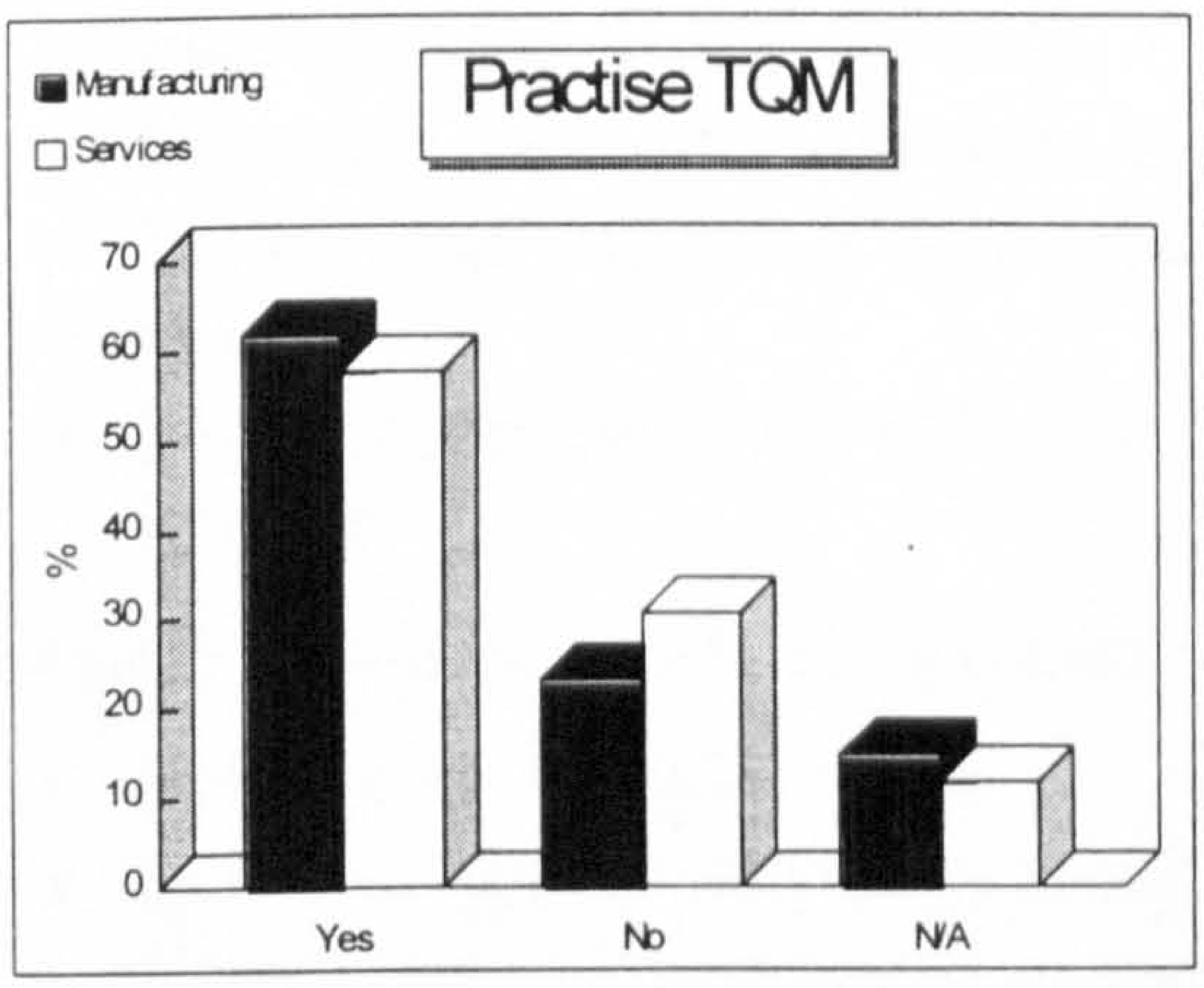


Figure 5.10A Practise TQM

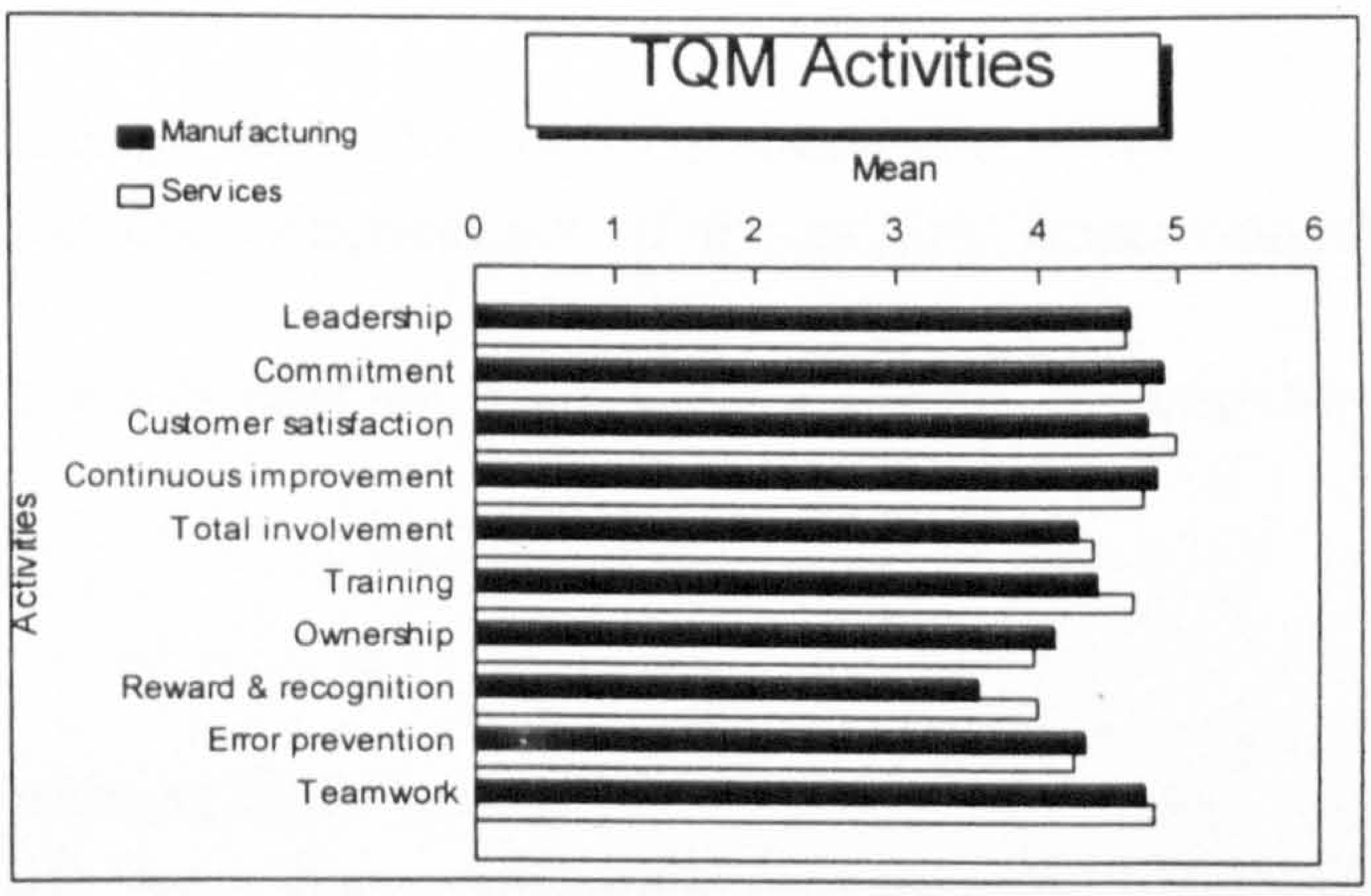


Figure 5.10B TQM activities

Figure 5.10B shows that the mean score ranges from 4 to 5.3. The ANOVA test result shows that there is no significant difference between the activities, i.e. companies consider all TQM activities as equally important.

Comment: Their average responses show that that 70% of manufacturing and 50% of services perceived a need for TQM within their organisations. Those already registered to ISO 9000 also considered that they had a need for total quality thus demonstrating the differences between the two quality orientations - one of quality control system and the other of quality culture. The reason for the average response in TQM may be because the lack of knowledge and understanding of TQM principles and many companies are still in the early stages of the TQM process.

5.2.4.2.7 Overall Quality Management Systems (UK)

The final set of questions was open-ended and encouraged opinions and suggestions on **merits, drawbacks** and **possible improvements** to company's existing QMS. The comments provided some important conclusions and recommendations to be considered by firms and they are summarised as follows.

Merits

- Some quality managers feel that their QMS provides them with better organisational structure, improves awareness of quality and commitment from top, attracts more customers, makes the company more customer oriented, provides more training, and improves image.
- The main merits of the QMS employed are to identify actual responsibilities, provide control of procedures and product quality, improve understanding of customer--supplier relationship and provide a base for TQM
- Some quality managers expect ISO 9000 to give them cost savings within a short time-period. About 10% claim quality costs reduction.

Drawbacks

- Some quality managers have difficulties in dealing with continuous paperwork, and in maintaining the system which requires a lot of human resources.
- Lack of senior management commitment and training.
- Most companies are unable to give details of drawbacks as they are still in the early stage of implementing the QMS.
- Some companies have difficulty in distinguishing between TQM and ISO 9000
- There is little emphasis on measuring the effectiveness of the quality improvement process.
- Some companies have difficulty in using cost of quality as a means of assessing progress.

Possible improvements (as quoted)

- Long term strategic thinking.
- Greater emphasis on quality-related training to all levels.
- Continuous improvement of equipment, working environment, attitudes and behaviour of people.
- More emphasis on quality circles, better policy deployment, procedure simplification and greater ownership.
- Use of Information Technology (IT) to reduce paper work and increase communication link between departments.
- Setting up operator teams to look at improvement area in their work place.
- Reduction in bureaucracy.
- More management involvement on quality cost reduction and more identifiable financial returns to increase top management commitment.
- Intention to look closely at benchmarking, value engineering and performance appraisal.

- There are no "quick fixes". The quality culture is well embedded and fairly well thought out. Better communication between QA and other department would help. Closer integration with health, safety and environmental management systems.
- Development from product quality to service levels and to increase process control and further deployment of responsibilities to lowest levels possible.
- More customer feedback, elimination of inspection, more automation of process.

Most of the possible improvements quoted above can be achieved by adopting good practices based on the TQMEX model, as discussed in (S.4.1). Perhaps the exception is the use of IT in business. Nevertheless, under BPR good marketing, production and purchasing control in modern day business, relies heavily on the proper use of IT, including computer networks and effective software.

Summarising different views from various companies will bring some light to the merits and drawbacks of quality management systems. In order to achieve excellence, all the steps in the TQMEX model are important for the betterment of quality.

5.2.4.2.8 Summary of the UK Survey Findings

Table 5.5 summarises the mean of means of the six groups of questions for both manufacturing and services industries. It is seen that the overall means for both industries is on the high side on the 7-point scale (all means are above 4, the medium of the scale). This is expected as most of the sample companies have already established their QMSs. Following the principle of continuous improvement, registered companies should aim at doing better than the means stipulated in Table 5.5. The information from this Table should also serve as a target for the unregistered companies aiming to adopt TQM principles.

When comparing the relative mean values of the 6 groups of questions, it is obvious that ISO 9000 QMS score is the lowest. This demonstrates that the companies see the ISO 9000 quality system as a passport to stay in business. On the other hand, the highest mean score is associated with QCCs. About half of the companies have practised QCCs and they strongly believe that QCCs are important for the company.

The second highest rating in the Figure is 5-S. Apparently, this is unexpected as the term '5-S' has not been widely used amongst the UK companies. However, quality companies are always concern about the 5-S constituents as a matter of course. The British are disciplined in organising their workplace in order to establish a conducive environment, the 5-S can be promoted easily and readily in the UK.

	Manufacturing: Mean of means	**Services: Mean of means**	**Weighed: Mean of means**
5-S	5.2	5.5	5.29
BPR	5.3	5.2	5.26
QCC	5.5	5.9	5.62
ISO	4.6	4.4	4.53
TPM	4.5	4.8	4.59
TQM	4.7	4.6	4.66
Overall	4.9	.5.0	4.93

Table 5.5 Mean scores for the 6 groups of questions

5.2.5 Questionnaire Survey in HK (Part 1)

The main survey was conducted during March 1995 to a random sample of 1500 HK companies. About 5 percent valid replies were obtained from the manufacturing and services industries.

5.2.5.1 Type of Business

Table 5.6 shows the questionnaire survey response from 41 manufacturing and 15 services in HK. The breakdown is as follows:

No.	Type of Industry	Percentage of Response (%)
A1	Garment or Textile	8.9
A2	Electrical Electronic	23.2
A3	Plastics, wood or Metals	1.8
A4	Mechanical Engineering or Automobile	5.4
A5	Civil Engineering or Construction	26.8
A6	Other	7.1
B1	Trading or Wholesale	7.1
B2	Retail, Restaurant or Hotel	1.8
B3	Finance or Insurance or Business Service	1.8
B4	Community, Social or personal services	0
B5	Transport or Distribution	7.1
B6	Others	8.9

Table 5.6 Percentage of response in HK

5.2.5.2 Employee Numbers and Company Age

The mean employee numbers are:

Manufacturing: 5440

Services: 857.2

The mean number of years established are:

Manufacturing: 24.9

Services: 26.1

5.2.5.3 Awareness of Quality

The mean numbers of years for awareness of quality are:

Manufacturing: 8

Services: 7.3

Awareness of Quality (No. of Years)	% of Manufacturing firm	% of Services firm
1-10	80.6	56.3
11-20	5.6	12.5
21-30	8.3	18.8
30+	5.6	12.5

Table 5.7 Awareness of quality (HK)

Comment: Table 5.1 reveals that majority of manufacturing and service firms have between one to ten years of awareness of quality.

5.2.5.4 Methods Used for Improving Quality

Figure Figure 5. 11 indicated the percentage of different method used for improving quality by HK companies.

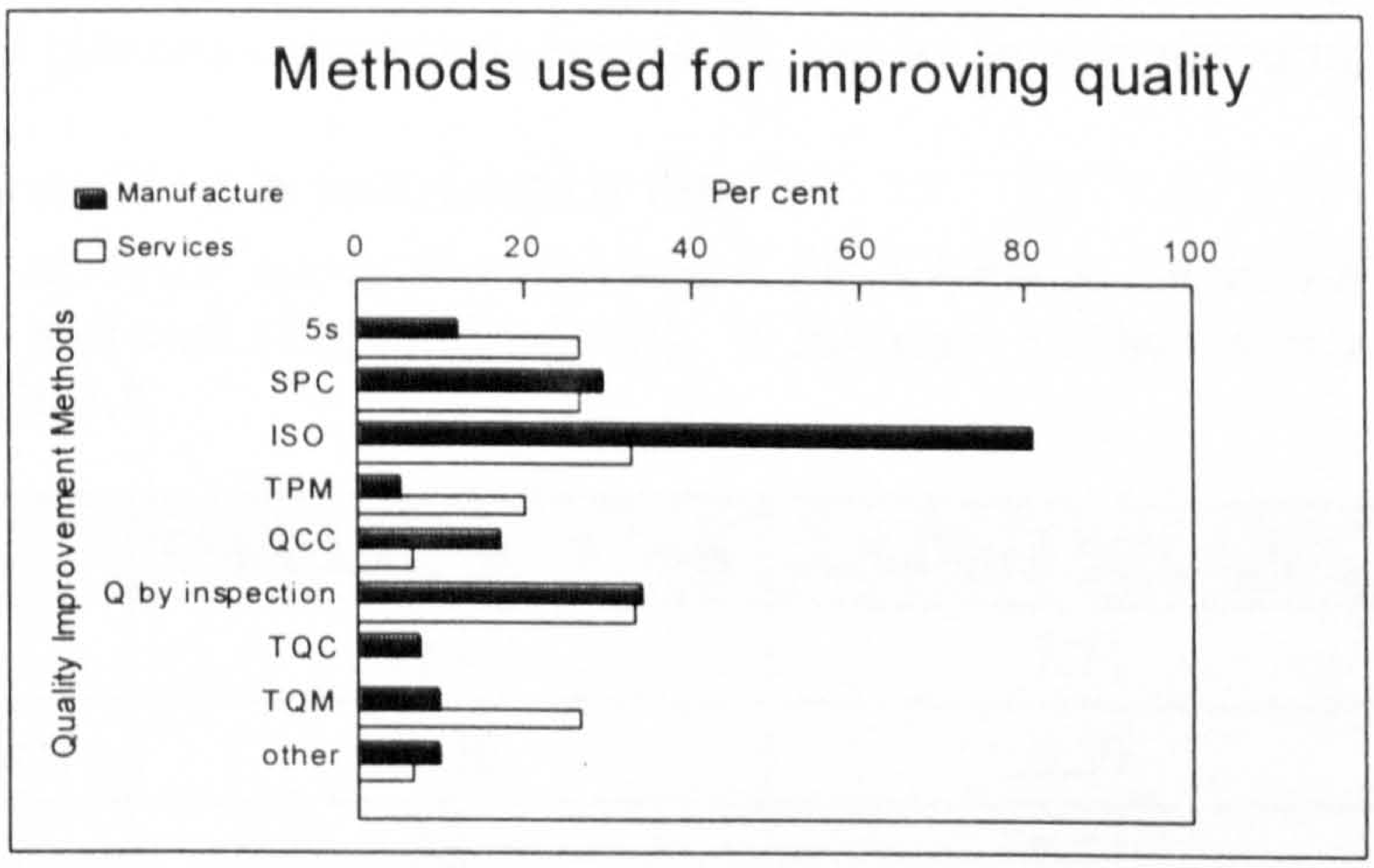


Figure 5. 11 Quality process used by company for quality improvement (HK)

Comment: Evidence from the results of the survey suggested that manufacturing company is likely have registered for ISO 9000 than service sector. Eighty percent of manufacturing company are registered and working to ISO 9000, compared with about 30 percent of service sector. Quality by inspection is relatively high in comparison with other quality improvement method.

5.2.5.5 Intervals between Quality Training

Companies were asked to indicate the frequency and intervals of training carry out on quality. Figure 5.12 shows a breakdown.

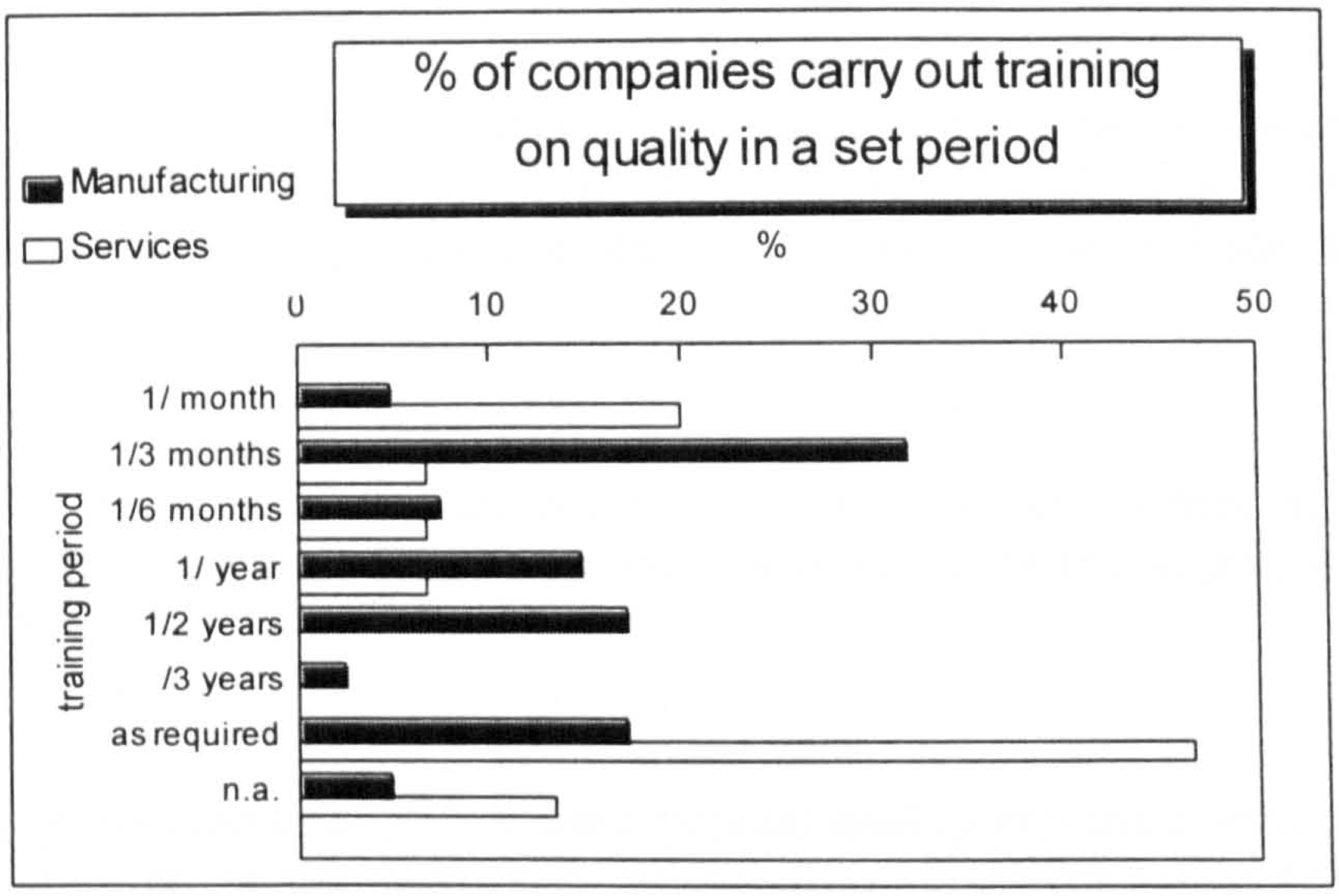


Figure 5.12 % of Company carrying out training on quality in a set period(HK)

Comment: The findings indicated that while over 45 percent of service firms do not carry out training on a planned basis as opposed to 18 percent in manufacturing firms.

5.2.5.6 HK Survey Results and Analysis Part 2

The data were analysed using the ANalaysis Of VAriance (ANOVA) procedure from Excel statistical software (See App.5.2.4-6). A summary of the test result and conclusion is shown in Table 5.8.

		Calculated "F" Values	Tabulated "F" Values	F-test result
5-S	Row	31.42	7.71	Different
	Column	2.40	6.39	No different
BPR	Row	7.53	7.71	No different
	Column	0.79	6.39	No different
QCC	Row	1.29	18.51	No different
	Column	2.59	19	No different
ISO	Row	4.00	5.59	No different
	Column	6.99	3.79	Different
TPM	Row	48.17	4.96	Different
	Column	10.18	2.98	Different
TQM	Row	6.97	5.12	Different
	Column	3.26	3.18	Different

Table 5.8 Summary of ANOVA result (HK)

CM: Column Means (between manufacturing & Services)
RM: Row Means (amongst variables within each entity)

5.2.5.6.1 5-S

The survey reveals that 85 percent of services companies and 75 percent of manufacturing companies have not been practise the 5-S.. The ANOVA result shows that both manufacturing and services companies consider organisation as more important than cleaning and neatness.

5.2.5.6.2 BPR

In comparing manufacturing and services companies, the result shows that each of the activities has a mean between 5 and 6. There is no significant difference in practising BPR between the two sector.

5.2.5.6.3 QCC

The result of the survey shows that QCC is not a popular quality process in HK, only 18% of manufacturing and 10% of the services companies have been practising QCCs. The average numbers of suggestions are 11.7 in manufacturing sector and 107 in services sector per company per year. The findings also indicated that there is no significant difference in practising the QCC activities between the two sectors.

5.2.5.6.4 ISO 9000

The ANOVA result reveals that although there are no difference in use of ISO 9000, but there is a significant difference in practise ISO 9000 between manufacturing and services sectors. Eighty percent of Manufacturing companies practise ISO 9000 as opposite to 30 percent in the services sector.

5.2.5.6.5 TPM

The emphasis of TPM for both sectors is very low (less than 20%). The result reveals that companies seem to spend most of their effort on corrective maintenance and safety, there are very little emphasis on preventive or autonomous maintenance. Also there is a significant difference in the use of TPM between manufacturing and services sectors. Manufacturing employs more TPM techniques than their services counterpart.

5.2.5.6.6 TQM

The survey result shows that 50 percent of manufacturing and 65 percent of services recognised a need for TQM. The statistical results show there is a significant difference between activities in the two sector. Companies see commitment and customer satisfaction more important than total involvement and ownership. According to many successful cases, for any TQM to work, it must involve everyone. This is what the word "TOTAL" means.

5.2.5.6.7 Overall Quality Management Systems (HK)

Merits

- Companies feel that their QMS improve there internal processes, improve employees' morale, good traceability, concise working procedures, improve communication, continuous improvements.
- The main merits are improve reputation and image, response to external change, top management support, balance productivity and quality requirement, satisfy customers.

Drawbacks

- Companies have difficulties in dealing with continuous paperwork, keeping quality management professionals, change management's attitude from traditional style of management to TQM, understand different ideas of quality management, finding the right approach for their companies.
- Lack of statistical techniques for performance monitoring, quality concept, quality improvement, training, top management commitment, recognition and reward, culture change, ownership, flexibility.
- Most companies did not found cost saving in the quality management system and rely heavily on QA department.

Possible improvement (as quoted)

- Improve equipment maintenance and calibration system
- More commitment at all levels
- The major areas to be improved include leadership, total involvement, teamwork, reward and recognition and application of SPC.
- Enforce departmental co-operation and teamwork activities
- More training and education on quality
- Simplify existing system continually
- Build a good infrastructure for information and reporting mechanism
- More expertise on how to setup a quality system
- Re-structure department to suit existing system
- Benchmarking
- TPM implementation
- 5-S implementation
- Recruitment of qualify staff to monitor the system
- Implement BPR

5.2.5.6.8 Summary of HK Survey Findings

Table 5.9 summarises the six groups of questions for both manufacturing and services sectors. It is seen that the overall means are on the high side on the 7-point Likert scale. When comparing the relative mean values of the 6 groups of questions, ISO 9000 QMS score is the lowest. A likely reason for that is companies see the ISO 9000 quality system as a passport to stay in business. On the other hand, the highest mean score is associated with QCCs. Although less than 20% of companies practise QCC, but for those that practise QCC considered it as a very important factor for successful TQM implementation.

	Manufacturing: Mean of means	Services: Mean of means	Weighed: Mean of means
5-S	5.08	5.9	5.49
BPR	5.26	6.06	5.66
QCC	5.63	5.93	5.78
ISO	4.66	4.46	4.56
TPM	4.39	4.95	4.67
TQM	4.73	4.46	4.6
Overall	4.96	5.29	5.13

Table 5.9 Mean scores for the 6 groups of questions (HK)

5.2.6 Questionnaire Survey in Japan (Part 1)

Survey on Japanese companies was conducted in January 1995 on a random sample of 1000 companies. They are selected from the "*Kompass 1994 Directory of the top 1000 firms in the UK and Japan*". The intention was to have a balance sample of companies.

5.2.6.1 Type of Business

Table 5.10 shows the questionnaire survey response from 23 manufacturing and 11 services in Japan. The breakdown is as follows:

NO.	TYPE OF INDUSTRY	PERCENTAGE OF RESPONSE
A1	Garment or Textile	2.9
A2	Electrical Electronic	17.6
A3	Plastics, wood or Metals	8.8
A4	Mechanical Engineering or Automobile	8.8
A5	Civil Engineering or Construction	11.8
A6	Other	20.6
B1	Trading or Wholesale	0
B2	Retail, Restaurant or Hotel	5.9
B3	Finance or Insurance or Business Service	2.9
B4	Community, Social or personal services	5.9
B5	Transport or Distribution	2.9
B6	Others	11.8

Table 5.10 Percentage of respond in Japan

5.2.6.2 Number of Employees and Company Age

The mean employee numbers are:
Manufacturing: 9827.6
Service: 8133.4

The mean number of years established are:
Manufacturing: 65.2
Service: 31.8

5.2.6.3 Awareness of Quality

The mean number of year that companies are aware of quality:
Manufacturing: 30
Service: 13

Awareness of Quality (No. of Years)	% of Manufacturing. firm	% of Service firm
1-10	30.4	45.5
11-20	17.4	27.3
21-30	8.7	18.2
30+	43.5	9.1

Table 5.11 Awareness of quality (Japan)

Comment: Table 5.11 reveals that about half of manufacturing firms have been aware of quality for over 30 years whereas service firms have only one to 10 years.

5.2.6.4 Methods Used for Improving Quality

Figure 5.13 indicated the percentage of different method used for improving quality by Japan companies.

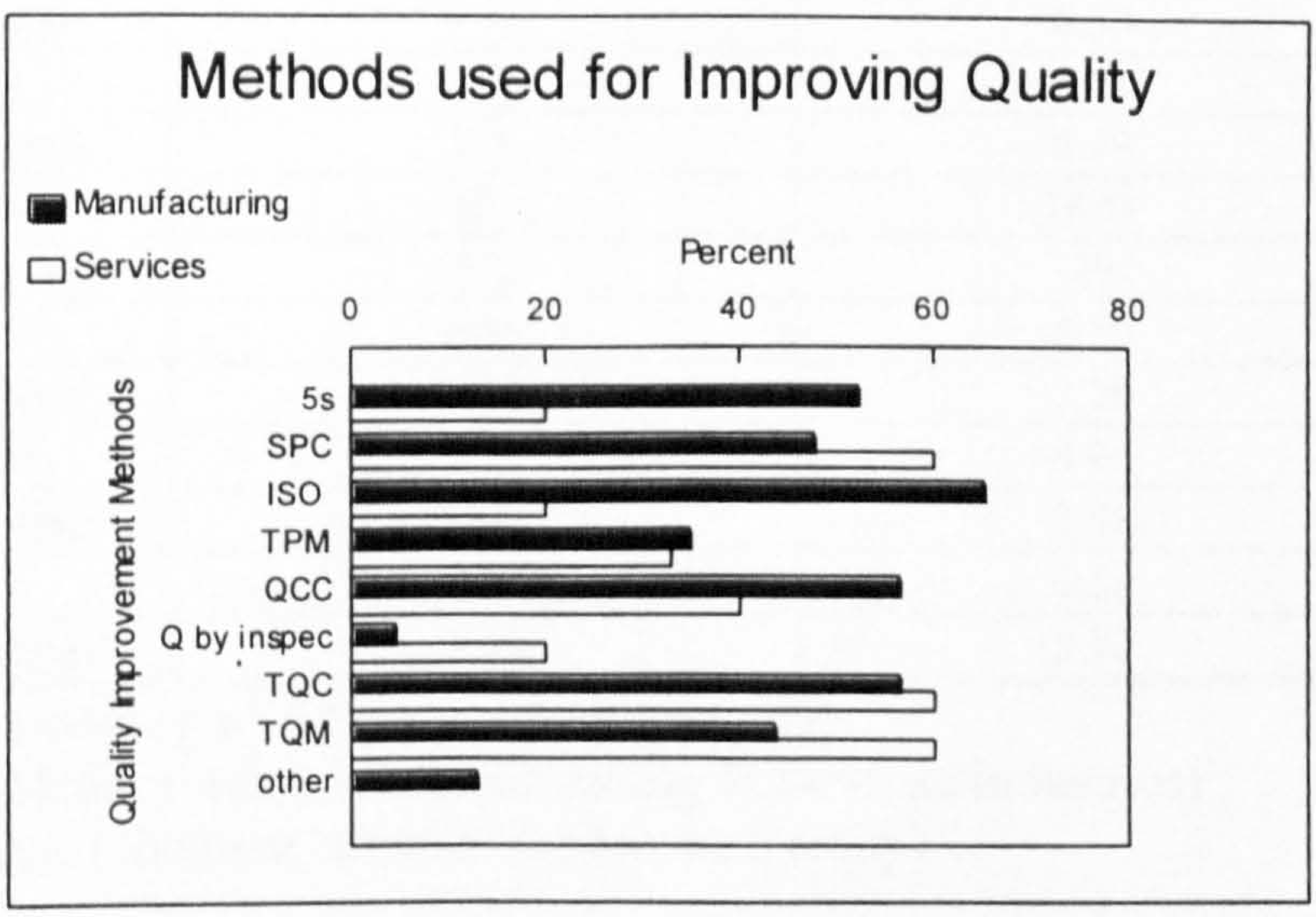


Figure 5.13 Quality processes used by company for quality improvement (Japan)

Comment: Figure 5.13 reveals that the percentage of quality processes used by the manufacturing and service companies are evenly spread across all the quality processes. Perhaps the exception of Quality by inspection. This suggested that all processes of the TQMEX model are considered by the Japanese companies as equally important. This also reveals the relevance of zero quality control and right first time.

5.2.6.5 Interval between Quality Trainings

Companies were asked to indicate the frequency and intervals of training carry out on quality. Figure 5.14 shows a breakdown

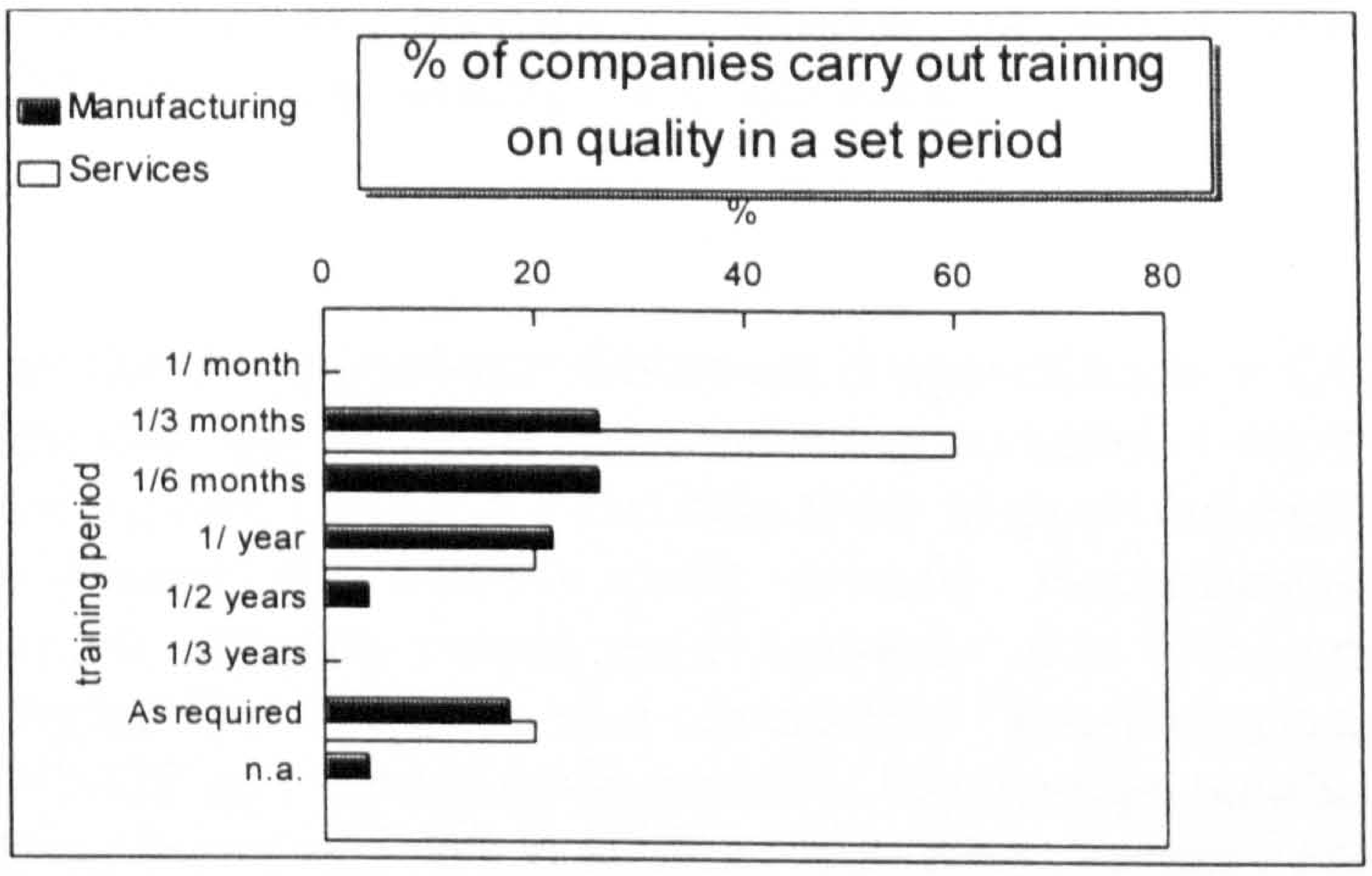


Figure 5.14 % of Company carrying out training on quality in a set period(Japan)

Comment: The findings indicated that 60 percent of the service firms carry out training on quality once every three months as opposed to 25 percent in the manufacturing firms.

5.2.6.6 The Japan Survey Results and Analysis Part 2

The data were analysed using the ANalaysis Of VAriance (ANOVA) procedure from Minitab statistical software (See App.5.2.7-9). A summary of the test result and conclusion is shown in table 5.12.

		Calculated "F" Values	Tabulated "F" Values	F-test result
5-S	Row	6.67	7.71	No difference
	Column	6.73	6.39	Different
BPR	Row	3.75	7.71	No difference
	Column	6.2	6.39	No difference
QCC	Row	121	18.51	Different
	Column	93	19	Different
ISO	Row	6.86	5.59	Different
	Column	3.02	3.79	No difference
TPM	Row	1.99	4.96	No difference
	Column	2.94	2.98	No difference
TQM	Row	1.10	5.12	No difference
	Column	3.59	3.18	Different

Table 5.12 Summary of ANOVA result (Japan)
CM: Column Means (between Manufacturing & Services Industries)
RM: Row Means (amongst variables within each entity)

5.2.6.6.1 5-S

The survey reveals that 55 percent of manufacturing companies and 20 percent of manufacturing companies have been practise the 5-S. The ANOVA result shows that each of the activities has a mean between 5.5 and 6.2. There is no significant difference in practising the 5-S activities between two sectors, i.e. companies consider all 5-S activities as equally important.

5.2.6.6.2 BPR

In comparing manufacturing and services companies, the result shows there is no significant different difference in practising BPR activities.

5.2.6.6.3 QCC

The survey reveals that this is a significant difference in appreciation of QCCs between the manufacturing and services sectors. The manufacturing companies view QCCs as more important because they believe that QCCs can help them to draw out individual potential, building cheerful environment and improve quality directly. Nevertheless, services sector sees QCC as an important tool with a mean result between 5.6 to 6, though somewhat less than manufacturing sector. The ANOVA also reveals that "improving quality" is seen as more important than "building cheerful environment". The average number of suggestions are 225 in manufacturing sector and 580 in services sector per company per year

5.2.6.6.4 ISO 9000

The result reveals that registered companies sees satisfying customer is their more important than reduction of waste or cost reduction. A likely reason is that if they put their objective of satisfying customers as their first priority. Then, monetary or (hard) benefits will follow as a matter of course. In some case this may mean reduced profit or even loss.

5.2.6.6.5 TPM

The survey reveals that about 40% of the surveyed companies in Japan have practised TPM. This shows TPM is a common practice amongst the Japanese companies. The ANOVA shows no significant difference in TPM activities between manufacturing and services sector.

5.2.6.6.6 TQM

The survey reveals that 45-60% of all the surveyed companies practised TQM. However services sector views TQM as more important because they believe that TQM can help them to improve their service quality directly. Nevertheless, manufacturing sector see TQM as an important tool, though somewhat less than the service sector.

5.2.6.6.7 Overall Quality Management Systems (Japan)

Merits

- Improvement of company constitution
- Increase of company reliability
- Expand sales by satisfying customers and increase employees' morale
- Supply the most satisfactory products, saving cost and activate the organisation
- Increased concern about own performance and achievement
- Improve employees' knowledge (let them know what they can do, should do, and must do for the company and themselves)
- We may be able to get the practice for design review and technical documentation
- Concentration of employee's consciousness towards company strategic targets in the competitive market.
- Improvement of efficiency by reducing failure rate, which results in cost reduction.
- Employee's ownership, quality improvement, shortens the delivery time.
- Top down leadership
- Consensus among senior executive. The spirit of being in the same boat. Promotion of improvement activity
- All the improving action on quality has been considered and carried out based on customer satisfaction
- Employees have worked with the concepts of market-in PDCA Cycle, more improvements achieved by QCCs
- All employees in their respective functions pledge to consider "customer first", master basic methodologies of QC, and put them into practice, as a result it can improve corporate robustness.

Drawbacks

- Some employees do not really understand TQM
- Give an influence on daily work when on the way to establish perfect QMS
- More likely to start losing cross-functional activity
- Lack of communication, complicated organisation
- Give the basic conditions to tender in the overseas market by ISO certification and keep the interest
- Weak organisation and lack of leadership
- Restructuring
- Indirect sector (white-collar staff) need to adopt TQM on a greater scale
- The way to achieve customer satisfaction could not be seen clearly.
- Head office was left behind in the improvement activities. The form of the activities rather than the content has become the objective

- Possible improvement (as quoted)
- Correct education
- Product stability for software
- Reporting system to top management and evaluation skill of top management about their subordinate
- We can get the uniformity for quality, but we may lose the individual superiority.
- Involve the meta-quality concepts such as safety, environment conservation, etc., and to deploy their targets to each division and subsidiary.
- Improvement of quality through the results of the preparation to become an ISO 9000 registered company
- Systematic policy deployment and evaluation
- Changes and improvements are ongoing.
- Emphasis on human factors, leadership by top managers, thorough customer orientation
- Comprehensive organisation in order to have co-operative teamwork and recognition.
- Create and develop our own TQM system, need understanding among line manager. TQM should be implemented by line managers, not by TQM facilitators.

TQM concepts have to be continued for the establishment of the corporate foundations under any circumstances from now on, although it is natural that the emphasis of TQM activities should be changed according to the environmental changes, for example in focus on environmental conservation, marketing strategy or employee satisfaction.

5.2.6.6.8 Summary of Japan Survey Findings

Table 5.13 summarises the six groups of questions for both manufacturing and services sectors. It is seen that the overall means are geared towards the higher side between 5.07 to 5.79 on the 7-point Likert scale. Most of the surveyed Japanese companies consider all processes of TQMEX as equally important. When comparing the relative mean values of the 6 groups of questions, QCC score is the highest. The Japanese companies believe that QCC could improve two-way communication. The management becomes more concerned with the staff problems and, in turn, the staff becomes aware of the day-to-day problems of running an organisation. Communication between departments also improves.

	Manufacturing: Mean of means	Services: Mean of means	Weighed: Mean of means
5-S	5.67	5.84	5.76
BPR	5.64	6	5.82
QCC	6.03	5.66	5.85
ISO	5.35	4.9	5.13
TPM	5.14	5	5.07
TQM	5.16	5.3	5.23
Overall	5.5	5.45	5.48

Table 5.13 Mean scores for the 6 groups of questions (Japan)

5.2.7 Comparison of the UK, HK and Japan Survey Results (Part1)

In analysing effective implementation of TQM, it is often more informative to look into how firms from more than one country operate. The advantage is that cultural, environmental and implementation differences can be compared, making it possible to highlight the merits of one country's practice over the other. This will shed light to further improvements for firms in the UK, HK and Japan.

As a result of the surveys carried out in the UK, HK and Japan, the numbers of valid replies are as shown in Table 5.14.

	UK	HK	JAPAN
Manufacturing	202	41	23
Service	103	15	11
Total	305	56	34

Table 5.14 Number of valid replies from the UK, HK and Japan

Because the survey sample size in the UK is much greater than those in HK and Japan, there are sufficient UK survey data for the comparison between SMEs and large enterprises. As for HK and Japan surveys -- only the larger enterprises are focused.

5.2.7.1 Percentage of Respondents from the Various Sectors

Figure 5.15 shows the proportion of response from the various manufacturing and services sectors.

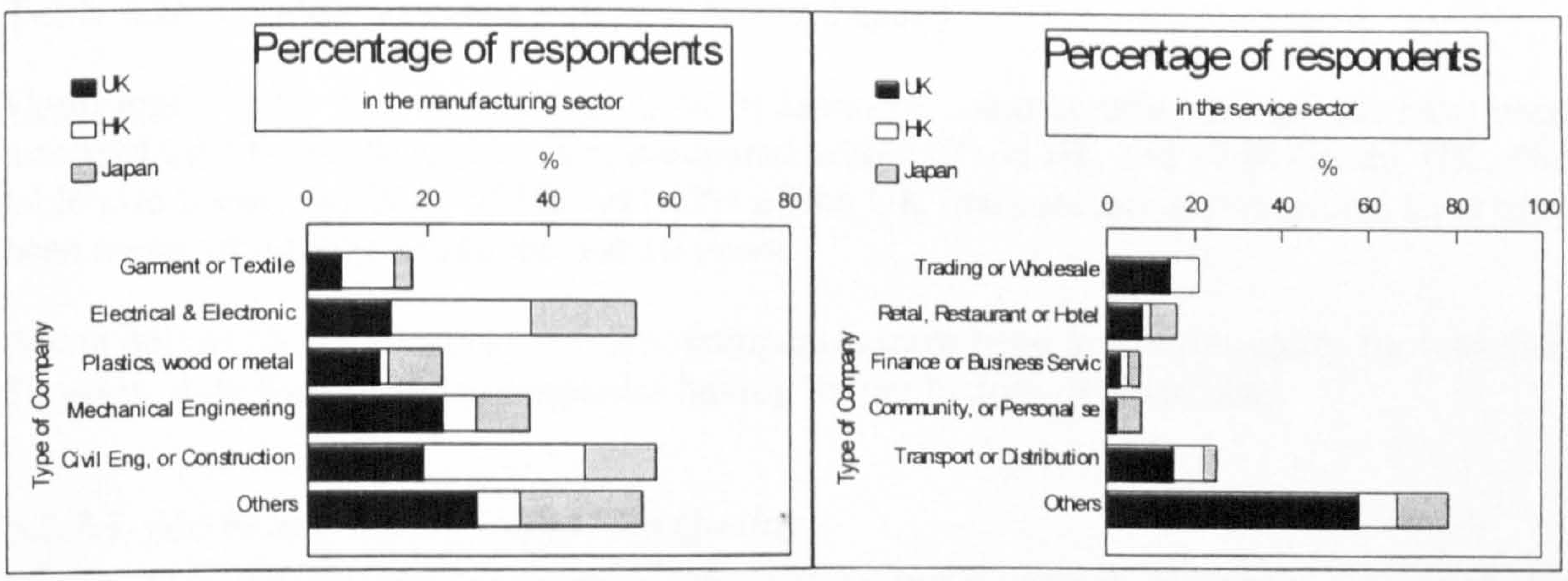


Figure 5.15 Distribution of respondents from various manufacturing and services industries (UK, HK and Japan)

5.2.7.2 Number of Employees and Company Age

Sector	No. of Employees and Company Age	UK	HK	Japan
Manufacturing	Mean employee number	1272	5440	9827
	Mean no. of years established	52.8	24.9	65.2
Service	Mean employee number	2670	857	8133
	Mean no. of years established	38.6	26.1	31.8

Table 5.15 No. of employees and company age (UK, HK and Japan)

5.2.7.3 Quality Awareness

The mean numbers of years that companies have awareness of quality are:

Quality Awareness (No. of years)	% of UK Firms		% of HK Firms		% of Japanese Firms	
	Manu.	Services	Manu.	Services	Manu.	Services
1-10	42.6	76.5	80.6	56.3	30.4	45.5
11-20	25.7	12.2	5.6	12.5	17.4	27.3
21-30	13.9	5.1	8.3	18.8	8.7	18.2
30+	17.8	5.1	5.6	12.5	43.5	9.1
Mean	19.2	35	8	7.3	30	13

Table 5.16 Quality awareness (UK, HK and Japan)

Comment: Table 5.16 reveals that 43 % of Japanese manufacturing companies have been aware of quality for about 30 years, compared with 5.6% in HK and 17.8% in the UK. The table also shows that 80% of HK and 42% of the UK manufacturing companies have only been aware of quality within the last 10 years.

About half of all the surveyed services companies have been aware of quality for less than 10 years, with the Japanese companies having longer history of awareness.

5.2.7.4 Methods Used for Improving Quality

Figure 5.16 shows the proportion of quality improvement methods employed by companies in the UK, HK and Japan.

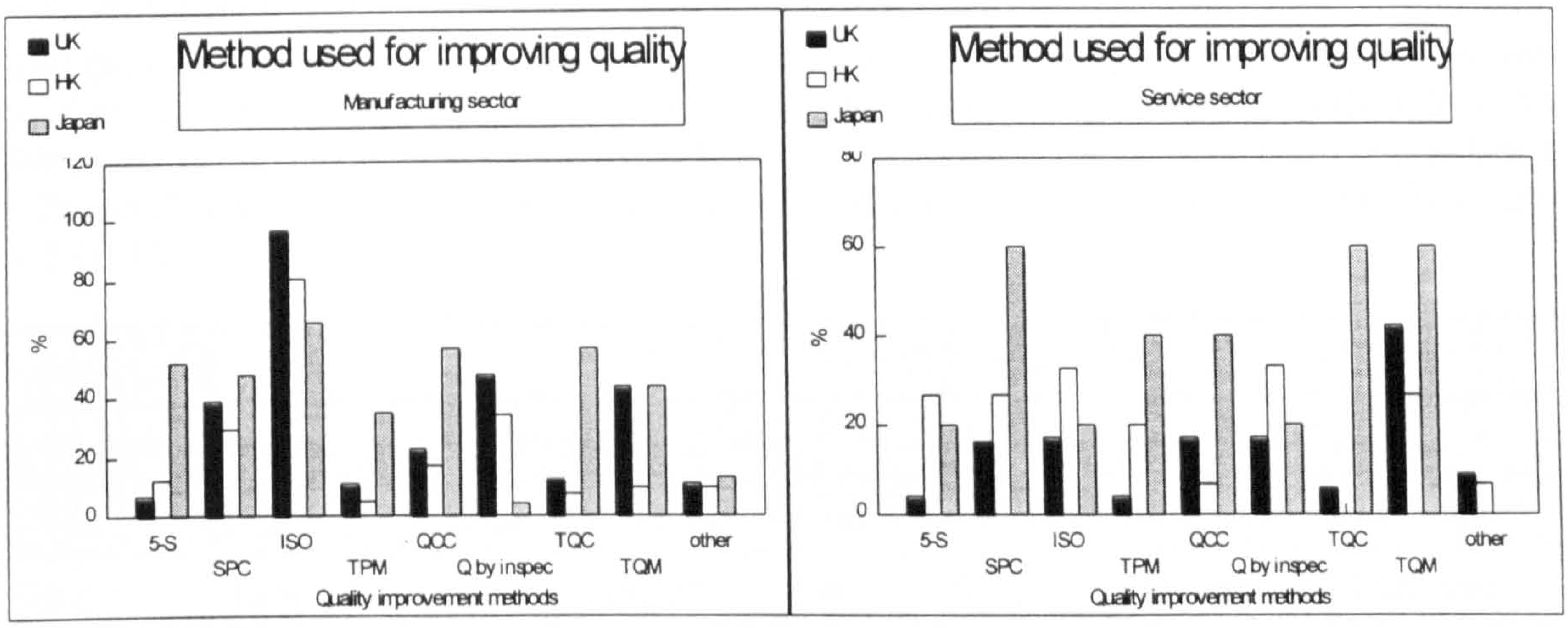


Figure 5.16 Method used for improving quality (UK, HK and Japan)

__Comment:__ Figure 5.16 reveals that among all the quality processes, 5-S and TPM are neglected by most HK and UK manufacturing companies. Over 80% of them have not come across the 5-S and TPM concepts. On the other hand over 50% and 40% of the Japanese companies have practised the 5-S and TPM respectively. The result also shows that 60% of Japanese companies practise QCC as oppose to 20% in the UK and HK. Furthermore about 40% of the UK and HK manufacturing companies use inspection as a means for control quality. Japanese companies recognised that good quality can minimise the inspection requirement. They believe in improving the process so that they will produce progressively less non-conforming product and eventually none. In the service industry, the difference between Japan and HK/UK is even more obvious. Japanese services firms have used significantly more on all scores, except the "Quality by Inspection" and ISO 9000 (because they have not taken it on board until lately).

5.2.7.5 Intervals between Quality Training

Figure 5.17 shows the time intervals between training on quality.

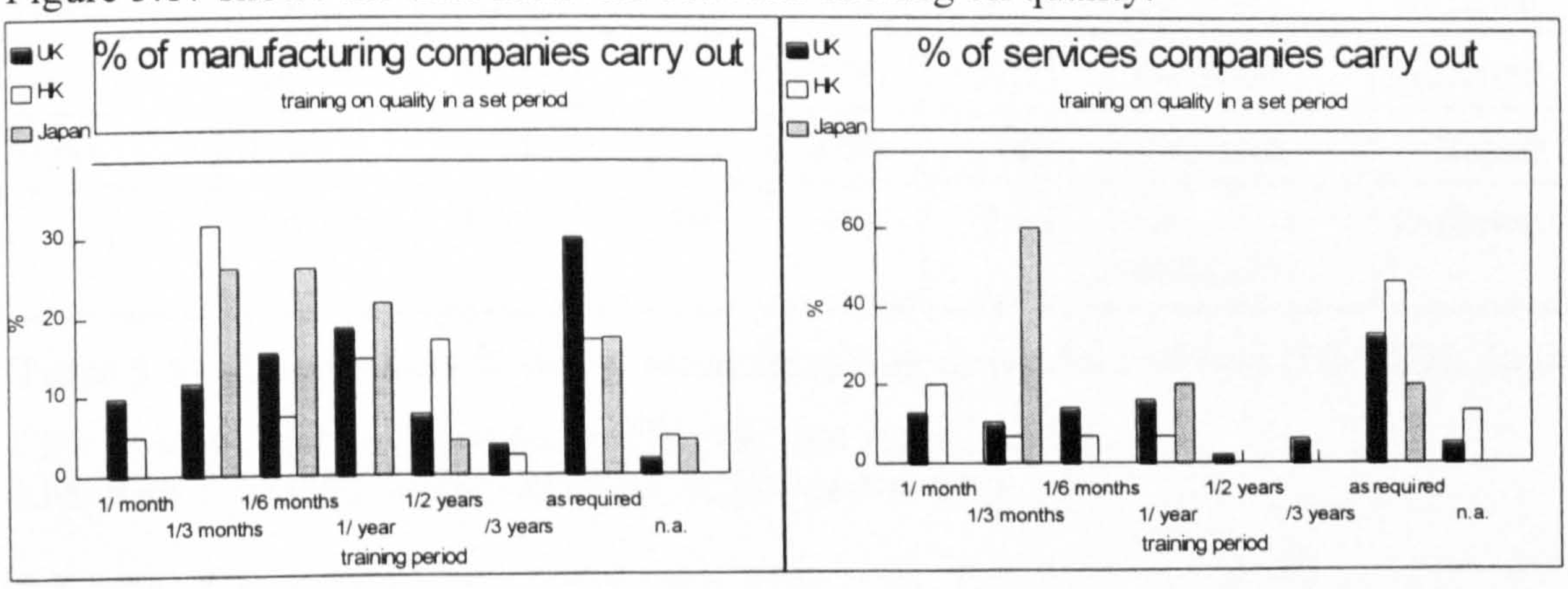


Figure 5.17 Percentage of firms carrying out training on quality (UK, HK & Japan)

__Comment:__ Figure 5.17 reveals that in the manufacturing industry, both the UK and HK firms have more frequent quality related training than their Japanese counterpart. The reverse is true for the service sector. This could be because the employees in the Japanese manufacturing sector are already very quality conscientious. On the other hand, their service quality is generally perceived as the most demanding in the world. Inevitably, training is repeatedly emphasised (60% having quarterly training).

5.2.7.6 Comparison between the UK, HK and Japan Survey Results (Part 2)

The data were analysed using the ANOVA statistical procedure. The F-test statistic was used to compare the survey results between manufacturing firms in the UK, HK and Japan. With the use of 2-way ANOVA, the differences within each set of variables were tested at 95% confidence level. A summary of the test result is shown in Table 5.17 (See App. 5.2.10-15).

		"F" Values					
Activities	**Mean**	**Calculated**		**Tabulated**		**F-test Result**	
		Manu.	**Services**	**Manu.**	**Services**	**Manu.**	**Services**
5-S	Row	9.75	26.00	4.46	4.46	Different	Different
	Column	7.13	7.05	3.84	3.84	Different	Different
BPR	Row	1.13	1.59	4.46	4.46	No difference	No difference
	Column	3.78	3.59	3.84	3.84	No difference	No difference
QCC	Row	1.68	1.23	6.94	6.94	No difference	No difference
	Column	2.95	13.30	6.94	6.94	No difference	Different
ISO	Row	16.94	3.07	3.74	3.74	Different	No difference
	Column	2.63	9.41	2.76	2.76	No difference	Different
TPM	Row	16.92	8.46	3.49	3.49	Different	Different
	Column	9.66	4.04	2.35	2.35	Different	Different
TQM	Row	7.74	32.03	3.55	3.55	Different	Different
	Column	2.20	7.56	2.46	2.46	No difference	Different

Table 5.17 Comparison between manufacturing & services sectors (UK, HK, Japan)

CM: Column Means (between the UK, HK and Japan)
RM: Row Means (amongst variables within each entity)

5.2.7.6.1 5-S

The ANOVA results show that both manufacturing and services companies consider organisation as more important than neatness and cleaning. Another result reveals that Japanese and HK companies have a significantly greater percentage than the UK in carrying out the 5-S in the manufacturing industry. In the service industry, the Japanese firms are more conscious about 5-S than both the UK and UK.

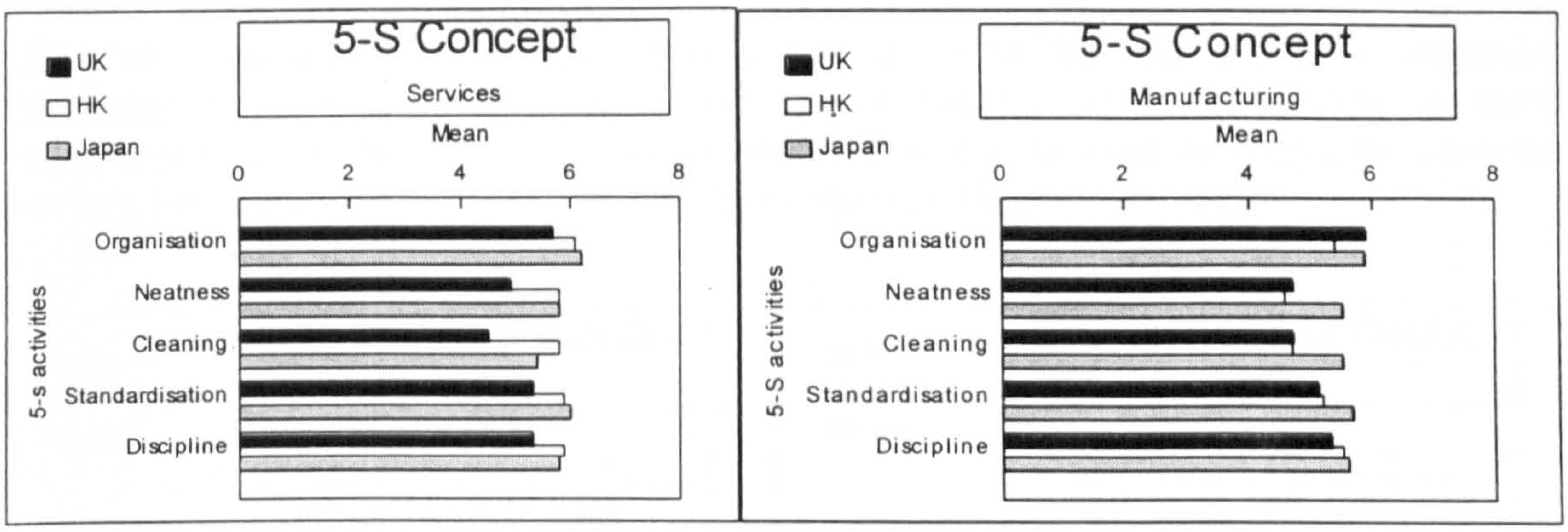


Figure 5.18 5-S activities (UK, HK and Japan)

__Comment:__ It is not surprising to find that the Japanese manufacturing and services firms have higher scores in 5-S because it was started in Japan. Moreover, the Japanese manufacturing sector has equally distributed mean scores on all the 5-S activities. This shows Japanese they consider all the 5-S activities as equally important. HK manufacturing industry has a higher score than the UK because the 5-S has been promoted to the manufacturing firms in HK for many years by both the HK Productivity Centre and the HK Government Industry Department. Nevertheless, the fact that UK firms score relatively high indicates that 5-S is being practised to some extent by many organisations, although they may not have heard of the term 5-S.

5.2.7.6.2 BPR

Although not significant at 95% confidence, the ANOVA result reveals that there is a marginal difference in carrying out BPR in the manufacturing sector for three countries.

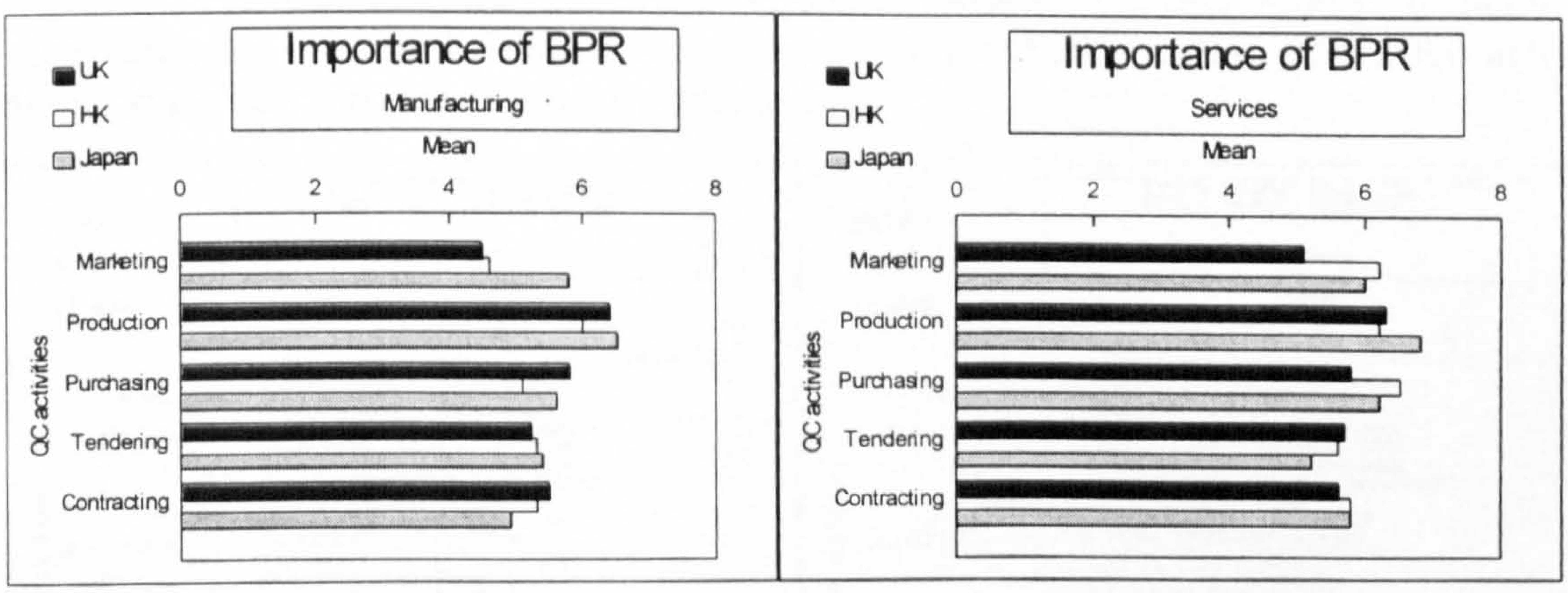


Figure 5.19 Importance of Business Process Re-engineering (UK, HK and Japan)

Comment: The result suggests that Japanese companies see BPR as a means for them to sustain competitive edge. This could be done by balancing the resources and emphasising in marketing, purchasing and other business functions as well as production. It is interesting to see that production/operations is leading the other BPR areas, possibly because quality managers see this function has more scope for improvement. The Japanese manufacturing industry considers marketing significantly more important than the UK and HK.

5.2.7.6.3 QCC

There is a no difference in the appreciation of QCCs between the two industries. Furthermore, there is no difference across countries in the manufacturing industry. Nevertheless, from the difference across countries in the services industry, the Japanese services firms view QCCs as marginally less important than the UK and HK.

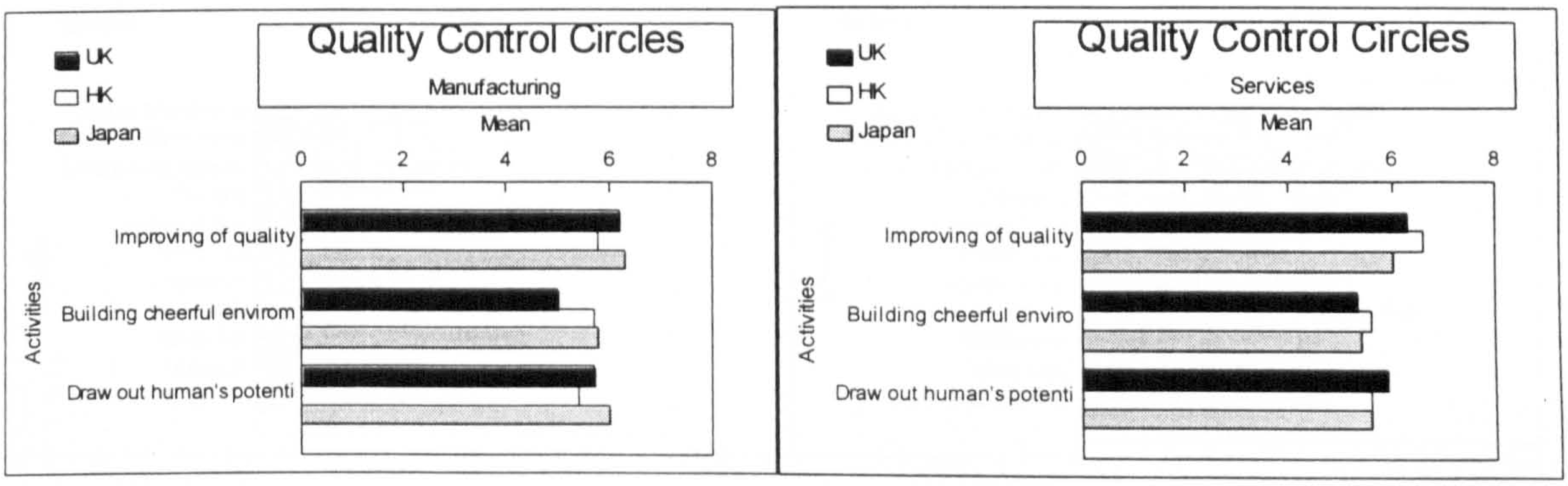


Figure 5.20 Quality Control Circles (UK, HK and Japan)

Comment: Many would agree that the Japanese service industry experience the highest demand in the world by their customers. This does not explain why their QCC activities are rated lower than the UK and HK. The reason for this disparity is that most Japanese firms practise QCC but much lesser firms in the other two countries have done so. Therefore for the more devoted firms in the UK and HK, they tend to rate the QCC activities higher than the average Japanese services firms.

5.2.7.6.4 ISO 9000

Figure 5.21 reveals that there are some difference between the ISO 9000 elements for the manufacturing industry. Furthermore there are some differences in ISO 9000 activities amongst the services firms in the three countries.

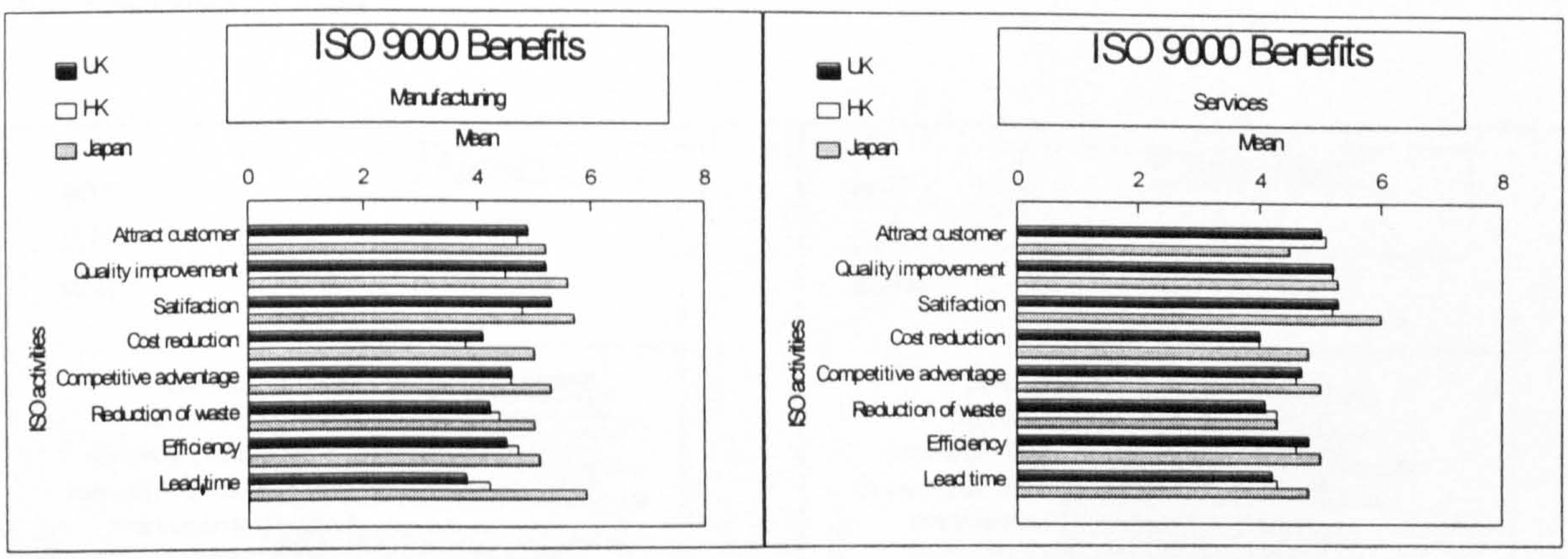


Figure 5.21 ISO 9000 benefits (UK, HK and Japan)

Comment: The manufacturing sector sees satisfying customer and quality improvement as more important than the other ISO 9000 contributions. It is worth-mentioning that the Japanese manufacturing firms see lead-time reduction more importantly than there UK and HK counterparts. In the services industry, the Japanese companies see satisfying customer as the most important factor.

5.2.7.6.5 TPM

The results of the survey (Figure 5.22) reveal significant difference in TPM activities between Japan, HK and the UK for both industries.

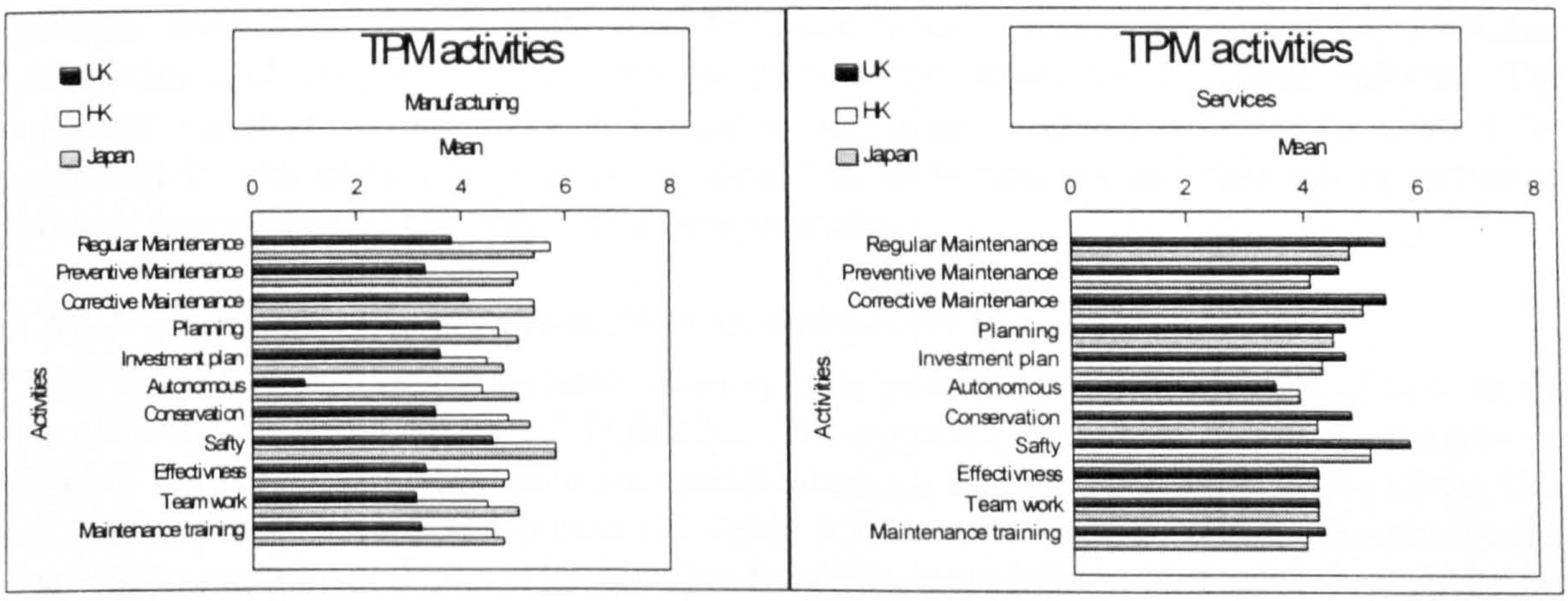


Figure 5.22 TPM Activities (UK, HK and Japan)

__**Comment:**__ The Japanese and HK companies have higher means in most TPM activities in the manufacturing industry. The reverse is true for the services industry. One point worth highlighting is the autonomous maintenance which is considered by the Japanese firms as crucial for TPM. It involves engineers and operators coming together to discuss and improve the efficiency and effectiveness of the equipment. The UK companies have to put in more effort to improve their TPM by improving their equipment and facilities for the manufacturing. Through these TPM activities, companies can establish a more effective relationship between operators and machines, and maintain equipment in the best possible condition.

5.2.7.6.6 TQM

Figure 5.23 shows that there are some differences in the TQM activities for both industries. Furthermore, Japanese services firms have a higher mean score than their UK and HK counterparts.

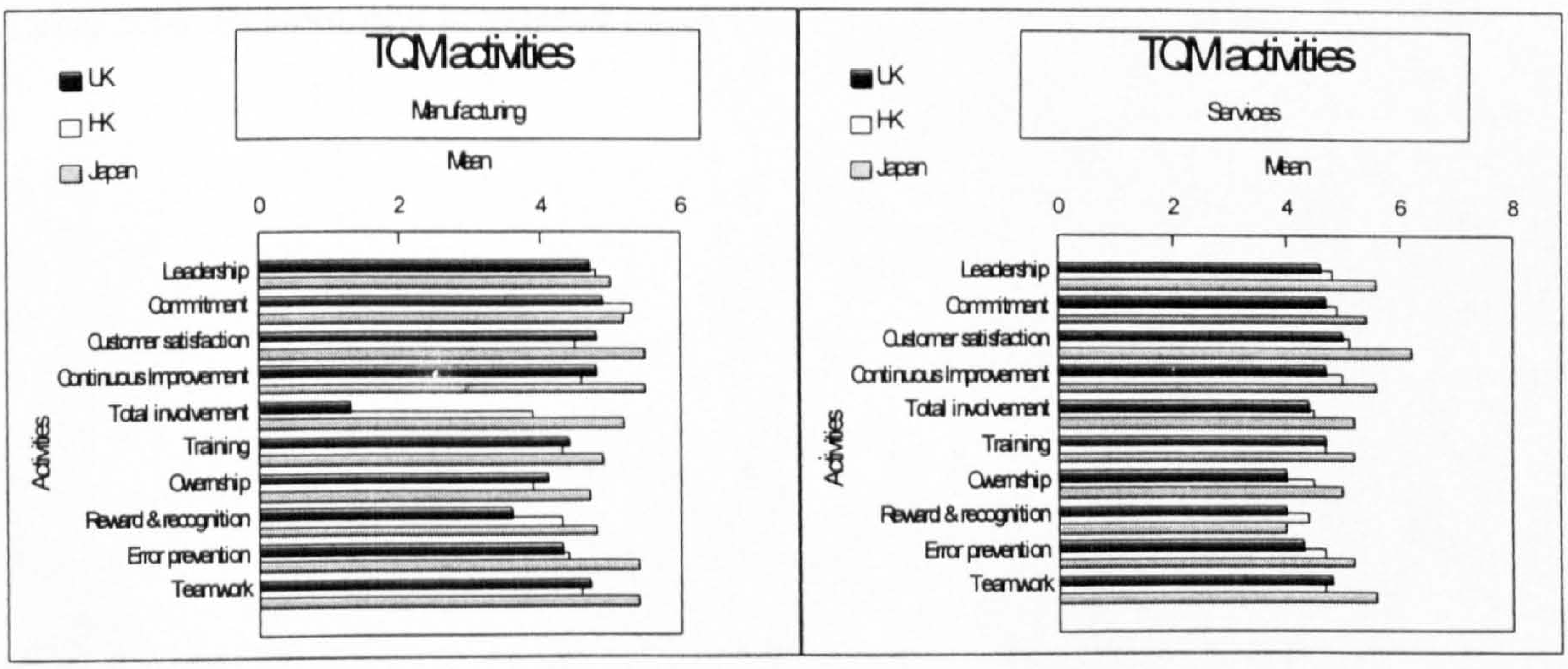


Figure 5.23 TQM Activities (UK, HK and Japan)

Comment: For both industries, the respondents see customer satisfaction, continuous improvement and teamwork as more important than the other TQM principles and activities. The less rated areas are ownership and reward & recognition. This implies that firms are more task-centred than people-centred. On the other hand, the difference in the services industry indicates that the Japanese firms emphasise more on customer satisfaction and teamwork. This finding proves very much the Japanese culture. The Japanese companies believe that business operations and efficiency can always be improved by reflecting the customer's needs and requirements and this can be achieved through teamwork and common objectives in quality.

5.2.7.7 Knowledge Contributions from Questionnaire Surveys

Using the results of the questionnaire survey, it is possible to establish a set of criteria for the effective implementation of TQMEX. The approach is to use statistical analysis to find out the practices of the more successful users, in this case the mean value of the UK, HK and Japan is used. The means on Table 5.19 can be used as criteria for companies wanting to implement TQM. On the other hand, for companies which have already started their TQM journey, they should aim at improving their means beyond those in the table. Therefore this table can be used as a minimum standard for achieving TQMEX. This knowledge is then structured so that it can form decision rules for the Expert System. The final three questions are aimed at acquiring suggestions on merits, drawbacks and possible improvements to their QMS. This knowledge is classified into four groups (Table 5.18). Thus, when a firm inputs its "Number of employees" and "Type of industry", the related drawbacks, merits and possible improvements are extracted and printed if necessary (see App. 5.3. for more details).

Size and Type of Industry	No. of Related Cases
Large Manufacturing	137
S&M Manufacturing	125
Large Services	81
S&M Services	53

Table 5.18 Breakdown of related cases

Variables	Quality Activities	Manufacturing (7-point scale Mean)	Service (Mean)
S1	Organisation	5.73	6.00
S2	Neatness	4.93	5.50
S3	Cleaning	4.97	5.23
S4	Standardisation	5.33	5.73
S5	Discipline	5.47	5.67
B1	Marketing	4.97	5.77
B2	Production	6.30	6.43
B3	Purchasing	5.50	6.17
B4	Tendering	5.30	5.50
B5	Contracting	5.23	5.73
Q1	Improving of quality	6.1	6.3
Q2	Building cheerful environment	5.5	5.43
Q3	Draw out human's potential	5.7	5.7
I1	Attract customer	4.93	4.87
I2	Quality improvement	5.10	5.23
I3	Customer satisfaction	5.27	5.50
I4	Cost reduction	4.30	4.27
I5	Competitive advantage	4.83	4.77
I6	Reduction of waste	4.53	4.23
I7	Efficiency	4.77	4.80
I8	Lead time reduction	4.63	4.43
M1	Regular maintenance	4.97	4.97
M2	Preventive maintenance	4.47	4.57
M3	Corrective maintenance	4.97	5.13
M4	Planning and management	4.47	4.73
M5	Equipment Investment plan	4.30	4.57
M6	Autonomous maintenance	3.50	4.03
M7	Conservation	4.57	4.67
M8	Safety	5.40	5.53
M9	Effectiveness	4.33	4.47
M10	Team work	4.23	4.70
M11	Maintenance training	4.20	4.33
T1	Leadership	4.83	5.00
T2	Commitment	5.13	5.00
T3	Total customer satisfaction	4.93	5.43
T4	Continuous improvement	4.97	5.10
T5	Total involvement	3.47	4.70
T6	Training and education	4.53	4.87
T7	Ownership	4.23	4.50
T8	Reward & recognition	4.23	4.13
T9	Error prevention	4.70	4.73
T10	Co-operation and teamwork	4.90	5.03

Table 5.19 Overall weighed means from the aggregate data

5.2.7.8 Experience from the UK, HK and Japan Surveys

Although the above analysis highlights the difference in approach in TQM implementation, there are other information that can be derived from analysing the practices of the UK, HK and Japan firms. One important finding is the difference in priority in the deployment of the TQMEX steps. This is now summarised in Table 5.20. (The number represents the priority.)

Quality Activities	Manufacturing			Services		
	UK	HK	Japan	UK	HK	Japan
5-S	3	3	2	2	3	2
BPR	2	2	3	3	1	1
QCC	1	1	1	1	2	3
ISO 9000	5	5	4	6	6	6
TPM	6	6	6	4	4	5
TQM	4	4	5	5	5	4

Table 5.20 Priority table from the aggregate data

An interesting observation is that most firms surveyed believe that 5-S, BPR and QCC should come before ISO 9000, TPM and TQM. This is in agreement with the general flow of the TQMEX model. Nevertheless, the difference in the sequence within these two group of TQM processes is due to the fact that many respondents are not fully aware of the content of the 5-S and TPM. So there is a tendency for them to rank those more familiar ones, such as QCC and TQM first. Another observation is that there is little difference between manufacturing and services firms in the use of different processes in the UK, HK and Japan, notwithstanding there is a slight difference in priority.

5.2.7.9 Principles of Knowledge Base Development

Based on the questionnaire result analysis, firms wishing to implement TQM effectively can learn from the experience of other firms (Q1.4, 1.5 & 1.6) by studying the different quality improvement method (Q1.8), and merit (Q8.1), drawbacks(Q8.2) and suggestion for improvement(Q.8.3). This is an important step before any implementation. Efforts should be concentrated on the areas with high priorities so that effectiveness can be achieved.

Efficiency is then maximised by using the appropriate quality processes (Q.2, 3,4,5,6,&7). This provides a guideline for implementation of different process in order to achieve the goal. This is relevant for companies starting to implement TQM or already achieved some form of achievement.

In developing the Expert System, it is important first to look at the ways the questions can be effectively structured. The questionnaire results from the UK, HK and Japan survey would form the basis for the ES. One major improvement is that only question sets (Q2, 3, 4, 5, 6, &7) are used in the ES. This is because, although each question set is designed to be as comprehensive as possible, the results show that most companies are interested in a subset of these answers. Therefore, the less relevant questions are dropped from the consultation. This helps to make the questions more concise and relevant for the users.

5.2.7.9.1 Summary of Decision Rules for the ES

Table 5.21 is a summary of the decision rules questions used in the ES. The knowledge will be developed using Visual Basic in Chapter 7.

Question	Description	Manufacturing		Services	
		Large	S&M	Large	S&M
1.4	Employees No.	>=300	<300	>=300	<300
1.6	Type of Business	--	--	--	--
1.8	Use of quality processes	--	--	--	--
2.2	5-S	S1	S1	S1	S1
		S2	S2	S2	S2
		S3	S3	S3	S3
		S4	S4	S4	S4
		S5	S5	S5	S5
3.1	BPR	B1	B1	B1	B1
		B2	B2	B2	B2
		B3	B3	B3	B3
		B4	B4	B4	B4
		B5	B5	B5	B5
4.1	QCC	Q1	Q1	Q1	Q1
		Q2	Q2	Q2	Q2
		Q3	Q3	Q3	Q3
4.3	No. of suggestion	--	--	--	--
5.3	ISO 9000	I1	I1	I1	I1
		I2	I2	I2	I2
		I3	I3	I3	I3
		I4	I4	I4	I4
		I5	I5	I5	I5
		I6	I6	I6	I6
		I7	I7	I7	I7
		I8	I8	I8	I8
6.1	TPM	M1-M11	M1-M11	M1-M11	M1-M11
7.1	TQM	T1-T10	T1-T10	T1-T10	T1-T10
8.1	Major merits	--	--	--	--
8.2	Major drawbacks	--	--	--	--
8.3	Possible improvements	--	--	--	--

Table 5.21 Summary of decision rules questions for ES

5.2.8 Statistical Analysis

At this point, it is useful to do a more advance statistical analysis of the questionnaire to determine a reasonable knowledge base for Advisory Service. Factor Analysis, Cluster Analysis and Discriminant Analysis are selected for consideration because they are among the most useful approaches for establishing the nature of relationships among set of interrelated variables [SPSS, 1989]. All statistical analysis methods used include the setting of objectives, discussion of research design issues, the partitioning of respondents into clusters, and the interpretation and validation of the results.

FACTOR ANALYSIS is a statistical technique that attempts to represent relationships among sets of interrelated variables by a smaller set of independent and interpretable, but not directly observable, factors. For example a factor analysis of scores on a battery of aptitude tests may result in describing aptitude in terms of factors such as verbal skills, mathematical aptitude, and perceptual speed. These factors would be linear combinations of the original battery variables. Likewise factor analysis of a consumer attitude survey could result in consumer preference being expressed as a function of product quality, value for money, and status. Thus factor analysis helps identify key underlying, not directly observable (i.e. latent), constructs.

CLUSTER ANALYSIS is a statistical technique that attempts to identify similar groups of objects or cases based on a variety of attributes. In biology, cluster analysis is used to classify animals and plants. This is called numerical taxonomy. In medicine cluster analysis is used to identify diseases and their stages. For example, by examining patients who and diagnosed as "depressed" one finds that there are several distinct subgroups of patients, corresponding to different types of depression. In marketing, cluster analysis is used to identify persons with similar buying habits. By examining their characteristics one may be able to target future marketing strategies more efficiently [Everitt, 1980].

Although both cluster analysis and discriminant analysis deal with the classification of objects or cases into categories, **DISCRIMINANT ANALYSIS** requires the knowledge of group membership for the cases used to derive the classification rule. For example, if one is interested in distinguishing among several disease groups, cases with known diagnoses must be available. Then, based on the cases whose group membership is known, discriminant analysis derives a rule for allocation undiagnosed patients. In cluster analysis, group membership for all cases is unknown. In fact, even the member of groups is often unknown. The goal of cluster analysis is to identify homogeneous groups of clusters.

(a) In this study the Factor and Cluster Analysis procedures are applied in an attempt to arrive at meaningful grouping of quality activities; and

(b) to establish how the grouping in (a) relate to the industries included in the study.

Discriminant analysis was not used because the pool of potential discriminant variables was of the nominal type.

For the factor and cluster analysis, the binary nature of the data was taken into consideration by use of an appropriate similarity measure.

5.2.8.1 Factor Analysis

The UK, HK and Japan aggregated manufacturing (266 cases) and services sectors (129 cases) are used for the analysis. The process involves two steps. Firstly, the proximity matrix of the set of variables is computed. The proximity matrix is then factored by means of the Principal Components method from the SPSS for Windows. The output from these routines is given in Appendix 5.4 The procedure is repeated for the six major set of common variables (Question 2, 3, 4, 5, 6, 7) and for both large and S&M enterprises. Bartlett's test of sphericity has been used to test the hypothesis that the correlation matrix is identity matrix; that is, all diagonal terms are 1 and all off-diagonal terms are 0. Since the value of the test statistic for sphericity is large and the associated significance level is 0 for all sectors. Therefore, it appears unlikely that the population correlation matrix is an identity.

The results are summarised in Table 5.22 and matched against the corresponding parts of Table 5.21. It is observed that the factor analysis suggests that some of the principal factors can be used to represent relationships among sets of variables. The refinement is that some less relevant questions are dropped from the consultation. This help to make the questions more concise and relevant for the users.

Question	Description	Manufacturing		Services	
		Large	S&M	Large	S&M
2.2.4	Standardisation	S4			S4
3.1.1	Marketing	B1			
3.1.3	Purchasing	B3			
5.3.4	Cost reduction		I4		
6.1.7	Environmental conservation		M7		
6.1.8	Safety		M8		
2.2.1	Organisation		S1		
2.2.5	Discipline		S5	S5	
5.3.2	Quality improvement		I2	I2	I2
5.3.3	Customer satisfaction		I3		I3
5.3.7	Efficiency		I7		I7
7.1.9	Error prevention		T9		
5.3.1	Attract customer			I1	
5.3.8	Lead time reduction			I8	
2.2.2	Neatness			S2	
3.1.2	Production / Operations			B2	
7.1.7	Ownership				T7

Table 5.22 Questions dropped from the ES

5.2.8.2 Cluster Analysis

As in other statistical procedures, a number of decisions must be made before one embarks on the actual analysis. Which variables will serve as the basis for cluster formation? Is distance or similarity between cases to be measured? How will the distance or similarity between cases be measured? What criteria will be used for combining the cases into clusters? For the present research, The objective is to identify companies with similar implementation process of TQMEX model. By examining their characteristics, it may be able to target future TQM implementation strategies more efficiently. Since the focus is on the six sets of questions, namely, 5-S, BPR, QCC, ISO 9000, TPM and TQM, it is natural to have them as the basis for cluster formation. The sample was split into four groups, each group was cluster analysed separately, and the results are then compared. When working with qualitative data, it is customary to work with similarities rather than distance measures. In this study similarity is measured by the centriod method.

The cluster analysis statistics are generated in Appendix 5.5. The grouping between aggregate data for the UK, HK and Japan are used. Most of the rules are found to be within the same group of cluster between large and small enterprise.

	Large Manu.	S&M Manu.	Large Services	S&M Services
5-S	❶	❶	❷	❷
BPR	❶	❶	❶	❶
QCC	❶	❶	❶	❶
ISO 9000	❷	❷	❷	❷
TPM	❸	❸	❸	❸
TQM	❷	❷	❷	❷

Table 5.23 Similarity of grouping from cluster analysis

Table 5.23 shown that In the manufacturing sector, 5-S, BPR and QCC belong to one cluster group. ISO and TQM belong to another group, and TPM stands on its own. The result also reveals that large and S&M manufacturing companies have the same cluster group.

Similarly, in services sector, 5-S, ISO and TQM belong to one cluster group. BPR and QCC belong to another group. TPM again stands on its own. The result again reveals that large and S&M services companies have the same cluster group.

The above result suggested that most of the TQMEX processes are inter-related. Perhaps the only stand alone for all sectors is TPM. A likely reason is that many companies have not yet practise TPM.

5.2.9 Field Survey based on UK, HK & Japanese Companies

The field survey was conducted in line with the thought under "Methodology" (S3.1). Based on Cohen & Manion [1989], case studies have been conducted in order to have deeper understand of the research area. Lee [1989] also supports the view that case studies are useful as a mechanism to update the knowledge.

Altogether there are 35 cases, half of which are collected from secondary research and the other half is from field survey. Interviews were undertaken at 17 companies in the UK and HK during 1994-1996. Due to the limitation of the present research, the Japanese firms operating in the UK and HK are interviewed instead of a field visit to Japan. Unstructured interview was the main research tool for opinion and longitudinal research. Owing to the fact that the complex interrelationships between different organisational characteristics, it was too difficult to prove conclusively that particular quality activities were more effective in certain organisations. Interviews involved the "planners" of TQM (therefore primarily directors or quality manager). The interviews were approximately two to three hours duration and investigated the factors that contribute to successful implementation of TQM. In order to find out their CSFs, the interviewee was asked what activities and steps the company has taken to contribute to successful (TQM) transformation and how well their approach ties in with the TQMEX Model. This is followed by further questioning to obtain details on the major merits and drawbacks of existing TQM process and suggestions for future improvement. For details, see appendix 5.6.

5.2.9.1 The UK

The UK Government's stated aim is to encourage enterprise through the working of a competitive market economy. Measures towards this end include the planned reduction in State ownership, the strengthening of competition policy and the promotion of measures to improve efficiency and competitiveness. Schemes of financial and other aid continue for areas and industries with special problems. Examples are:

- Generous allowances given for expenditure on scientific research and enterprise zone developments.
- Regional development grants do not reduce the expenditure on which tax depreciation allowances are given.
- Under business expansion scheme, qualifying investment in unquote UK companies deductible from taxable income of ordinarily resident individual
- Attractive grants available for investment in Assisted Areas.
- Emphasis on new and high technology investment, together with generous assistance from a wide variety of training schemes.

Initiatives to improve the quality of British goods and business practices have become one of the growth industries of the 90s. At Government, company and institutional level the drive to raise standards and performance has produced a rethink in the approach to improving performance and raising competitiveness. There has been remarkable progress, helped by the Investors in People initiative, the British Quality Foundation, National Vocational Qualifications, Citizen's Charter, and ISO 9000, the recognised yardstick for quality management systems [Gribben, 1996].

A growing list of companies is highlighting direct and indirect benefits from either applying the initiatives or introducing purpose-designed in-house programmes to raise levels of efficiency and customer satisfaction. But Britain's slide to 18th place in the competitiveness table of the prestigious World Economic Forum is an uncomfortable reminder of the gap still to be bridged in an unrelentingly tough international economic environment (see Table 5.24).

Ranking	Country	Ranking	Country
1	USA	11	Taiwan
2	Singapore	12	Canada
3	Hong Kong	13	Austria
4	Japan	14	Australia
5	Switzerland	15	Sweden
6	Germany	16	Finland
7	Holland	17	France
8	New Zealand	18	UK
9	Denmark	19	Belgium
10	Norway	20	Chile

Figure 5.24 World Economic Forum's Competitiveness League of Industrialised Nations 2/96

This assessment of Britain's standing in the industrialised world is based as much on subjective judgements as on objective analysis of available data, and the finding may be open to dispute. But it has given the UK Government and all the other organisations involved in the Business Excellence industry a fresh spur.

There are many companies, particularly in manufacturing, that have felt the hammer-blow of international competition over the last decade. According to the survey finding in S.5.2.3.2.6 50-60% of the UK companies perceive a need for TQM. However when some companies were interviewed many embarked on TQM without a clear idea of what they are attempting in tangible terms to achieve. Worse still, many lower and middle management do not understand how the process works and the role they will be expected to play. Many programmes which start at the top of the organisation and wash their way slowly down through the organisational level are doomed to failure. Some companies find the need for TQM but do not know where to begin and where to go. However many UK companies have realised the potency of the techniques in improving business performance. They are clearly here to stay.

5.2.9.2 Hong Kong

HK has enjoyed fast economic growth during the past decade. Economic policy in HK is to a large extent dictated, and constrained, by special circumstances of its economy. Owing to its small and open nature, the economy is vulnerable to external factors. Government actions to offset unfavourable external factors are often of limited effectiveness. The government is of the view that, except where social considerations are overriding, the allocation of resources in the economy based on market forces will normally be most efficient. Government intervention in the private sector is kept to a minimum.

This free-enterprise, market-disciplined system has contributed to HK's economic success. The narrowly based tax structure with low tax rates provides incentives for workers to work and for entrepreneurs to invest. Both workers and entrepreneurs are highly motivated, given that all people have equal opportunity to pursue the goal of individual betterment and accumulation of wealth. The primary role of the government is to provide the necessary infrastructure and a stable legal and administrative framework conducive to economic growth and prosperity.

Overall, the major factors that contributed to HK's success as a leading manufacturing and commercial centre continue to work well. These include the government's consistent commitment to free enterprise and free trade and a simple tax structure. Among other factors are the flexible and industrious work-force, a modern and efficient seaport with the world's busiest container port, a centrally located airport with a computerised cargo terminal, and an excellent world-wide communications.

All companies which have been interviewed are aware of all processes in the TQMEX model. All companies concerned the need to improve quality, many are not convinced that ISO 9000 is the best way to do so, because the inadequacies of the ISO 9000 series are being identified by companies adopting TQM to take their organisation on to greater improvement. When asked the implementation of TQM, they have different experienced. One companies had postponed the implementation of TQM, with the reason as due to the shortage of expertise in this area. Companies are generally confused with different theory and do not know where to begin. There are no or little step by step guild in assist implementation. Another company expressed that the bureaucratic system of the organisation and the company's culture, lead implementation of TQM difficult. There are many barriers existing, between department, top management and processing employees, etc. The commitment of the top management is not so enthusiastic. The boundaries between the departments had restrict the information flow and communication flow.

One Hong Kong company reveals that Hong Kong culture is different from Japanese or the UK. He claimed that traditional Chinese culture has rooted in our minded, bureaucracy need time to be remove or convert to another new system. A different story was given with another company in HK. The company adopted the continuous improvement approach in 1992, and the implementation seems to be very successful. Employees working spirit are very high. The number of Work Improvement Team (WIT) had rapidly expand from 85 teams to 120 teams. The quality manager claimed that the organisation is highly encourage to participation and commitment of the employees at all level. The average number of suggestions received from employees is increasing from 1 at the beginning to 5 per employee per year. The company also introduced a professional training programme once every three month on quality. Reward and recognition scheme is one of the crucial factors to motivate employee in this company. But most of all the support and encouragement of the chief executive determinant the success of the programme processing smoothly.

5.2.9.3 Japan

All countries are amazed at the development of the enterprises in Japan. The focuses of other countries are on the competitiveness of the Japanese products, the capital investment strategy and the industrial relationships. In the global manufactured product market, Japanese cars, commercial vehicles, machine tools, and robots are the world's number one.

Japanese companies believe that bringing new and quality products to the marketplace quickly is the means by which they can sustain their competitive edge. Organisations are forever looking at the needs of the customer. Companies expressed that the customer's quality requirements are becoming increasingly rigorous and these are a moving target and the driving force behind is to continuous delight the customer. One company interviewed believe that it is important for people in other department who are involved in the development of new product to go to locations where the equipment is being used and asks the user or operators, what is required to satisfy customer needs, expectations, thinking and ideas? This knowledge, together with that accumulated through other means of listening to "customer voices", is used to pinpoint the technical gaps of the competition and identify product features which the customer finds attractive.

Japanese companies believe that research and development is the main means for them sustaining competitive edge and this is part of their BPR activities. There is an ever-increasing demand from the marketplace for new products. Considerable efforts are concentrated on BPR for product development. Some companies have combined their R&D and marketing functions to facilitate the creation of new market demands.

The Japanese companies also consider that apply quality in all aspects of their business is the central core of TQM, and without effective quality procedures to support the communication of the company requirements TQM is difficult to achieve.

System thinking is part of the Japanese style of management. Consequently intensive effort is devoted to the assurance of quality on day-to-day basis. They are very careful about there mistake in the past. A lot of emphases is place on finding out exactly where are why they are doing things wrong or not as effective. When concerns are identified, they are analysed in considerable detail. One company suggested that in order to prevent a mistake to happen. Procedure is put into place some temporary counter measures to gain control of the situation whilst investigation is made into the root cause of the concern. Pro-active approach to quality assurance is a useful technique. This is based on defect prevention principle and uses a series of interrelating documents to control and monitor the project development. Typical activity is to review the strengths and weaknesses of the previous project to prevent concern recurrence.

The Japanese have developed an organisation culture and management style which, based on the evidence of their investment and success in world-wide production facilities, can operate successfully anywhere. Their success is not simply a matter of national culture. The key to their success lies in the ability to create an organisational culture within an (5-S) environment conducive to continuous improvement through open communication, understanding and trust (QCC), by collecting and analysing data on all aspects of the company's business (BPR), with effective quality procedures to support the communication of the company requirements (ISO 9000). This moving the organisation to a situation of autonomous improvement (TPM) and providing company goals and communicating to all levels to continuous improvement (TQM).

The findings from the field survey demonstrated that all the CSFs discussed above can be achieved by adopting good practices based on the TQMEX model.

5.2.10 Knowledge Contributions from Field Survey & Case Studies

Some UK, HK and Japan cases studies were studied during 1994 to 1996. Altogether there are 35 cases, half of which are collected from secondary research, They are included because their TQM implementations have direct link and value to the present research. Refer to appendix 5.6 for detail.

The companies with a description of their activities and number of employees are detailed in Table 5.25. Table 5.26 gives an analysis of the cross references for cases matching against various CSFs of the TQMEX model and industry. Thus, when the weaknesses and industry of the company are identified, the related cases are extracted and printed if necessary. This knowledge is developed using an ES and will be discussed in detail in S.7.1.6.6.

No.	KEY: ( ) Approximate number of employees C--Case H--Hong Kong J--Japan U--UK M–Manufacturing S--Services
1	CU1 A Microelectronics Company (17,000)
2	CU2 A Construction Company (300)
3	CU3 A Chemical Distribution Company (30)
4	CU4 A Chemicals and Polymers Company (280)
5	CU5 A Glass Manufacturer (200)
6	CU6 A Aircraft Manufacturer (8,500)
7	CU7 A Bank (6,000)
8	CU8 A chemist (>4000)
9	CU9 A Photocopier Manufacturer (1800)
10	CU10 A Tele-communication company (240,000)
11	CU11 A Hydrapower Dynamics Ltd
12	CU12 A Co-op Bank (600)
13	CU13 A Import Licensing Branch
14	CU14 A Software Engineering Company
15	CU15 A Aircraft Manufacturer
16	CU16 A Car Manufacturer
17	CH1 A Electronic Company (300)
18	CH2 A Sauce Manufacturer (1,100)
19	CH3 A Electronic Company (200)
20	CH4 A Survey on purchasing professionals
21	CH5 A Plastic injection moulding factory (200)
22	CH6 A construction firm (400)
23	CJ1 A Machine Tool Manufacturing Company (8,000)
24	CJ2 A Car Manufacturing Company
25	CJ3 A Electrical / Electronic Appliance Manufacturer
26	CJ4 A Food Retailer
27	CJ5 A Machine Tools Manufacturing (1,000)
28	CJ6 A Car manufacturing Company
29	CJ7 A Construction Company
30	CJ8 Quality Improvement Storyboard at Komatsu Company
31	CM1 A Electronic Company
32	CM2 A Petrochemical Company
33	CM3 Bowater Containers Southern
34	CS1 A Government Organisation
35	CS2 A School

Table 5.25 Summary of case studies

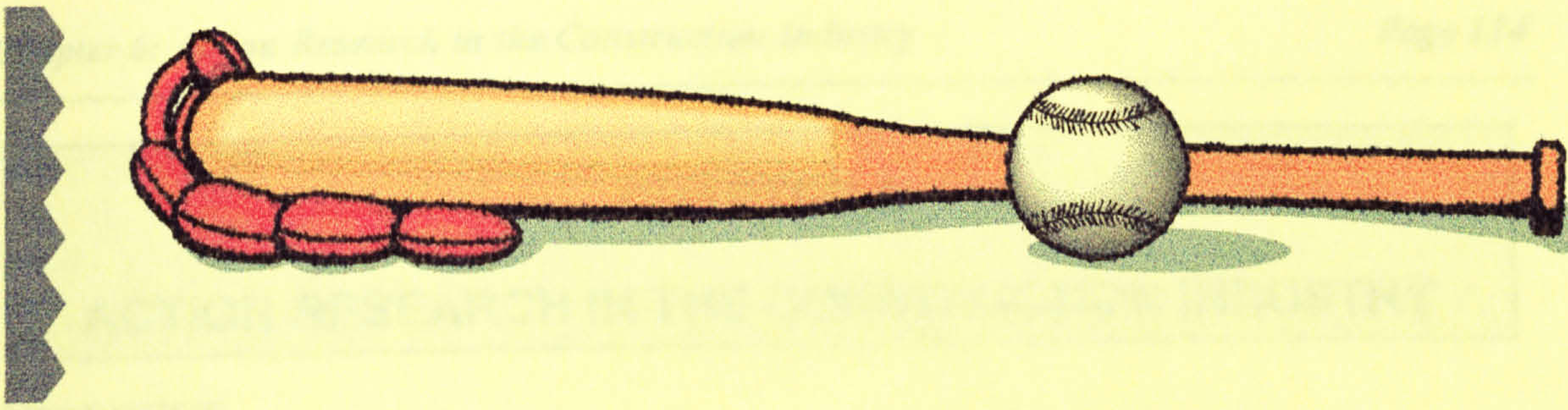
	5-S	BPR	QCC	ISO9000	TPM	TQM	Manufacturing	Services
CU1				R			R	
CU2		R	R	R		R	R	
CU3		R	R					R
CU4				R			R	
CU5		R				R	R	
CU6		R	R			R	R	
CU7				R		R		R
CU8		R						R
CU9		R			R	R	R	
CU10		R						R
CU11			R			R		R
CU12		R						R
CU13				R				R
CU14				R			R	
CU15		R	R				R	
CU16			R			R	R	
CH1	R	R	R				R	
CH2	R	R	R	R	R	R	R	
CH3			R				R	
CH4		R					R	R
CH5	R	R					R	
CH6	R	R	R	R	R	R	R	
CJ1	R		R		R	R	R	
CJ2	R				R	R	R	
CJ3	R	R	R	R	R	R	R	
CJ4			R					R
CJ5	R		R		R	R	R	
CJ6			R		R		R	
CJ7	R	R	R	R	R	R	R	
CJ8			R				R	
CM1						R	R	
CM2						R	R	
CM3				R			R	
CS1	R							R
CS2						R		R
Total	10	16	17	11	9	17	25	11

Table 5.26 Cross reference of Cases against CSF & Industry

Key: R= Relevant CSFs

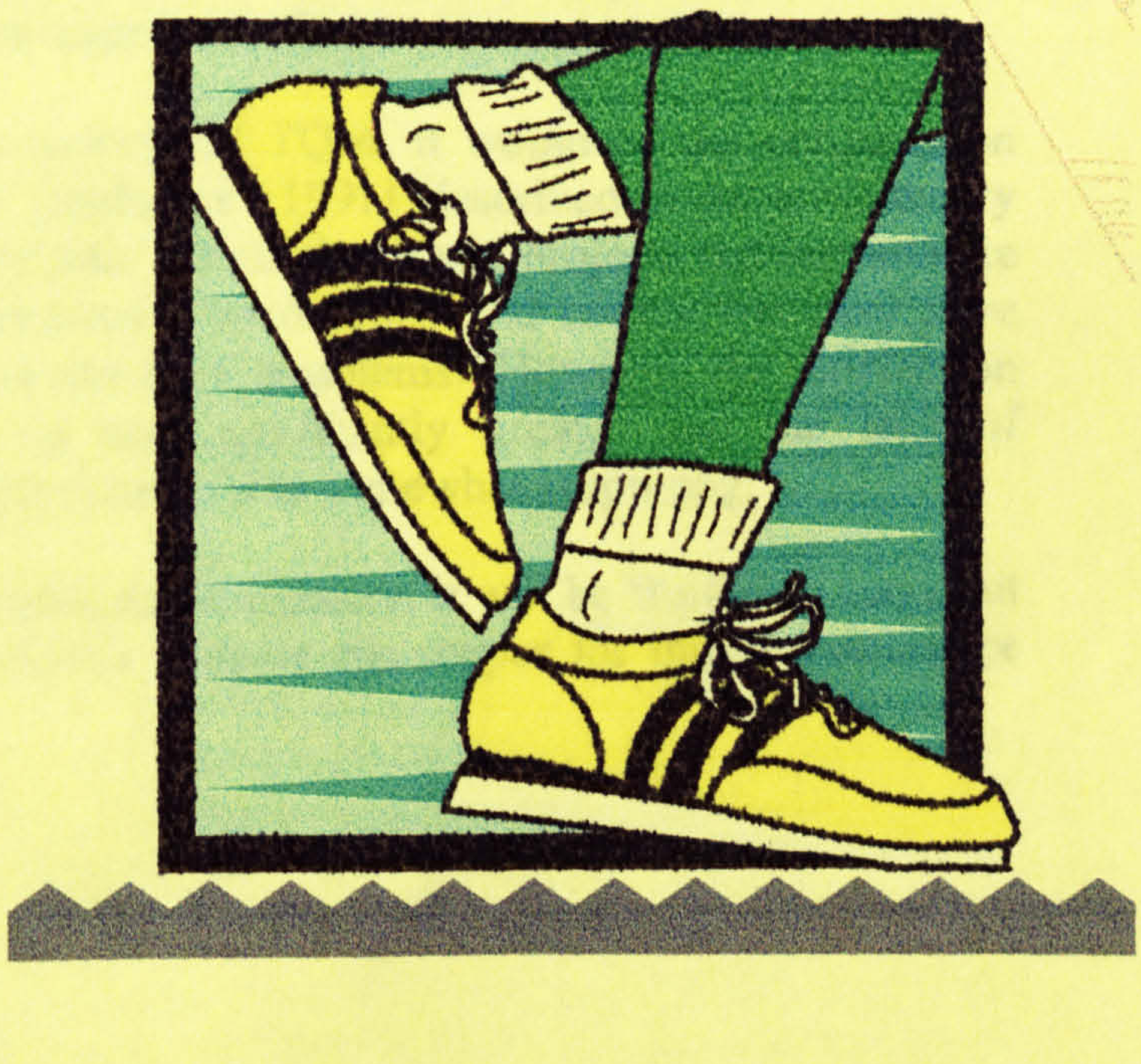
EPILOGUE

In this Chapter, both the questionnaire and field survey have been explored and reviewed. The results of the findings are useful for cross-reference by companies. These form the basis for the subsequent development of the Advisory Service System in Chapter 7.



Chapter 6

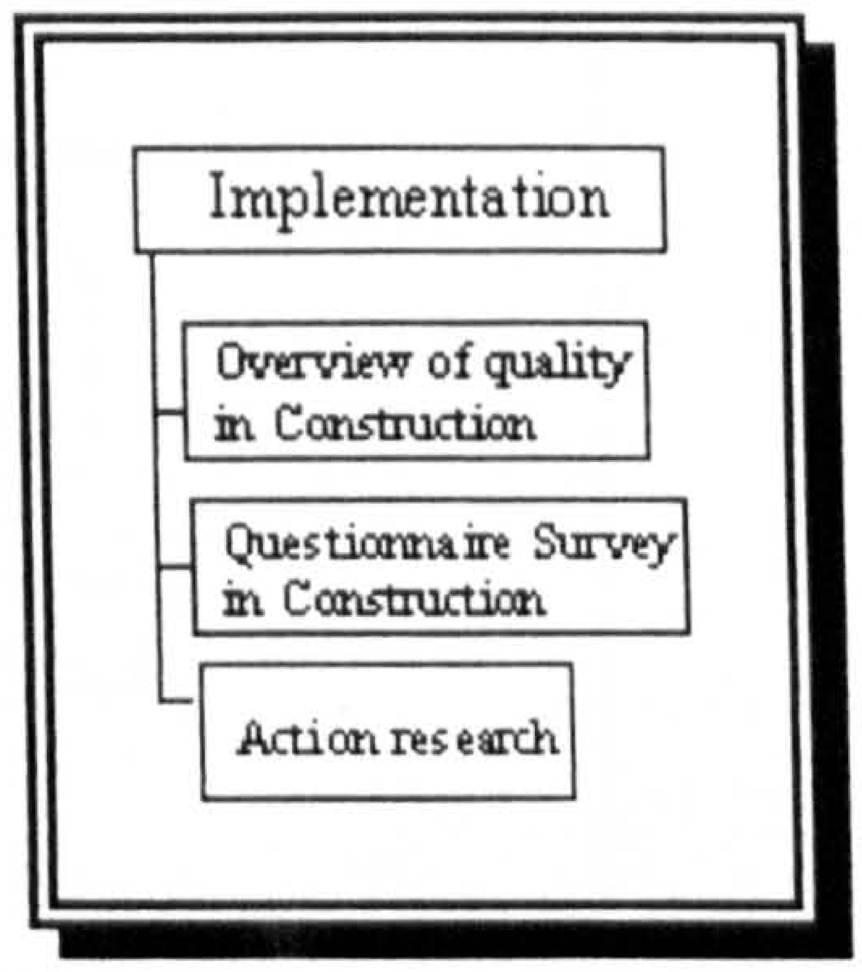
Action Research in the Construction Industry



CHAPTER 6

ACTION RESEARCH IN THE CONSTRUCTION INDUSTRY

PROLOGUE



After the discussion of the questionnaire and field surveys in Chapter 5, it is necessary to demonstrate that all the TQMEX steps can be implemented effectively in an organisation. Because of the author's background and contact in the construction industry, it was chosen as the industry for study. Firstly, the quality-related literature for the construction industry was reviewed. This was followed by an analysis of the questionnaires from the UK and Hong Kong based on construction firms. Through the author's contact, a large construction company in Hong Kong was chosen as the subject for action research. The research aims at establishing what measures and steps are taken by the construction firm in pursuit of TQM and its attitude towards the TQMEX model. Then pilot implementations on some of the steps of the TQMEX model are conducted under a controlled environment in order to evaluate their impacts to the organisation. Two further in-depth interviews are conducted based on UK and Japanese construction firms.

6.1 ACTION RESEARCH DESIGN IN THE CONSTRUCTION INDUSTRY

Although ISO 9000 has been used in the construction industry for some years, TQM is still seen by many people in the construction industry as something foreign. The recent trend towards quality management is encouraging. Ten years ago very few construction companies took an interest in quality management although it was already well established in the manufacturing industry. In the 90s, quality is an essential requirement for many construction companies without which they cannot survive.

If ever an industry needs to take up the concept of TQM, it would be the construction industry. The Institution of Structural Engineers [1991] described it as an industry associated with a patchy reputation, with public beliefs that many projects run late and are over budget. Quality problems in construction are obvious and contractors may have taken ISO 9000 on board as a means to solving these problems. However, the satisfaction with their professional services today is not significantly greater and the lack of enthusiasm for quality systems amongst professionals is somewhat surprising.

Leading from the above scenario in the construction industry, it will be fruitful to carry out an action research in the construction industry because the scopes for improvements are enormous.

6.1.1 Research Methodology

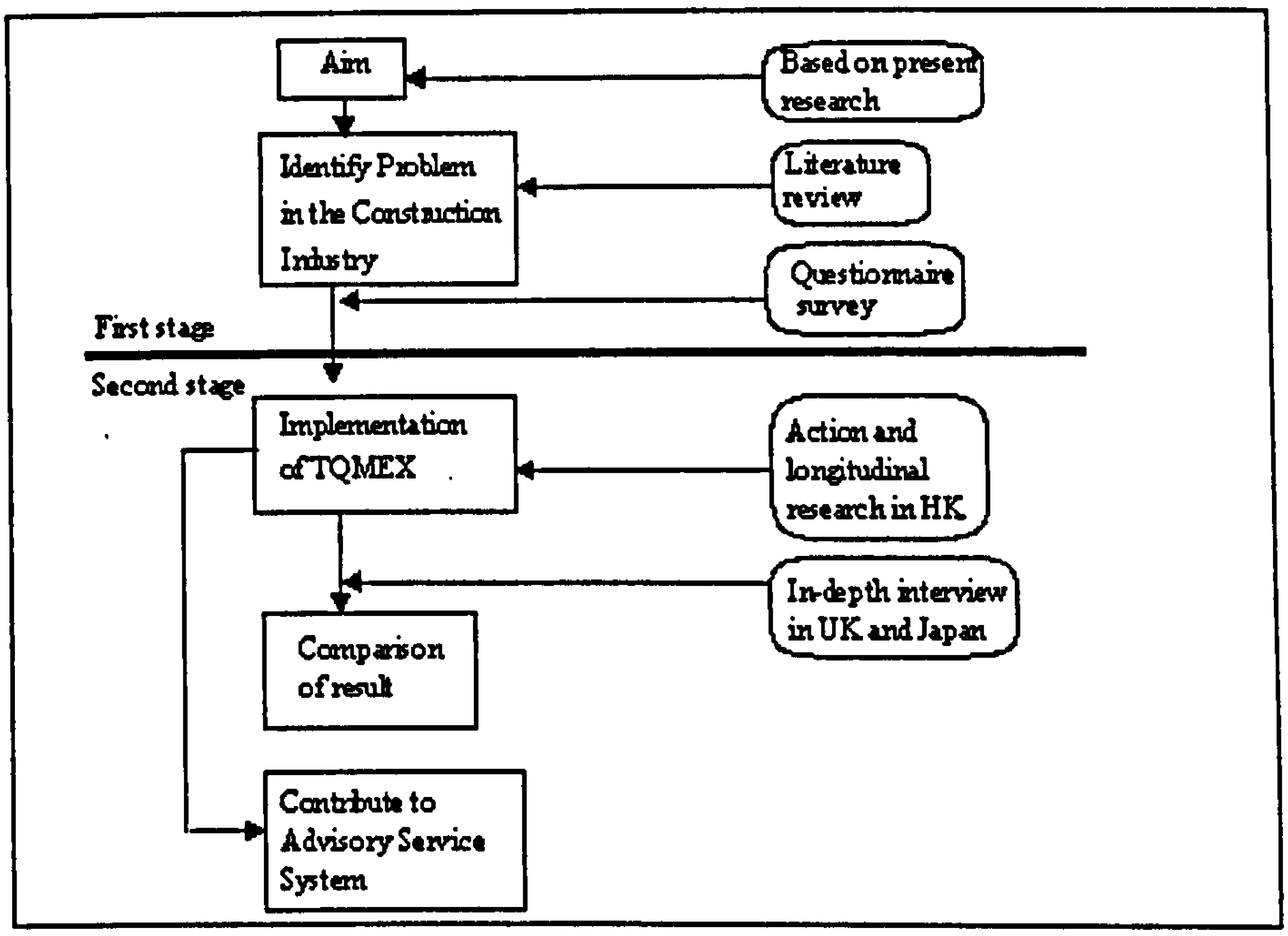


Figure 6.1 Research method for implementation of TQMEX

The method of action research in the construction industry is illustrated in Figure 6.1. The first step was to define the aim and the scope of the pilot implementation, followed by literature research to identify and understand the problem areas in the construction industry. The questionnaire data for the construction industry collected from the main survey were then extracted and analysed similarly to those in Chapter 5. The second stage is to conduct an action research of TQMEX. A pilot implementation was undertaken in a construction company in HK between Jan 95 to July 95. The questionnaire survey results were used together with the action research results to determine the CSFs. A set of implementation plans was derived based on the action research in HK. These implementation plans will be used as part of the TQMEX Advisory Service System. Further in-depth interviews were carried out with two other UK and Japanese construction firms of similar sizes. These results were then used to compared with the action research results in HK.

6.1.2 Overview of Quality in Construction

The Construction Industry Research and Information Association (CIRIA) follows the ISO 8402 definition of quality as: "The Totality of features and characteristics of a product or service that bear on its ability to satisfy a given need, ... or in simple terms, fitness for purpose" [C.I.R.I.A; 1988]. Where a contractor is providing a construction service to a client based on the client's design and specification, quality is the provision of an acceptable standard of construction to a respectable cost given and produced in the most feasible construction time possible.

A survey carried out by the Quality Liaison Group [1995] showed a majority of clients were barely satisfied with the quality of the construction process in the UK today, both in terms of waste and defects. A minority of clients expressed clear dissatisfaction.

When the literature for the construction industry was searched through the CD-ROM, over 585 articles on quality were found on ABI-Info over last ten year period, but TQM featured in only ten of these. The same search was also carried out with Anbar, and the figures were 286 and 2 respectively.

As with the trade journals, the focus was largely on ISO 9000. The Construction News [1992], for instance, published a supplement on quality which featured the ISO 9000 experience of 12 construction companies in conjunction with other QA-related matters. The Chartered Builder [1993] featured a "source book" majored on ISO 9000 quality management. Many of the construction engineering literature are case studies written by contractors describing their route to ISO 9000 [BSI, 1992], [QA Focus, 1993], [Grice, 1992]. While some of the articles provided the forum for expressing bad-feelings towards QA and the standard [Guest, 1988], [Chevin, 1991], [Ridout, 1988], criticisms associated with applying ISO 9000 tend to major on bureaucracy, administrative cost (particularly for small firms), loss of innovative opportunity and limitation to conformity rather than improvement. In short, the review suggested that the general attitude towards quality within the construction industry was limiting to quality assurance and ISO 9000.

6.1.2.1 Literature Review in the Construction Industry

The following is a list of books and articles on the subject of quality related to the construction industry. A brief summary of the literature is reviewed here in order to build up a picture of quality in the construction industry.

6.1.2.1.1 Building Maintenance Cost Information Service [1987]

This is an occasional paper published in February 1987. It takes the form of five individual views on various aspects of Quality Assurance.

Section 1 is written by R.R Easy [General Manager of Yardley Quality Assured Firms Ltd.]. This paper considers the various views and misunderstandings of quality assurance and puts quality assurance into perspective, when considered against the national resources being wasted by companies which ignore the benefits that a practical quality assurance system can bring.

Section 2 is written by Anthony Hill a Consultant Architect. Mr. Hill formulates this article from a very broad base trying to touch on all the facts of Quality Assurance. He stated that: "For Quality System to be effective in the building sphere it has to include the whole building team: Client, Designer, Contractor, Sub-contractor and Suppliers, and users. It is for lack of comprehensiveness of vision that quality in building has so often eluded us". He then goes on to state what is required from each of the teams in this search for Quality Assurance.

Section 3 is written by BSI Quality Assurance Schemes. This serves to compound attitudes towards Quality Standard within construction. i.e. as long as a product has a Quality Assured stamp on it then the final building made up of hundreds of these products will also achieve a Quality Assured standard. It is well known that this is not true.

Section 4 is written by the National Accreditation Council for Certification Bodies [N.A.C.C.B.]. This was in response to the Governments recognition for the need for an independent third party to re-establish the UK reputation for the manufacture of quality products. Its task is to be responsible for the assessment of certification bodies applying for government accreditation.

Section 5 is written by BSI Which shows just how long a company may expect to wait for recognition of its work in relation to ISO 9000.

6.1.2.1.2 British Cement Association [1989]

This illustrates that the planning for quality on site is dealt with not by producing model Quality documents but by describing the steps in the process of a quality plan and an inspection, and record sheet for part of a supposed contract. It is intended that the principles illustrated be applied to large or small contracts but for the purpose of the guide a medium sized re-enforced concrete structure is used. A possible organisation chart for such a contract is shown which indicates how the quality function is integrated into the site management structure as a whole. It is emphasised by B.C.A. that quality management must form an integral part of site management.

6.1.2.1.3 Duncan, Thorpe and Summer [1990]

This book is dedicated to shattering the illusion that Quality Assurance is a brand new phenomenon. It tells of the origins of the Quality Standard, what it actually means and identifies the numerous standards associated with it. This book formulates ideas on developing and implementing a quality system, it shows Quality Assurance relative to the client, the design team and also the construction contractor.

6.1.2.1.4 Building Service Research and Information Association [1990]

The B.S.R.I.A. booklet is intended to provide a guide which presents an outline of various ways in which firms can demonstrate their commitment to Quality and their implementation of its principles. This can be achieved, according to the author either through registration in one of several similar commercial schemes or by some from of self-certification. This booklet provides guidance to the preferred route to be taken in different situations. This booklet goes into more detail with ISO 9001, 2, and 3 as possible routes to formulating a manual.

6.1.2.1.5 Hooks [1990]

This article suggests that the process of quality should seek to be more closely aligned with work study. His definition of quality is "***consistent conformance*** to specification or plan". He opines that 'conformance' implies that producing above specification is as bad as producing below specification. He concludes that the problem of quality is a lot more simple than people really think.

6.1.2.1.6 Ridout [1988]

This is an article which concerns itself specifically with the inherent confusion which is bestowed upon the construction industry by the sheer volume of standards and bodies from which to seek approval in relation to Quality Assurance.

6.1.2.1.7 Atkinson [1988]

It tells of how Quality Assurance originated back in 1979 and the image that the construction industry has and why. He indicates some of the bodies from which approval can be sought, set out the current problems and suggest the direction of progression the industry will be taking in the future.

6.1.2.1.8 Develin [1989]

This article described a survey of quality improvement programmes in British business. This has uncovered some unpleasant facts about the lack of progress that most companies are experiencing. Over 3000 companies of all sizes were asked about their quality improvement programmes. The result indicates that Total Quality Management has been, and increasingly will be the most popular type of quality improvement programme undertaken. Most importantly, the survey highlights the key differences of approach and emphasis between those who have achieved good results and those who have failed.

6.1.2.1.9 Lane [1992]

This article discussed the issue of whether ISO 9000 quality assurance approval is the key to a contractor's successful future or is it merely an expensive waste of time. He discussed some of the problem that the firm face after the approval of ISO 9000 i.e. the burden of certification cost which will not help in the nature of competitive tendering. He went on to discuss that TQM is the way forward for British industry and he believes that company-wide registration is another step towards TQM and this can be an alternative to ISO 9000 for small firms.

6.1.2.2 Summary of Quality in Construction

The general finding from the above books and articles is that quality in construction is a very wide subject. It is not feasible to understand all aspects of quality related to construction. Therefore, it is hoped that by summarising different views, it will shed some light into the subject. When considering quality in construction, people normally look at the end-product only. They also have their own ideas about what constitutes a good standard of quality or whether a minimum standard of quality has been reached. Consequently there is a lack of a universal standard on construction quality.

For instance, a building company has to complete the project according to the requirements and meet the satisfaction of the client in terms of its construction. Then the project has to be completed within an acceptable period of time. Adding factors such as design, cost, appearance, life of building and any other factors on which an individual might consider as quality, it becomes very difficult to judge whether the builder has provided a good quality in the performance of a contract.

The Building Magazine published a Quality Survey in 1991 to rate the best firms in the construction industry. It rated firms of architects, quantity surveyors, contractors and consulting engineers by their standards of work, speed, efficiency, technical capability and cost awareness. This demonstrates that there are more to quality than ensuring that materials meet certain standards which have been the traditional form of quality control.

At a practical level, quality is concerned explicitly with workmanship. Workmanship is a difficult concept to appreciate in practice as it is usually based on an individual's opinion on the standard of performance which is acceptable in a given situation. Differences in workmanship where two identical subjects are doing identical sections of work are a result of their efforts. Workmanship is therefore measurable and is of most concern on site. Given identical situations and methods any variations in quality should be derived from the workers.

Whether a standard of quality has been reached is normally decided by the perceptions of individuals. Materials and components are largely covered by control standards such as the British Standards. In the case of manufactured materials, levels of quality can be set so that they are suitable for their intended purposes. It is rather more difficult to define a quality level for the performance of labour and it is also unlikely that such a standard would always be met. Perceptions of quality associated with workmanship include durability, reliability, precision and stability, although appearance is often the most influencing factor. Quality in construction industry is a very difficult subject to define although great emphasis is place on its attainment. Fortunately, it is not within the scope of the present research to analyse quality within the construction industry. The above summary builds up a picture of construction process and identifies the need for TQM.

6.1.3 Questionnaire Survey in the Construction Industry

This survey has two objectives: the first is to assess the TQM practices of the UK and HK construction firms; the second is to compare the differences in approach between the two countries.

The survey data were extracted from the main survey with a total of 62 construction companies from the UK and HK -- 41 UK construction companies with average employee number of 980 and 21 HK construction companies with average employee number of 540. Due to the lack of responses from the Japanese construction company, it is not possible to do comparative study of the three countries.

6.1.3.1 Survey Results and Analysis

The data were again analysed using the ANOVA procedure. The F-test statistic was used to compare the survey results between construction firms in the UK and HK With the use of 2-way ANOVA, the differences within each set of variables were tested at 95% confidence level. The details of the analysis are shown in App.6.1. The summary of the test results and conclusions is shown in Table 6.1.

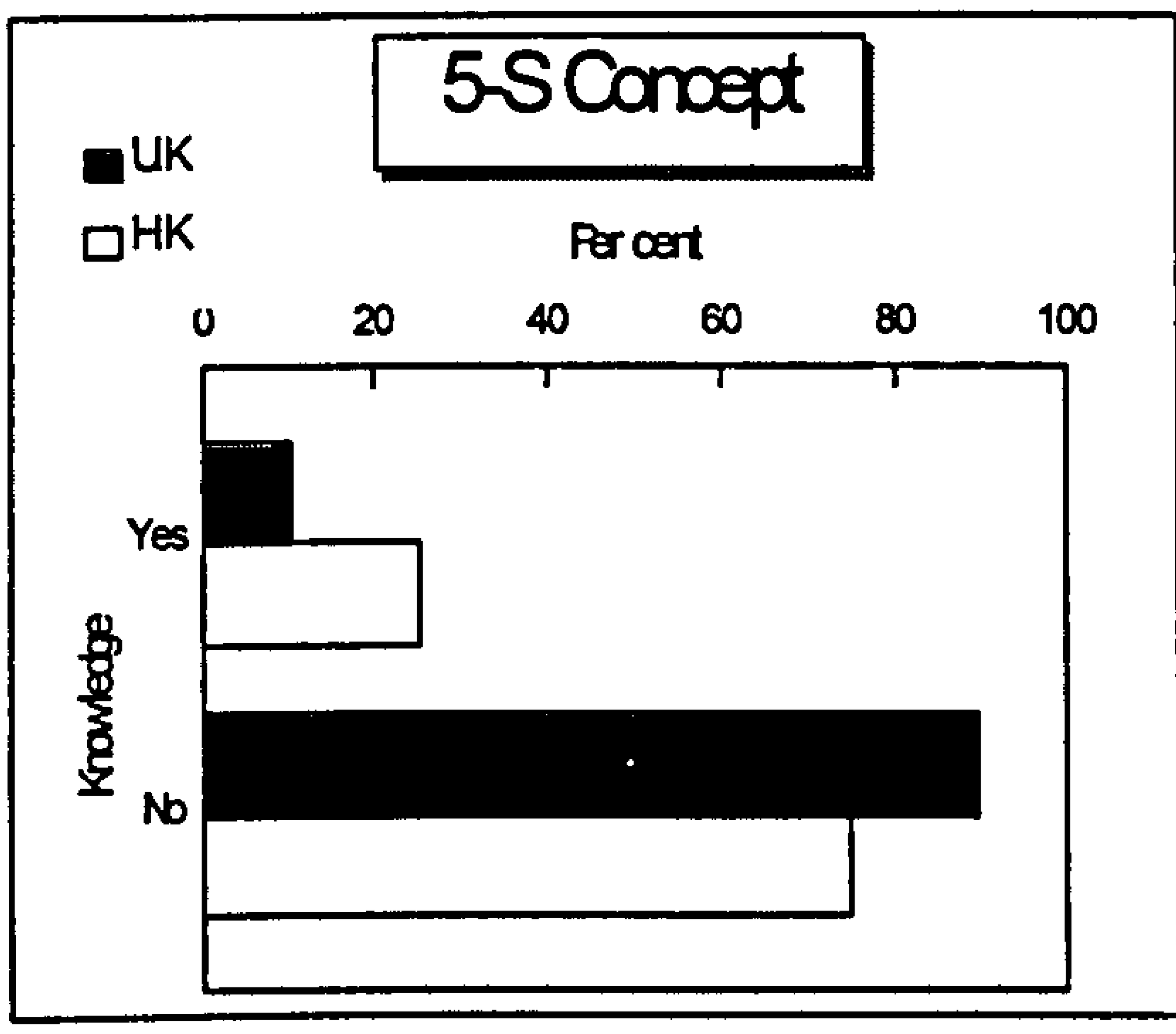
	Calculated "F" Values	Tabulated "F" Values	F-test result
5-S	3.97	7.71	CM are not different
	10.09	6.39	RM are different
BPR	3.97	7.71	CM are not different
	9.86	6.3	RM are different
QCC	2.71	18.51	CM are not different
	0.14	19	RM are not different
ISO	1.08	5.59	CM are not different
	2.65	3.79	RM are not different
TPM	4.83	4.96	CM are not different
	3.53	2.98	RM are different
TQM	4.33	5.12	CM are not different
	8.96	3.18	RM are different

CM: Column Means (between UK and HK construction industries)
RM: Row Means (amongst variables within each entity)

Table. 6.1: Summary of ANOVA results (UK & HK Construction)

6.1.3.1.1 5-S

Figure 6.2A reveals that only 10% of the UK firms have heard about 5-S, compared with 25% HK firms. This is not surprising as the 5-S has been promoted in HK for over 10 years by the HK Productivity Centre. Although over 70% of the surveyed companies have not come across the 5-S concept, many of the 5-S activities have already been built in to their day-to-day operations due to the tight legislation on health and safety imposed on the construction industry.



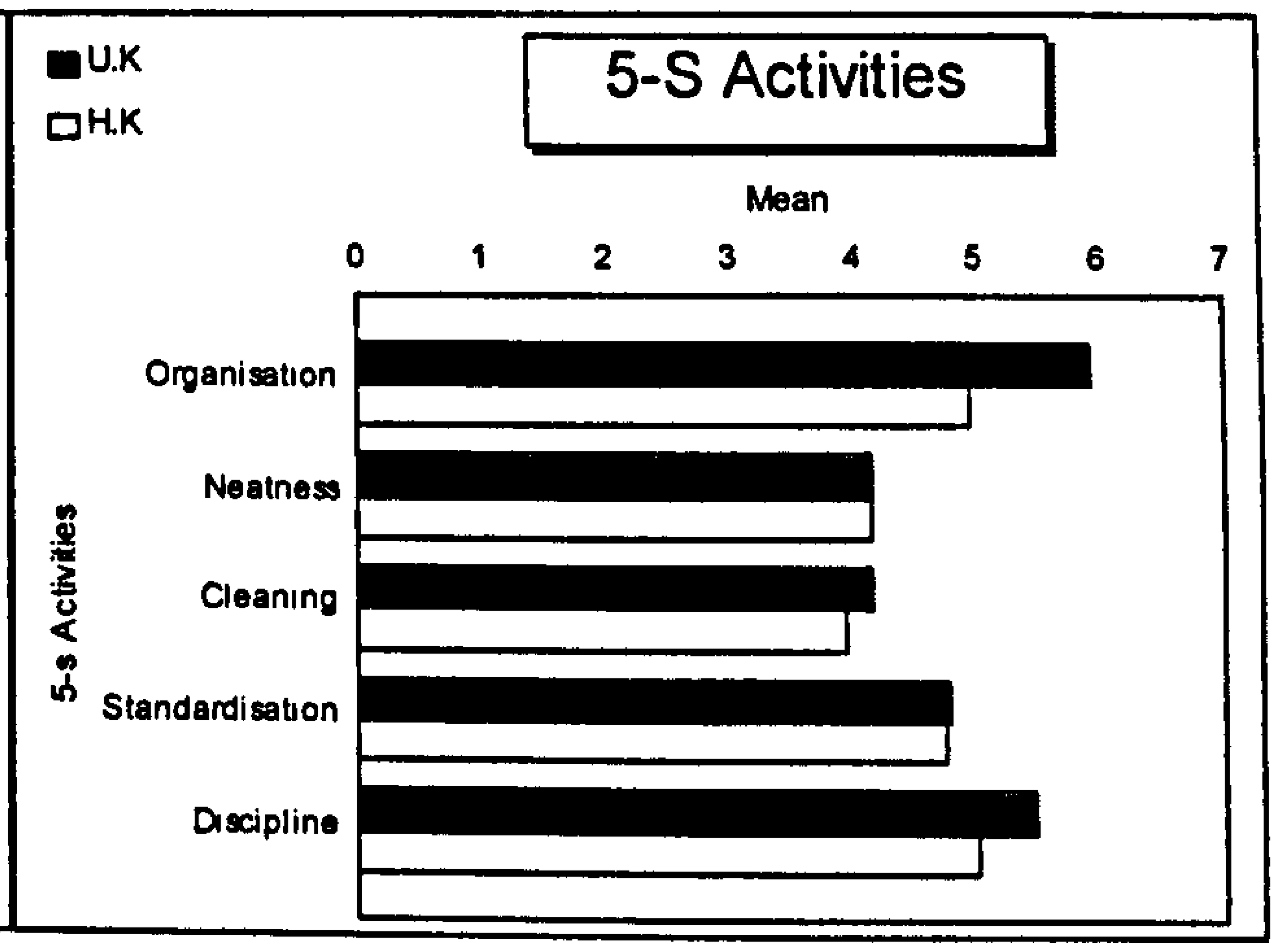


Figure 6.2A 5-S Concept **Figure 6.2B 5-S Practice**

Figure. 6.2B shows that each of the activities has a mean in between 4 to 6. There is no significant difference between the UK and HK in carrying out the 5-S. However, another result from the F-test shows that both UK and HK construction companies consider organisation as more important than cleaning and neatness. From the 5-S survey finding, it is apparent that the majority of UK and HK companies are practising 5-S to some extent without realising it. It would therefore be worthwhile to formalise the 5-S practice so that more companies can implement it as a matter of course.

6.1.3.1.2 BPR

Figure. 6.3 summarises the feedback on quality control as applied to marketing, production, contracting, tendering and purchasing functions. From the F-test result, it is revealed that there is little difference between the approaches adopted by the UK and HK construction firms. However, companies have put more emphasis on production/operations as the key areas for quality control, whilst paying less attention to other areas, in particular, tendering and marketing. BPR should therefore be used as a method for the continuous reassessment of a project's aims. It is vital for construction companies to review and balance their emphasis with all aspects of function. i.e. design, procurement, efficiency of project management, etc.

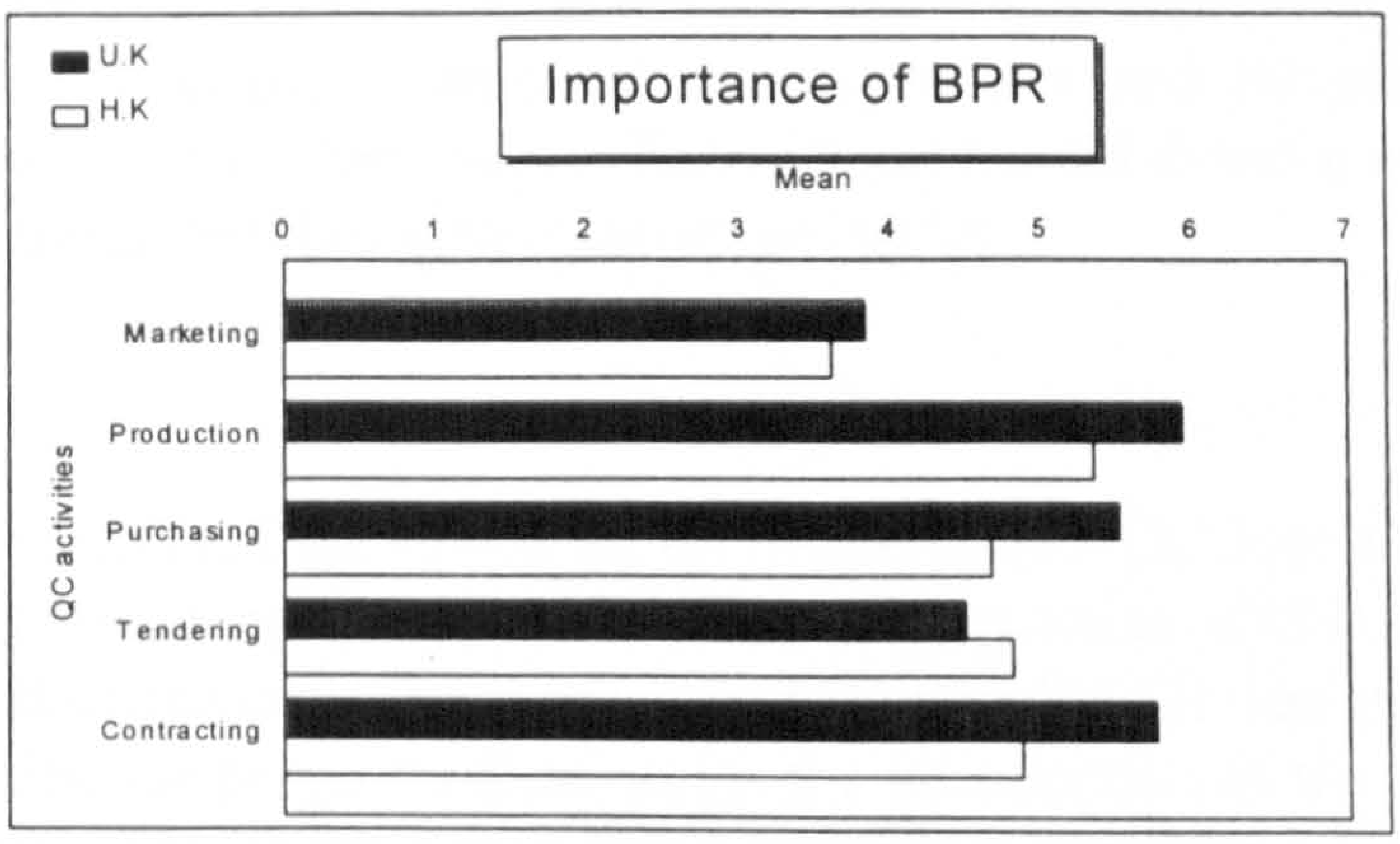


Figure 6.3 Importance of BPR

6.1.3.1.3 QCC

Evidence from the result of the survey (Figure 6.4A) suggests that 60 per cent of UK companies have practised some form of QCC as opposed to 35 per cent in HK. For those companies that practise QCC, over 60 per cent of them have no suggestions during the last year. For the remaining companies, the average number of suggestions is 22 (UK) and 5 (HK) per company per annum. This is very low compared with the Japanese standard (more than 50 suggestions per circle per annum for an average firm). This is probably due to lack of management commitment and training on the use of QCC tools.

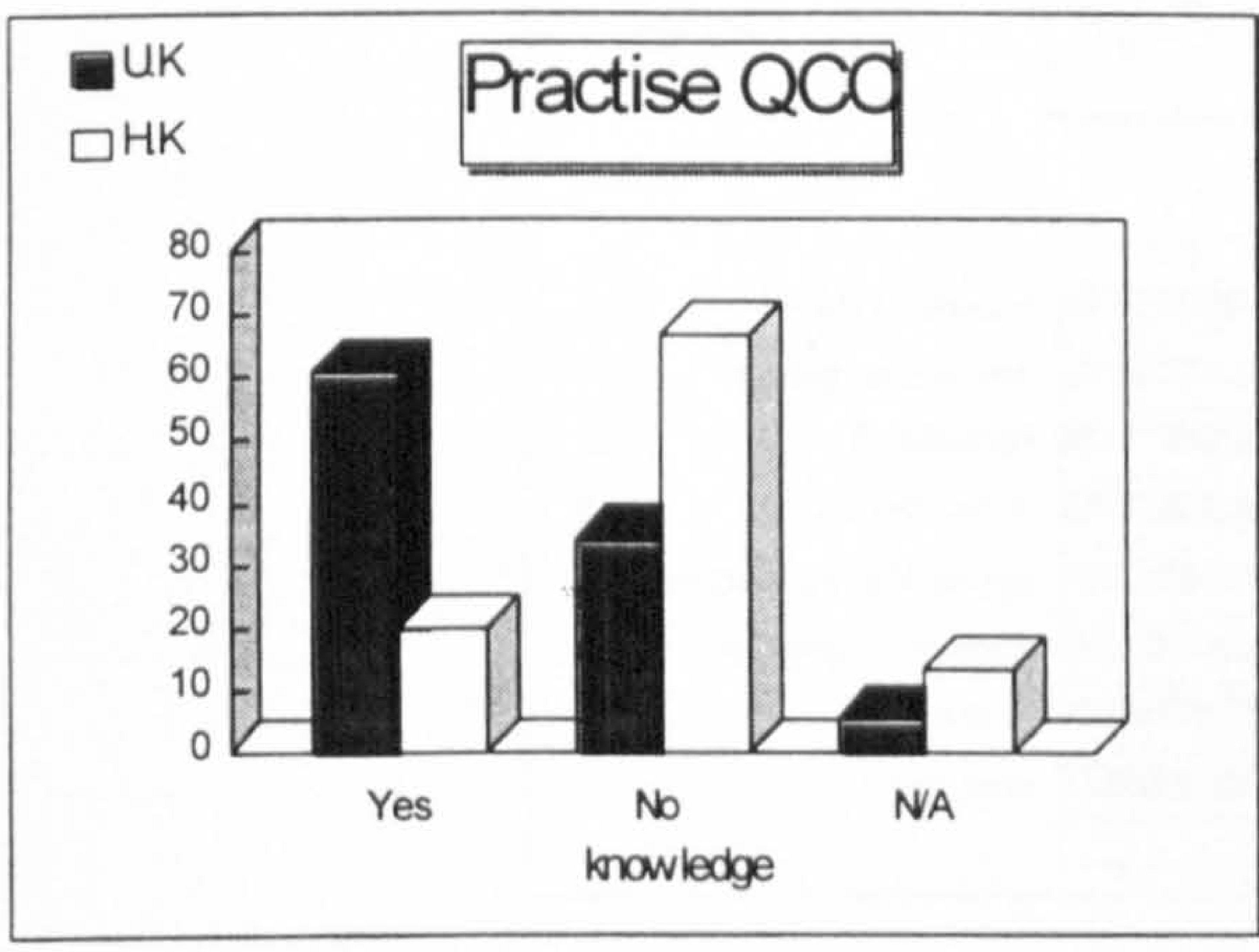


Figure 6.4A Practise QCC

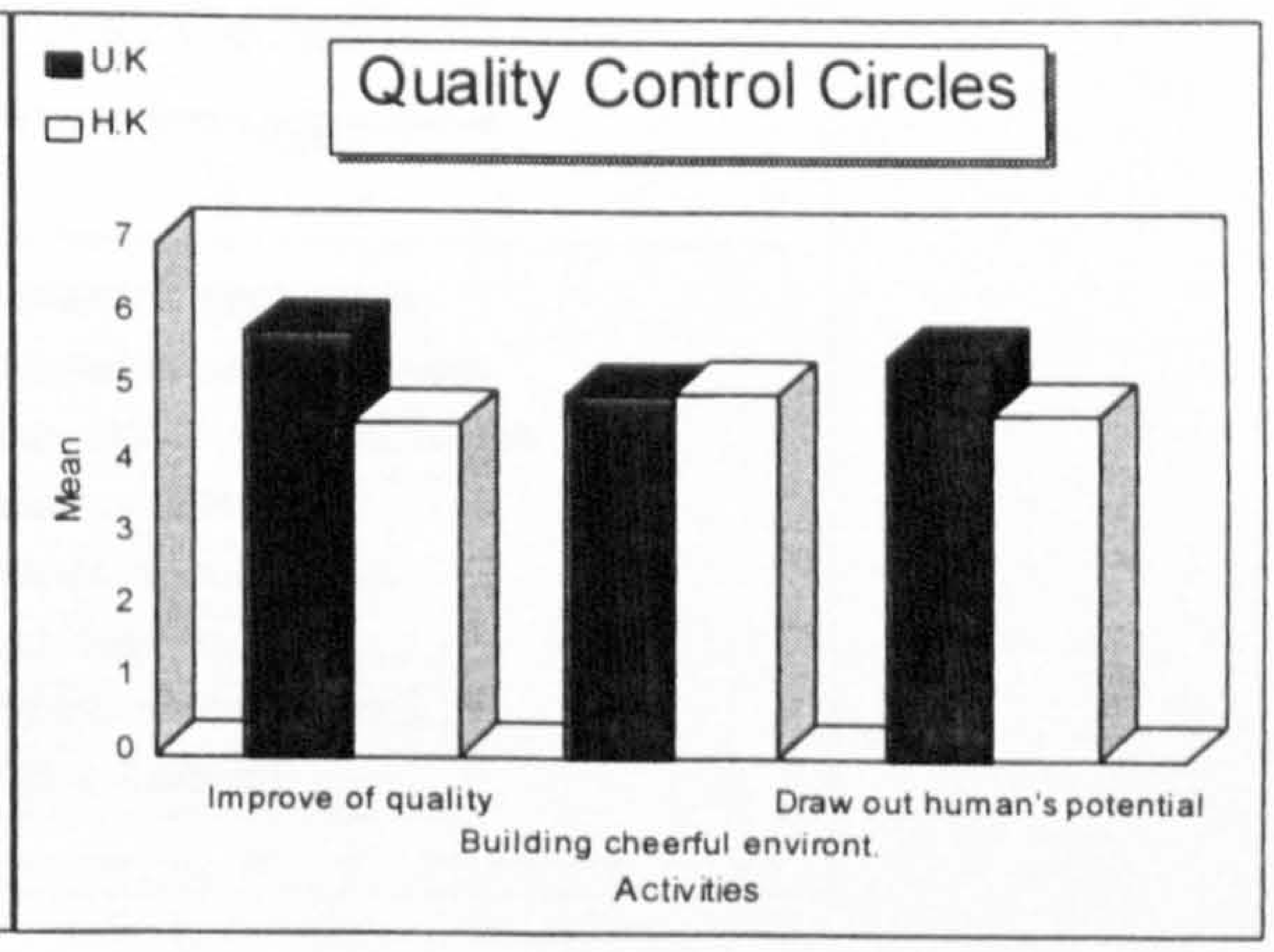


Figure 6.4B Importance of QCC

The survey feedback is summarised in Figure 6.4B The F-test reveals that there is no significant difference between the UK and HK construction companies. Moreover, there is no difference in the perception of the benefits of QCCs. The lack of interest in QCC practice could prove costly in the future. According to the Director of Quality Management of John Laing Plc., many of the potential problems or areas for improvements could be highlighted at the earliest opportunity by practising QCC [Ball, 1992]. The Chairman and Chief Executive of George Wimpey plc also stated "A chief executive who is not prepared to take the lead, openly and conspicuously, will not succeed in his task". [Chetwood, 1989] Without the participation by top and middle management, QCC activities cannot be sustained. In summary, QCC is useful to improve quality. Unfortunately, it is not widely practised in the UK and HK construction industries. QCC can bring about cultural change, improves communication and motivates the staff to contribute to the betterment of their work. Therefore, it should deserve more attention by management and be promoted throughout the organisation.

6.1.3.1.4 ISO 9000

Figure 6.5 shows the results of the survey on ISO 9000 QMS. The F-test reveals that there are no significant difference between UK. and HK in the practise of ISO 9000. Moreover, there is no significant difference among the ISO 9000 benefits. It was expressed by some of the interviewees that the prime motivation for the introduction of the quality system is due to client pressure. The graph shows that registered companies are enjoying more of the soft benefits of increased quality awareness, attract on and satisfy customers as opposed to some of the hard benefits (i.e. reduction of waste, time and cost). An explanation for this is that often companies are expecting ISO 9000 to give them cost savings within a short time. Unfortunately, this benefit will not be immediately available. Therefore, most companies are less satisfied with the hard benefits that they are getting out of ISO 9000. On the other hand, in order to measure the hard benefits, suitable measuring systems have to be built into the system, such as progress measurement, error-cause analysis, waste measurement, etc. In order to remain competitive, companies should put 'satisfying customers' as their first priority. Then, monetary (hard) benefits will follow.

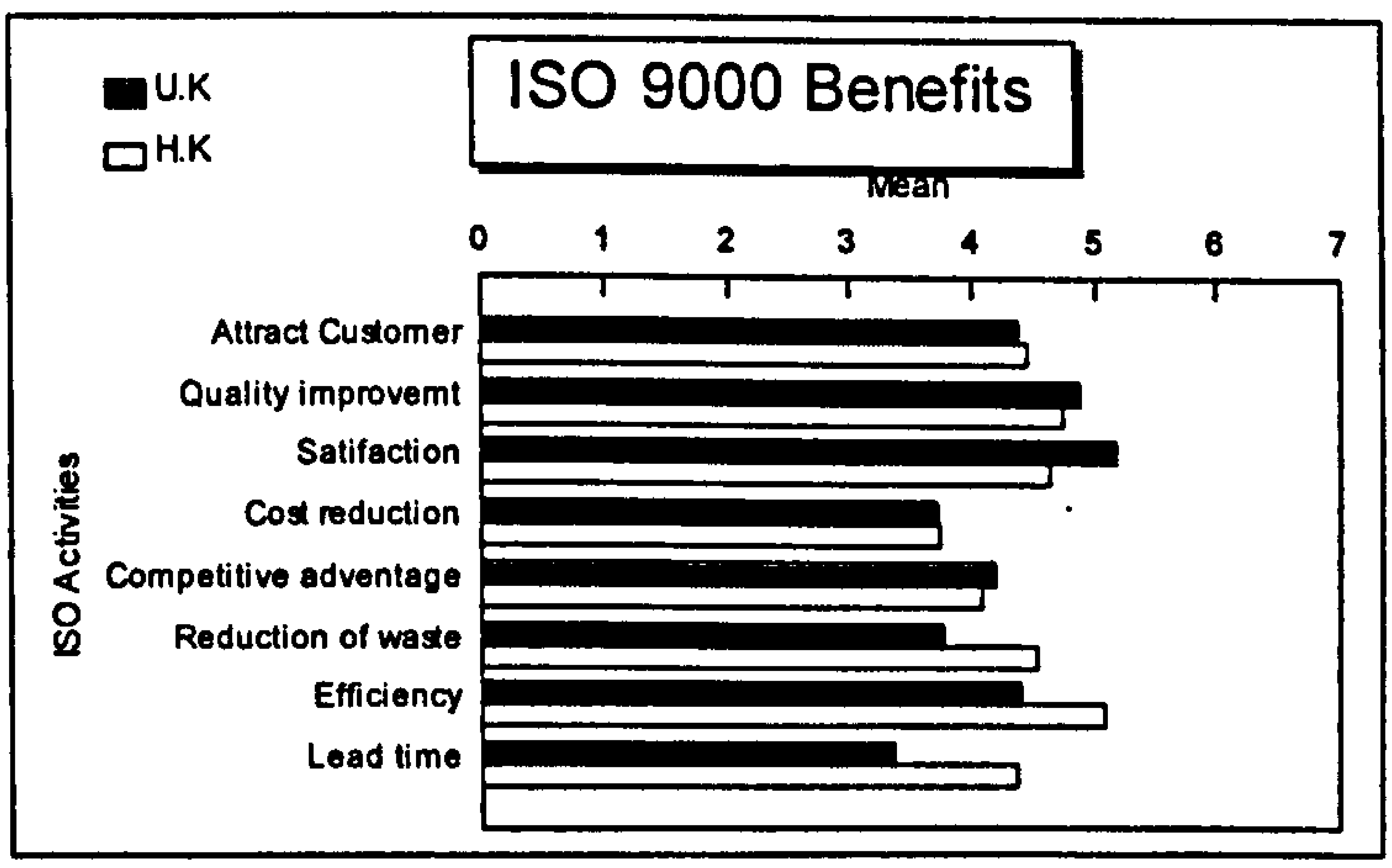


Figure 6.5 ISO 9000 Benefits

6.1.3.1.5 TPM

Figure. 6.6A shows that only about 20% of both UK and HK construction companies have practised TPM. A likely reason for this is that often companies do not know what benefits TPM could bring to them, again this comes back to the problem of lack of training.

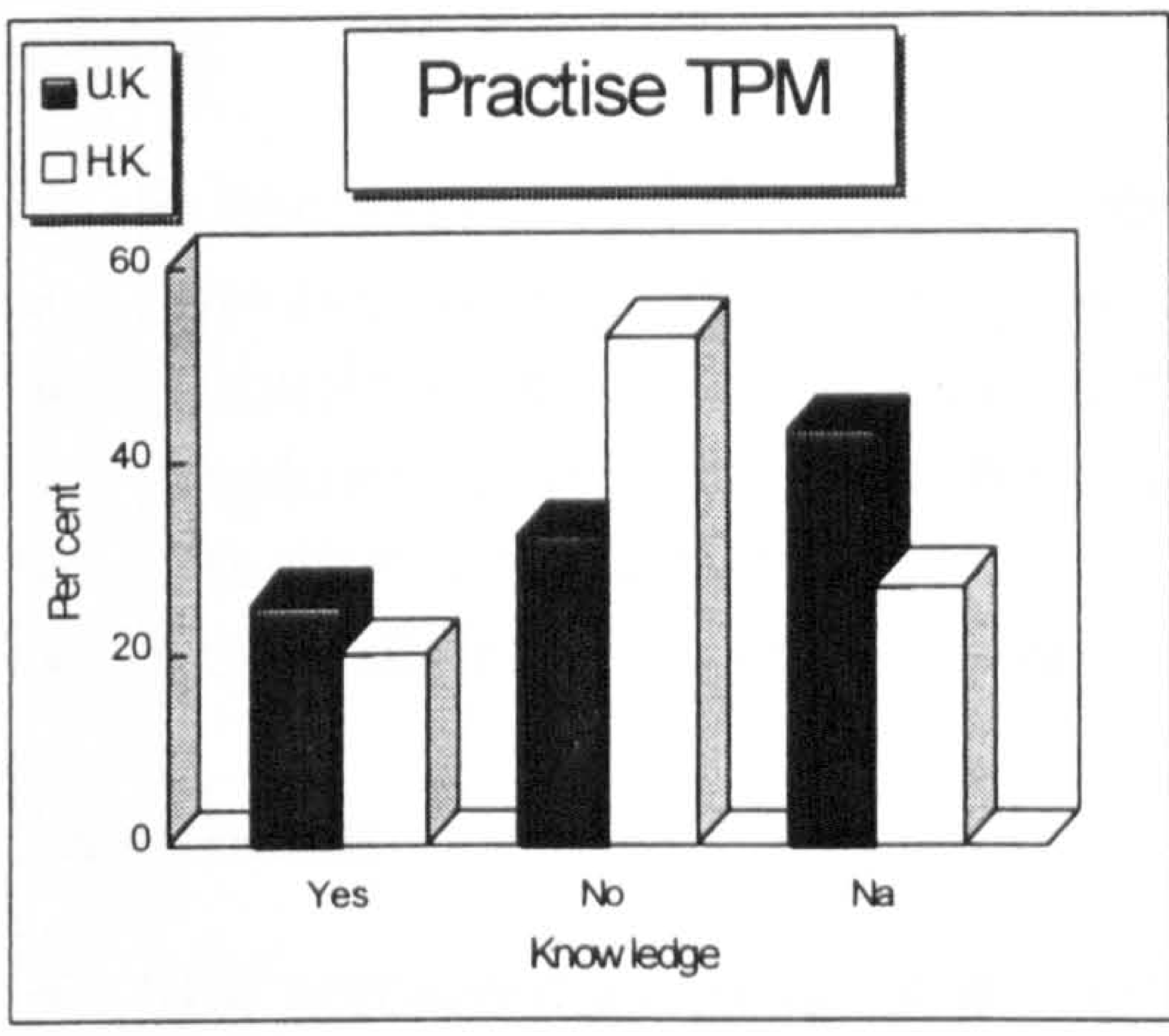


Figure 6.6A Practise TPM

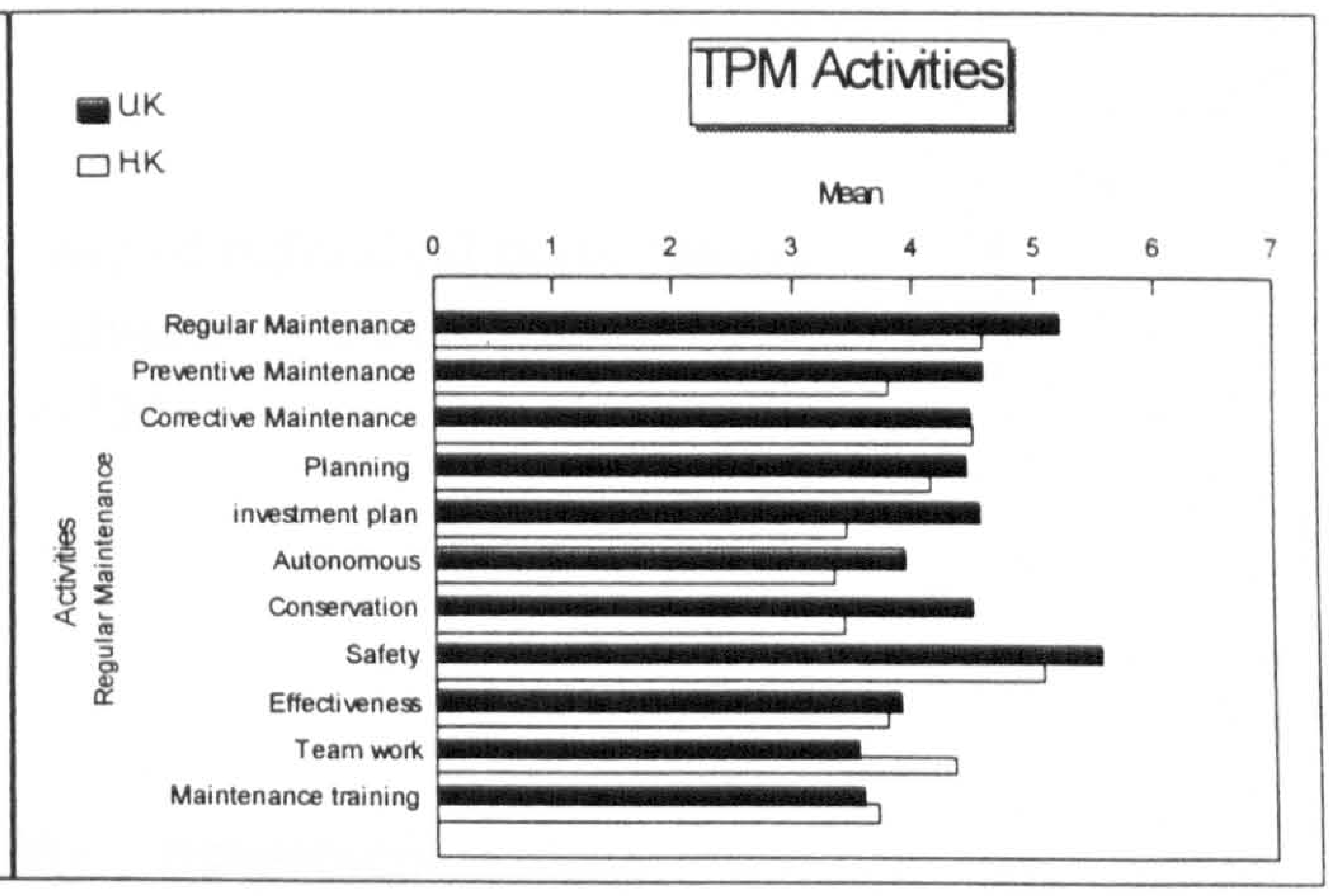


Figure 6.6B TPM activities

From Figure. 6.6B the F-test result shows some significant difference among the TPM activities. Companies seem to spend most of their effort on fire fighting and safety, there are very little emphasis on preventive or autonomous maintenance.

6.1.3.1.6 TQM

Figure. 6.7A shows that 35% of HK and 55% of UK construction companies perceived a need for TQM even for those ISO 9000 registered firms.

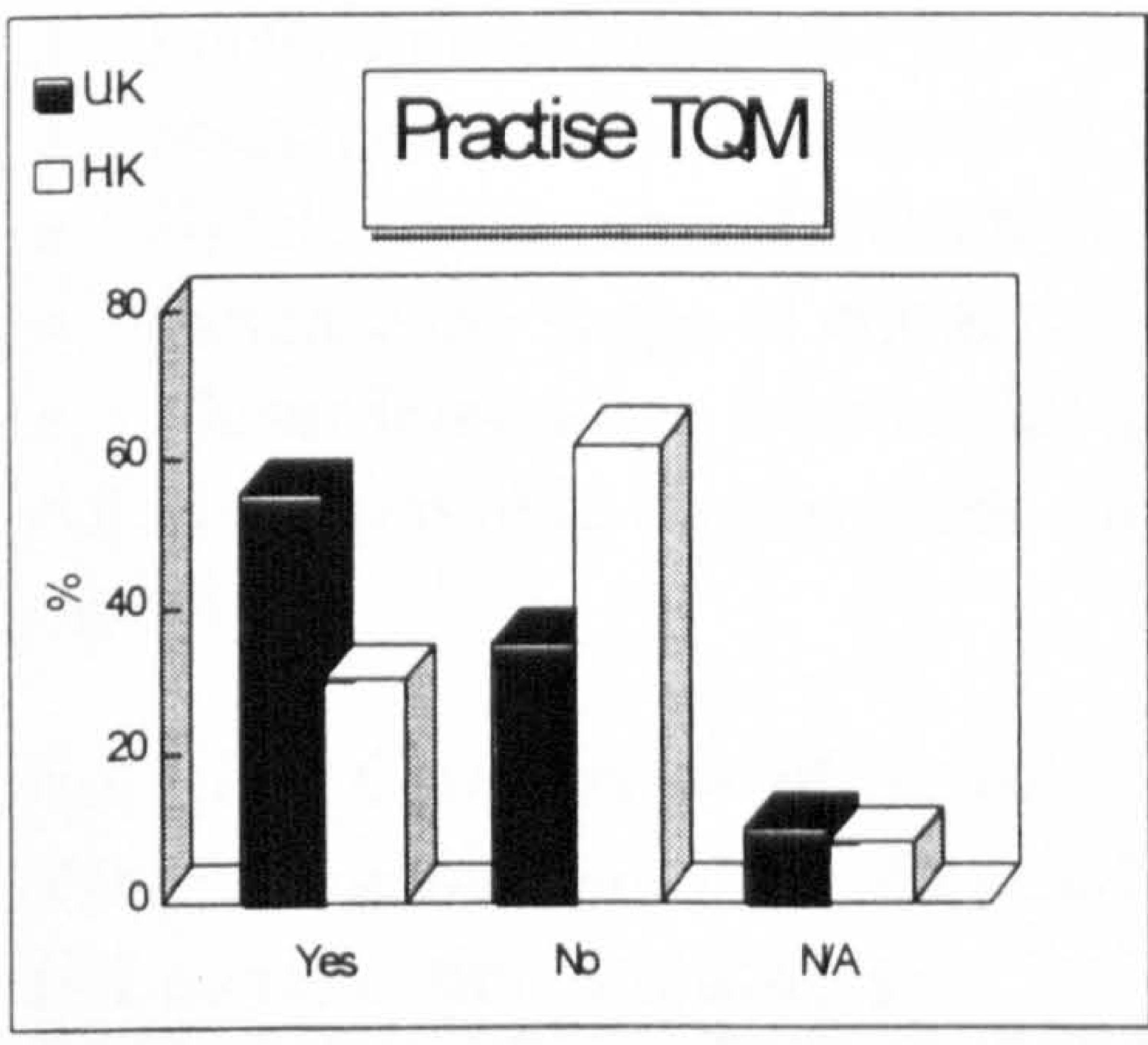


Figure 6.7A Practise TQM

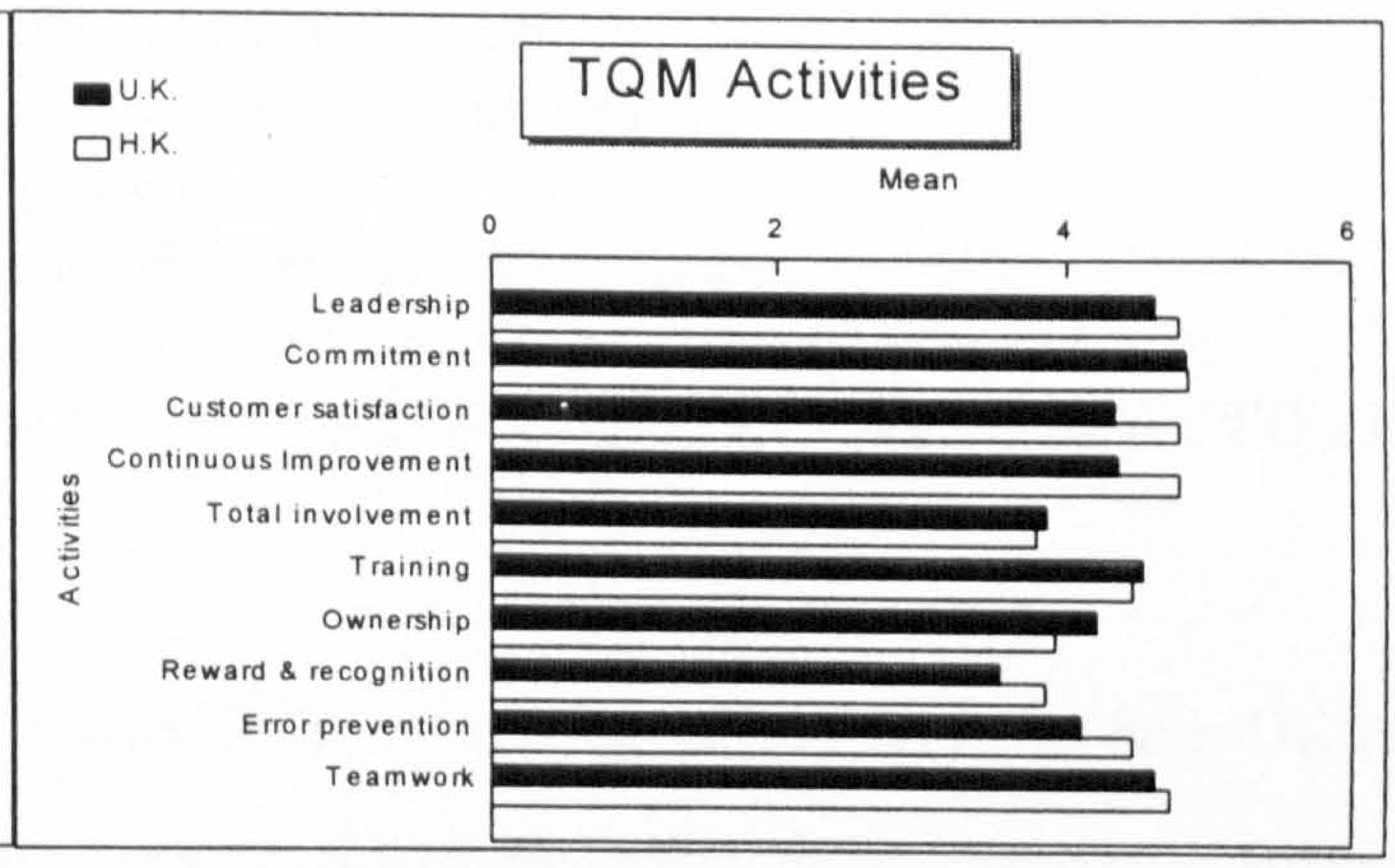


Figure 6.7B TQM Activities

Evidence from the results (Figure. 6.7B) of the survey, shows that the mean score ranges from 4 to 6. Although there is no significant difference between UK and HK companies, the statistical results show there is significant difference among the TQM activities. Companies see total involvement as less important. According to many successful cases, for any TQM to work, it must involve everyone. This is what the word "TOTAL" means. Although between 35-55% of the companies claimed that they had some TQM policy within their own company, some quality managers interviewed claimed that the majority of their staff did not understand the concept and the real benefits that TQM would bring to the company. Therefore, in order to implement TQM successfully in the construction industry, in addition to commitment, communication and confidence are of equal importance.

6.1.3.1.7 Overall quality management system

Merits

- Better records and document control
- Improve communication, responsibility of individual performance,
- Enthusiastic staff who is seeking continuous improvement
- Employee ownership of problem solving
- Effective marketing tool
- Standardisation of best practice

Drawbacks

- Still perceived as quality not a quality management system
- Difficult to maintain when work is tight
- Gaining ownership of TQM at site level when faced with immediate production issues.
- Lack of feedback on performance to allow improvement
- Lack of management commitment and training
- Administratively time consuming

Possible improvement

- Simplifying procedures
- BPR
- Focus on continuous improvement and training need
- More performance measurement, involvement of all levels
- Greater commitment from management
- Increase the scope of content to include management activities.
- Closer integration with health and safety and environmental management

All of the possible improvements quoted above can be achieved by practising the TQMEX model.

6.1.3.1.8 Comparison of result

Table 6.2 summarises the mean of means of the six groups of questions for both UK and HK construction industries.

	UK: Mean of means	HK: Mean of means	Weighed Mean of means
5-S	4.9	4.5	4.7
BPR	5.1	4.7	4.9
QCC	5.4	4.7	5.1
ISO	4.3	4.5	4.4
TPM	4.4	4	4.2
TQM	4.3	4.4	4.4
Overall	4.7	4.5	4.6

Table 6.2 Mean scores to the 6 groups of questions (UK & HK Construction)

When comparing the relative mean values on the 6 groups of questions, it was revealed that TPM scores were the lowest. It is amazing to see that one of the heaviest use of plant and machinery industry should score lowest. This demonstrates that the companies see TPM as something less important. If only companies consider TPM more seriously, this would significantly reduce construction machinery downtime, defects, unexpected equipment breakdown, manpower requirements. Hence, it would improve productivity and quality. On the other hand the highest mean score is QCC. About half of the companies have practised QCC and that they strongly believe that it is a good idea to implement QCC company-wide. Hence, it can be deduced that for those companies which have implemented QCC, they see QCC as a very important vehicle for quality improvement.

From the ANOVA summary results in Table 6.1, there are no significant differences between the 6 steps for UK and HK construction firms. Apparently, this seems to be in contradiction to the practices in the two places. In HK, construction cycle time is generally much shorter. This calls for good co-ordination, and sometimes, at the expense of quality compliance. Perhaps, one explanation is that despite the time constraint in the HK construction industry, the contractual requirements are generally in line with the standards set by BSI. Moreover, the monitoring systems by the architects are about the same for both places. Consequently, the same degrees of quality perceptions are found from the quality managers of the two places.

6.1.3.1.9 Summary of Questionnaire Survey

Based on the results of the survey among 62 ISO 9000 registered construction companies operating in UK and HK, each of the TQMEX steps is agreed as important in order to achieve TQM. The respondents are also aware of most of the improvement tools such as BPR, QCC, ISO 9000 and TPM. 5-S needs to be promoted in order to maximise its benefit to the construction industry. Overall, companies have rated high on each of the steps. This proved that TQMEX is a workable and practical model for implementing TQM. By going through the responses from the construction companies. The following conclusion can be made:

- Some companies have difficulty in distinguishing between TQM and ISO 9000
- There is a lack of implementation plan to guide company in achieving TQM.
- The main difficulty in gaining commitment to TQM is in changing people's behavior and attitude.
- There is a lack of knowledge of TQM principles and tools.
- Company does not integrate TQM principles and practices into project management.
- There is little emphasis on measuring the effectiveness of the quality process.
- Some companies are unable to give details of progress as they are still in the early stages of the TQM process.
- Using cost of quality as a means of assessing progress is not widely practised.

It is hoped that by summarising different views from various leading construction companies it will shed some light on the subject. They further endorse the importance of TQM and the need for correct approach.

6.2 ACTION RESEARCH (CKFC CONSTRUCTION CO. LTD.) HK

Action research was undertaken at a TQM operating construction company in HK between Jan 95 to July 95. The author was asked to develop a 5-year Quality Plan for the company. As a result of this assignment, TQMEX model was introduced to the company. TQMEX Model was implemented through a series of training and pilot implementation programmes. Table 6.3 shows a rough-cut estimate of the time required for training and implementation at Cheung Kee Fung Cheung Construction Ltd (CKFC). The estimated programme can vary depending on the size and nature of the business. The size of the organisation is assumed to be large. In general, the smaller the organisation, the shorter will be the time required for training and implementation.

	BRIEF DESCRIPTION	MAN-DAYS
A.	A.1 Training/ Consultancy Requirement Studies	5
	A.2 Establish Quality Council	5
B.	Conduct Training & Implementation on:	
	B.1 Housekeeping through 5-S practices	5
	B.2 Business Process Re-engineering	5
	B.3 Quality data collection & QC tools	5
	B.4 QCC & Problem Solving	5
	B.5 ISO 9000 Quality Manual Documentation	5
	B.6 Internal Quality Audit	5
	B.7 TPM Implementation and Training	5
	B.8 TQM Implementation and Training	10
C.	Documenting & Implementing ISO 9000 QMS	20

Table 6.3 Suggested TQMEX Initial Training/ Implementation Programme

The overall TQMEX Training & Implementation Programme is also shown in App.3.1. Through this "action research" the results on the dynamics of the TQM improvement process can be observed. Productivity measures are important in every stage of the implementation, so that improvement can tailor the programme to their special needs and changes can be identified for further improvement (See figure 6.8).

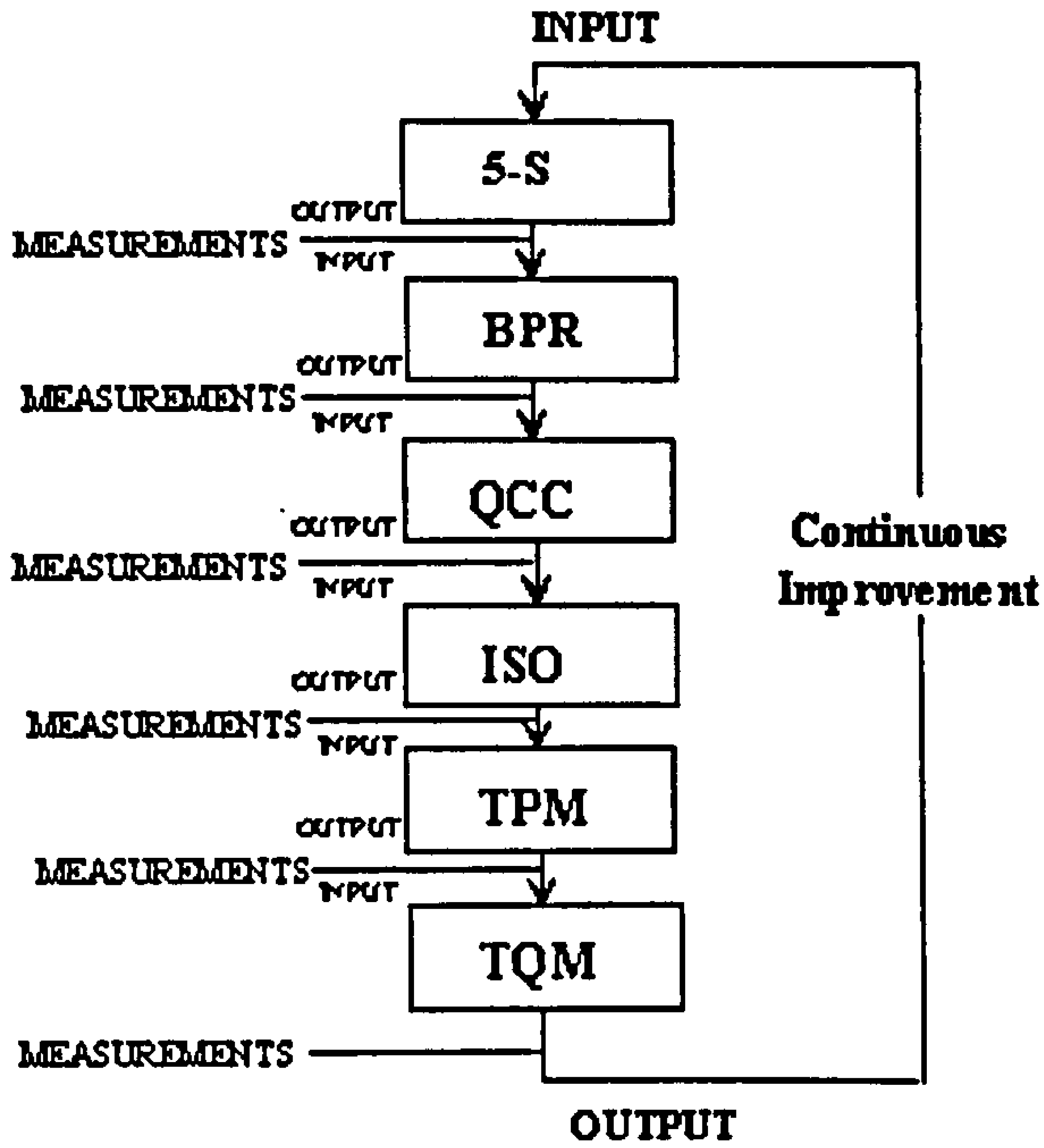


Figure 6.8 Implementation Cycle for TQMEX

The Deming Cycle has been followed at each stage of the TQMEX implementation. The following steps were followed as the guidelines:

- Establish appropriate measures
- Define and evaluate measurable inputs and outputs
- Define and document current procedures and working practice
- Identify problems that cause errors and reduce productivity
- Develop and implement corrective actions.
- Standardise the procedure
- Repeat activities for continuous improvement

It is important that upper management (leaders) should contribute to the output of each step and input to the next step so that they can "Check" the performance. The preconditions for effective leadership [Kondo ,1993] have been adopted and used throughout the course of implementation. They are:

1) Leaders must have a vision and shared goals
2) Leaders must have the strength of will and tenacity of purpose.
3) Leaders must be able to win the support of their followers.
4) Leaders must be able to do more than their followers. At the same time, they must not interfere with what their followers can do for themselves.
5) Leaders must always succeed, but they must never sacrifice their followers in order to do so.
6) Leaders must be able to give the right advice to their followers at the right times.

6.2.1 BACKGROUND OF THE COMPANY

Cheung Kee Fung Cheung Construction Ltd. CKFC is a long established and reputable large sized building contractor. The group has been involved in building construction in Hong Kong for over 35 years, and is principally engaged as a main contractor in the construction of public housing for the Hong Kong Housing Authority. The company is included on the list of qualified contractors of the Housing Authority under groups NW2 and M2 for building (new works) and building (maintenance) respectively.

The group may also tender for building contracts of any value from the Architectural Services Department and other government departments. The Group also provides maintenance and fitting services for various public sector properties.

In addition the Group is an approved specialist supplier of the Housing Authority for the supply of cooking benches, sink units and doorsets for use in public housing estates in Hong Kong. The Group also has a 35% interest in a joint venture with a local subcontractor, with production facilities in China engaged in the manufacturing and fitting out of aluminium windows set for sale in Hong Kong. Over the period in the year 1991 to 1992 the turnover of this company has increased from HK$345 million to $500 million.

6.2.2 Firm's Attitude Toward TQM

Quality has always been a prime concern of CKFC in both its construction and manufacturing operations. As a pre-requisite for working as a main contractor for the Housing Authority from March 1993, CKFC is required to obtain accreditation of their quality systems based on the requirements of ISO 9000 certification. The primary objective of CKFC's quality management is to meet every customer's needs through continuous improvements of quality. By March 1993 CKFC successfully obtained the accreditation of ISO 9000. This is not the end of their goal. In fact CKFC sees ISO 9000 as a stepping stone toward total quality.

6.2.3 Implementation Framework of TQMEX Model in CKFC

To achieve its quality management objective, CKFC has agreed to adopt the TQMEX Model. They are also committed to the 4C's of quality and the 4 pillars of TQM. Moreover, it is recognised that in the construction industry, companies compete on time, cost and quality. As a result of further discussion, the author came up with a model called "TQM Framework for construction industry" (see Figure 6.9). This framework will form the basis for the TQM implementation at the CKFC. The applicability of each part of this framework is discussed in the following paragraphs.

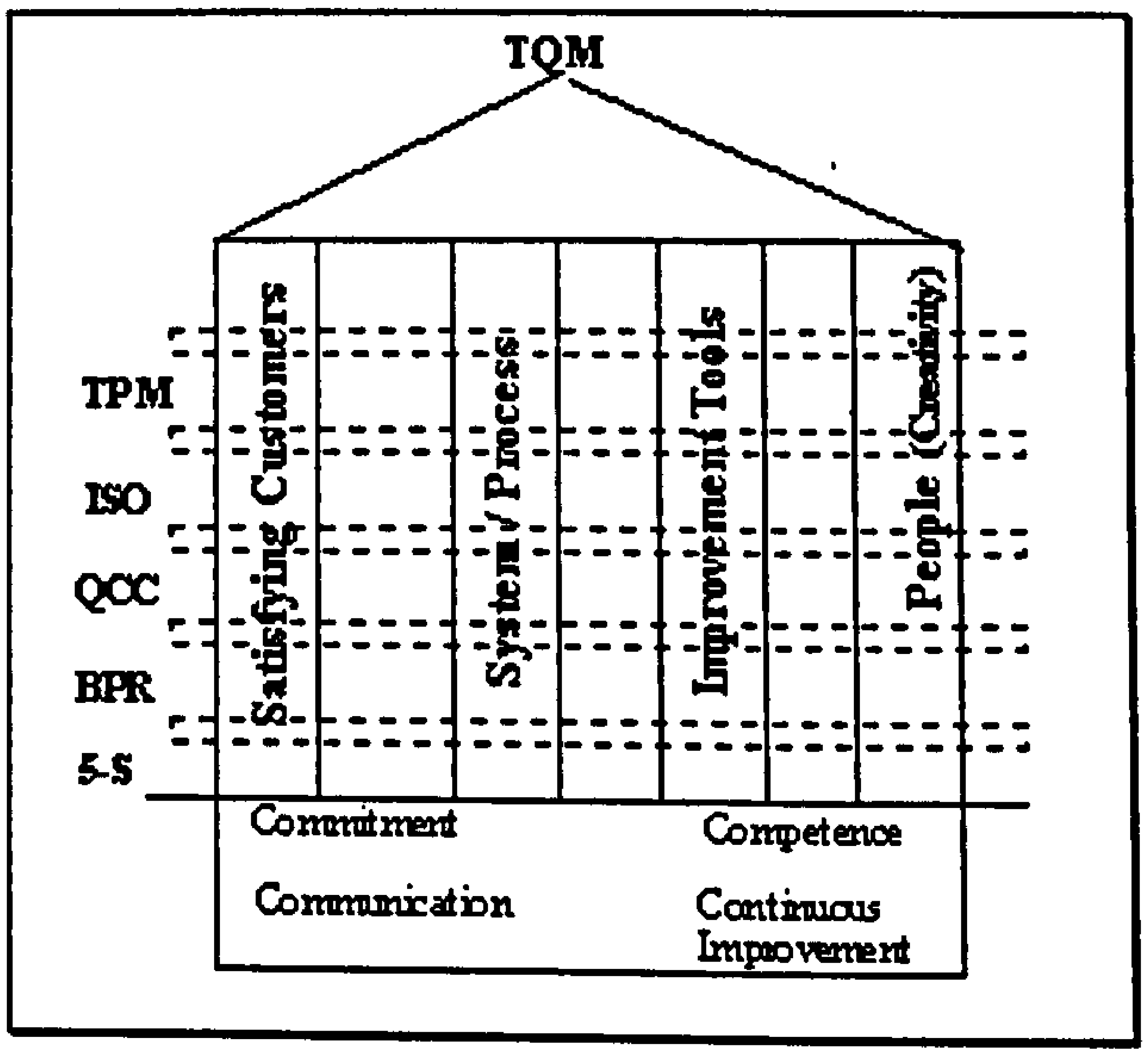


Figure 6.9 TQM framework for construction industry

The company believes that implementation of TQM and improvements heavily rely on people because it is a predominantly labour intensive industry. Human dimension is incorporated in each of the stages of the TQM journey and is the driving force behind the philosophy of total quality in business as well as in life. The emphasis must be on top management **commitment**. In order that all employees take on the ideas of TQM the initiative must be taken seriously at the very highest level. Along with commitment, quality goals require actions and attitudes based on **competence**. Competence is based on knowledge. Competence and quality work go hand in hand, because competent people can ensure their work to be done correctly and consistently to specification. **Communication** is a crucial factor for any construction project. The lack of communication is the greatest problem which impedes the pursuance of quality. For example information from the architect passes through the site management before it reaches the worker and there is little or no feedback from the worker to the architect. If a directive from the architect is not fully appreciated by the site management then the error may be compounded when passed on to the worker by the site management. Continuous improvement is a never ending process, because there are always two external forces acting on the organisation: 1) the improvement made by the competition, and 2) the ever increasing pressure from customers and the market place. Therefore it is important for the company to build awareness of continuous improvement process throughout the company. While the 4Cs form the foundation of TQMEX model, the four pillars can be seen as the support for the framework. The interpretations of the four pillars have been discussed in (S.4.2.1.1). The 4Cs and four pillars provided an important framework for the implementation of the TQMEX model.

6.2.4 5-S

The first step in implementing a TQMEX program started with training so that all employees are prepared to assume their duties. An action plan for 5-S was developed and implemented during the six month period of my action research (see appendix 6.2). 5-S was the first stage of the programme. It helped to clean up the work areas and sites. It also helped the worker to organise and discipline themselves. There were many improvements needed to keep the place clean and tidy. These also have a significant impact on TPM activities in terms of reducing equipment failures and identifying and reducing primary causes of defects. The 5-S programme ensured that any errors were identified quickly and corrected effectively so that the construction process was not interrupted. It was important to organise 5-S teams to initiate the TQMEX programme so that many potential problems can be solved. Surprisingly by simply cleaning up and organise the facilities and developing daily 5-S tasks for the workers, many of the problems which could have occurred during construction stage have been avoided. Examples of such problems are:

Organisation
- Unable to separate the things which are necessary for the job
- Things are not kept at convenient location
- Reluctant to throw away rubbish

Neatness
- Lack of understanding and awareness of the 5-S concept
- Not sure where things are kept
- No gangway to transport
- Not labeled
- Unclear if spare parts exist (no ledger and nowhere to ask)
- One brought was defective

Cleaning
- Things get dented or bent in conveyance
- Dust and other substances ruin the painting process
- Bad connections are made because the electrical contacts are dirty
- Fires are caused because garbage short-circuited the electrical equipment
- Computer always plays up because dirt is accumulated inside.

Standardisation
- Lack of standardisation i.e. Position mark, identification label, Safety label.

Discipline
- Lack of training and self-discipline

6.2.5 BPR

In a recent investigations in CKFC, I have found that the design stage of construction accounts for 50% of faults in the completed project, 40% are due to the on-site process and the remaining 10% lies with product failure (materials). Since the cost of the design stage accounts for about 5-10% of the total project cost on average, majority of the quality assurance was focused on the construction phases. This problem has become more acute with the increasing amount of design and build project in the company.

Because the quality of the design, marketing, and tendering stage leads to the quality of the end product, CKFC should take on board the idea of BPR to redesign their business as a whole or individual work process in order to maximise business effectiveness and reduce the errors during the early life cycle of the project. The approach was to look at the project from planning, design, bid, acceptance, procurement through to construction, to identify where the bottle-necks are and how future improvement can be made. The implementation of BPR followed a step-by-step approach shown in appendix 6.3. This created better understanding of "Quality" from the top down and focused on the concepts of "process" and "quality chains". There are several activities identified by BPR which should be considered at the earliest stage of the project cycle.

- The client's requirements and the project team. The aim of a quality system is client satisfaction and this will not be achieved unless the requirements of the client are clearly established. Also the project team should be formed and become active at the earliest possible stage of a contract so that the individuals can fully understand the requirements and their responsibilities.
- In a design and build project, all of the factors which are likely to effect the design should be established early on rather than discovered later. This saves time and ensures continuity of construction.
- The constraints of finance and time. These factors are very important when considering resource planning and the budgeting of a project. Thorough consideration of budgeting and timing at an early stage may prevent contract overruns and claims later on.
- Resources required to meet the client's needs. Which resources are required and how they can be best obtained should be considered.
- The procedures required to define the controls for the work progress. These should be included in a quality plan before other detail work procedures.
- Work packages to be sub-contracted and the suitability of sub-contractors.

6.2.6 QCC

As one of the integrated parts of 4Cs of TQM in construction, communication is vital if not most important part of day-to-day activities. The purpose of communication is to achieve mutual understanding. Based on the survey finding, most construction companies considered the weekly project meeting as a QCC. However they do not understand the concept and the real benefit behind QCC. One of the approach CKFC has taken was by setting up structures that encourage involvement in quality through teamwork. The staffs were organised into teams of six to eight people, and the teams developed improvements and implemented them on their own to solve routine and foreseeable problems. The implementation plan of QCC is shown in appendix 6.4. The approach being taken by this company is found to be effective, and this experience can be shared by other construction firms which are planning to set up QCC. These steps can be summarised as follows:

- Write policy statements
- Start a newsletter about quality
- Make a video about quality
- Create quality groups/teams
- Management -- hold employee talk sessions
- Have suggestion boxes and forums
- Organise recognition parties for quality performance
- Training and Practice on QC tools

6.2.7 ISO 9000 Quality System

CKFC achieved ISO 9002 certification through the HK Quality Assurance Agency assessment in March 1993. The activities covered by this standard are General Contracting and Build Contracting including administration, management, planning and site controls.

Implementing the TQMEX programme makes the company realise the beauty of the word "simplicity". Much of the procedure and instruction have been eliminated by practising 5-S, BPR and QCC. The implementation plan of ISO 9000 is over a period of 8 weeks as shown in App.6.5. The quality policy statement issued by the Managing Director of the Company is simple but effective:

1. Quality management is a primary concern of CKFC.
2. The Company is committed to producing and installing products which are fitted for clients' intended proposes; and delivering these products within the timeframe specified by clients.
3. To achieve these objectives, the Company operates a Quality System in accordance with the requirements of ISO 9002. The principles and practices of the Quality System are documented in the Quality Manual, Quality Procedures and Work Instructions.
4. Management ensures that this company quality policy is communicated to, and understood by, all levels in the company. The Quality System is implemented and maintained with full support from top management.

These quality policy statements confirm that quality is promoted from the top. The quality system employed by CKFC is simple. it is based on a four tier structure:
[1] **A Quality Manual.** This contains policy statements of all quality procedures employed by CKFC.
[2] **Quality Plans.** These are used for each contract and state all quality requirements for the contract.
[3] **Quality System Procedures.** These set out the various procedures in accordance with ISO 9002.
[4] **Construction Work Instructions.** These contain essential duties and details for ensuring that quality operations identified at pre-contract, construction and inspection stage are conducted in a controlled manner on site.

At Contract Review (Clause 4.3) stage certain criteria are specified which must be confirmed with the clients. These include work scope, sub-contract and supply elements and requirements, management staffing levels, client's specifications and any special contract requirements.

The CKFC Marketing Department informs all Directors of enquiries received and forward the documents to the Estimating Department for review. Other departments such as Planning and Purchasing are also, where applicable, involved at tender stage. consequently any points which require clarification or amplification are resolved through the Estimator who contacts the client in writing. In this way information is well communicated to all involved and specific procedures to ensure these are set down in Departmental procedure manuals.

Quality Plans (Clause 4.4) are identified at Contract Review Stages. These itemise the essential controls and inspection activities required by CKFC, its sub-contractors and the client. They also list all related documentation concerning materials and methods or work. Quality plans may be prepared by the planning Engineer for tender purposes or by the Site Manager at construction stage. It is stipulated that a Quality plan must be approved by the Quality Assurance Department and the client before being implemented. The satisfaction of the client and ISO 9002 requirements is thereby consistently maintained. CKFC have documented procedures for the creation of quality plans.

There are procedures laid down by CKFC for the Control of Documentation (Clause 4.5). The essential documentation referred to includes: Customer specification and Bills of Quantities, the Quality Manual, Quality System Procedures, Construction Quality Procedures, Quality Plans, Drawings, British Standards and Regulations, Copy purchase Order, Architects Instructions, Planning Schedules, Quality Control Documentation, Manufacturers (Suppliers) Special Instructions.

The control over all original issues and any subsequent change applied to any essential documentation, should ensure that correct and timely information is notified to relevant personnel to minimise contractual delay or rework (Clause 4.6). At CKFC the issue of such documentation is controlled by the use of covering letter or a transmittal notice. Any old documents are so marked by specifically authorised personnel and segregated from current documents. These procedures minimise the possibility of confusion of information by documentation becoming disorganised by too many hands.

The Purchasing Process (Clause 4.7) is controlled by a Purchasing Department Procedure Manual. This details responsibilities and duties and sets down procedures for the keeping of purchasing records. These records include details on the past performances of suppliers and sub-contractors. This enables CKFC to be aware of the likely quality of service a supplier or sub-contractor would provide in future contracts. All material orders are recorded on approved forms giving specific information regarding the material type and its intended use. It is requested of sub-contractors that they supply written procedures detailing their work methods and that these are available for client approval. Any Customer Supplied Material (Clause 4.8) is inspected on arrival on site for conformance to specification and treated with the degree of care as stipulated in ISO 9002, section 4.14.

When purchased materials arrive on site a system of Identification and Traceability (Clause 4.9) should be employed. CKFC keep records of all materials on site and where appropriate, due to critical safety or contractual requirements, a system of permanent identification is adopted which is recognised by all concerned. Sub-contractors and suppliers are required to comply with these procedures.

Ultimately a quality system can only be effective providing tight controls can be maintained over the Construction Process (Clause 4.10). In order to achieve this, procedures must be developed and implemented. Before a section of work is started the Quality plan for it must be approved by the client as must any sub-contract procedures. Procedures are set down by CKFC for this and it is checked that all activities will be performed by trained competent personnel. CKFC maintain records of personnel qualifications and competency at main office. Such records are available for client verification and sub-contractors are also expected to provide proof of their employees competency.

Responsibility for progressing and conducting Inspection and Testing (Clause 4.11) lies with the site manager or his appointed representative in accordance with the established procedures. CKFC stipulate that "All materials/ assemblies are verified/ inspected on receipt and inspected/ tested at suitable points/ locations to ensure workmanship and drawing requirements are met, prior to incorporation in the next construction stage."

After each stage of construction an inspection is conducted before it is offered to the client as complete. An inspection is also carried out to ensure that all of the inspections and tests have been completed. Records of all inspections and tests of CKFC work and sub-contract work are maintained. The extra paperwork involved in this procedure for the site manager may lead to errors due to the pressure of work. It is recommended therefore that CKFC might be wise to appoint an individual who is solely responsible for this paperwork on larger sites.

The procedures set down to ensure that measuring equipment is accurate are very similar to those required in (Clause 4.12). All equipment is constantly checked for calibration and procedures for remedying any errors that exist. Each piece of equipment is issued to an individual who is responsible for protecting it from damage by following certain handling and storage procedures stipulated by CKFC. Any hired equipment must be accompanied by a valid calibration certificate and the use of personally owned equipment is forbidden. CKFC demonstrates this by its committed policy of minimising potential construction errors.

Where non-conformance (Clause 4.13) occurs CKFC officially informs a supplier / sub-contractor by raising a defect report that remedial action is required. When this has been satisfied the report is signed off by the supplier/ sub-contractor, a representative of CKFC and where required, the client. All actions are noted on this report. In the event that the client concedes that a particular non-conformance is acceptable such a concession is recorded in the site diary. CKFC provide for a continuing analysis of non-conformance to determine the cause and corrective action needed. When defects or deficiencies are found the respective personnel are charged with determining the cause and to implement corrective action. It becomes apparent that a good quality system has to contain procedures for the comprehensive keeping of records. These records can then be audited regularly to ensure that procedures are being followed and, where faults occur, that remedies may be found from the analysis of these records.

The CKFC Quality Records (Clause 4.15) including audit reports, corrective action reports, records of supplier/ sub-contractor performance, inspection and test records and non-conformance reports are all made available to the client throughout a contract for review. These records are defined in the Quality plan and form a final documentation package for presentation to the client at contract or stage completion. All records are stored for ease of retrieval in an environment suitable for the prevention of damage or loss.

The review of the quality system (Clause 4.16) is essential if it is to maintain its effectiveness. All departments within CKFC are audited for quality compliance at a minimum of twelve monthly intervals, although these may be shorter where non-compliance is suspected. Audits are conducted by suitably trained personnel not directly connected with the department being audited. Also site audits are carried out at least once, on nominated sites, depending on contract duration. These include the evaluation of quality practises, procedures and instructions, and certification documents and records. The management of the site under audit agrees and correct non-conformances revealed which are then documented in the site audit report. All remedial actions whether on site or within departments are re-audited to verify compliance.

CKFC recognise that training (Clause 4.17) plays a very important part in the quality of service it is able to provide. Responsibility is given to the Managing Director to continue the Divisional policy of active development and training for all employees in order to maintain a high level of performance. This training is given right across the employee range, from general operatives to administrative staff. Heads of department are responsible for implementing such training with guidance from the personnel manager.

The performance of managers, senior staff and supervisors is assessed annually and training and development needs analysed. A training plan is prepared by the personnel manager for approval by the Managing Director and the training policy for each manpower category is indicated in the appropriate section of this plan.

The training of staff in quality assurance is an on going exercise. At CKFC this consists of both internal group discussions conducted by the quality Manager and outside courses arranged by the personnel Manager. All training records are kept by the personnel manager.

Such comprehensive elements of the quality system are essential if quality is to be consistently assured. By referring to the above documentation, the way in which CKFC meets the requirements of ISO 9002 can be followed easily.

6.2.8 TPM

Regarding TPM in the construction industry, about 60-70% of the surveyed companies have not practised TPM. CKFC, like many other companies, spent most of their maintenance time on fire-fighting. Many of the operators still hold an attitude of "I operate the machines, and someone else fixes them". CKFC realised the importance of TPM and convinced that TPM could solve a lot of their problems. 5-S had an important role to play in terms of TPM, because clean and tidy work areas would help to identify early signs of wear, oil spatters and loose parts etc. The next step was to implement TPM programme by starting with training equipment operators, so that they were prepared to assume their new duties as "I'm responsible for my own equipment," This went beyond oiling and cleaning, but involves the process of maintenance, repairs and preventive maintenance planning. The implementation plan for TPM is shown in App.6.6.

6.2.9 TQM

CKFC are still going through the first five stages of the TQMEX model, The top management believes that the first five stages could provide them a very strong base and a proactive culture for the final stage -- TQM. This will take place after they have had clear business objectives and effective processes installed, empowered employees committed to quality, ISO 9000 QMS in place to demonstrate the disciplined approach to quality improvement, and all equipment and facilities in good condition and utilisation. Then it will be the right time for the CKFC to consider obtaining benchmarking against a nationally or internationally recognised quality award (such as the Japan Deming Award, European Quality Award, Malcolm Baldrige Award).

6.2.10 Summary

This case has applied the TQMEX model specifically to the construction industry. The finding is that TQM is highly relevant to the construction industry. Implementation plans were developed for CKFC based on all the elements of TQMEX model. These knowledge forms the basis for the "ES Implementation Plan" in Chapter 7.

The investigation into the way CKFC have approached TQM is very encouraging. From the point of view of creating a quality system from within departments it can be seen that the company has progressed more than satisfactory. The company is well on its way to creating an effective quality system.

Although it has been very difficult to describe the quality procedures employed by CKFC in this case study, the investigation shows that a quality system must be thorough and comprehensive. The system developed by CKFC followed a period of extensive research, analysis and commitment. With the initial success, the Group has already made the move to register the subsidiary companies in construction material manufacturing under ISO 9000. Up till May 95, three other subsidiaries have been registered based on the CKFC's experience. The ultimate objective is to satisfy the customers basing on continuous improvement and long-term growth.

6.3 Case Study 1 (John Laing Midland)UK

The author had a 2-hour interview with the Contract Manager of the company. This is a semi-structured interview with the questions based on the TQMEX model and the findings from the Case 1 above. The interview results are summarised in the following paragraphs.

6.3.1 Company Background

John Laing Group (J.L) is an international organisation and their Midlands Construction Office employs over 300 people. In 1993 the Group's turnover was over £1.5 billion. It is one of the top construction, housing, mechanical and civil engineering groups in the UK offering a range of traditional and specialist contracting services for large and small scale contracts. Laing Midland achieved ISO 9002 in late 1991, and in Nov 1991 has become the first building and construction company to win the British Quality Award. It was 1983 when Laing Industrial Engineering and Construction, part of the John Laing Group Trading Division, started to look at the idea of developing quality systems within its business. This development and implementation were very successful and very new to the industry. The company became more efficient, staff knew more of what was wanted, and subsequently turnover increased through the confidence gained in the company's abilities. The company became very successful in the area of quality management and the power of quality was therefore gaining ground.

6.3.2 Firm's Attitude Toward TQM

The Laing approach to quality is based on achieving customer satisfaction, control of quality and continual improvement which are strategic business objectives essential to maintaining leadership within their industry. Quality is the key to the Group's success.

There was the growing recognition within the Group that, by applying more emphasis on quality and continual improvement, as a business strategy, and by getting the job done right first time every time, the end result could only be an increase in business efficiency and therefore benefit to the Group. The company approach to quality is one that fully recognises that customer needs and business goals are inseparable. Satisfying the customer and continual improvement are two very important policies that help in their successful and continued quest for customer loyalty, competitive advantage and the happiness of all their employees.

Their Definition of quality **is about people, how people work, how well they communicate with one another and how they develop and implement the improvement of everyday activities.**

Guidance and policy are given by the Group to its individual businesses on how one should develop and implement the many tools and methodologies that can be brought to bear on this improvement strategy. Table 6.3 is the quality policy of John Laing Group:

Quality Policy
It is the policy of the John Laing Group to: • Achieve customer satisfaction by completing contracts in most effective manner and by providing products and services that meet the specified requirements and are in accordance with the need and expectations of out customer • Develop and maintain an economical, practical and documented Quality Management System for each of our Divisions and operating business • Maintain and improve the quality, safety and performance of our products and services, leading to enhanced reputation before clients and the public • Ensure we manage quality as effectively as we manage time and cost • Organise and arrange our affairs in such a way that the factors affecting the quality of contract, product and services provided by the company are always under control. • Develop and implement a group-wide quality improvement process directed at creating committed customers, improving productivity, reducing costs and increasing employee participation in this process • Use our high standards in Quality Management to increase profitability and market share

Table 6.4 Quality Policy

6.3.3 5-S

The company had not come across the concept of 5-S. However, due to the health and safety regulations, the concern of site safety, cleaning, organisation are inevitable. The quality manager saw the relevance of 5-S, particular at the site level. He believed that in order for 5-S to work at the site level, it would require extensive training, both on their own staffs and the sub-contractors. However, because of the high labour turnover of the sub-contractors, it was difficult to provide them training. One solution to that was to promote a company-wide 5-S campaign, ensuring all the sub-contractors are present and reinforce the 5-S ideas as part of the company culture.

6.3.4 BPR

It was important for the company to consider other parts of business process rather than only the production process. The company saw BPR as a way to achieves customer satisfaction. Their approach to BPR was to bring their suppliers and customers into the total quality process. The approach was suggested as follows:

- Involve clients, sub-contractors and suppliers at the very beginning of the project.
- Assessment of suppliers
- Listening to suppliers
- Training of suppliers
- Monitoring of performance
- Awards for suppliers

The group have also an ethics policy that is given to all staff. This policy describes their ethical values in terms of customers, suppliers and subcontractors, personnel, business operations. For example, they state under "customer": "We aim to build long-term relationships with our customers on the basis of mutual trust to encourage them to place repeat orders and recommend our services to others". It is their declared aim at the benefit of all concerned to "do the job properly first time every time". It goes on to say: "The customer's reasonable expectations under his contract with us must come first even if this causes inconvenience and results in reduced profit or ever loss".

6.3.5 QCC

Their successful implementation of QCC has been through the use of "quality improvement teams", "corrective action teams" and "problem identification schemes". This has been brought about by bringing people together to tackle problems for themselves with every recorded problem or identified improvement being investigated and acted upon. They also run successful productivity groups and an employee suggestion scheme.

6.3.6 ISO 9000 Quality Management System (QMS)

It was 1983 when the Group started to develop and implement quality management. It is a system based upon the prevention of problems and the taking of corrective actions on problems that do occur, a system based upon continual improvement and a system based upon meeting the requirement of ISO 9000. The systems have been written in such a way that people's minds are focused on the subject, with amendments continually emerging to improve the practices originally adopted. The QMS have been successful in allowing all the question business processes, to look for better ways of doing things. Today the Group have over 25 individual registrations to either ISO 9001 or 9002, covering 95 per cent of the Group's turnover. For example, The group have registrations for: multi-discipline construction management; multi-discipline design i.e. building services, infrastructure, civil and structural; building construction operations; supply and erection of homes.

6.3.7 TPM

According to the quality manger, TPM was not consider as part of the TQM program. However, many of the TPM activities had been taken on board i.e. The company had a procedure for maintenance which consisted of equipment investment plans and preventive maintenance procedure. He expressed that the most difficult part was the autonomous maintenance. Changing operators' lack of interest in performing maintenance cannot be done overnight. He suggested it would take two to three years to implement autonomous maintenance due to the time required to change attitudes. One suggestion he made was to provide on the job training. These would help the operators to acquire maintenance knowledge and skills gradually. And as they moved through the training steps, they would develop a willingness to implement autonomous maintenance.

6.3.8 TQM

For TQM to work effectively, training of staff in the total quality concepts is of vital importance to the group. Continual training in total quality as a specific subject is a service being provided by their in-company training programmes. It is also being provided to graduates and new starters as part of their company induction. It is a subject that is addressed by all their Group management training courses. There are a wide variety of internal training courses, ranging from half-day to 14 days in duration.

6.3.9 Summary

As an important step towards TQM, Laing registered itself under the ISO 9000 QMS. This demonstrates their commitment towards quality and satisfying the needs of their customers. The evidence of customer satisfaction is measured through a variety of methods such as the number of repeated business, the use of postal customer questionnaires, direct interviewing, and third-party surveys. This includes internal as well as external customers. The implementation of BPR and QCC identify the root of the problems and set the direction for continuous improvement. Laing is committed to TQM and is already on its journey.

6.4 Case 2 (Maeda Corporation)JAPAN

The author had a 2-hour interview with the Quality Manager of the Hong Kong Branch of the company. This is a semi-structured interview with the questions based on the TQMEX model and the findings from the Case 1 above. The interview results are summarised in the following paragraphs.

6.4.1 Company Background

Maeda Corporation is one of the top construction, housing, mechanical and civil engineering groups in Japan offering a range of traditional and specialist contracting services world-wide. Its HK Office has been established since 1965 and it employs about 300 staffs.

6.4.2 Firm's Attitude Toward Total Quality Management

The Maeda (HK)'s approach to quality is based on meeting customer requirement, control of quality by inspection and an effective ISO 9000 QMS.

6.4.3 5-S

Although the company is aware of 5-S, they have not implemented the practice because they can exert little control over its sub-contractors. However, the Quality Manager considered organisation and discipline as highly important to their quality management. Some of their Japanese employees do 5-S autonomously as part of their habits. For instance, they would tidy up their site office every week.

6.4.4 BPR

The company considered production, purchasing and contracting as highly important. The Quality Manager had attended a 2-day seminar organised by the HK Productivity Council on BPR. His view was that it is a useful management technique provided that the person implementing it can have the authority to make decisions. Having said that, BPR is a sound concept and he would like to have a chance to apply the idea in future. When he was asked about the CSFs of Maeda (HK), his responses were: 30 years of solid experience in large civil engineering projects with good reputation, and fix price contracting without recourse which is typically a Japanese contracting practice.

6.4.5 QCC

Although the Quality Manager considered the ideas of QCC as good, surprisingly, it is not been practised by even a Japanese company. He admitted that in HK, the biggest enemy is time. Because of the nature of the civil construction projects in HK, there is little chance for staffs to come together to discuss and solve problems proactively and at leisure. There is no pressure from the Headquarters in Japan to implement QCC either. However, they still have regular monthly management meetings and daily site meetings to solve short-term engineering problems.

6.4.6 ISO 9000

The company considered ISO 9000 as the most important achievement in quality management so far. Although the rating of the achievements on the questionnaire is not very high, the Quality Management had good faith on it. Initially, ISO 9000 was driven by client's requirement. They adopted the KISS approach and came up with a standardise quality plan which can be adapted to most construction projects readily. Moreover, he believed one important by-product of the ISO 9000 QMS was the structured approach to a comprehensive management system. In fact, he was having such a faith on the QMS that he has initiated other management systems based on the ISO 9000 framework. Examples are Employee Registration, Safety Procedures, Financial Systems and Environmental Audits.

6.4.7 TPM

The company had not implemented TPM totally, but have been following the regular and corrective maintenance. They considered maintenance planning as important attributes towards site safety. Maintenance was usually carried out by the Electrical & Mechanical Manager and focusing on plan maintenance. They developed equipment maintenance procedures, maintenance checksheets, and repair records. Although they had not implemented preventive maintenance, they would very much like to do so in future.

6.4.8 TQM

The company was fully aware the importance of TQM, but was not yet ready for it. This was largely due to the short-termism of the construction projects in HK. The Quality Manager forecast that TQM would take root in the near future. Therefore, he was already trying to implant some of the TQM principles like leadership, commitment, training and education into the company's QMS.

6.4.9 Summary

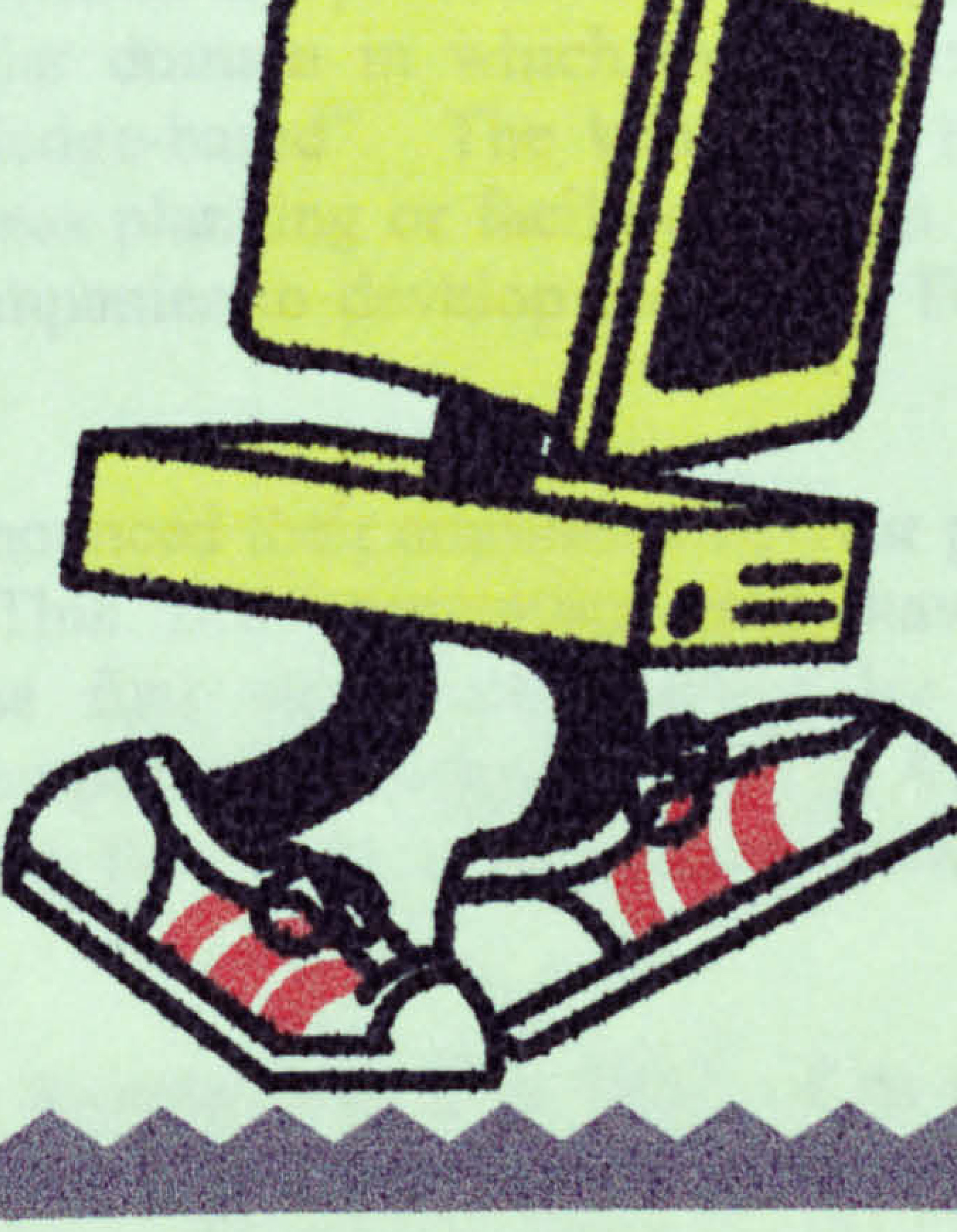
As an important step towards TQM, Maeda (HK) registered itself under the ISO 9000 QMS. This demonstrates their commitment towards quality and satisfying the needs of their customers. At present, the company is concentrating its effort to develop a comprehensive ISO 9000 based QMS and extending it to other management systems. Nevertheless, in view of the competitive nature of the HK construction business, they are largely constrained by the time available for other quality initiatives such as BPR, QCC and TQM. Their practice illustrates an interesting fact that the Japanese companies are not imposing their Japanese practice in a foreign market, but rather adopt themselves to the special environment of the market. However, they still try to retain their CSFs such as quality commitment to the clients rather than basing their profits on claim benefits. Overall speaking, they are moving towards the right direction, and judging on this alone, they are already on the TQM journey.

EPILOGUE

The quality-related literature for the construction industry shows that implementation of TQM is difficult. The questionnaires findings from the UK and HK construction firms reveal that the TQMEX model is also applicable for the construction firms. The action research based on a construction firm in HK has further proven the applicability of the TQMEX model in a real-live environment. The achievements for each of the steps of the TQMEX model were then compared with the other two firms from UK and Japan. The knowledge and experience will be used in the ES development in Chapter 7.

Chapter 7

Advisory Service Development

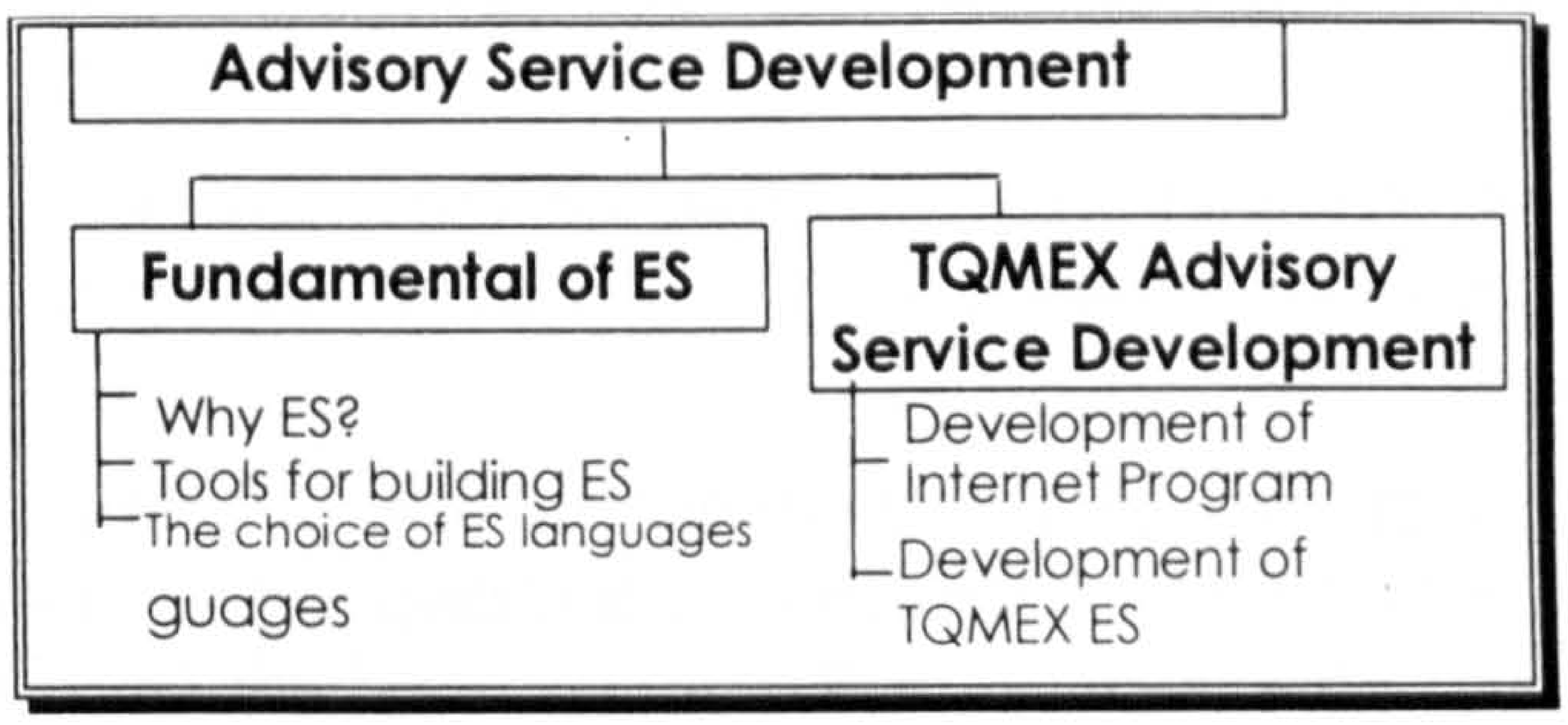


CHAPTER 7

ADVISORY SERVICE DEVELOPMENT

PROLOGUE

In Chapter 5, the TQMEX model has been validated based on questionnaire and field surveys. This Chapter extends this knowledge by developing an Advisory Service System called TQMEXAS which can deliver the knowledge effectively to the users. The method of development is explained, followed by pilot testing before delivery.



7.1 FUNDAMENTALS OF EXPERT SYSTEM

Expert system (ES) is a promising technology for solving some of the decision making problems. Fisher [1985] defines ES as:

"A computer program that achieves high levels of performance on problems that normally requires years of special education and training for human beings to solve."

Edward & Connell [1989] adopted a similar definition:

"A computer-based system in which representations of expertise are stored and which allows a user to access this expertise in a way similar to that in which he might consult a human expert, with a similar result."

As the technology progresses, however, these definitions will surely demand not only expert performance but additional expert qualities as well. In an ES, the private knowledge of a human expert, including factual, judgmental and procedural knowledge, is developed into a "knowledge base" for the particular domain in which the human is considered an expert – hence the system is "knowledge-based". The knowledge base could contain expert knowledge for scheduling, process planning or facilities design. In this research, the expert knowledge is in helping companies to develop their own TQM approach based on TQMEX model.

At the beginning of the 1980s, the Japanese MITI announced their ambitious 10-year plan to develop the next generation of computer systems. This "fifth" generation would have at its heart knowledge-based systems. In 1982, the first stage was marked by the establishment of the Institute for New Generation Computer Technology (ICOT). A key element of the development programme was to be the close co-operation between academics and industrialists.

The UK response to the Japanese initiative was the announcement, in 1982, of its own initiative. The Alvey Committee outlined plans for a five-year programme of government-supported collaboration between academe and industry under four broad research areas: software engineering, VLSI, man-machine interface, and intelligent knowledge based system (IKBS).

The world-wide activity in ESs fuelled by such government funding and simulated by articles and books such as "The Fifth Generation" [Feigenbaum and McCorduck, 1983] led to a flurry of activity in ESs. The range of applications at the end of 1980s was wide but with a firm emphasis on problem domains which were well structured.

A recent search has revealed that there are some commercially available software products which are to assist in the creation, operation and maintenance of QMS to meet the ISO 9000 requirements. This include: HelpDesk2, ISO Achiever +, TriangleQA, ISO-Pro, Proquis 9000, Q-Assure and Q-Sys [Haas, 1996].

On the other hand, the British Quality Foundation has recently produced two aids to facilitate and demystify the use of self-assessments to the UK Quality Award framework [Franks, 1996]:

ASSESS Rapid score is a questionnaire and PC disk providing a step-by-step guide through the self-assessment drills. Answers to the questions, which need take no more than an hour to complete, generate a profile of the business as well as a numerical score rating the company's performance.

ASSSESS Valid score offers a more rigorous package which includes the help of two independent validators who draw up a report on the results, highlighting areas for improvement or change.

These two categories of software products are addressing the partial needs of TQM only, i.e., the ISO 9000 and the EQA kitemark. There is a lack of software, in particular in the form of an ES, prescribing a comprehensive TQM process such as the TQMEX model. Moreover, the TQMEX ES offers a step-by-step implementation guide which is very valuable for companies planning for TQM.

7.1.1 The Architecture of an Expert System

An ES can be broken down into four components, besides the Input & Output phases).These are:

a) Knowledge representation

b) Inference engine

c) Control Mechanism

d) Explanatory interface

Their relationships can be illustrated in Fig 7.1

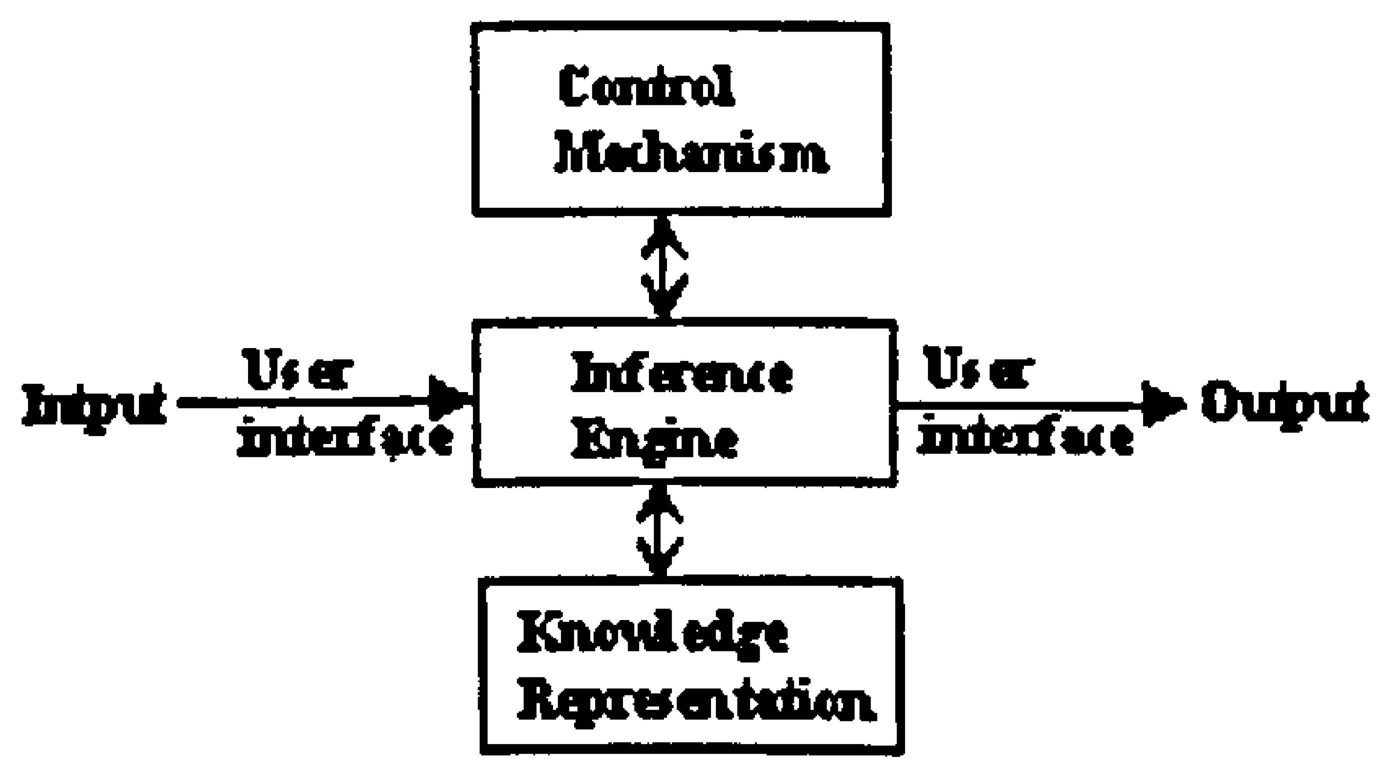


Figure 7.1 The structure of an Expert System

7.1.1.1 Knowledge Representation

Knowledge representation consists of domain specific knowledge when represented can be used in several ways depending on the level of sophistication of the ES. More popular methods of representation are: Production Rule, Frame, Semantic Networks, logic, and Hierarchies and Inheritance.

[A] Production Rules are used by many systems to represent an expert's judgmental knowledge about a given domain. The complete representation includes many rules (the rule base) and the declaration or description of objects important to the chosen domain. The knowledge can be entered as a set of rules. Such rules contain premises or conditions in the "if" clauses and conclusions in the "then" clauses. If-then rules in knowledge-based systems differ from similar ones in conventional computer system. They are more flexible since they can be modified much more easily to meet changing needs.

For example:-

IF	the firm has a quality system
	AND complied with all requirements in ISO 9000
	AND with some minor nonconformances
THEN	the firm is successful registration

[B] Frame-Based knowledge -- Frames are a kind of template for holding related clusters of data, facts rules, hypotheses, or any other knowledge in a single conceptual unit. They require conceptual reorganisation of situation data around key controlling concepts. The most basic type of inferencing with frames is provided through frame manipulation. This is facilitated either by the property of single inheritance i.e. a subclass has just one superclass, or through the property of multiple inheritance where a subclass may have more than one superclass. For this and other reasons frame systems enable more complex decision situations to be dealt with than can be dealt with in systems that contain just rules and questions. Frames can be linked to other frames to form a hierarchy. They can be manipulated by the inference engine to draw new information from other frames.

[C] Semantic Network -- These are similar to frame hierarchies. They differ primarily in the way the knowledge is represented. Semantic networks use groups of nodes and arcs instead of groups of text and pointers, which are used in frame hierarchies. Their advantage is that the total picture of knowledge can be visualised more easily. Their disadvantages are that, the network can get rather complicated when there are multiple inheritances between different classes of objects and the problem of maintaining consistency in the net can also be a tremendous task..

[D] Logic -- Logic consists of a symbolic language together with rules for manipulating the symbols. Predicate knowledge (based on objects and their relationships) can be useful for knowledge representation. PROLOG is a logic programming language which manipulates predicates according to rules of logical reasoning.

For example:

Is Successful (firm, pass all major requirements)
Is Qualify (firm, pass all major and acceptable number of minor requirements)
Is Fail (firm, fail any major, and unacceptable number of minor requirements)

[E] Hierarchies and Inheritance -- The inheritance relationships can be designated by inheritance indicators or pointers in a frame. For example, if Company X is in the construction industry, everything generally true about the industry is also true about Company X. Inheritance relationships are important in these systems because when new companies are added to an industry model they automatically inherit general industry characteristics without a system developer having to write them for each new company.

7.1.1.2 Inference Engine

The inference engine is a computer program that guides the manipulation of knowledge contained in a knowledge base. The inferential reasoning mechanism is distinct from the knowledge base. There are several ways of inferring reasons. The more popular ones are "Backward Chaining", "Forward Chaining", "Depth Search", and "Breadth Search".

[A] "Backward chaining" involves starting with one or more possible goals. For example, in a rule-based system, the inference engine tests each goal to see whether or not the if clauses in the rule containing each possible goal are all true. It tests each rule in turn until an answer is found or until all possible rules are examined and no answer can be found. For example during a standard audit assessment, the task of an auditor is to verify through objective evidence that what the company state in the procedure complies with what they are actually doing. In this case the auditor is performing backward chaining. This is because the auditor's system uses the standard procedure and looks through the rule base to see which if any of the rules are satisfied by this procedure.

[B] "Forward chaining" involves working from the opposite direction of the pervious method. It starts with the data, examines the "IF" clauses, and searches for a solution by working from the data toward a goal. Using this reasoning process, the system builds its case working from the data toward a solution from the data. When an answer is found for all the "IF" clauses in a rule containing a goal word in its "then" clause, the system gives the user its recommended solution.

For example, the job of the quality auditor is to compare what the company states in the procedure comply with what they are actually doing, this can be seen as data driven inferencing and it can be described as being controlled by the fact set. The way in which the TQMEX ES work is uses goal driven inferencing, because every company's performance are different.

[C] "In depth first search", the search mechanism first explores a line of reasoning up or down through the knowledge base. The backward chaining discussed above is a kind of depth search.

[D] "In breadth first search", on the other hand, it would first moves across the knowledge base before moving up or down a rule or frame hierarchy structure.

7.1.1.3 Control Mechanisms

Like other computer systems, knowledge-based system also has operators and control programs. For example, rule-based systems have an executor (operating program) that determines which rule are appropriate (matches), chooses one to execute, and executes the chosen rule. Some knowledge-based system developers consider such control mechanisms to be part of the inference engine. Others treat control mechanisms as separate components of the program. Object or frame-based systems have executors that can determine inheritance, traverse networks, and query and modify data given in frames. In addition, procedures can be written into frames to print, edit, handle messages, trigger default values, check restrictions, and manipulate values. A variety of controls can be included to handle the variables contained in many knowledge based systems.

Some knowledge-based systems developers consider such control mechanisms to be part of the inference engine. Other treat control mechanisms as separate components of the programme.

7.1.1.4 User Interface

The user interface facilitates interaction between the user and the expert system. This interaction will often take the form of the user asking questions of the system and examining how or why an answer was arrived at. It helps a user to understand the logic used and the assumptions upon which a decision was based. For example, it can show users the rules used to reach a conclusion or an explanation of why certain questions were asked. The interface also allows the computer to request extra information from the user. This occurs when currently unavailable information is required before a rule can be evaluated or a condition satisfied.

A good user interface should be able to emulate the real consultant. [Kidd, 1985] showed that the latter need to answer a range of question types, i.e.,

a) What constitutes a fault?

b) What constitutes the remedy?

c) Why did the fault occur?

d) Why did or didn't the remedy work?

e) Will another (specific) remedy work?

Overall, the consultant's explanations have to be fluent and are a function of the expert's view of the user. The construction of the user interface is often reported as being the single most costly element in the development of an ES.

7.1.2 Why Expert System?

It deals with realistic complexity that normally requires a considerable amount of human expertise. Many AI programs are really research vehicles and may therefore focus on abstract mathematical problems or simplified versions of real problems (sometimes called 'toy' problems) to gain insights or refine techniques on the other hand Expert systems solve problems of genuine scientific or commercial interests.

ES exhibit high performance in terms of speed and reliability in order to be a useful tool. AI research vehicles may not run very fast and may well contain bugs: they are programs, not supported software. However an expert system often proposes solutions in a reasonable time and is correct most of the time - at least as often as a human expert.

ES are capable of explaining and justifying solutions or recommendations to convince the user that its reasoning is in fact correct. Research programs are typically used only by their creators or by other personnel in similar laboratories. An ES is used by a wider range of users and should therefore be designed in such a way that its complexities are more transparent to the user.

According to [Fish E.L. 1985], ESs can provide many benefits to users. They are as follows:

- REDUCTION: Human expertise is very expensive when compared to a frequently used expert system.
- IMPROVE QUALITY: Expert systems can improve quality by providing consistent advice and by reducing the error rate.
- CAPTURING EXPERTISE: Human expertise is perishable since experts will leave or retire. On the contrary, once an expert system is built its knowledge is permanent.
- RELIABILITY: Expert systems are reliable. They do not become tired or bored, call in sick, go on strike, and they do not talk back to the boss. Also, expert systems will consistently pay attention to all details and will not overlook relevant information and potential solutions.
- RESPONSE TIME: Expert systems will respond in some cases much faster than a human would especially when it is necessary to go over a large volume of data.
- WORKING WITH INCOMPLETE AND UNCERTAIN INFORMATION: In contrast to conventional computer system, like human experts, expert systems can work with incomplete information. The user can usually give a "don't know" or "not sure" answer to one of the system's questions during a consultation and the expert system will still be able to produce an answer, although it may not be a certain one.

7.1.3 Tools for Building ES

Programming an ES using an AI language has been made more productive by adding frequently used routines onto the basic languages to form a toolkit. Thus today's expert system developer can choose between three different approaches: use a programming language (usually an AI language), use a shell or use an AI environment (or toolkit).

7.1.3.1 Languages

ESs may be written in AI programming languages such as LISP or PROLOG or in conventional high level languages. For example, FORTRAN, PASCAL, C AND BASIC have all been used to implement expert systems. There are several advantages to using AI languages (in preference to conventional languages) Turan [1988].

(1) AI languages are designed for symbolic processing, that is, for programming logical problems which involve facts and related facts. Symbolic processing depends on specifying the rules for making inferences. From rules and facts, infemcing produces new facts. So, it follows that this type of processing is appropriate for heuristic search procedures.

(2) AI languages involve highly interactive processing. If a trace facility is invoked, it can effectively explain the line of inferencing during runtime.

(3) Conventional languages are best for implementing algorithms (equations) and repetitive processes. If an expert system needs to use algorithms extensively or if these are already coded in a conventional language, it may be better to develop the expert system in the same programming language.

7.1.3.2 ES Shell

During the 1980s, a variety of pre-programmed ES shells were developed. They contain such components as inference engine programmes, programmed control mechanisms, programmed external software interface routines and capabilities for storing knowledge bases. Users of a shell are expected to create only the knowledge base. This allows people to create knowledge-based systems without knowing programming languages. Shells therefore offer a means of building ES relatively quickly and easily. A general ES development shell architecture is shown in (Fig. 7.2) Michael W. P[1987]. This type of development shell can be applied to many different expert system applications. There are numerous expert system shells available today which offer a wide range of price, capability and performance.

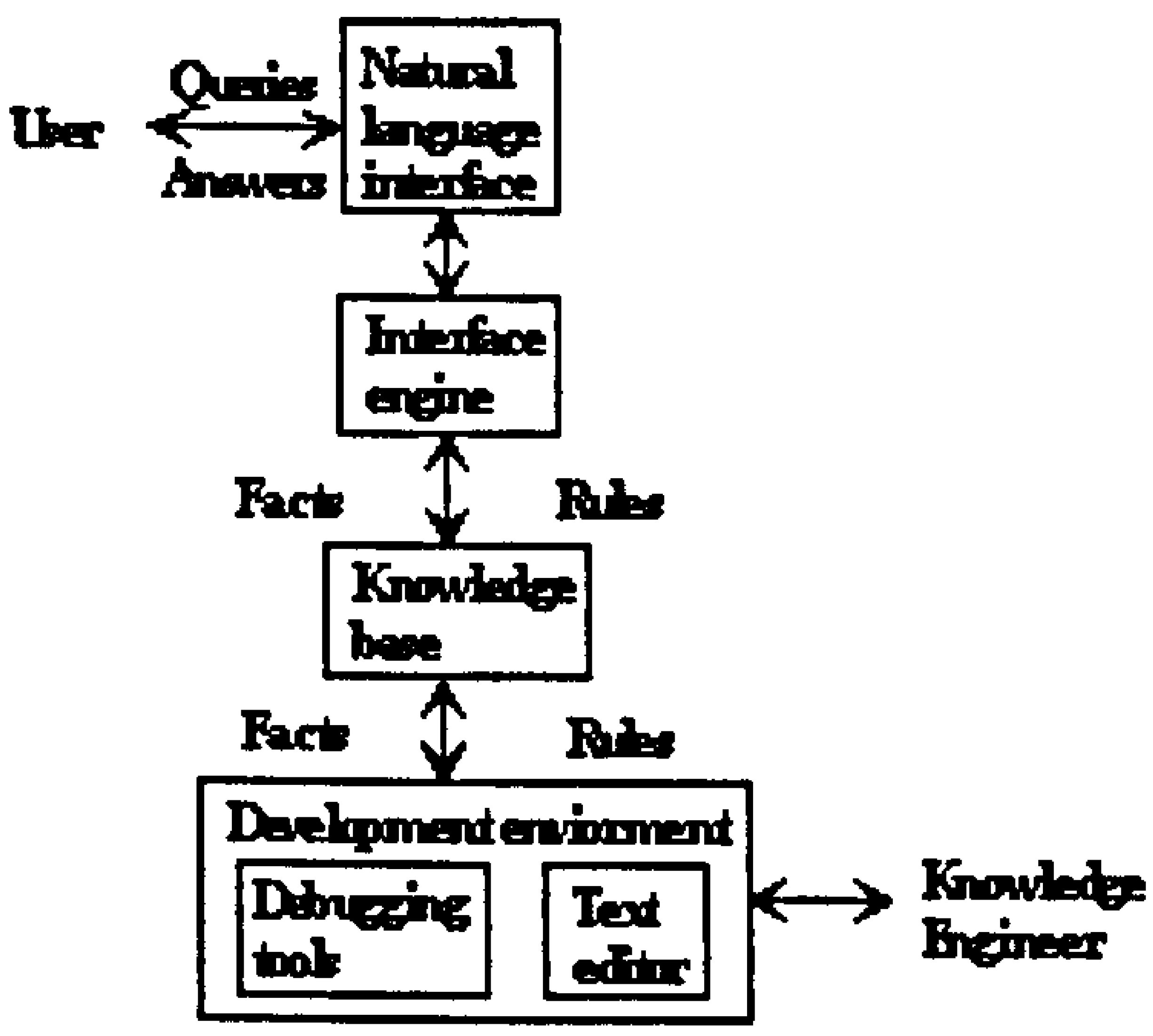


Figure 7.2 ES development shell architecture

7.1.3.3 Toolkits or Environment

The advantage of these toolkits is the variety of knowledge representational techniques they include. rules, frames and semantic networks can be supported and useful properties such as inheritance can be handled. However to use the toolkits effectively the programmer needs to know much more about symbolic programming and knowledge engineering. There are three main commercial expert systems building tools. They are Art, KEE and Knowledge Craft. All three toolkits are written in LISP and hence need to be used on dedicated hardware. They are ideal for people wishing to research the development of large expert systems.

7.1.4 The choice of ES languages for the research

In surveying developers of ESs in the UK, Edwards, [1990] found that whereas more than half the operational system were developed using shells, about one quarter were built using AI languages. The actual figures for the different development tools were:

- Conventional languages 11%
- AI languages 23 %
- Toolkits 11%
- Expert system shell 56%

Holsapple, Tan, & Whinston, [1988] give an in-depth overview of the available expert systems tools and a range of applications. They give comprehensive information of the main US tools available in 1988, the text being written for a management rather than technical audience. They compare tools on a language-environment-shell continuum and conclude that AI languages are more flexible than shells. Beside that the expert system requires the use of algorithms extensively. Therefore, it may be better to develop the expert system using programming language. The table 7.1 below shows how the different tools compare with respect to portability, delivery, hardware requires, integration and cost with existing applications.

	SHELL	LANGUAGES	TOOLKITS
PORTABILITY	Within a type	yes	Hard
DELIVERY	Easy	Easy	Difficult
INTEGRATION	Depends on scale	Depends on skill	Impossible
HARDWARE REQUIRE	No problem	No problem	dedicated hardware or mainframe
COST	Cheap 50 -1000	Cheap 50 -1000	Several Thousand
CONCLUSION	REJECTED	ACCEPTED	REJECTED

Table 7.1 A comparison of AI tools

7.1.4.1 The choice of application software for building the ES (Visual Basic)

The Basic programming language was created in 1963 by Kemeny and Kurtz. It was the first easy-to-use language that let the user concentrate on the methods and algorithms for solving programming tasks rather than requiring the user t o concentrate on the methods and algorithms. The Basic language has changed a lot over the last couple of decades. Since the breakthrough of "Windows", it has made personal computers more personal and user friendly. Programmers, however, have to retrain themselves and learn an entirely new set of programming concepts to achieve proficiency in developing applications for Windows. The birth of Visual Basic in the early 1990's has changed all this -- learning how to create applications for Windows are made much easier and programming in Windows has become more interactive and productive.

Visual Basic for Windows has many features that make it an ideal language for developing ES. These features increase productivity and provide all the tools and hooks needed to develop sophisticated ES. For example, graphics output can easily be directed to any part of a window or even to a printer. Colours for the graphical objects can be selected from more than 16 million shades. The rules are easier to understand and remember because they have been simplified and improved. There are few reasons why the ES are developed using Visual Basic:

- Visual Basic only required a short time to produce a sophisticated ES which would not be possible by using C, FORTRAN or PASCAL.

- The Basic language has always been superior for interactively trying out programming ideas. This interactive development concept also applies to creating the Windows user interface for application by using Visual Basic.

- Visual Basic provides easy-to-use mechanisms for Dynamic Data Exchange (DDE) and Object Linking and Embedding (OLE) among any Windows-based application that support these features.

- The ES that are developed in this thesis will be around for a long time. The Windows operating system is designed to remain stable, even as capabilities of computer hardware progress. For example, as the graphics resolutions and colour capabilities of computer hardware increase, Windows-base applications will not require modification; they will simply run better and faster.

Visual Basic program is event driven. This can include two types of files: forms which contain both the visual representations of and the code for windows and dialogue boxes; and modules, which contain only source code.

7.1.5 TQMEX Advisory System Development

After acquiring the knowledge through questionnaire surveys and field surveys in the 3 countries, it is imperative that this knowledge should be built into an Advisory service system so that it can be accessed by companies easily. In order to achieve this objective, the advisory system has to be developed to be meaningful and valid. Eventually, it is hoped to produce a computer program that achieves high levels of performance on assisting companies to implement TQM effectively. The advisory service consisted of two programmes (Internet Program and ES). The first part involved a Web page programming which is a method for providing distributed information on the Internet. In the World Wide Web, documents are hypertext, which means that they can provide links to other documents. Expert System language was used for developing the second part of the advisory service. The aim of this advisory system is to provide an interactive graphic forum for those who want to know the contemporary development in TQM and to identify those steps that are of particular importance to TQM implementation. The objectives of the TQMEX advisory system (TQMEXAS) are:

- To introduce the TQMEX model by using graphical presentation, concise summaries and short quizzes to refresh memories.

- To encourage participation in the "Forum For Discussion" through the sharing of experiences, problems solving, success / failure stories, research outputs or just the exchange of ideas and thoughts on activities in TQM.

- To benchmark the TQM status quo using an advisory service in the form of an Expert System based on the research findings in Hong Kong, Japan and the UK by the author.

- To assist companies to implement TQM in accordance with the TQMEX model.

- To validate whether the TQMEX model is a sound management method which advocates good quality practices based on the feedback from the professionals in the field.

7.1.5.1 Developing the Internet Program

The World Wide Web (WWW) deals in a wide variety of information. The programs are written in a form called Hypertext Mark-up Language (HTML) which is the most common document on the Web. Documents are marked up in this format, meaning that codes for formatting and linking are inserted into the text. A list of command used for develop the web program is summarised in table 7.2. The contents of the Internet are developed into 4 area:

1. Introduction to Quality (This introduce the concept of quality and the need for TQM)

2. TQM Gurus' Ideas (This discuss and summaries different ideas of quality gurus.

3. TQM Model (This explains the need for a model in TQM, the structure and the logic of TQMEX. This provides in-depth knowledge on what, why and how to implement all the processes based on the TQMEX model.

4. Validation, Conclusion & Future Improvement. This provides a summary of the concept, useful source of information and a validation form for validate the program. The link to the Expert System can help companies to benchmark their quality status quo. Finally forum for discussion provides a link to other newsgroup, thus encouraging the sharing of experiences, success/failure stories, research outputs and thoughts on activities in TQM.

Short excises are provided for the first three parts of the program which help to refresh memories. The details of the Internet Program can be seen on Internet (**http://www.dmu.ac.uk/dept/school/business/corporate/tqmex/abs**) or App.7.1-55.

Document Structure	
Body	<Body>
Head	<Head>
HTML	<HTML>
Titles and Headings	
Heading - First Level	<H1>
Heading - Second Level	<H2>
Heading - Third Level	<H3>
Heading - Fourth Level	<H4>
Heading - Fifth Level	<H5>
Heading - Sixth Level	<H6>
Title	<Title>
Paragraphs and Lines	
Break	
Horizontal Rule	<HR>
Paragraph	<P>
Character Formats	
Strong	<STRONG>
Typewriter	<TT>
Underscore	<U>
Graphics	
Alternative to image	<ALT>
Image Alignment	<IMG ALOGN=[top, middle, bottom] SRC="filename">
Images	<IMG SRC="filename">
Images map	<IMG SRC="image filename"ISMAP>
Lists	
Ordered List	<OL>
Unordered List	<UL>
List Item	<LI>
Glossary Lists	<DL>
Definition Lists	See Glossary Lists
Glossary List Terms	<DT>
Glossary List Definitions	<DD>
Forms	
Form	<FORM>
Submit button	<input type=submit value="Submit">
Reset button	<input type=reset value="Clear">
Text Field	<input type="text" size="xx" name="name" maxlength="yy" value="default">
Radio button	<input type="radio" name="name"
Check box	value="value"[checked]>
Popup list name	<input type="radio" name="name"
Selection List	value="value"[checked]>
Popup list option	<select name="name">
Popup list selected option	<option>
	<option selected>
Other Tags	
Comment	<!-comment->
Special Characters	& character code;

Table 7.2 HTML command tags

7.1.5.2 Developing Method of Assessment for ES

As explained in S.7.1.1.4, a good user interface should be able to emulate the real consultant. With this in mind, after using the ES the user should be able to answer the following question:-

[A] How successful is the degree of implementation so far?

[B] What constitutes a fault in its implementation?

[C] What constitutes the remedy?

[D] Why did the fault occurs?

[E] Why did or didn't the remedy work?

[F] Will another (specific) remedy work?

The knowledge of ES has already been acquired in chapter 5. The task here is to convert that knowledge into an ES. The first step is to structure the knowledge so that it can be of value to companies. The criteria are set based on the mean values of findings from the questionnaire survey (Fig 7.3). In order to have a quantitative measure of the degree of achievement by companies on TQMEX activities, some objective measurements have to be devised. The scoring system used in the consultation is based on the spread of the mean according to the following diagram:-

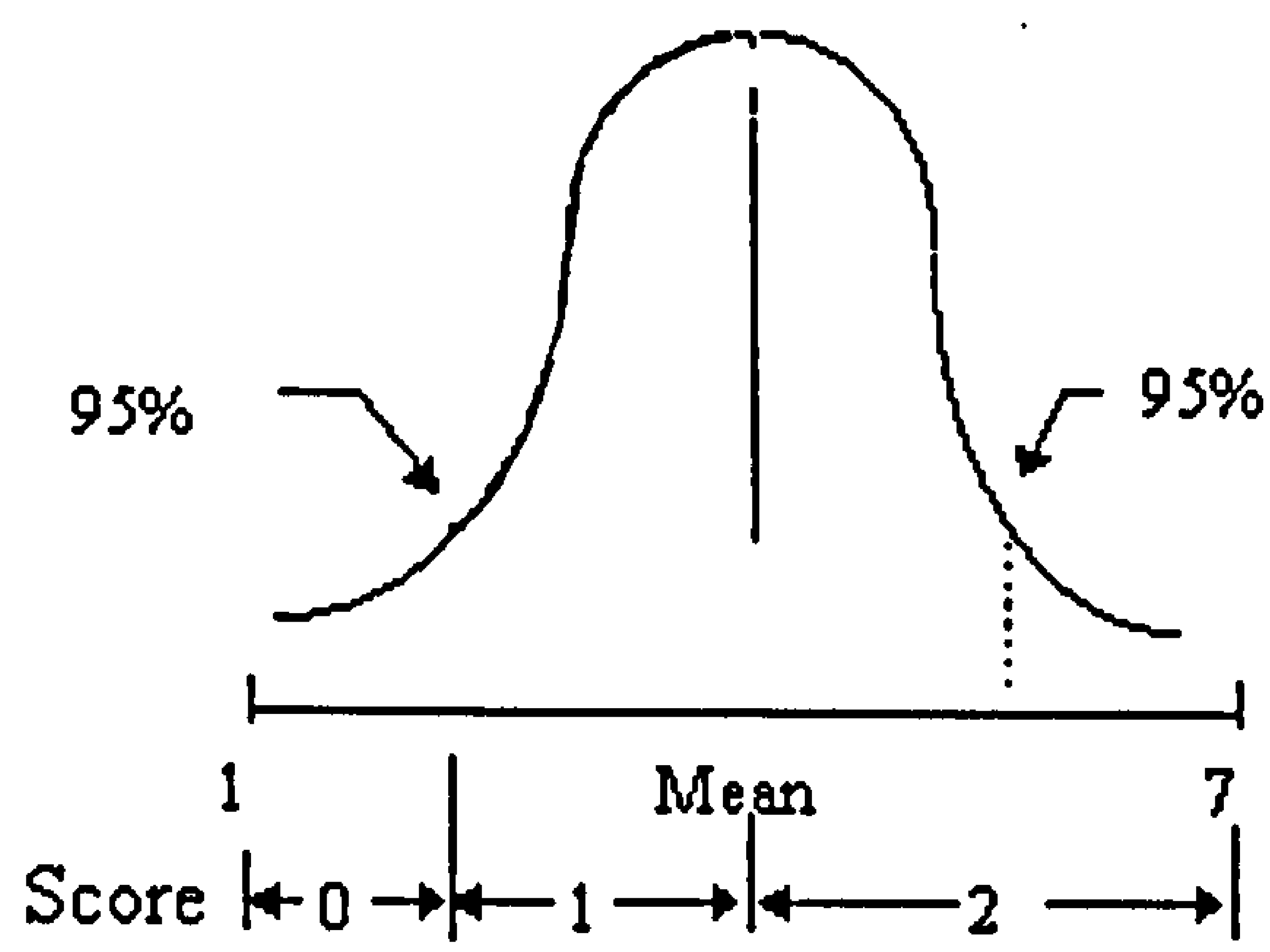


Figure 7. 3 Scoring System

For example, the mean no. of "Customer Satisfaction" for large manufacturing firms is 4. Let us assume that the normal distribution about the mean line of 4, and the standard deviation 'S' = 1 (calculated from the raw data). The scoring system is such that 1 point will be assigned for companies within the (-2) x (standard deviation) to the mean line. In this case, companies which have rating between 2 - 4 will be awarded a score of 1. Consequently, those with rating less than 2 will score 0 point, and rating more than 4 will score 2 points. This forms the basis of the scoring system. Table 5.21 is used as evaluation criteria. The actual table for evaluation is obtained by taking away the less important elements found from the Factor and Cluster Analysis (Table 5.22). Finally, the questions for the ES are reduced to those as shown in Table 7.3.

Question	Description	Manufacturing		Services	
		Large	S/M	Large	S/M
1.4	Employees No.	>=300	<300	>=300	<300
1.7	Mean No. of years' awareness of quality	26	17	13	9
1.8	Use of quality methods	--	--	--	--
2.2	5-S	S1	X	S1	S1
		S2	S2	X	S2
		S3	S3	S3	S3
		X	S4	S4	X
		S5	X	X	S5
3.1	BPR	X	B1	B1	B1
		B2	B2	X	B2
		X	B3	B3	B3
		B4	B4	B4	B4
		B5	B5	B5	B5
4.1	QCC	Q1	Q1	Q1	Q1
		Q2	Q2	Q2	Q2
		Q3	Q3	Q3	Q3
4.3	No. of suggestions	--	--	--	--
5.3	ISO 9000	I1	I1	X	I1
		I2	X	X	X
		I3	X	I3	X
		I4	X	I4	I4
		I5	I5	I5	I5
		I6	I6	I6	I6
		I7	X	I7	X
		I8	I8	X	I8
6.1	TPM	M1-M11	M1,2,3,4,5,6,9,10,11	M1-M11	M1-M11
7.1	TQM	T1-T10	T1,2,3,4,5,6,7,8,10	T1-T10	T1,2,3,4,5,6,8,9,10
Maximum Score		78	66	72	74

X = questions dropped from the consultation

Table 7.3 Summary of ES Questions

7.1.5.2.1 The Use of Control Chart in the ES

Control charts are pictures of variation over time. Data are plotted on graphs where the process is actually carried out. Decisions are then made about the state of the process and whether any action should be taken. The UCL and LCL stand for Upper and Lower Control Limits respectively. Control charts method is used for calculate the Upper and Lower limit of the mean for each activity. Control charts for variables consist of Mean and Range Charts. For example, the mean-and-range charts may be used to indicate what activities are within, above or below range so that the causes of variation can be identify and corrected.

The mean chart for variables make use of the properties of sample. For example a continuing series of samples is taken, their means are calculated (refer to table 5.19) and each mean plotted on a mean chart, See example Figure 7.4. Statistically, the mean chart can be expressed as a function of the mean of all the sample ranges (W) multiplied by a factor (A) dependent on the sample size. In this case the sample size is 10 and the mean chart factor is 0.21 (at 95% confidence intervals). The result is shown in Table 7.4.

For Mean chart: Lower Control Limit =(Mean of means) - A*W

NOTE: The Upper Control Limit is not used in this analysis. Instead, the mean is used as the criteria for the better performers as shown in Figure 7.4.

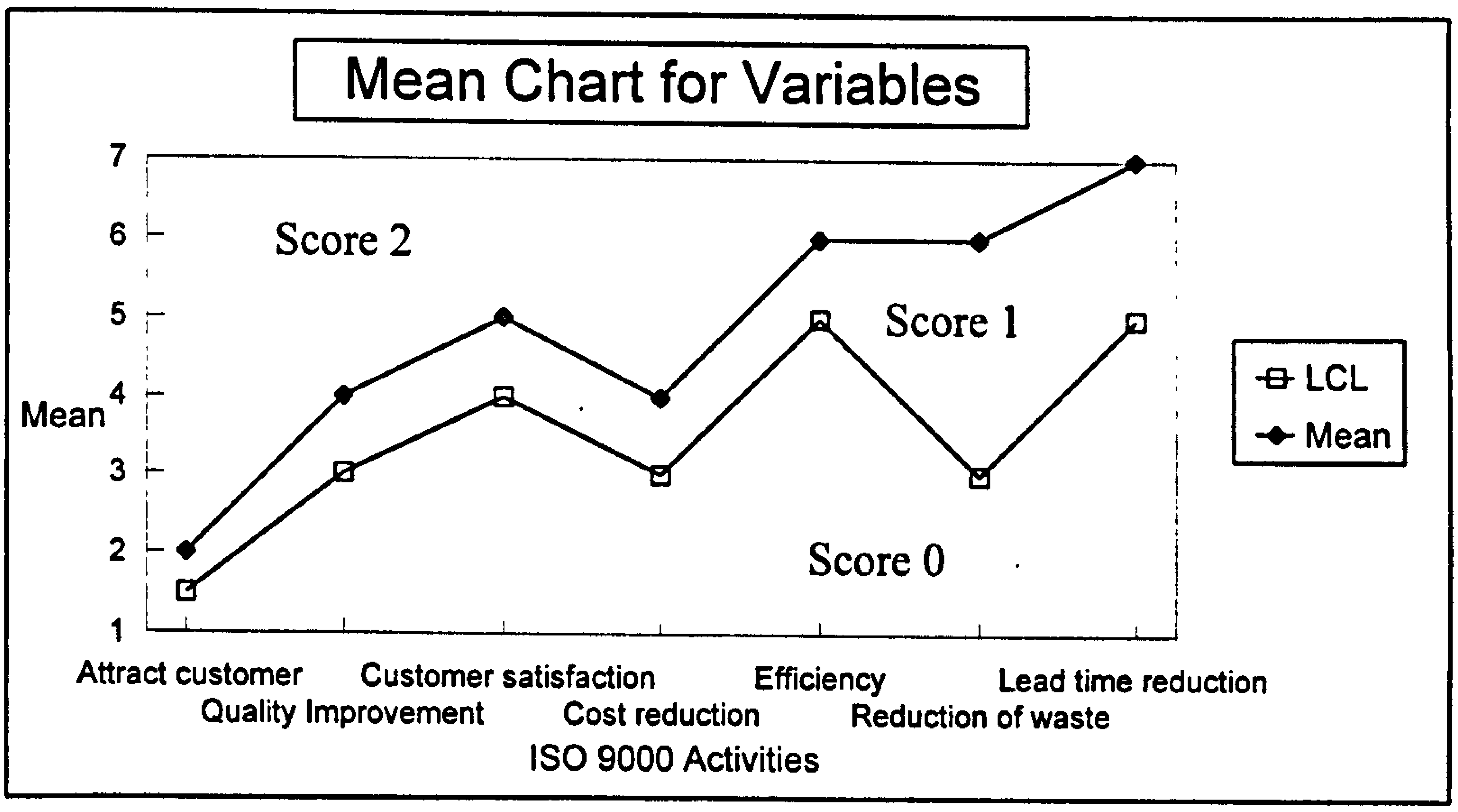


Figure 7. 4 Example of Control Chart

	Manufacturing				Services			
Variable	Large		Medium /Small		Large		Medium /Small	
	Mean	LCL	Mean	LCL	Mean	LCL	Mean	LCL
Organisation	5.78	4.8	5.96	5.0	5.94	4.8	6.05	4.9
Neatness	4.90	3.6	4.90	3.4	5.13	4.0	5.50	4.3
Cleaning	5.09	3.9	4.91	3.5	5.21	3.9	5.44	4.3
Standardisation	5.35	4.1	5.20	3.8	5.27	3.8	5.76	4.8
Discipline	5.43	4.2	5.52	4.3	5.46	4.3	5.89	5.0
Marketing	4.46	2.9	4.75	3.2	5.26	3.8	5.09	3.8
Production /Operations	6.36	5.6	6.35	5.6	6.28	5.5	6.27	6.0
Purchasing	5.72	4.6	5.62	4.4	5.75	4.5	6.02	4.9
Tendering/ Quotation	5.13	3.9	5.16	3.7	5.77	4.5	5.26	4.3
Contracting	5.45	4.4	5.55	4.2	5.76	4.8	5.07	4.0
Improve Quality	6.19	5.3	6.05	5.1	6.24	5.5	6.47	6.1
Building cheerful environment	5.21	4.1	5.12	3.9	5.17	3.9	5.73	4.6
Drawing out individual's potential	5.80	4.7	5.50	4.1	5.68	4.8	6.08	5.2
Attract customer	4.87	3.6	5.03	3.8	4.92	3.6	4.97	3.8
Quality improvement	5.17	4.1	5.24	4.3	5.08	4.1	5.17	4.3
Customer satisfaction	5.24	4.2	5.39	4.4	5.23	4.2	5.33	4.5
Cost reduction	4.18	3.0	4.07	2.8	4.09	2.8	3.86	2.5
Competitive advantage	4.68	3.4	4.60	3.2	4.85	3.8	4.35	2.8
Reduction of waste	4.24	3.0	4.28	3.2	4.00	2.9	4.27	2.7
Efficiency	4.62	3.4	4.53	3.3	4.80	3.7	4.84	3.9
Lead time reduction	4.10	2.7	3.73	2.4	4.43	3.6	4.10	2.5
Regular maintenance	5.01	4.0	4.70	3.4	4.20	5.1	5.34	4.8
Preventive maintenance	4.42	3.3	4.01	2.5	3.20	4.2	5.04	4.5
Corrective maintenance	5.15	4.2	5.35	4.4	5.45	4.9	5.40	4.9
Planning and management	4.63	3.4	4.41	3.3	4.69	3.7	4.95	4.8
Equipment investment plans	4.65	3.6	4.45	3.2	4.70	3.5	4.77	4.4
Autonomous maintenance	4.06	3.2	3.77	2.6	4.31	3.7	4.52	4.0
Environmental conservation	4.52	3.4	4.41	3.0	4.77	3.9	5.10	4.6
Safety	5.62	4.7	5.76	4.9	5.72	5.0	6.25	5.9
Assessment of effectiveness	4.14	2.9	4.31	3.2	4.07	3.2	4.85	4.4
Maintenance via team work	4.08	3.0	4.04	2.7	4.17	3.6	4.88	4.6
Maintenance training	4.48	3.4	3.71	2.3	4.41	3.6	4.16	3.5
Leadership	4.75	3.6	4.96	3.6	4.90	3.7	5.00	4.0
Commitment	4.87	3.7	5.29	4.1	5.02	4.0	5.31	4.4
Total customer satisfaction	4.88	3.7	5.20	4.1	5.16	4.1	5.33	4.6
Continuous improvement	5.03	3.8	5.05	3.9	5.01	3.9	5.00	4.1
Total involvement	4.44	3.3	4.55	3.1	4.42	3.2	4.90	3.8
Training and education	4.80	3.6	4.40	3.0	4.85	3.6	4.69	3.6
Ownership	4.45	3.3	4.52	3.1	4.57	3.3	4.65	3.9
Reward and recognition	3.97	2.6	4.00	2.6	4.33	3.2	4.35	2.9
Error prevention	4.63	3.3	4.63	3.4	4.46	3.3	4.75	4.0
Co-operation and teamwork	5.00	4.0	4.92	3.8	5.03	4.0	5.18	4.6

NB: Companies having values less than the LCL score 0 point.
Companies within the above values (both limits inclusive) score 1 point
Companies having values greater than the mean score 2 points.

Table 7.4 Calculation of Lower Control Limit

7.1.6 Development of Knowledge-Based for ES

This is the most important part of the ES development. Here the rules are determined and the knowledge-base established. Since the ultimate objective of the ES is to include Case Studies and implementation plan, the main menu is designed and shown in Fig.7.5 below: An overall program flow chart is shown in App.7.2

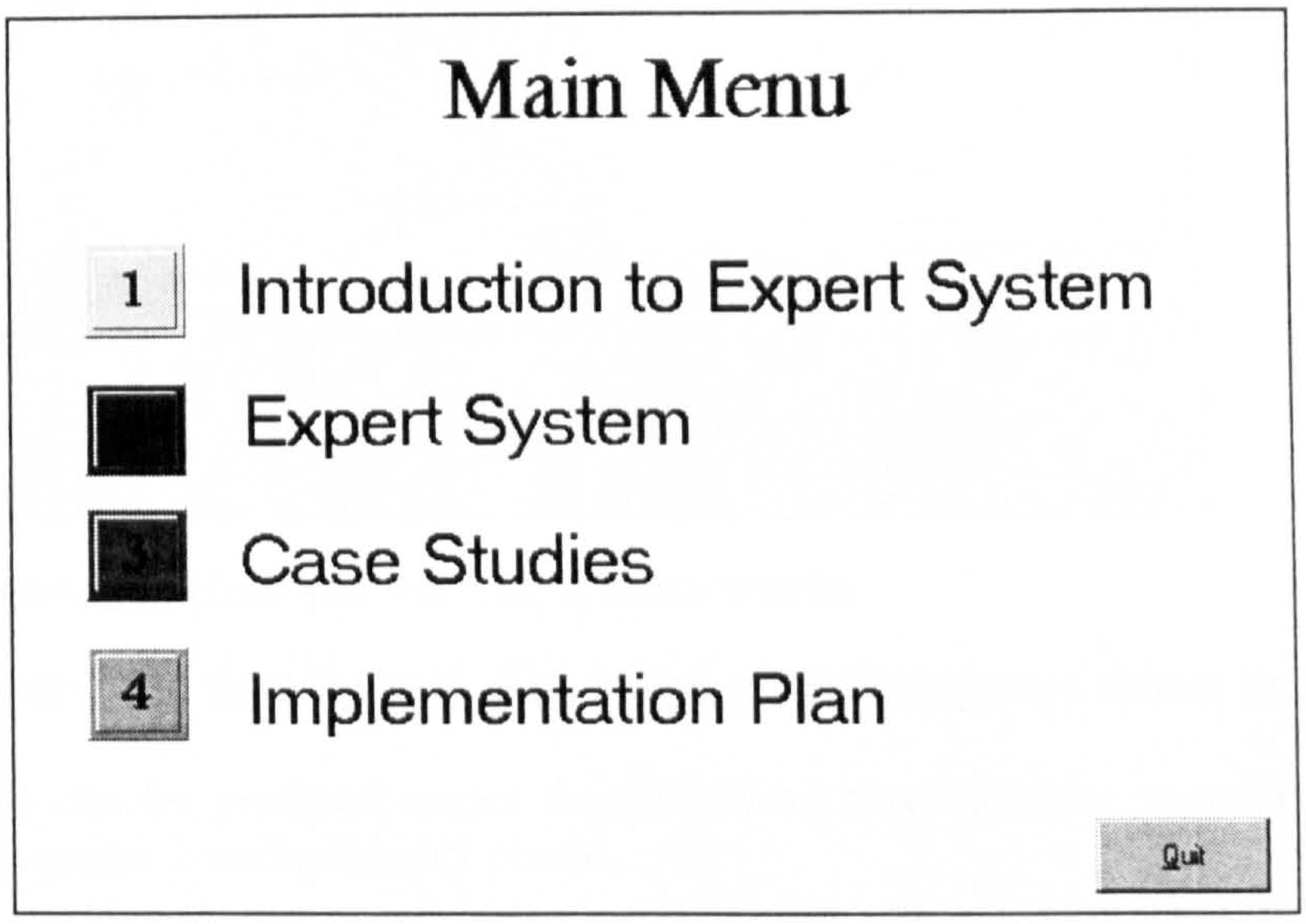


Figure 7. 5 Main Menu

Each of the options are self-explanatory from the titles. The first option on the main menu is to show the users how the scoring and method of assessment work. Typical examples of each of the processes is also illustrated under this option (see sample Figure 7.6 and 7.7).

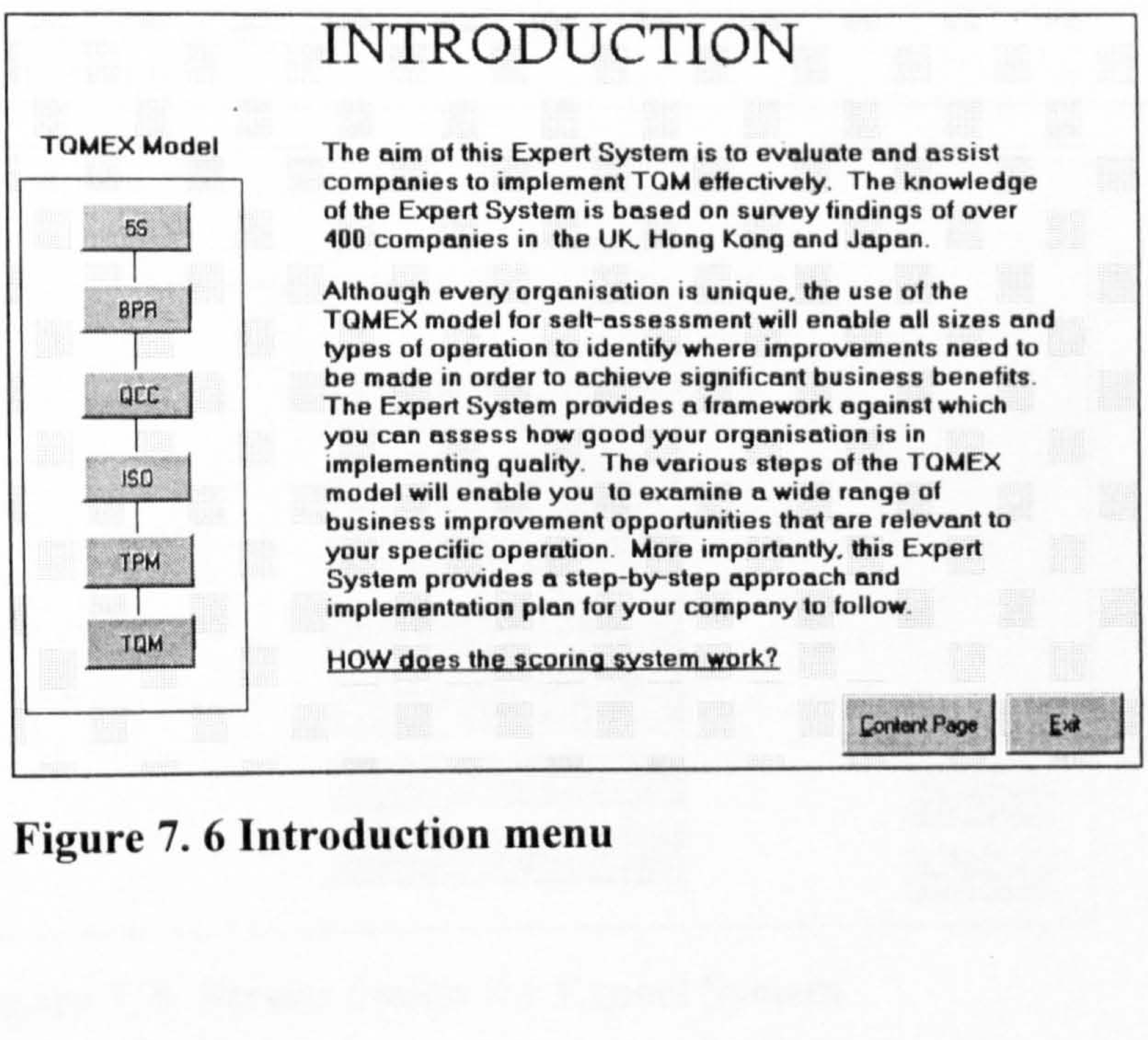


Figure 7. 6 Introduction menu

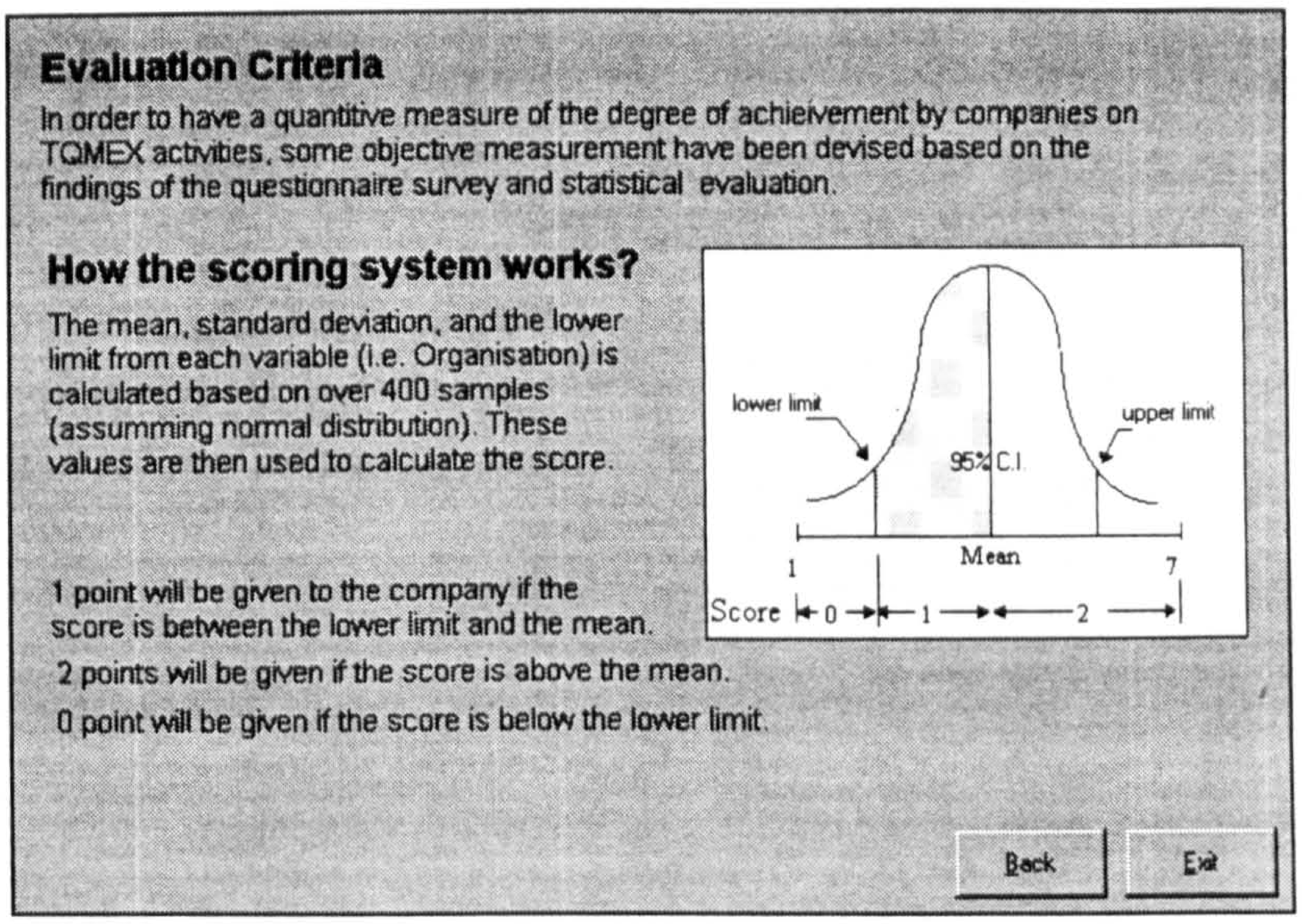


Figure 7. 7How the scoring system works

The next step is to develop the ES itself. The ES program listings are shown in App.7.3.

The overall design can be grouped under the following three phases: namely user input phase 1, user input phase 2 and advisory phase.

7.1.6.1 User Input Phase1 (general information):

The screen design for the user input phase 1 is shown in Figure 7.8 below.

Q1	Name of the company? FIND NAME
Q2	What type of industry? Choices of industry: MANUFACTURING or SERVICES
Q3	What is the number of employees in your firm? FIND EMPLOYEE

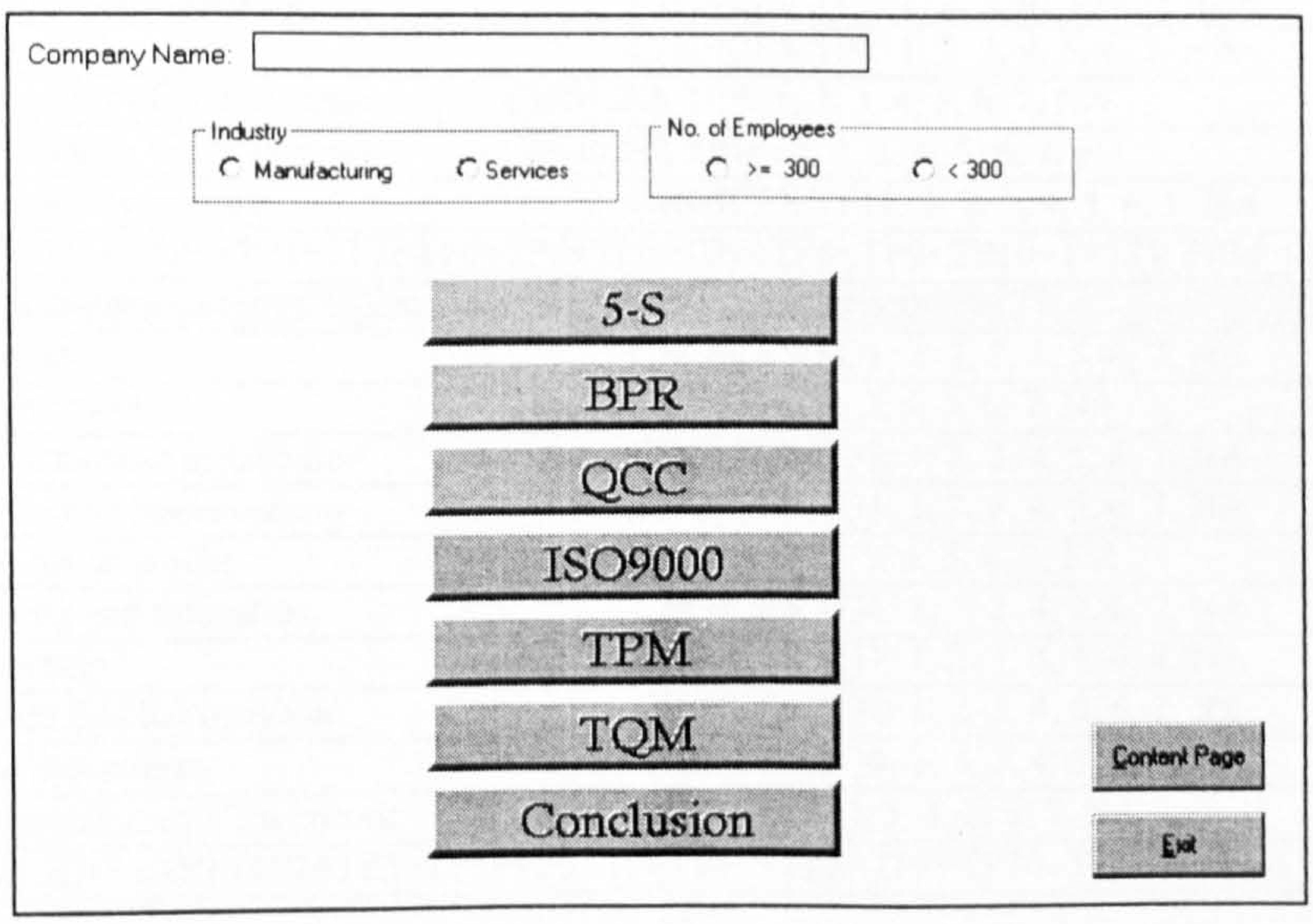


Figure 7. 8 Screen design for Expert System

7.1.6.2 User Input Phase 2 (perception of quality activities)

Q4	**How important to your company are the following objectives in relation to the working environment?**	
S1	Organisation	CHOICES S1: 1, 2, 3, 4, 5, 6, 7, NA
S2	Neatness	CHOICES S2: 1, 2, 3, 4, 5, 6, 7, NA
S3	Cleaning	CHOICES S3: 1, 2, 3, 4, 5, 6, 7, NA
S4	Standardisation	CHOICES S4: 1, 2, 3, 4, 5, 6, 7, NA
S5	Discipline	CHOICES S5: 1, 2, 3, 4, 5, 6, 7, NA
	S_MEAN = (S1 + S2 + S3 + B4 + S5)/ S_COUNT	
Q5	**How important to your company are quality control for the following?**	
B1	Marketing	CHOICES B1: 1, 2, 3, 4, 5, 6, 7, NA
B2	Production/ Operations	CHOICES B2: 1, 2, 3, 4, 5, 6, 7, NA
B3	Purchasing	CHOICES B3: 1, 2, 3, 4, 5, 6, 7, NA
B4	Tendering/ Quotation	CHOICES B4: 1, 2, 3, 4, 5, 6, 7, NA
B5	Contracting	CHOICES B5: 1, 2, 3, 4, 5, 6, 7, NA
	BPR_MEAN = (B1 + B2 +B3 + B4 + S5)/ BPR_COUNT	
Q6	**To what degree do you agree with the following purposes for teamwork?**	
Q1	Improvement of quality	CHOICES Q1: 1, 2, 3, 4, 5, 6, 7, NA
Q2	Building cheerful environment	CHOICES Q2: 1, 2, 3, 4, 5, 6, 7, NA
Q3	Drawing out individual's potential	CHOICES Q3: 1, 2, 3, 4, 5, 6, 7, NA
	QCC_MEAN = (Q1 + Q2 +Q3) /QCC_COUNT	
Q7	**How good is your quality management system in achieving the following?**	
I1	Attract customer	CHOICES I1: 1, 2, 3, 4, 5, 6, 7, NA
I2	Quality improvement	CHOICES I2: 1, 2, 3, 4, 5, 6, 7, NA
I3	Drawing out individual's potential	CHOICES I3: 1, 2, 3, 4, 5, 6, 7, NA
I4	Cost reduction	CHOICES I4: 1, 2, 3, 4, 5, 6, 7, NA
I5	Competitive advantage	CHOICES I5: 1, 2, 3, 4, 5, 6, 7, NA
I6	Reduction of waste	CHOICES I6: 1, 2, 3, 4, 5, 6, 7, NA
I7	Efficiency	CHOICES I7: 1, 2, 3, 4, 5, 6, 7, NA
I8	Lead time reduction	CHOICES I8: 1, 2, 3, 4, 5, 6, 7, NA
	ISO_MEAN = (I1 + I2 +I3 + I4 + I5 + I6 + I7 + I8)/ ISO_COUNT	
Q8	**How good is your company in operating equipment maintenance activities?**	
M1	Regular maintenance	CHOICES TP1: 1, 2, 3, 4, 5, 6, 7, NA
M2	Preventive maintenance	CHOICES TP2: 1, 2, 3, 4, 5, 6, 7, NA
M3	Corrective maintenance	CHOICES TP3: 1, 2, 3, 4, 5, 6, 7, NA
M4	Planning and management	CHOICES TP4: 1, 2, 3, 4, 5, 6, 7, NA
M5	Equipment investment plans	CHOICES TP5: 1, 2, 3, 4, 5, 6, 7, NA
M6	Autonomous maintenance	CHOICES TP6: 1, 2, 3, 4, 5, 6, 7, NA
M7	Environment conservation	CHOICES TP7: 1, 2, 3, 4, 5, 6, 7, NA
M8	Safety	CHOICES TP8: 1, 2, 3, 4, 5, 6, 7, NA
M9	Assessment of effectiveness	CHOICES TP9: 1, 2, 3, 4, 5, 6, 7, NA
M10	Maintenance via team work	CHOICES TP10: 1, 2, 3, 4, 5, 6, 7, NA
M11	Maintenance training	CHOICES TP11: 1, 2, 3, 4, 5, 6, 7, NA
	TPM_MEAN = (TP1+TP2+TP3+TP4+TP5+TP6+TP7+TP8+TP9+TP10+TP11)/ TPM_COUNT 11	
Q9	**How good is your company in operating quality management activities?**	
T1	Leadership	CHOICES TQ1: 1, 2, 3, 4, 5, 6, 7, NA
T2	Commitment	CHOICES TQ2: 1, 2, 3, 4, 5, 6, 7, NA
T3	Total customer satisfaction	CHOICES TQ3: 1, 2, 3, 4, 5, 6, 7, NA
T4	Continuous Improvement	CHOICES TQ4: 1, 2, 3, 4, 5, 6, 7, NA
T5	Total Involvement	CHOICES TQ5: 1, 2, 3, 4, 5, 6, 7, NA
T6	Training and Education	CHOICES TQ6: 1, 2, 3, 4, 5, 6, 7, NA
T7	Ownership	CHOICES TQ7: 1, 2, 3, 4, 5, 6, 7, NA
T8	Reward and Recognition	CHOICES TQ8: 1, 2, 3, 4, 5, 6, 7, NA
T9	Error Prevention	CHOICES TQ9: 1, 2, 3, 4, 5, 6, 7, NA
T10	Co-operation and Teamwork	CHOICES TQ10: 1, 2, 3, 4, 5, 6, 7, NA
	TQM_MEAN = (TP1+TP2+TP3+TP4+TP5+TP6+TP7+TP8+TP9+TP10+TP11) / TQM_COUNT	

A sample of the screen design from user input phase 2 is shown in Figure 7.9.

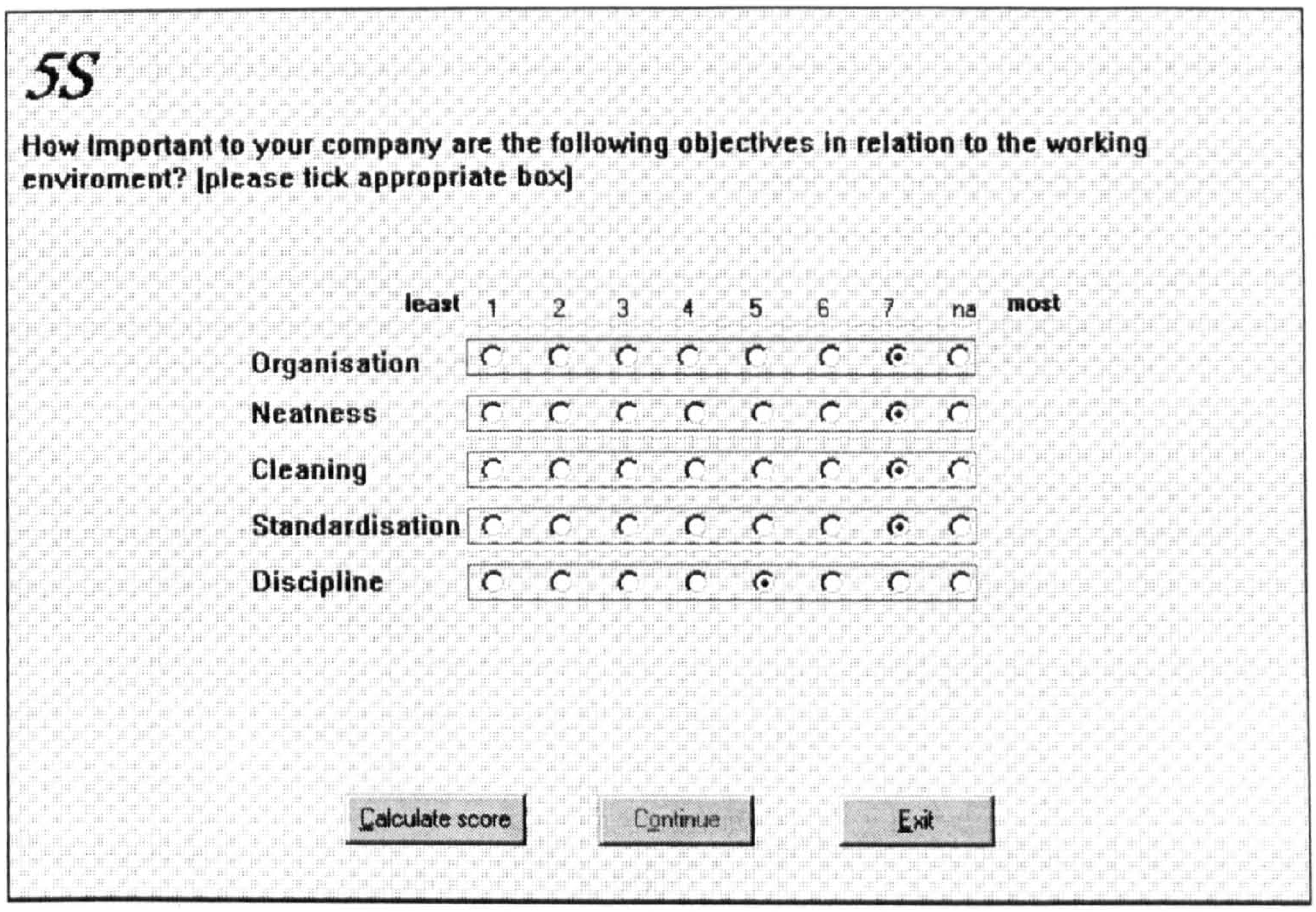


Figure 7. 9 Screen design for User Input Phase 2

7.1.6.3 Advisory Phase

Rule 1A	:	IF	INDUSTRY = MANUFACTURING.AND. EMPLOYEE >=300
		THEN	SECTOR = LM (Large Manufacturing)
Rule1B	:	IF	INDUSTRY = MANUFACTURING.AND. EMPLOYEE <300
		THEN	SECTOR = SM (Small & Medium Manufacturing)
Rule1C	:	IF	INDUSTRY = SERVICES .AND. EMPLOYEE >=150
		THEN	SECTOR = LS (Large Services)
Rule 1D	:	IF	INDUSTRY = SERVICES .AND. EMPLOYEE <150
		THEN	SECTOR = SS (Small Services)

RULE 2A	:	IF	SECTOR = LM
		THEN	S1_MEAN = LM_S1_MEAN
			S1_LIMIT = LM_S1_LIMIT
			S2_MEAN = LM_S2_MEAN
			S2_LIMIT = LM_S2_LIMIT
			S3_MEAN = LM_S3_MEAN
			S3_LIMIT = LM_S3_LIMIT
			S4_MEAN = LM_S4_MEAN
			S4_LIMIT = LM_S4_LIMIT
			S5_MEAN = LM_S5_MEAN
			S5_LIMIT = LM_S5_LIMIT
RULE 2B, 2C, 2D,2E, 2F			

The following rules assuming SECTOR = LM.

RULE 3Aa	:	IF	(S1 < LM_S1_LIMIT) .OR. (S1 = NA)
		THEN	S1_SCORE = 0
		ELSEIF	(S1 >= LM_S1_LIMIT) .AND. (S1 <= LM_S1_MEAN)
		THEN	S1_SCORE = 1
		ELSEIF	S1 > LM_S1_MEAN
		THEN	S1_SCORE = 2
RULE 3Ab	:	IF	(S2 < LM_S2_LIMIT) .OR. (S2 = NA)
		THEN	S2_SCORE = 0
		ELSEIF	(S2 >= LM_S2_LIMIT) .AND. (S2 <= LM_S2_MEAN)
		THEN	S2_SCORE = 1
		ELSEIF	S2 > LM_S2_MEAN
		THEN	S2_SCORE = 2
RULE 3Ac	:	IF	(S3 < LM_S2_LIMIT) .OR. (S3 = NA)
		THEN	S3_SCORE = 0
		ELSEIF	(S3 >= LM_S3_LIMIT) .AND. (S3 <= LM_S3_MEAN)
		THEN	S3_SCORE = 1
		ELSEIF	S3 > LM_S3_MEAN
		THEN	S3_SCORE = 2
RULE 3Ad	:	IF	(S4 < LM_S2_LIMIT) .OR. (S4 = NA)
		THEN	S4_SCORE = 0
		ELSEIF	(S4 >= LM_S4_LIMIT) .AND. (S4 <= LM_S3_MEAN)
		THEN	S4_SCORE = 1
		ELSEIF	S4 > LM_S4_MEAN
		THEN	S4_SCORE = 2
RULE 3Ae	:	IF	(S5 < LM_S5_LIMIT) .OR. (S5 = NA)
		THEN	S5_SCORE = 0
		ELSEIF	(S5 >= LM_S5_LIMIT) .AND. (S5 <= LM_S5_MEAN)
		THEN	S5_SCORE = 1
		ELSEIF	S5 > LM_S5_MEAN
		THEN	S5_SCORE = 2
RULE 3B, 3C, 3D, 3E, 3F			

Samples of screen design from advisory phase is shown in Figure 7.10 & 7.11.

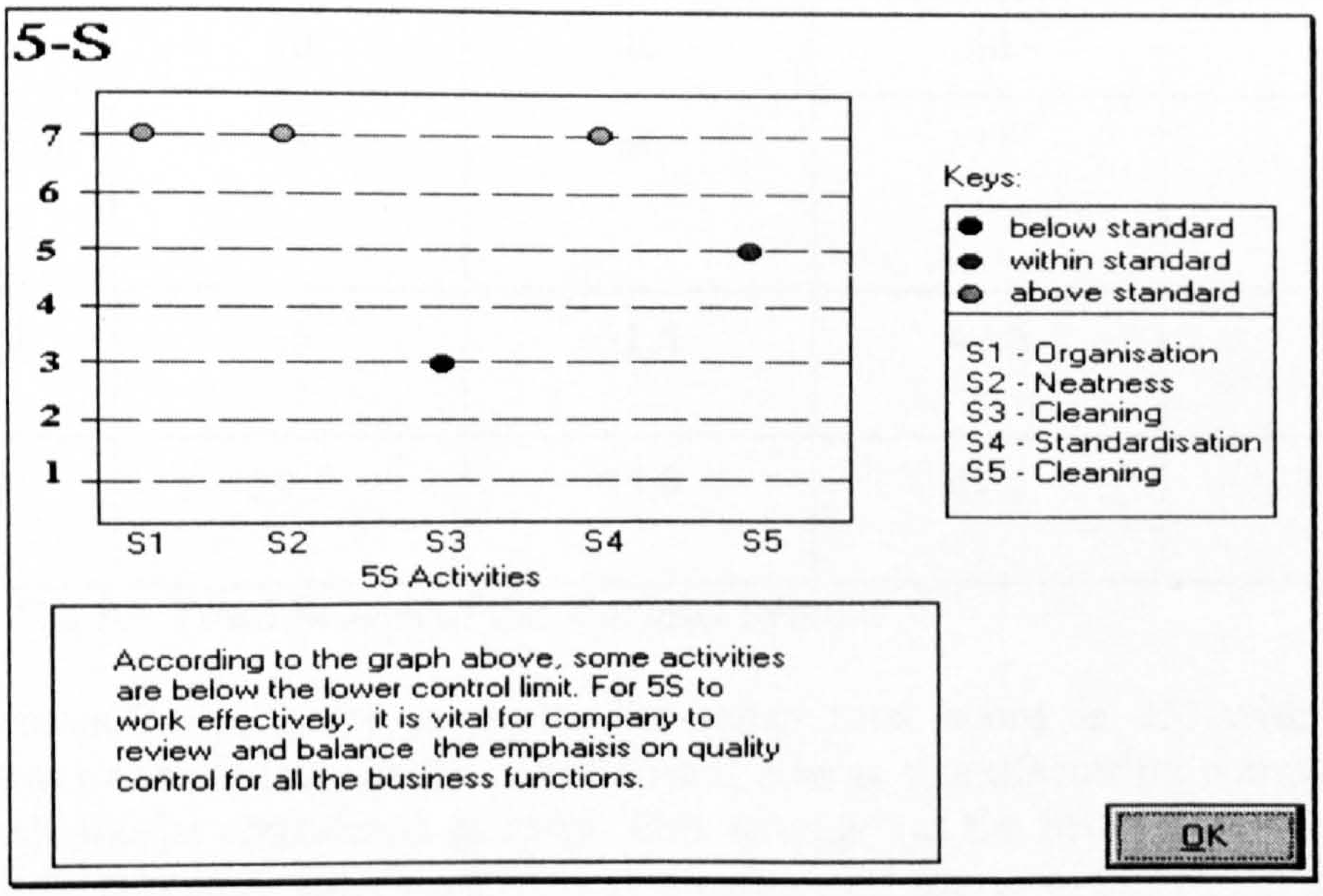


Figure 7. 10 Sample Screen for Decision Rules Phase (1)

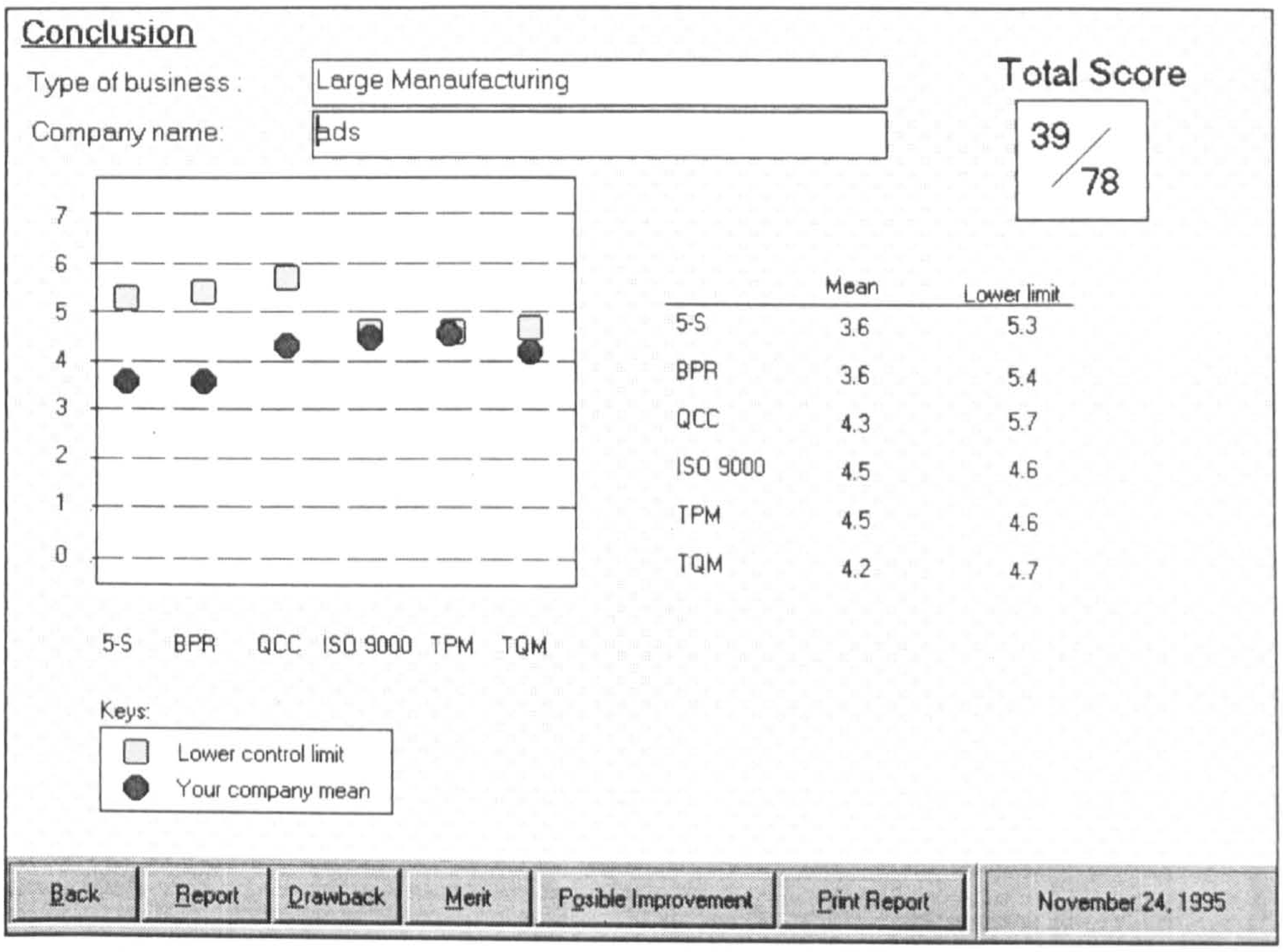


Figure 7. 11 Sample Screen for Decision Rules Phase (2)

7.1.6.4 Calculation of the LCL for Total Scores of Various Sectors

In order to ascertain the validity of the ES developed before field testing, it is necessary to work out a set of LCLs for the total scores as benchmarking. 40 questionnaire survey data from each sector are used for this purpose. The results are summarised as follows:

	Large Manu.	S/M Manu.	Large Services	S/M Services
Sample No.	40	40	40	40
Maximum Total Scores Attainable	78	66	72	74
Mean of Total Scores	35	31.8	47.4	37
LCL of Total Scores	29.1	25.9	41.5	31.1

Table 7.5 LCL for Total Scores of the Various Sectors

Take larger manufacturing for example, the mean total score is 35, with the 95% confidence lower control limit at 29. Therefore if a large manufacturing company scores below 29, it should be considered as lower than average (at the lower quartile). On the other hand, if the company scores above 35 (the mean total scores of large manufacturing), it should be considered as higher than the average. These criteria now form the basis for the comparison. Based on the findings in the above pilot test, the following recommendations are added to the ES:

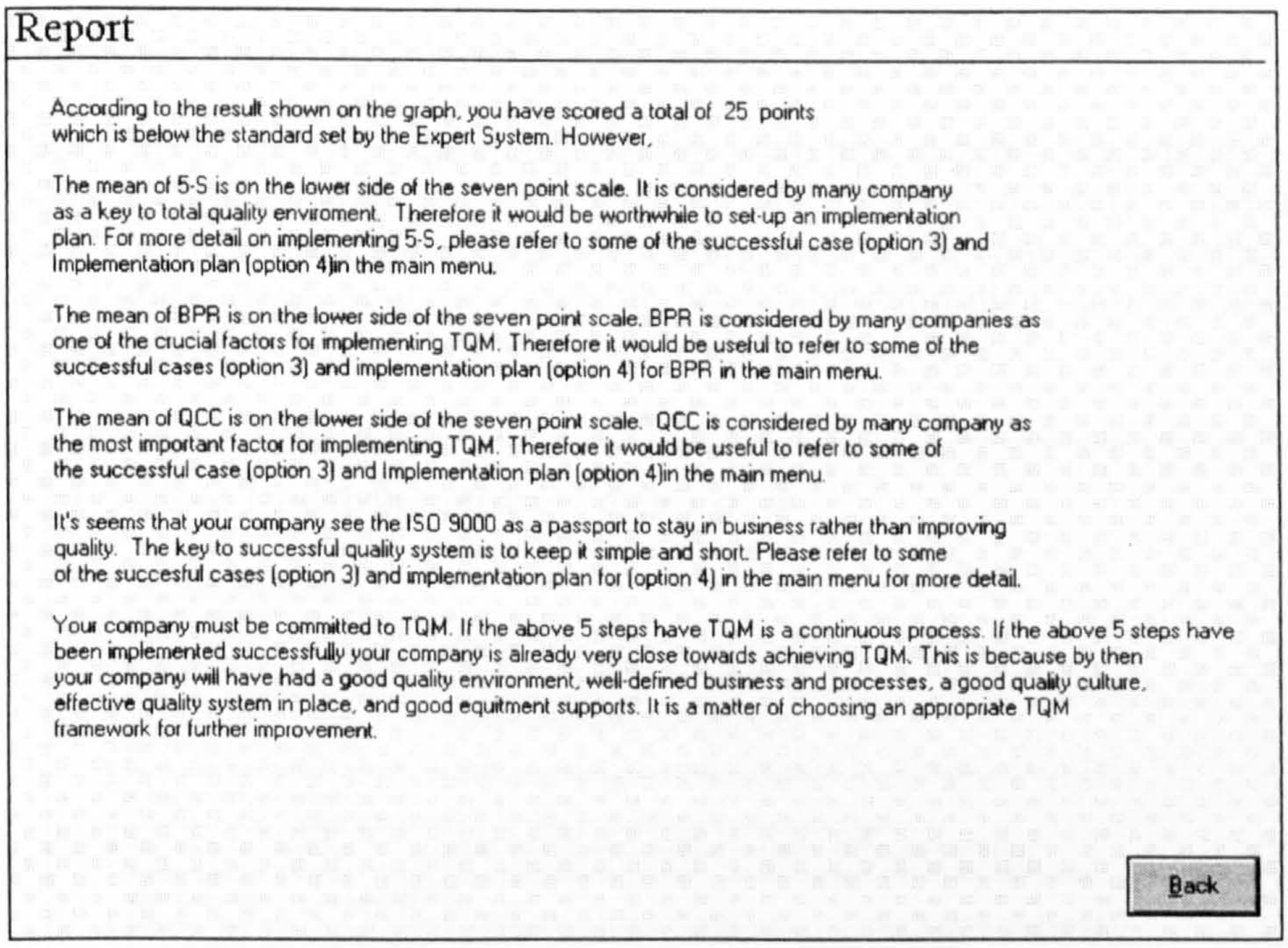
The mean total score for a successful large manufacturing company is 35, with a 95% confidence lower control limit of 29.

Large manufacturing company with mean total scores below 29 will need to consider ways in which their scores can be improved. This score can be used as a yardstick for companies wishing to improve their existing quality system. Companies should aim at doing better than the mean i.e 35 or aim at the maximum which is 78 for this group. With this picture in mind they should then repeat the consultation again.

7.1.6.5 Scope of Guidance Provided by ES

After the ES consultation is complete, the total score and the mean of means of each part of the TQMEX model are calculated. They provide the user with the overall result of the assessment. A final report will then be given based on their performance. It will also suggest to the users which part of their system require attention. With this report they should then refer to the ES-Case and implementation plan for further advice. The details of the final report is shown in Figure 7.12.

The recommendations from ES are based on the statistical results of survey of 400 large,



Report

According to the result shown on the graph, you have scored a total of 25 points which is below the standard set by the Expert System. However,

The mean of 5-S is on the lower side of the seven point scale. It is considered by many company as a key to total quality enviroment. Therefore it would be worthwhile to set-up an implementation plan. For more detail on implementing 5-S, please refer to some of the successful case (option 3) and Implementation plan (option 4)in the main menu.

The mean of BPR is on the lower side of the seven point scale. BPR is considered by many companies as one of the crucial factors for implementing TQM. Therefore it would be useful to refer to some of the successful cases (option 3) and implementation plan (option 4) for BPR in the main menu.

The mean of QCC is on the lower side of the seven point scale. QCC is considered by many company as the most important factor for implementing TQM. Therefore it would be useful to refer to some of the successful case (option 3) and Implementation plan (option 4)in the main menu.

It's seems that your company see the ISO 9000 as a passport to stay in business rather than improving quality. The key to successful quality system is to keep it simple and short. Please refer to some of the succesful cases (option 3) and implementation plan for (option 4) in the main menu for more detail.

Your company must be committed to TQM. If the above 5 steps have TQM is a continuous process. If the above 5 steps have been implemented successfully your company is already very close towards achieving TQM. This is because by then your company will have had a good quality environment, well-defined business and processes, a good quality culture, effective quality system in place, and good equitment supports. It is a matter of choosing an appropriate TQM framework for further improvement.

Back

Figure 7. 12 Final Report

medium and small Enterprises in the UK, HK and Japan. The questions are designed based on an improvement of the similar questionnaire used for the main survey. They have been modified to suit all types of companies. Although every organisation is unique, the use of the TQMEX model for self-assessment will enable all sizes and types of companies to identify where improvements need to be made to achieve business excellence. The Expert System provides a framework against which the user can assess how good their organisation is at implementing quality. The different processes of the TQMEX model will encourage them to examine a wide range of business improvement opportunities that are relevant to their specific operation. More important the model provides a step-by-step approach and implementation plan for companies to follow.

Based on the users' scores, a summary advice will be given to guide them for further improvement. Overall speaking, there are 7 possible outcomes from the 6 sets of questions as shown in Table 7.6. It should be noted that whenever there is a n/a, the question is dropped from the overall mean calculation.

Possible Outcomes =====>	**A**	**B**	**C**	**D**	**E**	**F**	**n/a**
Mean score above mean of question set	✓	✓	✓				
Mean score within controlled range of question set		✓	✓	✓	✓		
Mean score below LCL of question set			✓		✓	✓	*

Table 7.6 The Possibility of Outcomes of the Total Scores for the 6 Sets of Questions

In order to simplify the number of recommendations, the possible suggestions is grouped under the following 5 categories instead of the 7 groups (A-F & n/a) identified above.

Possible Outcome = (A)

Possible Outcome = (B) & (D)

Possible Outcome = (C) & (E)

Possible Outcome = (F)

Possible Outcome = (n/a) for the whole question set (*)

The final three questions from the questionnaire were aim at acquiring suggestions on the merit, drawbacks and possible improvements to their QMS (S.5.2.6.3). This knowledge has also been classified into larger and S/M enterprises which enables the users to refer to and consider before developing their specific implementation plan. An example of this is shown in Figure 7.13.

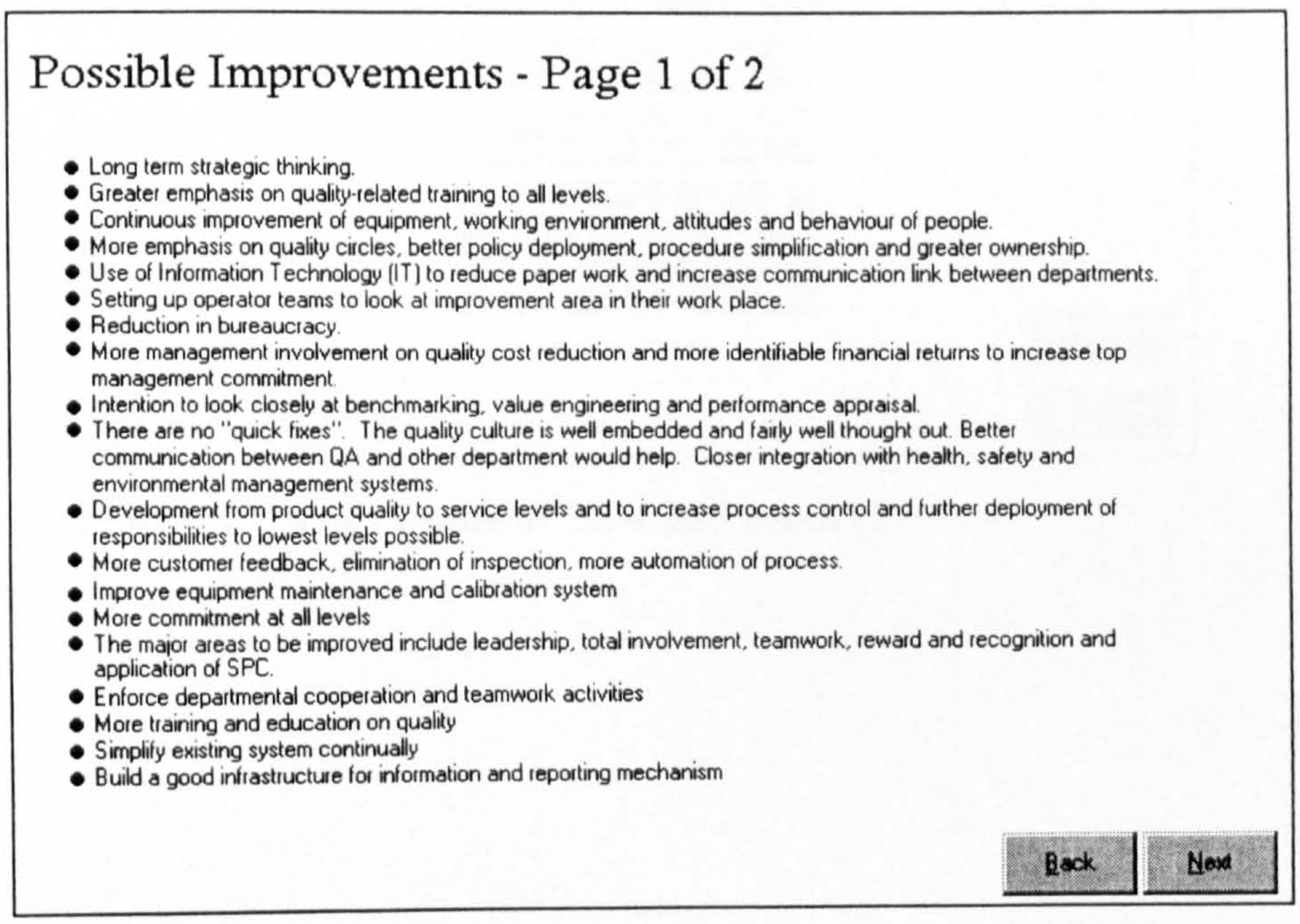


Figure 7. 13 Example of Possible Improvements

7.1.6.6 Development of ES-Case Bank

It has been established in S.3.1.2 that Action Research and Case Studies are appropriate methods to learn about how TQM can be implemented effectively in organisations. More important is that the study can often be replicated in other organisations so that the CSFs can be generalised. Thus, the ES are useful as an "Acid Test" of the effectiveness of TQM implementation. However, it would not be sufficient to advise companies how good or bad they are just based on a set of parameters and a single overall measurement. This is because the implementation process could depend on the type of business, history, style of leadership and cultural environment.

In many cases, a company learns about implementation of TQM through the experience of other similar organisations. However, finding a good match to the operations of a particular company could be tedious and sometimes difficult. As discussed in Section 5.2.8, some 34 cases have been studied by the author from the three countries (the UK, HK, and Japan). The recommendations from the ES-Case are based on the 34 cases. Case studies are proven methods to understand the implementation of quality system in organisations. It is therefore useful to structure these cases based on their CSFs (Table 5.24). With the use of ES-Case, the user can search for the related cases based on the ES final report (suggesting to the users which of the processes or CSFs need to be improved). Then, they should study the related CSFs and try to emulate them for their own operations. Examples of these are shown in Figure 7.14 & 7.15.

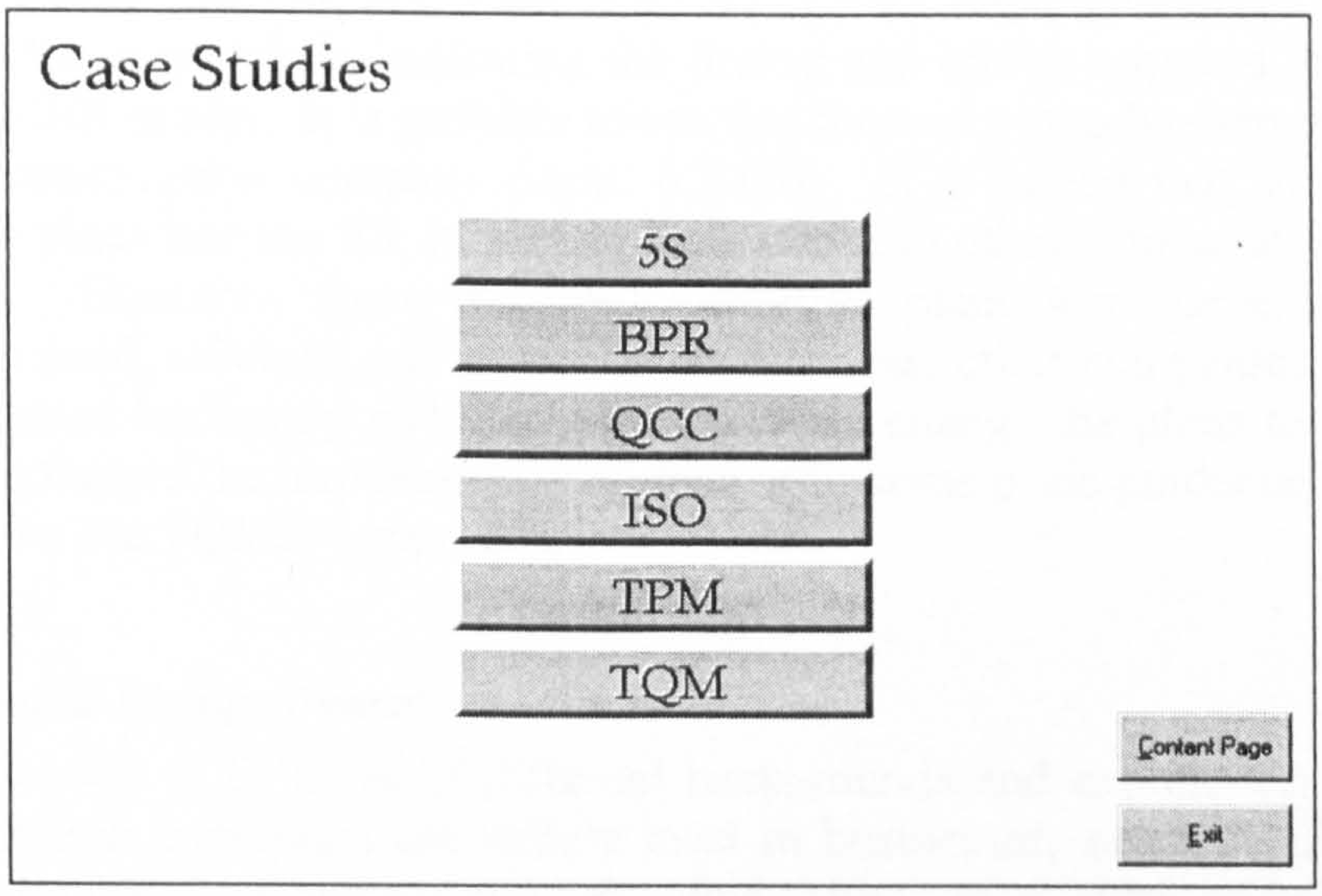


Figure 7. 14 Example of ES-Case Bank (1)

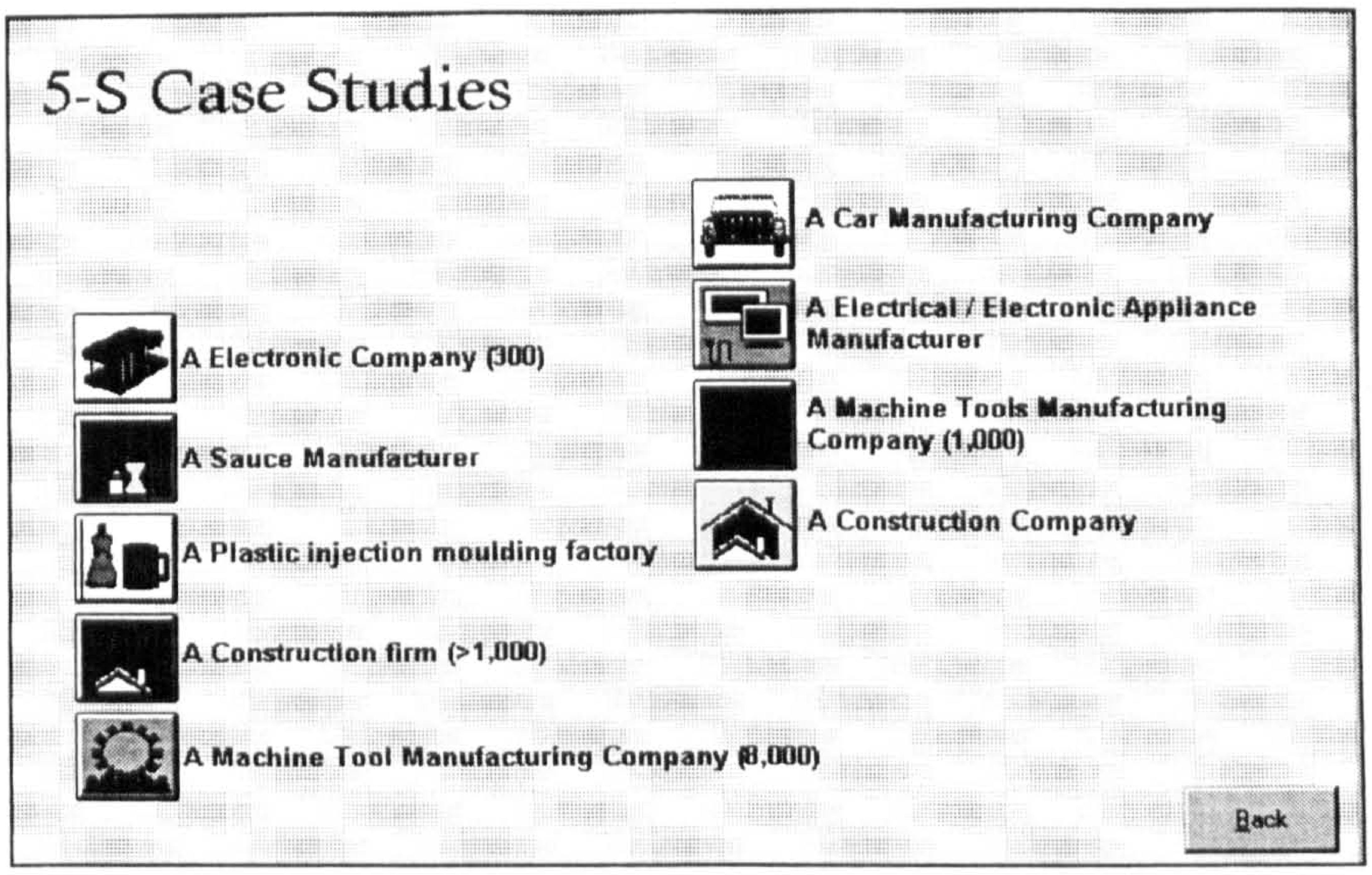


Figure 7.15 Example of ES Case Bank (2)

7.1.6.7 Development of Implementation Plans

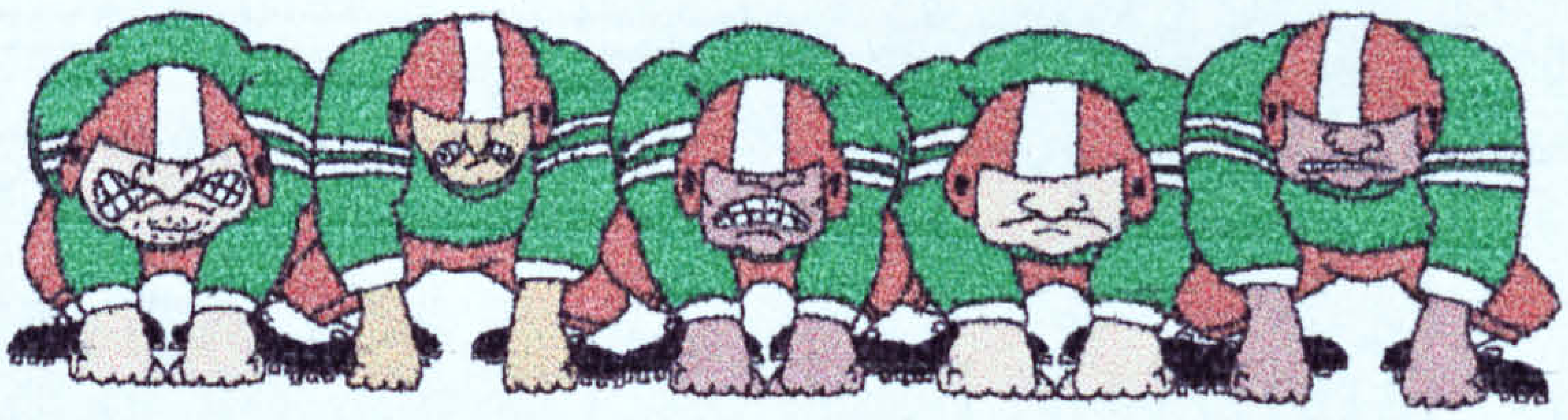
The implementation plans were developed based on the action research carried out in the CKFC Construction Ltd. in HK (see S.6.1.4). The implementation plans provide information on the steps taken, indicating the timing and efforts required to achieve each step of the TQMEX model. It is possible to see that there is a step-by-step approach being taken by this construction company (App. 6.2-6.6). It is hoped that by including the implementation plans into the ES, it can be of assistance to other companies contemplating the same goal. However, since the implementation plans were developed based on CKFC's background, resource and nature of its business, other companies with different background, size or leadership style, etc., may have to change the plans to suit their own business. Nevertheless the implementation plans offer some basic guidance for companies wishing to follow the TQMEX approach.

7.1.6.8 Additional Design Features

The ES are intended to fit users of different backgrounds and experience from different industries. Although computers are widely used in businesses, some people may not be familiar with Internet operations and, in some cases, may even be afraid of using computers. Therefore, the package has to be immediately appealing to users who are computer laymen. Thus it was decided that the ES should be user-friendly and have good graphics. An on-line instruction manual is also provided to advise users on the hardware and software requirements for setting up the system.

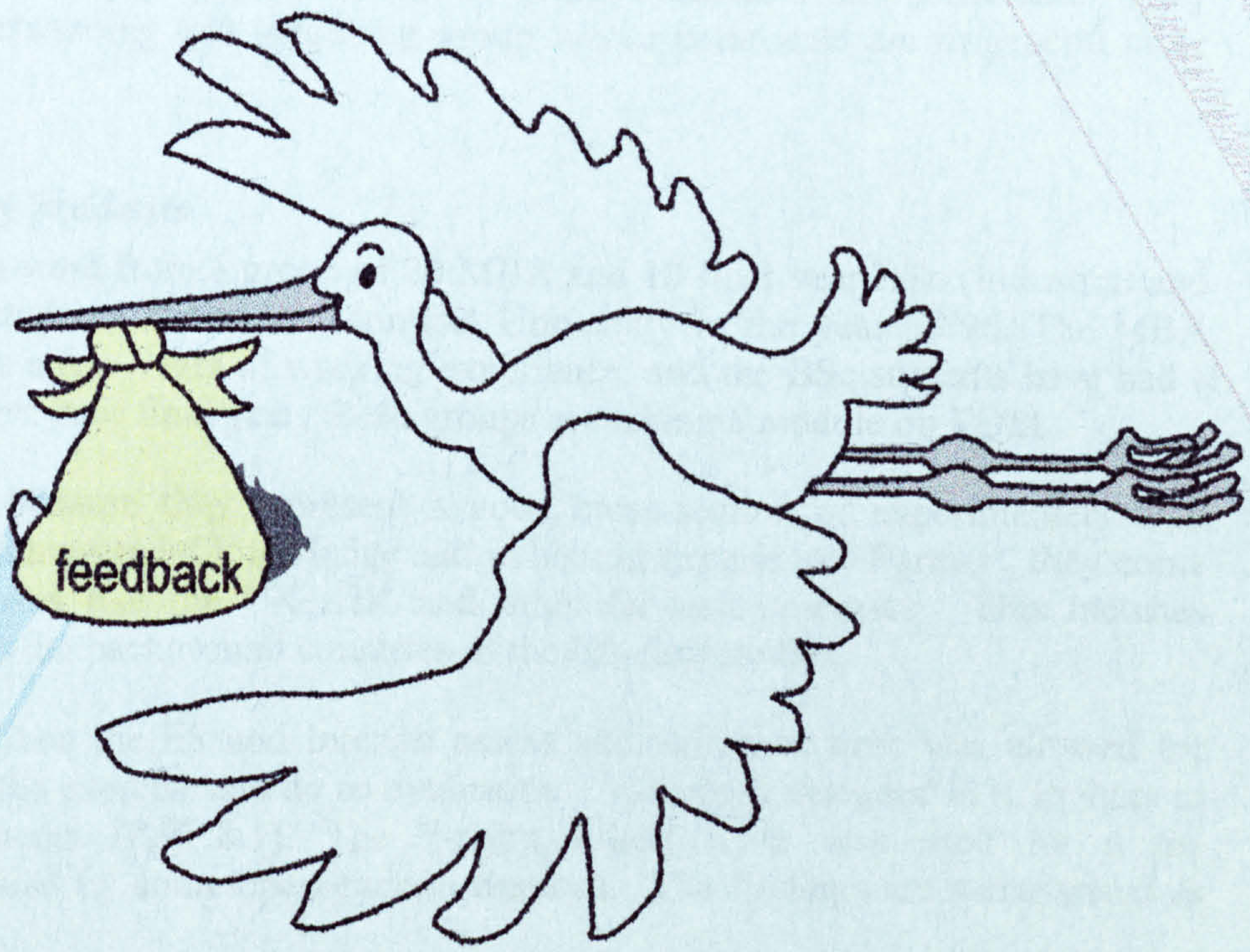
EPILOGUE

In Chapter, the TQMEX Advisory Service System has been developed based on the findings in Chapter 5 and 6. It uses HTML and Visual Basic as the development tools. During the development process, it has demonstrated that knowledge can be efficiently built into the Internet and ES which can be used by a third party. The effectiveness of this TQMEX Advisory Service System will be tested in Chapter 8.



Chapter 8

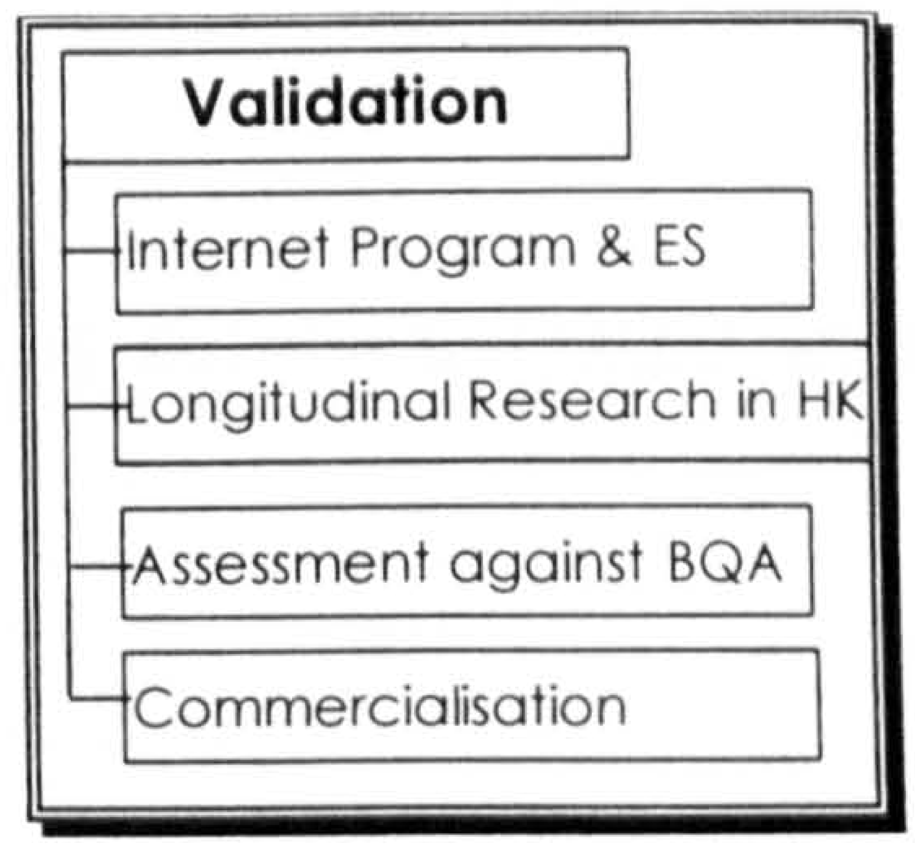
Validation



CHAPTER 8

VALIDATION

PROLOGUE



The TQMEX Advisory Service (TQMEXAS) developed in Chapter 7 has to be validated first before it can be released for use by companies. In order to do so, the TQMEX model will be tested in longitudinal case study. If proven successful, the TQMEXAS will be verified as a result. After validation and refinements, the TQMEXAS will be packaged for commercialisation and a marketing plan is suggested.

8.1 VALIDATION OF THE TQMEXAS

The purpose of validation is to test the TQMEXAS under appropriate working conditions so that bugs can be identified and improvements can be made. A more important objective is to test the value of the TQMEXAS as a tool for companies to develop their own TQM system. The validation process consists of two phases. The first phase is the validation by a group of students who have had some experience in the field of quality management system. Their opinions are then taken on-board to further improve the TQMEXAS. The second phase is the validation by professionals who have experience in planning and implementing QMS i.e. quality representatives, quality managers and consultant. They represent a more demanding and practising group whose comments are in general more critical and precise.

8.1.1 Validation by Students

The subjects chosen were from a group of 20 MBA and 10 final year BSc (Industrial and Business Studies) students at the De Montfort University in the year 95/96. The MBA students would have a few years of working experience, and the BSc students have had a placement year before their final year. Both groups are taking a module on TQM.

They were chosen because they represent a good cross-section of experimenters with reasonable quality management knowledge and industrial experience. Further , they come from various countries like the UK, HK and other far east countries. This matches reasonably well with the background countries of the ES-case studies.

Each student was given the ES and Internet assess and sufficient time was allowed for them to go through the exercise and do an evaluation. A form is designed to help them to give critical comments (APP.8.1). The 7-point Likert scale was used for a the questionnaire, followed by some open-ended questions. The findings are summarised as follows:

8.1.1.1 Background of Subject

Working Experience:	0 year	-- 5
	1-3 years	--18
	4-6 years	-- 5
	7-10 years	-- 2
Most recent job being in Manufacturing Sector:		16
Most recent job being in Services Sector:		9

8.1.1.2 Internet program Validation

The answers obtained from the questionnaire were complied and the following scale of interpretation is used:

Point 7	- excellent
Point 6	- very good
Point 5	- good
Point 3 & 4	- acceptable
Point 2	- poor
Point 1	- very poor

The complied results are shown in Table 8.1 :

		Excellent	Very good	Good	Acceptable	Poor	Very poor
Q.1	Ease of Use	10	12	7	1	0	0
Q.2	Easy to Understand	8	9	8	5	0	0
Q.3	Breadth of the content	4	7	12	7	0	0
Q.4	Depth of the content	4	8	10	8	0	0
Q.5	Use of colour and graphics is attractive	4	4	12	10	0	0
Q.6	Understand more about TQM implementation	6	12	5	7	0	0
Q.7	Use as a training package for practising TQM	6	9	6	9	0	0
Q.8	Step-by-step framework for implementing TQM	6	9	5	10	0	0
Q.9	Overall rating	2	15	11	2	0	0

Table 8.1 Validation of Internet Program (Students)

Comments from the Author:

The responses to Q1-9 indicate that the Internet program has been designed successfully to meet the needs of the users and as a learning tool as well. The overall rating is on the higher side of the 7 point scale. This proves the effectiveness of the Internet program in the introduction of the TQMEX model.

The responses to Q10 to Q12 are extracted from the original questionnaires for the rest of this Chapter, with minor improvements in grammar and sentence structure.

Q10 Major Merits

- It is a great learning tool, providing me an excellent insight into this subject area.
- It has been a pleasure to use this package and I would greatly appreciate if the whole group had another assignment like this.
- The software is very good because it is self-explanatory. Every student has got equal access to the computer.
- This is the first Internet assignment that I have done and it is excellent that you are trying to use this new and very important medium.
- It has very interesting contents and information for any student. It's helpful for revision and I would like a copy for myself.
- This whole exercise is one which, I feel, brings me to enjoy what I am learning and making it more interesting also.
- It is easy to use in a step-by-step way.
- The software is already at a standard that is perfectly acceptable.
- It asks very straight forward questions and has a very good guide to answer these questions.
- Pictures and drawings makes it appealing.
- It is easy to access in the Internet.
- Easy to operate, content is simple and easy to understand.
- Easy to use and understand. The depth of contents is appropriate.
- The software is easy to access and follow. The exercise is very useful and it provides great understanding of TQM.
- Easy to follow and understand. The instructions are simple and straight forward.
- With quick processing, the exercise is very useful in getting a better understanding of TQM
- Being user friendly and easy to follow, it is an excellent approach for the first contact with Internet.
- Allows easy testing of the understanding of the concepts.

<u>Comments from the Author:</u>
After summarising the above major merits, it is found that users like the simplicity of the Internet program. It provides valuable information about the relationship between TQM and the TQMEX model. Most users like the idea of self-assessment, which helps them to brainstorm and refresh memories. On the whole, the Internet program has been well received by students.

Q11 Major Drawbacks

- The assignment is too long as my attention arise from the initial interest was lost very quickly.
- In terms of acting as a learning tool, the explanations behind the questions may not be sufficient.

- Some titles do not have any information that can be accessed. This should not be the case or it should be cancelled, making it easier to send the right information.
- When navigating through the software it can sometimes be difficult
- Prefer the exercises immediately after the main content rather than in separate pages
- Having to write name when sending e-mail
- Not being able to save or print

Comments from the Author:
Most of the drawbacks are due to the limitation of the Internet. Nevertheless, the Internet program has provided print-and-save facilities for user. Some of the drawbacks quoted is related to the exercise. This has been modified and included in the revised version of the Internet programme.

Q12 Suggestions for Improvement

- More rooms should be given to write comments.
- More information on the ISO 9000 section.
- More bullet points in the summary.
- To have a brief description on how to use this software and show the contents at the very beginning so to arouse the interest of users.
- More examples, case studies, more diagrams, more graphics.
- Shorten the text slightly.
- In section 2, add in a comment column so to allow users to express their opinions about the Gurus' ideas and develop an areas to enable users to share their experience on the quality movement around the world and the difficulties in implementing TQM.
- System can be improved by introducing more Internet machines in the university.

Comments from the Author:
Some of the above comments are similar to the "Drawbacks" and hence are not further discussed here. Other comments on the user-interface are incorporated into the revised version for Internet program.

8.1.1.3 Expert System Validation

		Excellent	Very good	Good	Acceptable	Poor	Very poor
Q.1	Ease of Use	6	10	9	5	0	0
Q.2	Easy to Understand	8	12	10	0	0	0
Q.3	Breadth of the content	5	13	12	0	0	0
Q.4	Depth of the content	4	13	10	3	0	0
Q.5	Use of colour and graphics is attractive	4	10	12	4	0	0
Q.6	Understand more about TQM implementation	7	12	4	7	0	0
Q.7	Use as a training package for practising TQM	10	11	7	2	0	0
Q.8	Step-by-step framework for implementing TQM	6	15	8	1	0	0
Q.9	Overall rating	3	18	9	0	0	0

Table 8.2 Validation of ES (Student)

Score: 3, 4, 4, 5, 5, 6, 6, 7, 7, 7,7, 9, 11, 11, 11, 11, 12, 13, 13, 13, 14, 15, 16, 16, 18, 19, 19, 21, 21, 28

Comments from the Author:
The scores are skewed towards the lower end, comparing with the LCLs (25-41) for the various sectors. The lower tail of the respondents indicates that they are thinking on companies which are less geared towards TQM. When the students who gained the lower tail results were consulted, they admitted that the firms they tested were in fact poor in quality management and in some cases no formal system was available for measuring the quality. The responses to Q1-9 indicate that the TQMEXAS has been successful in assessing how good a company is at implement TQM.

Q10 Major Merits

- The result of consultation is very simple and effective by just giving the mean score and comparing the survey results.
- Sufficient information for comparison / reference by any individual company.
- Good model for self-assessment.
- Graphical presentations are very impressive.
- Window based with help and related message is quite user-friendly.
- The user can have a brief idea about the implementation stages required.
- Guidelines for implementation are very useful.
- Only numerical values are inputted. This helps to reduce ambiguity from the usual natural language.
- It is good to know how the score is estimated.
- Can promptly give out a figure of score and suggestions for the extent of TQM implementation of the company.
- Covers the major areas for companies to consider TQM development.
- Good user interface, easy to follow.

Comments from the Author:
When summarising the above major merits, most users like the simplicity and the user interface of the ES, yet it provides a single indicator on how good the company is on implementing TQM. Furthermore, the questions asked are based on the logical sequence of the TQMEX model which can help companies to further develop their existing quality system more effectively. Most user like the implementation plan, which provides detail process, people and time require for implementation.

Q11 Major Drawbacks

- Some documentation is more general rather than specific.
- Insufficient information provided for a first time user
- Not enough detail information for the answers.
- There is no help menu on the screen to guide the user through the system
- The user becomes very tired after continuous viewing at the terminal.
- Some variables are not clearly defined
- No general guidance to help in deciding the entries. This may only be good for those who are professional rather than those who do not have any experience.
- Do not see the application /use for an non-expert user.

Comments from the Author:
Most of the above drawbacks quoted focus on the need for explanation and recommendation. The former one has been included in the revised version of the ES. The latter problem is much reduced if the user chooses the option of printing the consultation. Nevertheless, more recommendations have been included in the revised version as well.

Regarding the last drawback, it is believed that although an expert user has an obvious advantage in using the consultation, non-expert users can also benefit as it helps to set direction as to areas of improvement which can be taken up with experts within his organisation or outside.

Q12 Suggestions for Improvement

- It is not specific in the type of business environment. It is possible that in different manufacturing environment, the implementation of TQM could differ. It might reflect the result of consultation.
- It would be better if the knowledge-base of the ES is enlarged so that it can cover more question areas.
- If the score is less than average, it is good to have some recommendations about where and what needs to be improved.
- The ES can be further developed so that it can be a mature consultant.
- An explanation test can be designed. At each score, an explanation of the average selection can be shown. This helps the user to learn more easily about the requirement

Comments from the Author:
The ES is designed not to be specific to a particular industrial sector. Although there is a distinction between large and S&M enterprises, the rationale for this approach is that the survey data can be shared among more industrial sectors, and hence more accurate results can be achieved.

Some of the comments on the user-interface are incorporated into the revised version as and when appropriate.

8.1.2 Validation by Professionals in the Quality Field

An invitation for validation of the Advisory Service was sent through the Internet in Feb. 96. The Emails were sent to the largest News Group in the UK called Mailbase. The database stored a comprehensive list of professional related to the field of quality management. A total of three reply was received. Seven other people were also chosen from industry who have experience in planning and implementing of QMS i.e. quality representatives, quality managers and consultants. These represent a more demanding and practical group whose comments are, generally speaking, more critical.

Working Experience:	1-3 years	-- 4
	4-10 years	-- 3
	10+ years	-- 3

Most recent job being in Manufacturing Sector: 5
Most recent job being in Services Sector: 5

8.1.2.1 Internet Program Validation

		Excellent	Very good	Good	Acceptable	Poor	Very poor
Q.1	Ease of User	1	9	0	0	0	0
Q.2	Easy to Understand	3	6	1	0	0	0
Q.3	Breadth of the content	2	4	3	1	0	0
Q.4	Depth of the content	1	4	3	2	0	0
Q.5	Use of colour and graphics is attractive	2	4	4	0	0	0
Q.6	Understand more about TQM implementation	1	6	3	0	0	0
Q.7	Use as a training package for practising TQM	2	5	3	0	0	0
Q.8	Step-by-step framework for implementing TQM	2	5	3	0	0	0
Q.9	Overall rating	1	8	1	0	0	0

Table 8.3 Validation of Internet program (Professionals)

Comments from Author:
The Responses to Q1-9 indicate that the use of TQMEX as a model for implementing TQM has been successful in meeting the needs of the users and as a learning tool. The overall ratings are on the higher side of the 7 point scale. This proves the effectiveness of the Internet program on introducing the TQMEX model.

Q10 Major Merits

- Easy to use
- Very good value as a learning tool.
- Excellent learning tool, exciting, and motivating
- The Internet program could be accessed from anywhere in the world.
- It is a good tool for both beginner and experienced user.
- Sufficient information for reference by any individual.
- Excellent graphic presentation.
- Good step-by-step examples.

Comments from the Author:
When summarising the above major merits. Most users like the graphic and information provided. This further confirmed that the Internet program is an effective tool for introduces the TQMEX model.

Q11 Major Drawbacks

- There is not enough detailed information for implement TQM.
- The Internet system is difficult to use for a beginner.
- It requires long time to download graphic files.
- There is no help menu on the screen to assist user.
- Too much text.
- Not enough literature and reference to support the Model.
- Not enough guru's ideas.

Comments from the Author:
Some of the drawbacks quoted focus on the need to expand the content and literature of the Internet program. However, it is not the aim of the Internet program to discuss literature of TQM in depth. The aim is to introduce the TQMEX model and to identify those steps that are of particular importance to TQM implementation.

Regarding some of the drawbacks on user-interface, they were incorporated into the revised version of the Internet program.

Q12 Suggestions for Improvement

- More detail on implementation of the model
- Help menu may be provided on screen for all the pages.
- Model answer should be given at the end of the assessment
- More graphic and picture to attract the user
- Reduce text to minimum
- More details on guru's ideas
- Good enough

Comments from Author:
Most of the above suggestions are similar to the "Drawbacks" and hence are not further discussed here. Other comments on the user-interface are incorporated into the revised Internet program.

8.1.2.2 ES Validation

		Excellent	Very good	Good	Acceptable	Poor	Very poor
Q.1	Ease of Use	2	8	0	0	0	0
Q.2	Easy to Understand	2	6	2	0	0	0
Q.3	Breadth of the content	4	4	2	0	0	0
Q.4	Depth of the content	1	4	3	2	0	0
Q.5	Use of colour and graphics is attractive	2	4	2	2	0	0
Q.6	Understand more about TQM implementation	0	6	4	0	0	0
Q.7	Use as a training package for practising TQM	2	5	3	0	0	0
Q.8	Step-by-step framework for implementing TQM	2	4	4	0	0	0
Q.9	Overall rating	1	8	1	0	0	0

Table 8.4 Validation of ES (Professionals)

Score: 21, 28, 28, 29, 31, 35, 42, 46, 49, 60

Comments from the Author:
The scores were a reflection of their commitment towards their quality system. Most of the scores were within the lower range of 25-41. The results were expected, since eight of the companies have achieved ISO 9000 accreditation. When the two companies gained the lower tail results were consulted, they expressed that due to the lack of commitment from upper management, quality was always considered as a secondary option.

The responses to Q1-9 indicate that all users like to use the ES as a tool for evaluation and comparison. It also indicates that the ES could provide a step-by-step framework for implementing TQM.

Q10 Major Merits

- Comprehensive System.
- Cases acting as a study or learning tool is valuable. Information may also be useful for management.
- Good reference for TQM principles and practices
- Ease of use and manage.
- A valuable contribution to the effective introduction and implementation of TQM philosophy in an organisation.
- Good benchmarks & graphics.
- User-friendly.
- Intelligibility is good.
- Well structured.
- Provides good guidelines for implementing TQM.

Comments from the Author:
The ES has been well received by professional in the quality field, as can be seen in some of the above comments. The elements of the ES will also encourage companies to examine their existing quality system.

Q11 Major Drawbacks

- More guidelines.
- Few if any.
- Downloading of the ES can be difficult.
- Subjective answers.
- Not easy to understand the logic of TQMEX model.
- There are so many special terms making it difficult for a participant to understand.
- No general guidance to help in deciding the entry points. This may only be good for those who are professional rather than those who do not have any experience.
- Sometimes, background colour makes contrast difficult.
- It does not provide a separate score for individual section.
- More operating instructions to the user needed.

Comments from the Author:
Most of the above drawbacks are similar to the MBA student's answer. The above drawbacks quoted focus on the user interface. However, some of the drawbacks, like the use of special terms and understanding of the logic of TQMEX can be minimise, if the users spend more time to study the Internet program. Those drawbacks which can be improved are incorporated into the revised version of the ES. There is no critical comment on the contents of the cases. This agrees with the Merit section that the cases are valuable information for companies to refer to whenever appropriate.

Q12 Suggestions for Improvement

- Provide separate score for individual section.
- Change to lighter background colour.
- Internet Program and ES should be integrated.
- Copyright it soon.
- More cases.
- More operating instruction to the user.
- It will be better if pull down menu is used.
- The ES should consider more self-assessment models, e.g. Deming Award model or the UK Quality Award model.

Comments from the Author:
Some of the above suggestions for improvement are similar to the "Drawbacks". These are incorporated into the revised version of the ES. However, the comments about more cases and more self-assessment models can only be done with further questionnaire and field survey. Due to the limited time of the present research. This can be used as a recommendations for future research.

8.1.3 General Comment

Overall speaking, there are little significant differences between the responses from the students who have some TQM knowledge and those quality practitioners. The main reason for this is that both the Internet System and the ES are designed for entry-level users. Having said this, the TQMEXAS should still be useful for the professionals to refresh their memories and also to identify further areas of improvement for their own organisation.

8.2 LONGITUDINAL RESEARCH IN HK

As explained in Section 3.1.11 of the Research Methodology, there are obvious advantages in using longitudinal research as a research approach. A case in HK is reviewed based on this principle. This company is selected because the author has been working in this company for considerable length of time both before and during the present research. This provides a better insight into the background of the case studies, and also gives the author a chance to follow up the case "longitudinally". Last but not the least, this is a representative case with recorded successes in their implementation.

It is a worthwhile exercise as the process dynamics of change due to the introduction of TQMEX model can be assessed critically. Furthermore, this case can enhance the validity of the TQMEXAS. The revised version of TQMEXAS is tested by the responsible person (Contract Director) through her company's Internet service. After that, she was given the same questionnaire (App.7.1-54) for evaluating the effectiveness of the TQMEXAS through the Internet.

8.2.1 A Construction Firm in HK

The author was invited as a consultant to develop the QMS for this firm during a 6-month period in 1995. As a result, the five steps of the TQMEX have been implemented and/or improved. The details have been discussed in Chapter 6 already.

After introducing 5-S to the company, the management had gained confidence in implementing the other steps of the TQMEX model. The 5-S provided the staffs a quality environment to work in. This also led to increase in productivity by reducing re-works and waste.

The main effect after the implementation of BPR was the increase of the number of contracts taken from quality conscious clients. The staffs were more aware of their company objective. Communication between internal and external customers had been clearly improved. Securing contracts meant secure jobs and this had increased confidence and staff morale.

The use of monthly QCC had improved the effectiveness and team spirit of the companies. Every month, site supervisors also joined the meetings to review and improve their procedures. Thus confusions were minimised. These also produced a greater involvement and motivation for all the workforce.

After the implementation of 5-S and BPR, the ISO 9000 quality system was revised. The procedures and instructions were refined and simplified. The Contract Manager expressed that the revised ISO 9002 system had provided better work flow on site, and improved efficiency and communication. The consistent reduction of rework resulted in savings of time and money which is crucial for any construction projects in HK.

Regarding TPM, CKFC traditionally has most of the major construction equipment on hire from suppliers. As a result, they do not take a proactive view on equipment maintenance, because they think that maintenance is the responsibility of the equipment rental companies. The Contract Director admitted that, sometimes, they have to suffer the consequence due to lack of attention to maintenance, but her reason was "lack of manpower to look after equipment". One principle of TPM is total involvement. Therefore, CKFC should become part of the maintenance team, otherwise the first party to suffer from downtime and losses is CKFC itself.

Overall speaking, TQMEX implementation at CKFC has been very successful and they have recognised the benefits. The Contract Director was then asked to evaluate the TQMEXAS. Her score was 39 which is just above the standard mean score of 35. This score is remarkable in view of the beginning stage of their TQM development. The 7-point scale results answered by Contract Director are as follows:

		Excellent	Very good	Good	Acceptable	Poor	Very poor
Q.1	Ease of Use	✓					
Q.2	Easy to Understand		✓				
Q.3	Breadth of the content	✓					
Q.4	Depth of the content		✓				
Q.5	Use of colour and graphics is attractive		✓				
Q.6	Understand more about TQM implementation		✓				
Q.7	Use as a training package for practising TQM		✓				
Q.8	Step-by-step framework for implementing TQM	✓					
Q.9	Overall rating		✓				

Table 8.5 Response to ES feedback questionnaire by the Contract Director of CKFC

The Director found the TQMEXAS as a suitable tool for training, evaluation and comparison. She also thinks that it is not only easy to use, but also able to provide a fair judgement of the effectiveness of their quality system and good inspirations for implementation of quality. By going through some of the conclusion reports and cases, she realised their company's strength was to start from 5-S, which is the most effective platform for their business. Further, she also realised the areas which require more attention. She also said that the "Applications" and "Achievement" of the consultation are useful in their future development.

8.3 ASSESSING THE TQMEX AGAINST THE UK QUALITY AWARD

The British Quality Foundation (BQF) administers the UK Quality Award with aims of recognising excellence and identifying examples of best practice that will serve as models for other organisations to emulate. The model suggests that customer satisfaction, people satisfaction, and impact on society are achieved through leadership, which drives policy and strategy, people management, resources, and processes. These will lead ultimately to excellence in business results. The above nine elements correspond to criteria that may be used to assess an organisation's progress towards TQM. Therefore, it is useful to match the elements of the TQMEX model against the UK Quality Award criteria. The results shown in table 8.3 reveal that most of the criteria can be met by adopting the TQMEX model. The TQMEX model can therefore be used as a process/system for achieving quality awards such as the UK Quality Award.

No.	Evaluation Criteria: Assessment of.....	5-S	BPR	QCC	ISO	TPM
1	Leadership (10%) -- This criterion looks at how managers drive the organisation towards the achievement of organisational excellence.					
1.1	Visible Involvement -- How managers are actively and visibly involved in driving towards the achievement of organisational excellence based on the concepts and principles of Total Quality.	✓			✓	
1.2	Culture -- How managers develop and maintain an environment / culture consistent with continuous improvement and corporate excellence.	✓		✓		
1.3	Recognition -- How individuals and teams are recognised by managers.	✓		✓		
1.4	Support -- How managers support improvement activities with appropriate resources and assistance.			✓		✓
1.5	Customers and Suppliers -- How managers are involved in improvement and other activities with customers and suppliers.		✓		✓	
1.6	Promotion -- How managers promote continuous improvement and quality values outside the organisation.				✓	
2	Policy and Strategy (8%) -- This criterion looks at your Mission, Vision, Values and Strategies and how you plan to achieve them.					
2.1	Quality Values and Concepts -- How the concepts of total quality are reflected in your policies and strategies.		✓		✓	
2.2	Relevant Information -- How you use all sources of information, relevant to organisational excellence, as inputs to your policies, strategies and plans.		✓		✓	
2.3	Business Plan Deployment -- How your plans are effectively produced and aligned to the achievement of business goals, policies and strategies.		✓			
2.4	Policy and Strategy Communication -- How policies, strategies and			✓	✓	

	plans are communicated.					
2.5	Regular updating and improvement of policy and strategy -- How you review and improve your strategies, policies and plans.		✓		✓	
3	People Management (9%) -- This criterion looks at how your organisation releases the full potential of its people.					
3.1	Continuous Improvement Practices -- How people management processes are aligned to business needs and continuously improved.			✓		✓
3.2	Training, Recruitment and Career Progression -- How effective use is made of recruitment, training and career progression processes to develop skills and capabilities.			✓	✓	
3.3	Targets for People and Teams -- How team and individual targets and objectives are agreed and how these are reviewed.	✓		✓		✓
3.4	Involvement and Empowerment -- How everyone is empowered and encouraged to become involved in continuous improvement activities.	✓		✓		✓
3.5	Communication -- How communication is made two-way and effective.			✓		
4	Resources (9%) -- This criterion looks at the ways your organisation manages its key resources in support of its policy and strategy.					
4.1	Financial -- How you manage your financial resources effectively.		✓	✓		
4.2	Information -- How you manage your information.	✓			✓	
4.3	Material -- How you manage your material resources, fixed assets and supplies/suppliers.	✓	✓		✓	✓
4.4	Technology -- How you identify and manage appropriate, alternate and emergent methods and technologies.		✓	✓		✓
5	Process (14%) -- This criterion looks at how you identify, manage, review and, where appropriate, revise your organisation's processes.					
5.1	Identifying Critical Processes -- How you identify and define the key processes within your organisation.		✓			✓
5.2	Managing Processes -- How you manage ALL the processes within your organisation.	✓		✓	✓	
5.3	Measures, Targets and Reviews -- How you use all relevant information, including measurement and feedback, to review processes and set improvement targets.			✓	✓	
5.4	Innovation and Creativity -- How you stimulate innovation and creativity in process improvement.		✓	✓		✓
5.5	Process Change -- How you implement and evaluate process changes.		✓			
6	People Satisfaction (9%) -- This criterion looks at the organisation's achievement in relation to the satisfaction of its people.					
6.1	Direct Results -- Perception measures and results, i.e., judgement by the people/employees of what the organisation is achieving in relation to the satisfaction of its people.	✓		✓	✓	
6.2	Indirect Results -- Predicting, leading and influencing measures and results, i.e., judgement by the organisation of factors that are likely to influence employee satisfaction.		✓			
7	Customer Satisfaction (20%) -- This criterion looks at the organisation's achievement in relation to the satisfaction of its external customers					
7.1	Direct Results -- Perception measures and results, i.e., judgement by the customers of the organisation's products, services and customer relationships.		✓		✓	✓
7.2	Indirect Results -- Predicting, leading and influencing measures and results, i.e., judgement by the organisation relating to customer	✓	✓			

	satisfaction.					
8	Impact on Society (6%) -- This criterion involves assessing what the organisation is achieving in satisfying the needs and expectations of the community at large. This includes views on the organisation's approach to the quality of life, the environment and to the preservation of global resources.					
8.1	Direct Results -- Perception measures and results, i.e., judgement by community at large of the organisation's impact on society.	✓				✓
8.2	Indirect Results -- Predicting, leading and influencing measures and results, i.e., judgement by the organisation of factors that are likely to influence 'Impact on Society'.	✓				✓
9	Results (15%) -- This criterion involves an assessment of what the organisation is achieving, in relation to its planned business performance, in satisfying the needs of everyone with an interest in the organisation and in achieving its planned business service objectives.					
9.1	Direct Results -- Financial, 'Bottom Line' results that indicate an organisation's successes.		✓		✓	
9.2	Indirect Results -- Non financial key efficiency and effectiveness measures and the results of the key processes identified in Criteria 4 and 5 that are vital indicators of an organisation's current and continuing success.	✓		✓		✓
	Total No. of Matching (out of 33)	13	15	16	15	12
No.	Evaluation Criteria: Assessment of	5-S	BPR	QCC	ISO	TPM

Table 8.6 Relationship between the EQA Framework and the TQMEX Model

8.4 COMMERCIALISATION OF RESEARCH FINDINGS

After substantial quality research work has been done, it is worthwhile to commercialise the results so that more people/companies can benefit from the findings. This is similar to what the author has done: much of the research finding was published. Today, since software development is fast advancing and cheaply available, it is more cost-effective to develop knowledge commercially in software format and disseminate through the widely available Internet system. There are many advantages over printed work if it is done properly. Example are:

- More user-friendly.
- More efficient to search.
- More concise information with user-interaction.
- Can be tailor-made to user's environment.
- Editing and updating is easier.

The first product is to market and package the ES through the use of Internet. The Internet program can be used as a promotional material to give the potential customers a 'favour' of what TQM and TQMEX is about. The ES can be downloaded easily from the Internet with an on-line help. The selling price should be £49, including VAT and payment can be done electronically through credit card transfer . An on-line manual will be included to guide users to use the ES.

It is suggested further to try out and implement a more adventurous approach to package the product. The traditional way of selling software is through computer shops or mail order. However, unlike other application packages, ES are more educational in nature. Therefore, it would be more suitable to consider the products as reference materials. The idea is to package it in the form of a text book and then include the software as a complement. Thus, the software is seen as an additional bonus, rather than a product in its own right.

After determining the Product and Price, the next "P" in the marketing plan is "Place". This includes the distribution channels and after-sales services. Apart from distributing through the Internet, trade magazines and direct mailing could also be considered.

It is also important to provide good after-sales service. This could be provided through E-mail or toll-free phone enquiry service for the first 15 minutes. Further questionnaire feedback from the users is important for continuous improvement of the service. Users should be encouraged to join the mail-base/club so that information can be exchanged amongst users. Eventually, the database should grow and a data-bank can be established which is freely available to members through the Internet.

The budget for doing some or all of the above depends on the extent and the choice of channels. However, for the initial period, it would have to be via the Internet, because it is the cheapest and most effective distribution channel for a trial run. For the initial period of the first three month the ES can be download as a shareware free of charge with a condition of feedback for further improvement and detection of bugs. This pilot promotion is followed by an assessment of the value of the service to them. The results of the assessment can be used as reference for further promotions. If it works out to be promising, a full scale marketing and promotion plan can be launched. However, the first £1000-2000 has to be considered as venture capital, and could possibly be financed from the Government supports such as the Task Force Grant of City Council, Venture Capital Grant from the Dept. of Trade & Industry or the Prince of Wales Grant for Young Entrepreneur.

In order to test out the ideas, the Director of a computer training firm has been approached. Basing on the above products and prices, he has agreed to purchase one set for evaluation. If it is found suitable, he will recommend the product to his trainees who are mostly graduates and professionals.

The ultimate objective of the project is to promote the TQMEX model as a way for continuous improvement through sharing of knowledge and experience, with the possibility of establishing a co-operative organisation to enhance such activities.

EPILOGUE

In this Chapter, the TQMEXAS has been validated. The validation process has demonstrated that knowledge can be effectively built into ES and Internet program which can then be acquired by third party without the need to consult an expert personally. The Internet System and ES are further improved after validation. Longitudinal research has also been conducted in a construction firm. The findings reflected the importance of an effective implementation model in TQM. Moreover, most part of the UK Quality Award framework can be fulfilled by adopting the TQMEX approach. This reconfirms the validity of the model. Finally, a plan has been suggested for the marketing of the ES developed.

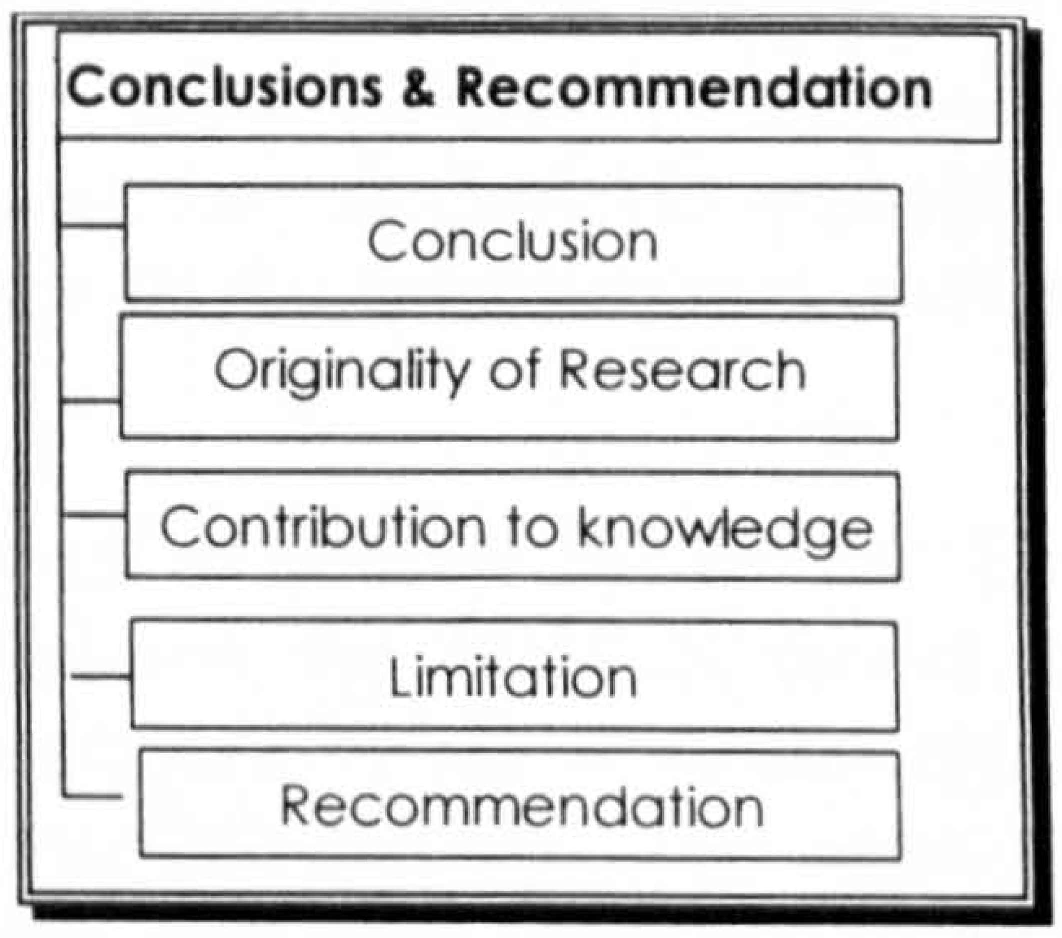
Chapter 9

Conclusions & Recommendations

CHAPTER 9

CONCLUSIONS AND RECOMMENDATIONS

9.1 Conclusions



The scope of the research was based on firms in the UK, HK and Japan. The mix of countries has enabled comparison of applications and implementation of TQM across cultural and geographical differences. Furthermore, the research objectives can be extended to large and S&M enterprises in various countries where social and economic conditions are similar.

9.1.1 State of TQM Development

The constituents of contemporary TQM development have been reviewed via literature search in Chapter 2. The general findings are that the development of TQM is very fast. The benefits are plentiful. Many companies saw the need for TQM but do not know where to begin. For some company, TQM is just a minor operation. There needs to be new ideas and innovation to keep the organisation alive and growing. However, it is important for companies to develop their specific quality system that is most suitable for their organisation. In Chapter 4 the TQMEX model offered a path to achieve TQM which is an ongoing process of continuous improvement that begins when the company commits itself. The model illuminates the elements that form a base to the understanding of TQM philosophy and implementation of the process company-wide.

The review of chapter 3 "research methodology" has established the direction for the present work. Techniques which have been used in the research include: historical research, action research, user development, longitudinal research, opinion research, network planning analysis, triangulation, and use of statistics. They are found to be very useful tools in achieving the objectives of this research.

9.1.2 Factors Critical to the Success of TQM Implementation

The factors critical to the success of implementing TQM are identified based on a study of enterprises in the UK, HK and Japan. Firstly, they are verified via questionnaire survey in Chapter 5. Based on the analysis and summaries of the merits, drawbacks and possible improvement, the findings have been classified into large and S&M enterprises. Evidence is established to support the relevance of TQMEX model, the usefulness of each process and their activities. This also provides valuable information for other companies to consider when developing a quality plan. In order for companies to implement quality effectively, it is necessary to develop a systematic model arranged logically to serve as a guideline for implementation. Efforts have been concentrated on the areas with high priorities so that effectiveness could be achieved.

The questionnaire survey findings have been further verified via extensive case studies. The countries selected for the study were the UK, HK and Japan. The companies visited in these countries contribute to case studies and their experience could be shared by companies of similar operations. Further, this approach has provided some understanding on the cultural and environmental difference for the effective implementation of TQM by companies from different countries. The above finding are developed into the TQMEXAS in Chapter 7.

In an attempt to prove the validity of the TQMEX model against the real-life situation, action and longitudinal research have been conducted in a construction company in HK (Chapter 6). The findings are also confirmed by the Quality Managers of two other construction companies in the UK and Japan. They agreed that the model is workable and based on good quality practices. This evidence also supports the flexibility and usefulness of the model.

The TQMEX Advisory System (TQMEXAS), in the form of Internet System and Expert System, is produced to enable user to understand and use the TQMEX model more effectively. The TQMEXAS can be used for self-assessment by all sizes and types of companies to identify where improvements are needed. Firstly, the appropriate communication system and ES language for this purpose have been identified. Then the Internet program and ES have been developed based on the findings in Chapter 4,5 and 6.

The development process has demonstrated that knowledge could be built effectively and efficiently into ES and Internet for use by a third party. Pilot test has been run and results are found satisfactory. After further improvement, the TQMEXAS is validated and results are analysed in Chapter 8.

The results of the validation have proven that the knowledge built into ES and Internet program could be used by a third party without the need to consult an expert personally. The validation has also proven that the TQMEX model provides a framework to assess how good a company is at quality management and provides guidelines for step-by-step approach to achieving TQM. Longitudinal research has also been conducted in a company in HK. The findings reflected the importance of TQMEX model. Moreover, this company has shown great faith in the implementation of each process. Finally, a plan has been suggested for the marketing of the TQMEXAS developed.

9.1.3 Originality of the Research

This research is highly original. This fact has been reiterate through the thesis. It is worthwhile, at this point, to summarise the main arguments on originality as follows:-

The first point is that very little research has been done to identify the implementation steps that should be considered when planning a TQM journey. Moreover, many consultants provide a good service on what TQM is, but fail on the mechanics of clearly identifying how the businesses should implement the philosophy (see S.1.1).

The second point is that although some researchers concluded that "because of the variety of starting points and motivations for quality improvement it is not possible to identify an implementation plan detailing the order in which techniques should be used", this research actually develops and validates a step-by-step model for the successful implementation of TQM Furthermore, companies can decide on the entry point if they have already implemented some of the TQMEX steps (see S.1.1).

The third point and perhaps the most important point on originality is that the TQMEX model developed is based on sound and well-established quality practices. Although individual step is not original from the author, the development of the logical sequence of this model is original and it offers a lot of good insights for people who have already implemented some of the steps (see S.4.2).

The fourth point is in the original use of the fast-developing Internet service. The TQMEX Internet System developed is probably the first one in the world making use of the highly popular Internet services to disseminate the research findings and obtain feedback from the users. Its use is highly creative, innovative and interactive. Users are finding its effect beyond their expectations (see S.7.1.5.1).

9.1.4 Contributions to Knowledge

This research has numerous contribution to knowledge. This is possible because the TQMEX model is unique. It provides companies with a step-by-step framework to follow in achieving continuous improvement. Through reviewing the research process, the following contributions to the knowledge of TQM are identified:

The first point is that the TQMEX model helps to promote the very important Japanese 5-S practice in the western world, possibly for the first time in the history of TQM. Many interviewees and respondents agreed that they have never heard of the 5-S which is so crucial to the Japanese quality movement (see S.2.3).

The second point is on the very extensive and critical review of over 70 pertinent literature on TQM based on published books, journal articles, trade magazines, on-line search, etc. More important is the critical analysis of the knowledge in the field of TQM and the identification of the gaps in knowledge. These gaps have become the focuses of subsequent research efforts.

The third point and possible the most important contribution, is that research results are well-based on the analysis of over 400 questionnaires from intensive and in-depth surveys conducted in three countries. These enable difference in approach and culture to be compared. The survey data has been analysed rigorously by various statistical methods, and therefore the results are of significant values to the development of TQM. Moreover, there are 17 case studies based on interview with the quality managers / directors of organisations which are on the TQM journey already. Their experiences are of significant value to the knowledge and development of TQM.

The fourth point is that an ES has been constructed for the effective dissemination of the knowledge developed in the research. This is supplemented by the TQMEX Internet system which helps users in the global village to access and learn more about TQM before they try the ES. The ES can also be downloaded through the Internet services and the combined product is called TQMEXAS. A marketing plan has been proposed to making it widely available to those who would like to improve their knowledge in TQM.

The fifth point is on the academic rigour of the research. In order to validate the TQMEX model, efforts have been put into action research for 6 months and also a longitudinal study over the entire period of the research. This is possible because the author has been working in the same company before, and there are further contacts after the action research period. The validation process has established the credibility of the TQMEX model and identified the shortcomings in its implementations.

9.1.5 Limitations of the Research and their Implications

Research could be defined as: seeking through methodical processes to add to one's own body of knowledge and, hopefully, to that of others, by the discovery of non-trivial facts and insights [Howard and Sharp, 1983]. In order to do so, one must define his/her scope of knowledge. Such scope is crucial to the understanding and use of the knowledge developed. It also opens up scopes for further development of the knowledge.

The overall strand of research has been explained in S.1.4. However, like any other research activities, it is not without limitations. Since there are two main "products" of the research, it is logical to go through their limitations.

The ES is based on questionnaire surveys conducted in the UK, HK and Japan during 94-95. On the other hand, the pace of quality movement has been swift. Thus, some of the mean scores in Table 5.19 may have been shifted over time. For instance, more and more companies have been aware of the needs for improving quality of their products or services. Thus, the use of different quality methods is increased(Q.1.8). Likewise, the number of companies registered to ISO 9000 quality system is also increased. The level of quality awareness is likely to increase as well due to the increase of training on quality (Q.1.9).

Unfortunately, it is over a year since the first questionnaire was sent out. The implication of all these changes over time is that the mean figures have to adjusted upward, until they come to a stable level. If these are not corrected, the mean overall score would not be able to reflect the actual mean pertinent to the time of use. Therefore, if the ES were to be used accurately and effectively by companies, further questionnaire survey would need to be conducted to find out the differences in means for the current year.

The ES-Case is based on 34 case studies collected from field surveys and secondary research. Although efforts have been made to cover as many industrial sectors as possible, there are still some which are not covered. Moreover, due to the limited time and resources, Japanese firms operating in the UK and HK are interviewed instead of a field visit to Japan.

Another limitation in the ES-Case is that due to the handful TQM companies recognised by quality awards, it is very difficult, if not impossible to interview the quality managers of these companies. As an alternative, secondary data have been used instead. This is feasible because almost every successfully award companies have case written up by the quality staffs or other researchers already.

The last significant limitation of this research is the time and resources available for action research and longitudinal. Only one company in HK has been used, instead of one each from HK, Japan and the UK. Consequently, in-depth comparison on the implementation of the TQMEX is not possible. Perhaps, this should be the subject for future research as well.

The implications of these limitations are that the quality managers or planners have to be more flexible and ambitious in their planning and implementation. Firstly, they should use the mean values of the ES with some upward adjustment built-in over time. The simplest objective is to seek continuous improvement on all major quality activities. Secondly, they should study and analyse the various success factors of business, not only in their trade, but also in other trades. This will provide them with a better chance of successful implementation. Lastly, they should focus on their weakness and built on their strengths as their competitive advantages.

9.1.6 Overall Conclusion

Based on the discussion of the last 8 chapters, the objectives in S.1.3.1 have been achieved successfully. Thus, the aim of the research "To develop and validate a TQM model to improve business performance and consequently develop a TQMEXAS to assist companies in implementing TQM" has been accomplished.

9.2 Recommendations

In order to use the TQMEXAS effectively, the background for the developing the Internet program and ES for the TQMEX model have to be well understood. The following sections suggest the possible ways to make the best use of the advice from this advisory service.

9.2.1 Recommendation to the Use of TQMEX model

The TQMEX model has been validated base on intensive questionnaires and field surveys. It has been prepared with the utmost care. Yet like any other questionnaire survey, it is subjected to confidence limit in its accuracy. A generally acceptable level of 95% confidence limit is aimed at. Further, when the ES is used, some of the answers could be subjective, and could vary slightly even if answered by the same person at different times. It should therefore be understood that there is no hard line between success and failure in implementation so long as the company satisfy with their performance. The mean of means for every question from all the questionnaires should act as a guidance to the degree of success in quality management. It is useful to take note of the areas of low score and try to consider and reconsider the areas which could give the company higher score. It is also worthwhile to select a group of people from each department to use the ES. The difference in score can then be compare. Thus, more accurate results can be obtain for further improvements. The use of the ES can also be extended to the customer, this is very useful in understanding the expectation and perception of the customers about your company's performance.

The ES-Case is to provide a qualitative approach to effective implementation of TQM. This is supplementary to the quantitative approach adopted by the ES. They are in effect a collection of successful case studies. Obviously, not all cases are of direct relevance to your organisation. However, it is worthwhile to note the factors of success which are universal. Then, try to find the more relevant cases which match with the operation of your firm. They will then become valuable evidence to be based upon.

During the implementation of the steps of the TQMEX model, organisational changes are inevitable. Unfortunately, in management, every change is a potential problem. Therefore, it is important to be aware of the possibility of such problems occurring and be prepare to solve them before they become worse. One effective way of doing this is through the Kepner-Tregoe (K-T) [1981] Method of problem solving and decision making process. They reckon that problem solving is a process that follows a logical sequence. The process begins with identifying the problem, continues with analysis to find the real cause, and concludes with decision making. K-T also find out that any improvement of product/process is also a potential problem area. Therefore, effective managers always prepare to solve potential problem area. even before they occur. K-T concepts are important to the TQM development because they help to identify the real problem by investigating into "Changes".

Another principle that should be used in every stage of the implementation is the Plan-Do-Check-Action Cycle [Deming, 1982]. If some areas of improvement are spotted, there should be a good plan to implement it. This includes the commitment from all levels, and the allocation of resources, etc. Then, there should be a pilot test to "Do" the work. The results of the pilot test are further "Checked". so that a more effective implementation scheme can be drawn up. Finally, the scheme is "Action" accordingly, ready to feedback for the next stage of development, and hence the word "Cycle".

It is also important to consider people motivation and creativity when implementing the TQMEX model. It is important for management to provide opportunities and environment to exercise the workers' infinite potentials. It is also important to give them the freedom in the means and methods they can use in performing their work. The more freedom the management give to the workers, the greater their sense of responsibility will be and the more creative they can become.

9.2.2 Recommendation for Further Work

The Internet program and ES were developed based on thorough analysis, testing and validation. Unfortunately, there was insufficient time and resources to conduct an intensive validation using a large number of recognised TQM companies. Thus, if there is an opportunity for further work, it would be very useful to further validate these models in a systematic manner. For instance, such validation could be conducted across representative samples of industrial sectors, or from different countries. More specific recommendation are:-

9.2.2.1 Recommendations for Improving the ES

More questionnaire surveys should be conducted. If they are conducted yearly, the change over time can be observed and analysed. Questionnaires can be given to the companies that were surveyed in the previous years so that longitudinal research can be conducted. With the growing amount of companies connected to the Internet. Quality managers could be requested to use the ES freely to assess their own quality system. Provided that they have declared that they have filled in true information, their scores can then be cumulated into the score distributions. Further, they should be requested to fill in an on-line questionnaire at regular intervals, these questionnaires could be analysed, and if appropriate, merged with the original set of data. Thus, the knowledge could be expanded very rapidly.

9.2.2.2 Recommendations for Improving the ES-Case

More field surveys could be conducted. If possible, the researcher should be involved in the development of the quality system so that more action research can be conducted. This is similar to the longitudinal research carried out at CKFC in HK. The advantage of action research conducted in the future is that one can make use of the ES-Case developed to arrive at quicker and better results. Such results can be used to improve and extend the knowledge of the ES-Case.

9.2.2.3 Recommendations in Improving the TQMEXAS

Regarding TQMEXAS, the Internet program and ES can be modified to include multimedia. Moving picture, sound and interactive graphics can be included to improve the presentation of the advisory service system. The ES could also be enhanced by Artificial Neural Network Shells (e.g., Neurun, Neuroshell, Neuroware, etc.) to include self-learning features so that both the database and knowledge-base can grow in size and accuracy.

Since there is no boundary to ambition, one possibility is to offer the development work as a proposal to the "ALVEY" project. The ALVEY Committee has in the past funded smaller projects and community clubs to further R&D in specific areas of interest. Examples are the ALFEX (ALvey Financial EXpert systems) and ARIES (Alvey Research into Insurance Expert Systems). The idea here is to convince the ALVEY Committee to fund another club which can be called "ATQMES" standing for Alvey Total Quality Management Expert System. The aim of the club will be similar to this thesis, i.e., "To develop a TQM model through the knowledge-based advisory service to assist companies in implementing TQM and improve productivity and efficiency of their business operations." If the proposal is accepted, then the Advisory Services can be supplied at a token value to those wanting to implement TQM. The beneficiary population will be as huge as the growing number of quality assured companies in the country. The reciprocal benefit to the club is that more experience can be gained, and hence the advisory services can be further improved.

9.2.2.4 Recommendations for TQMEX Applying to the Construction Industry

From the experience in the CKFC in HK, it was found that there are plenty of scope for TQM implementation in the construction industry because the customer-supplier relations are complicated and sometimes difficult to handle. Moreover, most jobs are one-off or batch in nature with very high technical requirements. A good quality system can offer a number of competitive advantages, such as time, cost and better quality. On the other hand, applications of TQM in the construction industry are traditionally behind that in the manufacturing industry. Therefore there are more opportunities for improvement if TQMEX can take root. Furthermore at least one company each from HK, Japan and the UK can be based to conduct action research and longitudinal research so that in-depth comparisons on the implementation of the TQMEX can be effected.

9.2:3 The Final Words

There is literally no limits as to the scope of recommendations and further work. Like the theme of TQM, it is a journey, it will never end. Finally, the research findings have supported the notion that "The key to business successes is continuous improvement through the implementation of TQMEX model developed".

--END--

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Appendices

APPENDICES

Deming's 14 Points

1. *Create constancy of purpose for improvement of product and service.* Dr. Deming suggests a radical new definition of a company's role: A better way to make money is to stay in business and provide jobs through innovation, research, constant improvement and maintenance.
2. *Adopt the new philosophy.* We no longer need to live with commonly accepted delays, mistakes, defective materials and defective workmanship.
3. *Cease dependence on mass inspection.* Eliminate the need for mass inspection by building quality into the product.
4. *End awarding business on price.* Instead, aim at minimum total cost and move towards single suppliers.
5. *Improve constantly and forever the system of production and service.* Improvement is not a one-time effort. Management is obligated to continually look for ways to reduce waste and improve quality.
6. *Institute training.* Too often, workers have learned their job from other workers who have never been trained properly. They are forced to follow unintelligible instructions. They can't do their jobs well because no one tells them how to do so.
7. *Institute leadership.* The job of a supervisor is not to tell people what to do nor to punish them, but to lead. Leading consists of helping people to do a better job and to learn by objective methods.
8. *Drive out fear.* Many employees are afraid to ask questions or to take a position, even when they do not understand what their job is or what is right or wrong. They will continue to do things the wrong way, or not do them at all. The economic losses from fear are appalling. To assure better quality and productivity, it is necessary that people feel secure. "The only stupid question is the one that is not asked."
9. *Break down barriers between departments.* Often a company's departments or units are competing with each other or have goals that conflict. They do not work as a team, therefore they cannot solve or foresee problems. Even worse, one department's goal may cause trouble for another.
10. *Eliminate slogans, exhortations and numerical targets for the workforce.* These never help anybody do a good job. Let workers formulate their own slogans. Then they will be committed to the contents.
11. *Eliminate numerical quotas or work standards.* Quotas take into account only numbers, not quality or methods. They are usually a guarantee of inefficiency and high cost. A person, in order to hold a job, will try to meet a quota at any cost, including doing damage to his company.
12. *Remove barriers to taking pride in workmanship.* People are eager to do a good job and distressed when they cannot. Too often, misguided supervisors, faulty equipment and defective materials stand in the way of good performance. These barriers must be removed.
13. *Institute a vigorous programme of education.* Both management and the work force will have to be educated in the new knowledge and understanding, including teamwork and statistical techniques.
14. *Take action to accomplish the transformation.* It will require a special top management team with a plan of action to carry out the quality mission. Workers cannot do it on their own, nor can managers. A critical mass of people in the company must understand the 14 points.

Deming's System of Profound Knowledge

Appreciation for a System

This emphasises the need for managers to understand the relationships between functions and activities. Everyone should understand that the long term objective of an organisation is for everybody to win - employees, share holders, customers, suppliers, and the environment. Failure to accomplish the objective causes loss to everybody in the system. However, there is no doubt that optimisation of a sub-system is easier to achieve than optimisation of the whole system. But it is also costly: it gives the impression of improvement yet, in reality, builds barriers which obstruct genuine progress. Optimisation of one part also harms other parts so that, overall, the change causes more harm than good.

Often a company's main aim is just to get a bigger slice of the pie than another company. The same is true with nations. If this is the sole or prime aim, the result is loss. The aim must be to bake a bigger pie, which brings more profit to both the company and the market. Everybody wins on that.

Knowledge of Statistical Theory

> *"We'll have to learn from the mistakes that others make. We can't live long enough to make them all ourselves."*
>
> -- *W. Edwards Deming*

This includes knowledge about variation, process capability, control charts, interactions and loss functions. All these need to be understood to accomplish effective leadership, teamwork, etc.

Firstly, there are two causes of variation, special and common. **Special causes** of variation in a product, process or service are those causes which prevent its performance from remaining constant. These special causes are often easily assigned: change of operator, shift, or procedure, for example. They can often be identified, and sometimes eliminated by local operators. On the other hand, **common causes** are those which emerge once the special causes have been eliminated. They are due to the design, or the operation of the process or system. Examples are poor design, inadequate equipment and procedure. They may be identified by the operators, but only management can eliminate common causes because they are a result of the poor system of work.

Deming [1993] believed that managers who lacked this understanding of variation, and confused the two types of variation could actually make matters worse. Furthermore he estimated that management was accountable for up to 98% of the potential improvement. Most losses are unknown, often unrecognised, not even suspected.

Theory of Knowledge

All plans require prediction based on past experience. An example of success cannot be successfully copied unless the theory is understood. For instance, there can be no absolute value of any parameter that is defined in terms of measurement or observation. We can get a number by carrying out a procedure. However, when we change the procedure, we are likely to get a different number.

By definition, there is no prediction in an unstable system; in a stable system, prediction is provided by control limits. In either case, there is considerable difference between the past and future when looking for what is best. Interpretation of data from a test or experiment is prediction. This prediction will depend on knowledge of the subject-matter, not just on statistical theory. Theory leads to prediction. Without prediction, experience and examples teach nothing.

Operational objectives put communicable meanings into concepts. We need to know precisely what procedure to use in order to measure or judge something, and we need an unambiguous decision-rule to tell us how to act on the result obtained. Communication and negotiation (as between customer and supplier, between management and union, between countries) require optimisation of operational objectives.

There is no such thing as a fact based on an empirical observation. Any two people may have different ideas on what is important to know about any event, and hence what to record concerning anything which has happened. In this situation, there is no meaning for "Get the facts!"

Knowledge of Psychology

It is necessary to understand human interactions. Differences between people must be used for optimisation by leaders. People have intrinsic motivation to succeed in many areas. Extrinsic motivations in employment may smother intrinsic motivation. These include pay rises and performance grading. It has removed joy in work and in learning. Managers must give back to people intrinsic motivation for innovation, for improvement, for joy in work, for joy in learning.

Management must also avoid over-justification. Over-justification comes from faulty systems of reward. Over-justification is resignation to outside forces. It could be monetary reward to somebody, or a prize for an act or achievement that he did for sheer pleasure and self-satisfaction. The result of reward under these conditions is to throttle repetition; the person will lose interest in such pursuits; he may never do it again. Monetary reward is often used as a way out for those managers who do not understand how to manage intrinsic motivation.

The founder of the British Deming Association, Dr. Henry R. Neave [1995], pointed out in the First British Deming Memorial Lecture, 'The Man and his Message': "My final thought is this. If, in spite of his brilliance, his knowledge, his understanding, his experience, he was still so keen to continue learning in all humility from whatever the source, then what possible excuse there be for any of us who remain to ever stop learning?"

The Juran Quality Trilogy

Quality Planning	Quality Control	Quality Improvement
• Determine the customer's needs • Identify the customer • Develop product features • Establish quality goals • Develop a process • Prove process capability	• Choose control subject • Choose units of measurement • Establish standards of performance • Measure actual performance • Interpret the difference • Take action on the difference	• Prove the need for improvement • Identify specific projects for improvement • Organise to guide the project • Organise for diagnosis • Diagnose to find the causes • Provide remedies • Prove that the remedies are effective under operating conditions • Provide for control to hold gains

Cost of Quality

Prevention Costs -- The cost of all activities undertaken to prevent defects in design and development, purchasing, labour, and other aspects of beginning and creating a product or service. Also included are those preventive and measurement actions conducted during the business cycle. Specific items are:

- Design reviews
- Product qualification
- Drawing checking
- Engineering quality orientation
- Make Certain programme
- Supplier evaluations
- Supplier quality seminars
- Specification review
- Process capability studies
- Tool control
- Operation training
- Quality orientation
- Acceptance planning
- Zero Defects programme
- Quality Audits
- Preventive maintenance

Appraisal Costs -- These are costs incurred while conducting inspections, tests, and other planned evaluations used to determine whether produced hardware, software, or services conform to their requirements. Requirements include specifications from marketing and customers, as well as engineering documents and information pertaining to procedures and processes. All documents that describe the conformance of the product or service are relevant. Specific items are:

- Prototype inspection and test
- Production specification conformance analysis
- Supplier surveillance
- Receiving inspection and test
- Product acceptance
- Process control acceptance
- Packaging inspection
- Status measurement and reporting

Failure Costs -- Failure costs are associated with things that have been found not to conform or perform to the requirements, as well as the evaluation, disposition, and consumer-affairs aspects of such failures. Included are all materials and labour involved. Occasionally a figure must be included for lost customer credibility. Specific items are:

- Consumer affairs
- Redesign

- Engineering change order
- Purchasing change order
- Corrective action costs
- Rework
- Scrap
- Warranty
- Service after service
- Product liability

Crosby 14 Steps

1. Management commitment	Help management recognise that it must be personally committed to participating in a quality improvement programme
2. Quality improvement team	Bring together representatives of each department to form such a team
3. Quality measurement	Determine the status of quality throughout the company
4. Cost of quality evaluation	Establish the cost of quality to indicate where corrective action will be profitable for a company
5. Quality awareness	Share with employees the measurement of what non-quality is costing through training and communication material
6. Corrective action	Bring problems to light for all to see and resolve them on a regular basis
7. Establish an ad hoc committee for the Zero Defect programme	After a year has gone by, a Zero Defects Day will reaffirm management's commitment, to the words "Zero Defects" and the thought that everyone should do things right the first time.
8. Supervisor training	A formal orientation of the Zero Defects programme with all levels of management should be conducted prior to its time.
9. Zero Defects Day	Zero Defect as the performance standard of the company is established in one day to provide emphasis and long lasting impression
10. Goal setting	Regular meeting between supervisors and employees help people learn to think in terms of meeting goals and accomplishing specific tasks as a team
11. Removal of error causes	Individuals are asked to describe any problems that keep them from performing error-free work. The appropriate functional group will develop an answer to those problems
12. Recognition	Award programmes are established to recognise those who meet their goals or perform outstanding acts. Awards should not be financial; recognition is what is important
13. Quality councils	Quality professionals and team chairpersons should meet regularly to communicate and determine actions to upgrade and improve the quality improvement program
14. Do it again	Set up a new team of representatives and begin again to overcome the turnover and changing situation that can occur in the year to 18 months to implement the typical quality improvement programme

Kondo's Key Factors for Motivation

1. **When giving work instruction, clarify the true aims of the work.**

   Instead of explaining clearly what the aim of a job is, people tend to concentrate on the methods and means to be used for achieving that aim. However, every job has an aim, and it goes without saying that achieving this aim is the most important thing. Aside from mandatory restrictions related to safety and quality assurance, information concerning means and methods should be given for reference only, and we should encourage people to devise their own best ways of achieving the objectives.

2. **See that people have a strong sense of responsibility towards their work.**

   This is related to the previous point. As we know well, human beings are often weak and irrational and tend to try to shift responsibility onto someone else when their work goes wrong, complaining or being evasive. It is, therefore, necessary to devise ways of nipping such excuses in the bud whenever they seem likely to appear. The 'mandatory objectives, optional means' approach described in Point 1 above serves this purpose, and techniques such as the stratification of data, the correction of data by mean value or by regression, and the application of the orthogonal principle in the design of experiments [Taguchi, 1986] are all effective devices for putting a stop to excuses.

3. **Give time for the creation of ideas.**

   Once people start feeling such a strong sense of responsibility, they will go back to the essence of the problem and think about it deeply. This will result in flashes of inspiration and the creation of new ideas. Excellent ideas are most easily generated during those times when we have pondered the problem deeply and have arrived at a detached, meditative state of mind. An ancient Chinese proverb tells us that this kind of time occurs when we are horseback riding, lying down and relaxing. The times at which ideas come most readily are different for every individual. The important thing is to give people the time to be creative..

4. **Nurture ideas and bring them to fruition.**

   New-born ideas created in this way are extremely fragile. If they are examined critically with the intention of picking them to pieces or squashing them down, it is very easy to obliterate them completely. However, to find out whether such ideas are really good or not, or to develop them in superior ways, they must be allowed to grow. There is no objection during this stage of growth to allowing an idea to change gradually from its original form into a better one. It is often said that the main enemies of new product development are found within the company itself. This means that people are more concerned about going around stepping on new ideas than about encouraging their development. A new born idea is like a new-born baby, and raising it to maturity always requires someone to look after its interest and act as a loving parent. In most cases, those in positions of authority are the only ones who can play this role. In other words, managers should not go around throwing cold water on new ideas but should become their patrons and encourage their growth.

Kondo concludes that only by addressing all four points will it be possible for work to be reborn as a creative activity. If ideas are created and fostered, those concerned will come to feel a real sense of self-confidence. This is an extremely valuable experience from the standpoint of motivation.

Peter's Twelve Attributes for Implementation of Excellence

1. **Management obsession with quality**: This stresses the importance of practical action to back up the emotional commitment, e.g. halving the number of rework mechanics, never walking past shoddy goods.
2. **Passionate system**: Failure is invariably due to passion without system, or system without passion Peters believes. Both are necessary and an ideology is important whether based on Gurus or not.
3. **Measurement of quality**: This should begin at the outset of the programme, should be displayed, and should be carried out by the participants.
4. **Quality is rewarded**: Quality based incentive compensation can cause an early breakthrough in top management's attitude.
5. **Everyone is trained for quality**: Every person in the company should be extensively trained. Instruction in cause and effect analysis, statistical process control, and group interaction should be given to all.
6. **Multi-function teams**: Quality Circles, or cross functional teams such as Error Cause Removal or Corrective Action Teams should be introduced.
7. **Small is beautiful**: There is no such thing as a small improvement. There is significance in the fact that a change has occurred.
8. **Create endless "Hawthorne" effects**: This is the antidote to the 12-18 month doldrums. New goals, new themes, new events are the antidote.
9. **Parallel organisation structure devoted to quality improvement**: This describes the creation of shadow quality teams and emphasises that it is a route through which hourly paid workers can progress.
10. **Everyone is involved**: Suppliers especially, but distributors and customers too, must be part of the organisations quality process. Joint improvement teams may be formed.
11. **When quality goes up, costs go down**: Quality improvement is the primary source of cost reduction.
12. **Quality improvement is a never-ending journey**: All quality is relative. Each day, each product or service is getting relatively better or worse, but never stands still.

OVERALL RESEARCH PROGRAM
Qtr 1, 1994 Qtr 3, 1994 Qtr 1, 1995 Qtr 3, 1995 Qtr 1, 1996
Jan Mar May Jul Sep Nov Jan Mar May Jul Sep Nov Jan Mar
ID Task Name
1 Project Start
01/01
2 Literature Survey
3 Bibliography onTQM
4 Literature review on TQM
5 Expert System
6 Develop model
7 Publish paper 1
8 Research Methodologies
9 Questionnaire Survey
10 Survey in UK
11 Survey in Japan
12 Survey in HK
13 Field Survey in UK
14 Action research In HK
15 5-s Training
16 Implemention of 5-S
17 5-S measurment
18 Implemention of BPR
19 Implemention of QCC
20 Implementaion of TPM
21 Implementation of ISO
Project: TQMEX Research Program
Date: 1/12/95
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress
APP 3.1-1


OVERALL RESEARCH PROGRAM
ID
Task Name
Qtr 1, 1994
Qtr 3, 1994
Qtr 1, 1995
Qtr 3, 1995
Qtr 1, 1996
Jan
Mar
May
Jul
Sep
Nov
22 Implementation of TPM
23 TQM Training
24 Publish Paper 5
25 Field Survey in HK
26 Result & Analysis
27 Evaluation of activities
28 Analysis result from survey
29 Case studies result
30 Compare survey results
31 Publish paper 2,3 & 4
32 Contribution to book
33 Improve TQM model
34 Develop Advisory Service
35 Develop Web program
36 Develop Expert System
37 Validation of result
38 Results and recommendation
39 Write up of thesis
40 Preparation of Viva Voce
41 Project Finish
14/04
Project: TQMEX Research Program
Date: 1/12/95
Task
Progress
Milestone
Summary
Rolled Up Task
Rolled Up Milestone
Rolled Up Progress

QUALITY MANAGEMENT QUESTIONNAIRE

1. Company Information

1.1 Your name: ____________

1.2 Your post: ____________

1.3 Company name: ____________

1.4 Number of employees: ______

1.5 Year established: ______

1.6 Type of Business:

A. Manufacturing -
- A1 Garment or Textile ☐
- A2 Electrical and Electronic ☐
- A3 Plastics, wood or Metals ☐
- A4 Mechanical Engineering or Automobile ☐
- A5 Civil Engineering or Construction ☐
- A6 Others- ____________

B. Services -
- B1 Trading or Wholesale ☐
- B2 Retail, Restaurant or Hotel ☐
- B3 Finance or Insurance or Business Service ☐
- B4 Community, Social or personal services ☐
- B5 Transport or Distribution ☐
- B6 Others- ____________

1.7 When did your company start to become aware of quality? 19_____

1.8 What Quality methods does your Company use for improving performance? (Please tick appropriate boxes.)

☐ 5-S ☐ Quality Control Circles
☐ Statistical Process Control ☐ Quality by inspection
☐ ISO 9000 / BS5750 ☐ Total Quality Control
☐ Total Productive Maintenance ☐ TQM

Others- ____________

1.9 How often does your company carry out training on quality?

☐ 1/month ☐ 1/ 3 months ☐ 1/ 6 months
☐ 1/ year ☐ 1/ 2 years ☐ 1/ 3 years

Others-____________

2. 5-S Practices

2.1 Have you ever come across 5-S concept. i.e. (Organisation, Neatness, Cleaning, Standardisation, Discipline)?

Yes ☐ No ☐

2.2 How important to your company are the following objectives in relation to the working environment?

	least 1	2	3	4	5	6	7 most	N/A
Organisation	☐	☐	☐	☐	☐	☐	☐	☐
Neatness	☐	☐	☐	☐	☐	☐	☐	☐
Cleaning	☐	☐	☐	☐	☐	☐	☐	☐
Standardisation	☐	☐	☐	☐	☐	☐	☐	☐
Discipline	☐	☐	☐	☐	☐	☐	☐	☐

3. Quality Control in Marketing, Production & Purchasing

3.1 How important to your company are quality control for the following?

	least 1	2	3	4	5	6	7 most	N/A
Marketing	☐	☐	☐	☐	☐	☐	☐	☐
Production / Operations	☐	☐	☐	☐	☐	☐	☐	☐
Purchasing	☐	☐	☐	☐	☐	☐	☐	☐
Tendering / Quotation	☐	☐	☐	☐	☐	☐	☐	☐
Contracting	☐	☐	☐	☐	☐	☐	☐	☐

4. Quality Control Circles (QCC)

4.1 To what degree do you agree with the following purposes for teamwork?

	least 1	2	3	4	5	6	7 most	N/A
Improvement of quality	☐	☐	☐	☐	☐	☐	☐	☐
Building cheerful environment	☐	☐	☐	☐	☐	☐	☐	☐
Drawing out individual's potential	☐	☐	☐	☐	☐	☐	☐	☐

4.2 Does your company intend to practise QCC in the next 3 years?

Yes ☐ No ☐ N/A ☐

4.3 How many suggestions have been generated during the last year?

____________ N/A ☐

5. BS 5750 / ISO 9000 Quality Management System

5.1 When did your company become a registered firm (i.e. under BS5750, ISO 9000, EN29000, etc.)? 19_____

5.2 If your company is not yet registered, does your company intend to get register in the next 3 years? Yes ☐ No ☐ N/A ☐

5.3 How good is your quality management system in achieving the following?

	Very poor 1	2	3	4	5	6	7 Very good	N/A
Attract customer	☐	☐	☐	☐	☐	☐	☐	☐
Quality improvement	☐	☐	☐	☐	☐	☐	☐	☐
Customer satisfaction	☐	☐	☐	☐	☐	☐	☐	☐
Cost reduction	☐	☐	☐	☐	☐	☐	☐	☐
Competitive advantage	☐	☐	☐	☐	☐	☐	☐	☐
Reduction of waste	☐	☐	☐	☐	☐	☐	☐	☐
Efficiency	☐	☐	☐	☐	☐	☐	☐	☐
Lead time reduction	☐	☐	☐	☐	☐	☐	☐	☐

5.4 How often does your company revise the quality manual?

☐ 1/month ☐ 1/ 3 months ☐ 1/ 6 months
☐ 1/ year ☐ 1/ 2 years ☐ 1/ 3 years

Others-____________________

5.5 How often do your company carry out internal quality audit?

☐ 1/month ☐ 1/ 3 months ☐ 1/ 6 months
☐ 1/ year ☐ 1/ 2 years ☐ 1/ 3 years

Others-____________________

6. Total Preventive Maintenance (TPM)

6.1 How good is your company in operating equipment maintenance activities?

	Very poor 1	2	3	4	5	6	7 Very good	N/A
Regular maintenance	☐	☐	☐	☐	☐	☐	☐	☐
Preventive maintenance	☐	☐	☐	☐	☐	☐	☐	☐
Corrective maintenance	☐	☐	☐	☐	☐	☐	☐	☐
Planning and management	☐	☐	☐	☐	☐	☐	☐	☐
Equipment investment plans	☐	☐	☐	☐	☐	☐	☐	☐
Autonomous maintenance	☐	☐	☐	☐	☐	☐	☐	☐
Environmental conservation	☐	☐	☐	☐	☐	☐	☐	☐
Safety	☐	☐	☐	☐	☐	☐	☐	☐
Assessment of effectiveness	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance via team work	☐	☐	☐	☐	☐	☐	☐	☐
Maintenance training	☐	☐	☐	☐	☐	☐	☐	☐

6.2 Does your company intend to practise TPM in the next 3 years?

Yes ☐ No ☐ N/A ☐

7. Total Quality Management

7.1 How good is your company in operating quality management activities?

	Very poor 1	2	3	4	5	6	7 Very good	N/A
Leadership	☐	☐	☐	☐	☐	☐	☐	☐
Commitment	☐	☐	☐	☐	☐	☐	☐	☐
Total Customer Satisfaction	☐	☐	☐	☐	☐	☐	☐	☐
Continuous Improvement	☐	☐	☐	☐	☐	☐	☐	☐
Total Involvement	☐	☐	☐	☐	☐	☐	☐	☐
Training and Education	☐	☐	☐	☐	☐	☐	☐	☐
Ownership	☐	☐	☐	☐	☐	☐	☐	☐
Reward and Recognition	☐	☐	☐	☐	☐	☐	☐	☐
Error Prevention	☐	☐	☐	☐	☐	☐	☐	☐
Co-operation and Teamwork	☐	☐	☐	☐	☐	☐	☐	☐

7.2 Does your company intend to practise TQM in the next 3 years?

Yes ☐ No ☐ N/A ☐

8. Overview

8.1 What are the major merits of your firm's Quality Management System?

____

____

____

8.2 What are the major drawbacks of your firm's Quality Management System?

____

____

____

8.3 What changes and improvement, if any, would you suggest to improve your firm's Quality Management System?

____

____

____

____

*** THANK YOU FOR YOUR CO-OPERATION ***

United Kingdom ANOVA Result

5S	5.9	4.7	4.7	5.1	5.3	
	5.7	4.9	4.5	5.3	5.3	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	25.7	5.14	0.248		
Row 2	5	25.7	5.14	0.208		
Column 1	2	11.6	5.8	0.02		
Column 2	2	9.6	4.8	0.02		
Column 3	2	9.2	4.6	0.02		
Column 4	2	10.4	5.2	0.02		
Column 5	2	10.6	5.3	0		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	9.1E-14	1	9.1E-14	4.55E-12	0.999998	7.70865
Columns	1.744	4	0.436	21.8	0.005602	6.388234
Error	0.08	4	0.02			
Total	1.824	9				

BPR	4.5	6.4	5.8	5.2	5.5	
	5.1	6.3	5.8	5.7	5.6	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	27.4	5.48	0.497		
Row 2	5	28.5	5.7	0.185		
Column 1	2	9.6	4.8	0.18		
Column 2	2	12.7	6.35	0.005		
Column 3	2	11.6	5.8	0		
Column 4	2	10.9	5.45	0.125		
Column 5	2	11.1	5.55	0.005		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.121	1	0.121	2.494845	0.189367	7.70865
Columns	2.534	4	0.6335	13.06186	0.014452	6.388234
Error	0.194	4	0.0485			
Total	2.849	9				

United Kingdom ANOVA Result

QCC	6.2	5.0	5.7						
	6.3	5.3	5.9						
Anova: Two-Factor Without Replication									
SUMMARY	*Count*	*Sum*	*Average*	*Variance*					
Row 1	3	16.9	5.633333	0.363333					
Row 2	3	17.5	5.833333	0.253333					
Column 1	2	12.5	6.25	0.005					
Column 2	2	10.3	5.15	0.045					
Column 3	2	11.6	5.8	0.02					
ANOVA									
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*			
Rows	0.06	1	0.06	12	0.07418	18.51276			
Columns	1.223333	2	0.611667	122.3333	0.008108	19.00003			
Error	0.01	2	0.005						
Total	1.293333	5							
ISO	4.9	5.2	5.3	4.1	4.6	4.2	4.5	3.8	
	5.0	5.2	5.3	4.0	4.7	4.1	4.8	4.2	
Anova: Two-Factor Without Replication									
SUMMARY	*Count*	*Sum*	*Average*	*Variance*					
Row 1	8	36.6	4.575	0.285					
Row 2	8	37.3	4.6625	0.256964					
Column 1	2	9.9	4.95	0.005					
Column 2	2	10.4	5.2	0					
Column 3	2	10.6	5.3	0					
Column 4	2	8.1	4.05	0.005					
Column 5	2	9.3	4.65	0.005					
Column 6	2	8.3	4.15	0.005					
Column 7	2	9.3	4.65	0.045					
Column 8	2	8	4	0.08					
ANOVA									
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*			
Rows	0.030625	1	0.030625	1.874317	0.21329	5.59146			
Columns	3.679375	7	0.525625	32.1694	8.35E-05	3.787051			
Error	0.114375	7	0.016339						
Total	3.824375	15							

United Kingdom ANOVA Result

TPM	3.8	3.3	4.1	3.6	3.6	2.8	3.5	4.6	3.3	3.1	3.2
	5.4	4.6	5.4	4.7	4.7	3.5	4.8	5.8	4.2	4.2	4.3

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	11	38.9	3.536364	0.248545
Row 2	11	51.6	4 690909	0.430909
Column 1	2	9.2	4.6	1.28
Column 2	2	7.9	3.95	0.845
Column 3	2	9.5	4.75	0.845
Column 4	2	8.3	4.15	0.605
Column 5	2	8.3	4.15	0.605
Column 6	2	6.3	3.15	0.245
Column 7	2	8.3	4.15	0.845
Column 8	2	10.4	5.2	0.72
Column 9	2	7.5	3.75	0.405
Column 10	2	7.3	3.65	0.605
Column 11	2	7.5	3.75	0.605

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	7 331364	1	7.331364	267 9236	1.51E-08	4.964591
Columns	6.520909	10	0.652091	23.83056	1.16E-05	2.97824
Error	0.273636	10	0.027364			
Total	14.12591	21				

TQM	4 7	4.9	4 8	4.8	4.3	4.4	4.1	3.6	4.3	4 7
	4.6	4.7	5	4.7	4.4	4.7	4	4	4.3	4.8

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	10	44.6	4.46	0.162667
Row 2	10	45.2	4.52	0.112889
Column 1	2	9 3	4.65	0.005
Column 2	2	9.6	4.8	0.02
Column 3	2	9.8	4.9	0.02
Column 4	2	9.5	4.75	0.005
Column 5	2	8.7	4.35	0.005
Column 6	2	9.1	4 55	0.045
Column 7	2	8.1	4.05	0 005
Column 8	2	7.6	3.8	0.08
Column 9	2	8 6	4 3	0
Column 10	2	9.5	4.75	0.005

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.018	1	0.018	0.94186	0.357157	5.117357
Columns	2.308	9	0.256444	13 4186	0.000329	3.178897
Error	0.172	9	0.019111			
Total	2.498	19				

Hong Kong ANOVA Result

5S	5.4	4.6	4.7	5.2	5.5		
	6.1	5.8	5.8	5.9	5.9		
Anova: Two-Factor Without Replication							
SUMMARY	*Count*	*Sum*	*Average*	*Variance*			
Row 1	5	25.4	5.08	0.167			
Row 2	5	29.5	5.9	0.015			
Column 1	2	11.5	5.75	0.245			
Column 2	2	10.4	5.2	0.72			
Column 3	2	10.5	5.25	0.605			
Column 4	2	11.1	5.55	0.245			
Column 5	2	11.4	5.7	0.08			
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Rows	1.681	1	1.681	31.42	0.00	7.71	
Columns	0.514	4	0.1285	2.40	0.21	6.39	
Error	0.214	4	0.0535				
Total	2.409	9					
BPR	4.6	6	5.1	5.3	5.3		
	6.2	6.2	6.5	5.6	5.8		
Anova: Two-Factor Without Replication							
SUMMARY	*Count*	*Sum*	*Average*	*Variance*			
Row 1	5	26.3	5.26	0.253			
Row 2	5	30.3	6.06	0.128			
Column 1	2	10.8	5.4	1.28			
Column 2	2	12.2	6.1	0.02			
Column 3	2	11.6	5.8	0.98			
Column 4	2	10.9	5.45	0.045			
Column 5	2	11.1	5.55	0.125			
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Rows	1.6	1	1.6	7.53	0.05	7.71	
Columns	0.674	4	0.1685	0.79	0.59	6.39	
Error	0.85	4	0.2125				
Total	3.124	9					

Hong Kong ANOVA Result

QCC	5.8	5.7	5.4
	6.6	5.6	5.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	3	16.9	5.633333	0.043333
Row 2	3	17.8	5.933333	0.333333
Column 1	2	12.4	6.2	0.32
Column 2	2	11.3	5.65	0.005
Column 3	2	11	5.5	0.02

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.135	1	0.135	1.29	0.37	18.51
Columns	0.543333	2	0.271667	2.59	0.28	19.00
Error	0.21	2	0.105			
Total	0.888333	5				

ISO	5.1	5.2	5.2	4	4.6	4.3	4.6	4.3
	4.7	4.5	4.8	3.8	4.6	4.4	4.7	4.2

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	8	37.3	4.6625	0.21125
Row 2	8	35.7	4.4625	0.108393
Column 1	2	9.8	4.9	0.08
Column 2	2	9.7	4.85	0.245
Column 3	2	10	5	0.08
Column 4	2	7.8	3.9	0.02
Column 5	2	9.2	4.6	0
Column 6	2	8.7	4.35	0.005
Column 7	2	9.3	4.65	0.005
Column 8	2	8.5	4.25	0.005

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.16	1	0.16	4.00	0.09	5.59
Columns	1.9575	7	0.279643	6.99	0.01	3.79
Error	0.28	7	0.04			
Total	2.3975	15				

Hong Kong ANOVA Result

TPM	4.8	4.1	5	4.5	4.3	3.9	4.2	5.1	4.2	4.2	4
	5.7	5.1	5.4	4.7	4.5	4.4	4.9	5.8	4.9	4.5	4.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	11	48.3	4.390909	0.164909
Row 2	11	54.5	4.954545	0.240727
Column 1	2	10.5	5.25	0.405
Column 2	2	9.2	4.6	0.5
Column 3	2	10.4	5.2	0.08
Column 4	2	9.2	4.6	0.02
Column 5	2	8.8	4.4	0.02
Column 6	2	8.3	4.15	0.125
Column 7	2	9.1	4.55	0.245
Column 8	2	10.9	5.45	0.245
Column 9	2	9.1	4.55	0.245
Column 10	2	8.7	4.35	0.045
Column 11	2	8.6	4.3	0.18

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	1.747273	1	1.747273	48.17	0.00	4.96
Columns	3.693636	10	0.369364	10.18	0.00	2.98
Error	0.362727	10	0.036273			
Total	5.803636	21				

TQM	4.8	4.9	5.1	5	4.5	4.7	4.5	4.4	4.7	4.7
	4.8	5.3	4.5	4.6	3.9	4.3	3.9	4.3	4.4	4.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	10	47.3	4.73	0.051222
Row 2	10	44.6	4.46	0.171556
Column 1	2	9.6	4.8	0
Column 2	2	10.2	5.1	0.08
Column 3	2	9.6	4.8	0.18
Column 4	2	9.6	4.8	0.08
Column 5	2	8.4	4.2	0.18
Column 6	2	9	4.5	0.08
Column 7	2	8.4	4.2	0.18
Column 8	2	8.7	4.35	0.005
Column 9	2	9.1	4.55	0.045
Column 10	2	9.3	4.65	0.005

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.3645	1	0.3645	6.97	0.03	5.12
Columns	1.5345	9	0.1705	3.26	0.05	3.18
Error	0.4705	9	0.052278			
Total	2.3695	19				

Japan ANOVA Result

5S		5.9	5.5	5.5	5.7	5.6	4.9
		6.2	5.8	5.4	6	5.8	5.8
Anova: Two-Factor Without Replication							
SUMMARY	*Count*	*Sum*	*Average*	*Variance*			
Row 1	5	28.2	5.64	0.028			
Row 2	5	29.2	5.84	0.088			
Column 1	2	12.1	6.05	0.045			
Column 2	2	11.3	5.65	0.045			
Column 3	2	10.9	5.45	0.005			
Column 4	2	11.7	5.85	0.045			
Column 5	2	11.4	5.7	0.02			
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Rows	0.1	1	0.1	6.67	0.06	7.71	
Columns	0.404	4	0.101	6.73	0.05	6.39	
Error	0.06	4	0.015				
Total	0.564	9					
BPR	Manu	5.8	6.5	5.6	5.4		
	Serv	6	6.8	6.2	5.2		
Anova: Two-Factor Without Replication							
SUMMARY	*Count*	*Sum*	*Average*	*Variance*			
Row 1	5	28.2	5.64	0.343			
Row 2	5	30	6	0.34			
Column 1	2	11.8	5.9	0.02			
Column 2	2	13.3	6.65	0.045			
Column 3	2	11.8	5.9	0.18			
Column 4	2	10.6	5.3	0.02			
Column 5	2	10.7	5.35	0.405			
ANOVA							
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*	
Rows	0.324	1	0.324	3.74566	0.12504	7.709	
Columns	2.386	4	0.5965	6.89595	0.04406	6.388	
Error	0.346	4	0.0865				
Total	3.056	9					

Japan ANOVA Result

QCC	Manu	6.3	5.8	6.00					
	Serv	6	5.4	5.60					
Anova: Two-Factor Without Replication									
SUMMARY	*Count*	*Sum*	*Average*	*Variance*					
Row 1	3	18.1	6.03333	0.06333					
Row 2	3	17	5.66667	0.09333					
Column 1	2	12.3	6.15	0.045					
Column 2	2	11.2	5.6	0.08					
Column 3	2	11.6	5.8	0.08					
ANOVA									
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*			
Rows	0.201667	1	0.20167	121.00	0.0082	18.513			
Columns	0.31	2	0.155	93.00	0.0106	19			
Error	0.003333	2	0.00167						
Total	0.515	5							
ISO	Manu	5.2	5.6	5.7	5	5.3	5	5.1	5.9
	Serv	4.5	5.3	6.0	4.8	5.0	4.3	5.0	4.8
Anova: Two-Factor Without Replication									
SUMMARY	*Count*	*Sum*	*Average*	*Variance*					
Row 1	8	42.8	5.35	0.11714					
Row 2	8	39.5	4.9375	0.28125					
Column 1	2	9.7	4.85	0.245					
Column 2	2	10.85	5.425	0.06125					
Column 3	2	11.7	5.85	0.045					
Column 4	2	9.75	4.875	0.03125					
Column 5	2	10.3	5.15	0.045					
Column 6	2	9.25	4.625	0.28125					
Column 7	2	10.1	5.05	0.005					
Column 8	2	10.65	5.325	0.66125					
ANOVA									
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*			
Rows	0.680625	1	0.68062	6.86139	0.0344	5.5915			
Columns	2.094375	7	0.2992	3.0162	0.0842	3.7871			
Error	0.694375	7	0.0992						
Total	3.469375	15							

Japan ANOVA Result

TPM	5.4	5	5.4	5.1	4.8	5.1	5.3	5.8	4.8	5.1	4.8
	4.7	5.0	5.0	5.0	4.7	4.7	5.0	5.7	5.0	5.7	4.7
Anova: Two-Factor Without Replication											
SUMMARY	*Count*	*Sum*	*Average*	*Variance*							
Row 1	11	56.6	5.145454545	0.096727273							
Row 2	11	55	5	0.133333333							
Column 1	2	10.06666667	5.033333333	0.268888889							
Column 2	2	10	5	0							
Column 3	2	10.4	5.2	0.08							
Column 4	2	10.1	5.05	0.005							
Column 5	2	9.466666667	4.733333333	0.008888889							
Column 6	2	9.766666667	4.883333333	0.093888889							
Column 7	2	10.3	5.15	0.045							
Column 8	2	11.46666667	5.733333333	0.008888889							
Column 9	2	9.8	4.9	0.02							
Column 10	2	10.76666667	5.383333333	0.160555556							
Column 11	2	9.466666667	4.733333333	0.008888889							
ANOVA											
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*					
Rows	0.1164	1	0.116363636	1.99376947	0.1883	4.9646					
Columns	1.717	10	0.17169697	2.94184839	0.05186	2.9782					
Error	0.5836	10	0.058363636								
Total	2.417	21									
TQM	5	5.2	5.5	5.5	5.2	4.9	4.7	4.8	5.4	5.4	
	5.6	5.4	6.2	5.6	5.2	5.2	5	4	5.2	5.6	
Anova: Two-Factor Without Replication											
SUMMARY	*Count*	*Sum*	*Average*	*Variance*							
Row 1	10	51.6	5.16	0.087111111							
Row 2	10	53	5.3	0.322222222							
Column 1	2	10.6	5.3	0.18							
Column 2	2	10.6	5.3	0.02							
Column 3	2	11.7	5.85	0.245							
Column 4	2	11.1	5.55	0.005							
Column 5	2	10.4	5.2	0							
Column 6	2	10.1	5.05	0.045							
Column 7	2	9.7	4.85	0.045							
Column 8	2	8.8	4.4	0.32							
Column 9	2	10.6	5.3	0.02							
Column 10	2	11	5.5	0.02							
ANOVA											
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*					
Rows	0.098	1	0.10	1.10	0.32	5.12					
Columns	2.882	9	0.32	3.59	0.04	3.18					
Error	0.802	9	0.09								
Total	3.782	19									

U.K., H.K. Japan Manufacturing ANOVA Result

5S						
UK	5.9	4.7	4.7	5.1	5.3	
Japan	5.9	5.5	5.5	5.7	5.6	
HK	5.4	4.6	4.7	5.2	5.5	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	25.7	5.14	0.248		
Row 2	5	28.2	5.64	0.028		
Row 3	5	25.4	5.08	0.167		
Column 1	3	17.2	5.73333	0.083333		
Column 2	3	14.8	4.93333	0.243333		
Column 3	3	14.9	4.96667	0.213333		
Column 4	3	16	5.33333	0.103333		
Column 5	3	16.4	5.46667	0.023333		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.945	2	0.47	9.75	0.01	4.46
Columns	1.384	4	0.35	7.13	0.01	3.84
Error	0.388	8	0.05			
Total	2.717	14				

BPR						
UK	4.5	6.4	5.8	5.2	5.5	
Japan	5.8	6.5	5.6	5.4	4.9	
HK	4.6	6.0	5.1	5.3	5.3	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	27.4	5.48	0.497		
Row 2	5	28.2	5.64	0.343		
Row 3	5	26.3	5.26	0.253		
Column 1	3	14.9	4.96667	0.523333		
Column 2	3	18.9	6.3	0.07		
Column 3	3	16.5	5.5	0.13		
Column 4	3	15.9	5.3	0.01		
Column 5	3	15.7	5.23333	0.093333		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.364	2	0.18	1.13	0.37	4.46
Columns	3.083	4	0.77	4.78	0.03	3.84
Error	1.289	8	0.16			
Total	4.736	14				

U.K., H.K. Japan Manufacturing ANOVA Result

QCC			
UK	6.2	5.0	5.7
Japan	6.3	5.8	6.0
HK	5.8	5.7	5.4

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	3	16.9	5.633333	0.36333
Row 2	3	18.1	6.033333	0.06333
Row 3	3	16.9	5.633333	0.04333
Column 1	3	18.3	6.1	0.07
Column 2	3	16.5	5.5	0.19
Column 3	3	17.1	5.7	0.09

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.32	2	0.16	1.68	0.29	6.94
Columns	0.56	2	0.28	2.95	0.16	6.94
Error	0.38	4	0.09			
Total	1.26	8				

ISO								
UK	4.9	5.2	5.3	4.1	4.6	4.2	4.5	3.8
Japan	5.2	5.6	5.7	5.0	5.3	5.0	5.1	5.9
HK	4.7	4.5	4.8	3.8	4.6	4.4	4.7	4.2

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	8	36.6	4.575	0.285
Row 2	8	42.8	5.35	0.11714
Row 3	8	35.7	4.4625	0.10839
Column 1	3	14.8	4.933333	0.06333
Column 2	3	15.3	5.1	0.31
Column 3	3	15.8	5.266667	0.20333
Column 4	3	12.9	4.3	0.39
Column 5	3	14.5	4.833333	0.16333
Column 6	3	13.6	4.533333	0.17333
Column 7	3	14.3	4.766667	0.09333
Column 8	3	13.9	4.633333	1.24333

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	3.7358	2	1.867917	16.94	0.00	3.74
Columns	2.0296	7	0.28994	2.63	0.06	2.76
Error	1.5442	14	0.110298			
Total	7.3096	23				

U.K., H.K. Japan Manufacturing ANOVA Result

TPM											
UK	3.8	3.3	4.1	3.6	3.6	2.8	3.5	4.6	3.3	3.1	3.2
Japan	5.4	5.0	5.4	5.1	4.8	5.1	5.3	5.8	4.8	5.1	4.8
HK	5.7	5.1	5.4	4.7	4.5	4.4	4.9	5.8	4.9	4.5	4.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	11	38.9	3.5364	0.24855
Row 2	11	56.6	5.1455	0.09673
Row 3	11	54.5	4.9545	0.24073
Column 1	3	14.9	4.9667	1.04333
Column 2	3	13.4	4.4667	1.02333
Column 3	3	14.9	4.9667	0.56333
Column 4	3	13.4	4.4667	0.60333
Column 5	3	12.9	4.3	0.39
Column 6	3	12.3	4.1	1.39
Column 7	3	13.7	4.5667	0.89333
Column 8	3	16.2	5.4	0.48
Column 9	3	13	4.3333	0.80333
Column 10	3	12.7	4.2333	1.05333
Column 11	3	12.6	4.2	0.76

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	17	2	8.50	169.20	0.00	3.49
Columns	4.86	10	0.49	9.66	0.00	2.35
Error	1	20	0.05			
Total	22.9	32				

TQM										
UK	4.70	4.90	4.80	4.80	1.30	4.40	4.1	3.6	4.3	4.7
Japan	5.00	5.20	5.50	5.50	5.20	4.90	4.7	4.8	5.4	5.4
HK	4.80	5.30	4.50	4.60	3.90	4.30	3.9	4.3	4.4	4.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	10.00	41.60	4.16	1.17
Row 2	10.00	51.60	5.16	0.09
Row 3	10.00	44.60	4.46	0.17
Column 1	3.00	14.50	4.83	0.02
Column 2	3.00	15.40	5.13	0.04
Column 3	3.00	14.80	4.93	0.26
Column 4	3.00	14.90	4.97	0.22
Column 5	3.00	10.40	3.47	3.94
Column 6	3.00	13.60	4.53	0.10
Column 7	3.00	12.70	4.23	0.17
Column 8	3.00	12.70	4.23	0.36
Column 9	3.00	14.10	4.70	0.37
Column 10	3.00	14.70	4.90	0.19

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	5.27	2.00	2.63	7.74	0.00	3.55
Columns	6.73	9.00	0.75	2.20	0.07	2.46
Error	6.13	18.00	0.34			
Total	18.12	29.00				

U.K., H.K. Japan Services ANOVA Result

5S					
UK	5.7	4.9	4.5	5.3	5.3
Japan	6.2	5.8	5.4	6.0	5.8
HK	6.1	5.8	5.8	5.9	5.9

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
UK	5.0	25.7	5.1	0.2
Japan	5.0	29.2	5.8	0.1
HK	5.0	29.5	5.9	0.0
Organisation	3.0	18.0	6.0	0.1
Neatness	3.0	16.5	5.5	0.3
Cleaning	3.0	15.7	5.2	0.4
Standardisation	3.0	17.2	5.7	0.1
Discipline	3.0	17.0	5.7	0.1

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	1.8	2.0	0.9	26.0	0.0	4.5
Columns	1.0	4.0	0.2	7.1	0.0	3.8
Error	0.3	8.0	0.0			
Total	3.0	14.0				

BPR					
UK	5.1	6.3	5.8	5.7	5.6
Japan	6.0	6.8	6.2	5.2	5.8
HK	6.2	6.2	6.5	5.6	5.8

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	5	28.5	5.7	0.2
Row 2	5	30	6	0.3
Row 3	5	30.3	6.06	0.1
Column 1	3	17.3	5.76667	0.3
Column 2	3	19.3	6.43333	0.1
Column 3	3	18.5	6.16667	0.1
Column 4	3	16.5	5.5	0.1
Column 5	3	17.2	5.73333	0.0

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.372	2	0.186	1.59	0.2618	4.46
Columns	1.677	4	0.41933	3.59	0.0585	3.84
Error	0.935	8	0.11683			
Total	2.984	14				

U.K., H.K. Japan Services ANOVA Result

QCC			
UK	6.3	5.3	5.9
Japan	6.0	5.4	5.8
HK	6.6	5.6	5.6

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	3	17.5	5.83333	0.25333
Row 2	3	17	5.66667	0.09333
Row 3	3	17.8	5.93333	0.33333
Column 1	3	18.9	6.3	0.09
Column 2	3	16.3	5.43333	0.02333
Column 3	3	17.1	5.7	0.03

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.108889	2	0.05444	1.225	0.3846	6.9443
Columns	1.182222	2	0.59111	13.3	0.0171	6.9443
Error	0.177778	4	0.04444			
Total	1.468889	8				

ISO								
UK	5.0	5.2	5.3	4.0	4.7	4.1	4.8	4.2
Japan	4.5	5.3	6.0	4.8	5.0	4.3	5.0	4.8
HK	5.1	5.2	5.2	4.0	4.6	4.3	4.6	4.3

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	8	37.3	4.6625	0.25696
Row 2	8	39.5	4.9375	0.28125
Row 3	8	37.3	4.6625	0.21125
Column 1	3	14.6	4.86667	0.10333
Column 2	3	15.65	5.21667	0.00083
Column 3	3	16.5	5.5	0.19
Column 4	3	12.75	4.25	0.1875
Column 5	3	14.3	4.76667	0.04333
Column 6	3	12.65	4.21667	0.01083
Column 7	3	14.4	4.8	0.04
Column 8	3	13.25	4.41667	0.08583

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.40	2	0.20	3.07	0.08	3.74
Columns	4.33	7	0.62	9.40	0.00	2.76
Error	0.92	14	0.07			
Total	5.649583	23				

U.K., H.K. Japan Services ANOVA Result

TPM											
UK	5.4	4.6	5.4	4.7	4.7	3.5	4.8	5.8	4.2	4.2	4
Japan	[redacted]										
HK	4.8	4.1	5	4.5	4.3	3.9	4.2	5.1	4.2	4.2	4

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	11	51.6	4.69091	0.43091
Row 2	11	55	5	0.13333
Row 3	11	48.3	4.39091	0.16491
Column 1	3	14.9	4.96556	0.15259
Column 2	3	13.7	4.56667	0.20333
Column 3	3	15.4	5.13333	0.05333
Column 4	3	14.2	4.73333	0.06333
Column 5	3	13.7	4.56556	0.04926
Column 6	3	12.1	4.02222	0.35148
Column 7	3	14	4.66667	0.17333
Column 8	3	16.6	5.52222	0.13815
Column 9	3	13.4	4.46667	0.21333
Column 10	3	14.1	4.68889	0.71704
Column 11	3	13	4.32222	0.11148

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	2.0406	2	1.0203	8.45767	0.002	3.4928
Columns	4.8788	10	0.48788	4.04421	0.004	2.3479
Error	2.4127	20	0.12064			
Total	9.3321	32				

TQM										
UK	4.6	4.7	5.00	4.70	4.40	4.70	4	4	4.3	4.8
Japan	[redacted]									
HK	4.8	4.9	5.10	5.00	4.50	4.70	4.5	4.4	4.7	4.7

Anova: Two-Factor Without Replication

SUMMARY	Count	Sum	Average	Variance
Row 1	10	45.2	4.52	0.11
Row 2	10	53	5.30	0.32
Row 3	10	47.3	4.73	0.05
Column 1	3	15	5.00	0.28
Column 2	3	15	5.00	0.13
Column 3	3	16.3	5.43	0.44
Column 4	3	15.3	5.10	0.21
Column 5	3	14.1	4.70	0.19
Column 6	3	14.6	4.87	0.08
Column 7	3	13.5	4.50	0.25
Column 8	3	12.4	4.13	0.05
Column 9	3	14.2	4.73	0.20
Column 10	3	15.1	5.03	0.24

ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Rows	3.258	2	1.63	32.03	0.00	3.55
Columns	3.4617	9	0.38	7.56	0.00	2.46
Error	0.9153	18	0.05			
Total	7.635	29				

MANUFACTURING		SERVICES		MERITS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
#				Aim for customer satisfaction, well established, automotive standards
			#	Tight up with systems already in place
	#			Just keep up with the paper work necessary, no change on std of work even in recession
		#		Professional approach with a forward thinking attitude
		#		Cost saving, improved quality
#				Better organized internal systems
#				Supported by Quality improvement/action team, recognition of continuous improvement
	#			Better organization
	#			Good for error prevention
			#	
	#			Cost reduction, customer satisfaction, Qty improvement
#				Better record and document control and consistency of documentation
		#		Clear understanding of processes and the individual role
#				Make company to decide how to do things and force pro-active mgt
			#	Omission reduction
		#		improve organization & control, retain & obtain new customers
	#			High commitment to improvement, strong support from MD on training & improvement initiated & implemented & approved BS5750 in 5 months
#				Job satisfaction, increased business, customer satisfaction
#				To meet any customer requirements due to selection std procedures
#				Documented procedures, reduce waste, reject control, supplier assessments
#				Provide mgt visibility to non financial performance measures
		#		Identify training needs, inefficient practices, Continuous improvement, Documentation of existing practice & procedures
#				Senior Mgt involvement, total involvement, encourage openness and honesty, planning process
		#		Discipline, & standardization
#				Good foundation to continuous improvement, product consistency
#				Specific control and documentation
		#		All staff work the same system, clear guidelines for trained staff
#				Able to sell product, improvement by auditing
	#			Tractability
	#			lower no. of customer complaints, good final inspection and testing
	#			Higher reputation for top quality
	#			Best practice system to work throughout the site
	#			Save waste, it is recognized universally, customer satisfaction
			#	Discipline to procedures
	#			Total involvement
#				Consistency, planning and mgt prior to actual work
	#			Formal procedures, previous uncontrolled systems now controlled satisfactory
		#		Better recognition
#				Compliance with BS risk mgt
#				Compliance with Company's strategy, more recognition
#				
		#		identify problem
		#		Identification of activity responsibilities, facilitate quality improvement
		#		Provide strategic framework for qty
	#			Continue improvement, maintain product qty, provide control of procedure and std
		#		Commitment and ownership of continuous improvement
			#	Common goal for all, allow creativity & ownership whilst encouraging responsibility
			#	Simple documentation, practical, ease of user input, access quality team
		#		Structure, comprehensive
#				
		#		formal structured
	#			everyone more quality conscious
	#			discipline, improve communication
#				Maintain control and quality
		#		standardized system, high employee involvement, improve performance
		#		feedback reports generated
#				communication, training, improve individual performance
#				improve ownership, improve quality
#				continuous improvement to be correctly focused
		#		efficiency increase, structured approach
		#		streamlined and standardized systems & work method reducing waste & non productive item
	#			
	#			general reduction in staff cost and greater efficiency
	#			work effectively, reduce complaints rate, every try their best at quality
	#			increase business, more control of internal processes
	#			high recognition, reduce quality costs, more efficient
	#			
#				
		#		helps to generate customer satisfaction
			#	gain competitive advantage over competitors, more efficient, team building tool
			#	
	#			better record, improve quality control, continuous improvement and review, fewer customer audit required
	#			improve quality on product
#				bring reward with the application
#				well structure, quality manual & plan and procedures
		#		differentiate from competitors, reduce internal and external (supplier) quality costs
#				
	#			proactive planning
			#	better services, more mgt commitment
#				
	#			better plan, higher speed of reaction to change of circumstances
	#			keep control while growing

MANUFACTURING		SERVICES		MERITS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
#				teamwork
			#	
	#			identify of problem prior to occurrence, team building and cost reduction
	#			increase focus on qty, improved discipline & control over procedures, improve understanding-customer-supplier
		#		everyone understand, totally commitment, continuous improvement
		#		good direct line communication to people responsible
		#		improved response to complaints/corrective action monitoring, improved control sales process & document control
	#			structured disciplines
	#			
	#			I have enthusiastic staff who are seeking perfection
			#	system effectiveness
#				attract a wide customer base
#				
#				achieve accreditation, an entry level requirement for our business, impressive to customers
#				provide effective machine tool, produce std operation and the basis for good mgt
#				continuous improvement of qty & reduction of costs, high levels of confidence at customer assessment
		#		commitment from individuals and the regional director towards qty
#				high profile TQM program sustained over 5 years, clear message to staff, customers and suppliers
#				well established
#				standardization, corrective action, customer complaints
#				everyone has had an input into the content of procedure and work instruction
		#		user friendly, everyone aware of the procedures
		#		N/A
		#		improve performance & business
#				clarity, regular review, continuous improvement
#				satisfy customer
#				flow charted for simple application
#				provides a based line std for working practices
	#			drawn together separate sections into controlled units
#				each site can draw upon the knowledge and experience of the whole
		#		production ownership of their qty system same as technical design
		#		achieved standardization across many locations, provide high std of services to internal & external customer
#				each employee is responsible for the qty of his own work
	#			reduced customer complaints + claims, high level of product reliability and life expectancy
			#	clear identification of what we do and how we do it, everyone understand
			#	improving discipline in tractability and accountability
#				clear std, integrated production/qty policy, qty responsibility for everyone
#				clear definition of responsibility, procedures, better planning
	#			discipline
			#	re-audited give continuous improvement
	#			continuity order from major customer
			#	improves passage of information , provides detailed historical records, links planning to execution of work
#				best practice from different depts.
			#	identify key process and improved involvement of all
#				bs5750 does bring improvements, increase involvement by most in improvement activities
		#		creating a group to draw best practice, devolving responsibility to front liner
#				
#				mgt commitment, our people are good, well training
#				commitment to customers
	#			customer confidence
		#		auditing documented systems ensures these are up to date, continuous improvement to system, reduce complaint
		#		provide structure allow the best advertising, documentation quotes
		#		
	#			provides route map for assurance, measure across co. remain dynamic to the needs of users
		#		standardization of operation
	#			firm look & act more professional, more checks on business, better methods of waste reduction, IIP achievement
		#		empowerment by all business center managers delivers consistency
			#	just starting
	#			it appear simple
	#			
#				able to demonstrate Continuous improvement satisfy customer through team work
	#			attract customers
	#			internal & external customer satisfaction, efficiency through participation and teamwork
			#	
		#		standardization, endorsement of external body
	#			reduction in waste
#				flexible and practical, continuously audited aiding improvement
			#	
	#			not having to change anything we did before
			#	uniform documentation, streamlining of procedures
			#	attract customers, reduce complaints
	#			provide accessible data base of methods
	#			peace of mind for all employees
		#		customer retention
	#			ensuring good qty products
	#			strong commitment from technical section, good qty documentation
		#		standardization of best practice, communicated throughout co. competitive advantages
			#	documentation and employee understanding tasks and responsibility
		#		involves everyone not just leading players continuous appraisal
			#	
			#	
		#		consistency, work instructions
	#			close relationship between depts

MANUFACTURING		SERVICES		MERITS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
		#		
#				standardizing system to give greater control
		#		creating an awareness at all level of the std
		#		McDonald's qty mgt implementation commenced 24/11/94
	#			
#				consistent product qty
		#		give a measurable tool to asses individual and company productivity
#				adherence to principle of TQM, involvement of staff at all levels, focus on areas of customer and business
			#	tractability, qty product
	#			fairly effective senior mgt ownership, ability to assess customer requirement, recognize rooms for improvement
	#			contract review prior to tender, corrective action customer complaint
#				openness, flexibility, focus on business needs
	#			brings in the work
		#		Flexible in the sense that a qty plan is written for each commission won, allows specific issues to be addressed
	#			awareness of needs fro tractability & risk analysis process
	#			continuous improvement in all areas. Justifying investments by measured results
#				just operate
	#			acceptance onto client, tender lists improved purchasing, safety, control on site + customer complaints procedures
			#	continuous improvement, individual responsibility for qty uniform systems
		#		
		#		uniform system, responsiveness to errors, reduction of duplication
		#		the procedures are well written and provide a closed loop system
	#			team building and awareness of other activities and their need
#				maximize productivity & profit, improve qty and full customer satisfaction, skill up of employees/manager
	#			customer satisfaction, control production procedure
			#	allowed more awareness of qty throughout co.
		#		competitive advantage, standardization, due diligence defense
	#			standardization of practice
#				customer satisfaction, structured approach
#				strong procedure for iso9000 compliance
#				efficiency, marketing tool
#				improvement driven by data, ownership of processes by areas controlling process
#				our system is sufficiently adaptable to be used in all project
		#		provide information, guidance & spread good practice, give confidence that activities are being carried out
#				combination of qty and safety, reduction in reject and rejected production, much better housekeeping
#				
	#			efficiency of production and control of costs
#				iso 9000
		#		no formal written QMS after from "staying on top" ideas which generates ideas for improvement, recognition and reward
		#		continuous improvement in the qty of services provide to customer & colleague, increasing understanding & knowledge of all employees
#				all item in 5.3
#				involvement of all levels in production focus on product
#				program is being structured to deal with mgt by policies, process mgt.
#				a more systematic procedualised business reducing variations, tackling breakdown in communication
#				bs:en: ISO9000 approval, internal audits, customer complaints analysis
#				opportunity for employee to involved in influencing what happens in the co.
			#	provision for consistency, effective mgt contact, sufficiently flexible to accommodate individual experience
	#			everyone believes it can work
	#			provide foundation to build on, give an personnel opportunity to effect improvement
		#		effective procedures in operation for 5 yr. large investment make
		#		
	#			bs5750 has put discipline into the co.
	#			standardize procedure, product qty improve, high qty image
#				forced us to document our work practices
			#	identification of certain areas of improvement
	#			quality awareness
#				focused on customer satisfaction
	#			simple structure
	#			
#				good organization
#				ownership or work performed is encouraged. employee's are free to make suggestions for improvement
	#			an ongoing process, part of the day to day job
	#			system enable control of product, minimize the errors made by not following procedures. Demand close customer contact and individual
#				core of basic practices via iso 9002 now spreading to all depts via a CI program
#				practical, straight forward, it works
#				bs en iso 9002 internationally recognized
		#		prevents errors of omission & creates necessary check and balance to reduce obvious errors
	#			used to support TQM, created by the people for the people
#				moving from vertical mgt & segmented processes to matrix mgt, process owners and teamwork
		#		
	#			well documented, ;user friendly
#				good marketing tool, continuity of working practice
			#	all systems are followed up on a regular basis
#				good tractability
#				core of basic practices via iso 9002 spreading to all depts. through continuous improvement program
	#			total satisfaction for worker and customer
#				enables co. to trade within its market
#				it is people based, relying on their involvement to achieve our qty aims
	#			cohesive at all levels towards a common aim
#				being a defense co., a high basic std so the qty concept is part of the co. culture
		#		integrated with the European foundation for qty management approach to excellence
	#			secure future and attract investment, maintain profit, keep customers
	#			sales requirement, improved organization, continuous improvement

MANUFACTURING		SERVICES		MERITS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
	#			constant introduction of new technology
			#	
#				well documented, SPC control widely used
#				improve NPI process, reduction of error, commitments to customer met
#				better control of production, corrective action taken, aids training
#				aids business objectives, enhances safety, minimize costs
	#			better control, improved knowledge of the process involved
	#			standardizing of procedure throughout business. Greater operations control, tractability and improve document records
		#		qty system enable implement std systems across 25 locations, assists the mobility of the workforce
		#		reduce error, mistakes and problems, reduce customer complaints,
	#			planning & organization ISO 9000 is minimum std for our industry
	#			framework for control of product & services qty. Platform for continuous improvement
#				enforced mgt practices, recognition training needs, support to inexperienced mangers
#				continuous improvement, team building, marketing & commercial advantage
	#			continuous improvement, encourage team work, generates results
		#		improving the level of training & safety through documented instructions
	#			more organization
	#			cost effective
	#			std of procedures, simplification of processes to improve effectiveness of service provided
		#		spell out clearly procedures
	#			focused attention on the subject
	#			delivers most consistent products , dominance in competitiveness
			#	ensuring that all products are purchased supplied to specification
	#			accountability tractability
		#		seen to be used for change
	#			customer satisfaction all the time, continuously trying to minimize cost
			#	has improved tightened up the business practices we use
			#	it made us take time off to review the business
		#		std and adoption of best practice, achieve of contract
	#			improve customer satisfaction
#				provide mgt & staff awareness, to review our performance in structured manner
#				flexibility, quick response
#				structured approach through iso 9000
#				increased opportunities, assessment & knowledge of subcontractor, supplier capabilities based on past performance, std of good practice, accurate rec
		#		
#				good response to corrective action, corrective action system
#				well established system, understood by most, continually updated to reflect current products
		#		
	#			ability to introduce new products quickly
	#			focused attention satisfy prospective and existing customer. audit prevent std from slipping
	#			reduced customer activity, increase markets
			#	
	#			helping to unify effort
	#			getting better
#				achieves bs 5750 certification- planning, formalized system- control of sub-contractors-give some feedback
#				high level of commitment, built in check procedures.
	#			marketing tool & prevention of resources of qty problems
	#			set the qty std for products, promotes discipline in qty procedure, creates customer confidence
			#	written down system on which to focus
	#			office efficient, tractability, marketing
#				ability to tender for world, status of bs5750 registration, improving qty/awareness of qty
#				simple streamlined mgt structure, attention to prevention rather than repair, total involvement with suppliers on qty of raw material
		#		N/A
			#	lowest return of it group, market demands it able to be main player, image technically led
#				
	#			improve product
#				involving everyone, drawing out potential developing people, rewarding a job well done
		#		major no of repeat customer and word of mouth accommodations
	#			provide a recognized std of qty for clients, fewer audits by clients required
			#	gives a recognized system of operation, with accepted practices, insists on the regular review of what we are doing, where we are going
			#	better working environment, knowledge of problem, corrective action, less error
#				efficiently, standardization
		#		provide data and discipline to maintain, the edge in the market place, provides common goals and aims-measurable
			#	improvement in mgt information on problem, efficiency marketing
		#		works as a system
#				contractual requirement met
		#		continuing improvement of performance against statuary std
#				controlled mgt
			#	
	#			major merits are as a commercial aid and obvious production benefits

MANUFACTURING		SERVICES		DRAWBACKS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
#				Time consuming
			#	
	#			
		#		Still at early stage
		#		No control on customer
#				Document control
#				Not all elements of company exposed to QA system and TQM training
	#			Too much paperwork
	#			Poor leadership
			#	
	#			Too much paper work
#				Perceived qty control and not mgt system
		#		Requires continual investment in future
#				Self serving audit internally & externally, people follow paper trails rather than how the factory is managed & the involvement of employees
			#	inflexibility
		#		Documentation updating
	#			Doubt on systems capability, high turnover in personnel
#				
#				Procedures are wide ranging to give adaptability
#				Paperwork, personnel using them as an excuse
#				Lack of integration at a corporate & business unit level
		#		Existing culture, involve complex monitoring and amendment
#				Group is made up of 105 locations
		#		Paperwork
#				No total commitment from senior management
#				Paperwork, not totally user friendly
		#		
#				Paperwork, require resources to operate
	#			Paperwork
	#			Process control requirements inadequately defined
	#			Time
	#			Problem in letting quality dept. know about the need to change methods
	#			Not eliminating the need fro personal inspection for neatness
			#	Paperwork
	#			
#				Poor previous history of failed attempts
	#			Nil
		#		Paperwork, costly. The BSI + internal auditors
#				Waste auditees time
#				Time, Maintenance of good std qty level
#				
		#		paperwork, not easy to track rapid changes in business requirement
		#		Review & actual implementation of quality/ cost improvements
		#		Lack of leadership & commitment
	#			Lack teamwork & training
		#		
			#	Not fully accepted by lower level staff
			#	Old fashioned approach to quality
		#		not user friendly
#				paperwork.
		#		nil
	#			slow down process because of those procedures
	#			lack commitment from top
#				slow to response to business changes
		#		costly across 2000 location
		#		not completely support/ understand. more difficult to implement
#				try to improve with limited resources during recession
#				not totally commitment
#				effort to maintain
		#		slight increase in documentation
		#		paperwork, time consuming
	#			review and update
	#			time to review and maintain
	#			more firefighting, no ongoing training. no relationship between myself and customers
	#			paperwork
	#			initial cost of implementation like training and documentation, now none
	#			paperwork
#				
		#		lack of comprehensive education
			#	nil
			#	
	#			paperwork, interpretation difficulties of the std. time and maintain the system
	#			nil
#				commitment from middle managers
#				ownership of this quality system by some departments
		#		not total commitment
#				time
	#			ownership, involvement & empowerment are kept at too high a mgt level
			#	large mgt resources required
#				
	#			time
	#			

MANUFACTURING		SERVICES		DRAWBACKS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
#				lack of resources, commitment
			#	
	#			education of staff, paperwork, weakening personal position
	#			ensuring top down commitment
		#		Bureaucracy
		#		Tend to be reactive more than proactive
		#		resources to maintain are considerable, qty not improved unless mgt use system properly
	#			time
	#			
	#			labor availability
			#	monitoring through audit, more personnel required & mgt involvement
#				
#				paperwork
#				insufficient staff to satisfy the requirements of some of the procedures
#				some employees have -negative attitude . system introduce too quickly.
#				complicated to cover all necessary aspects, understanding & commitment not at all level
		#		lack of application of this commitment
#				too dependent on commitment/attitudes of local mgt
#				
#				paperwork, lack of understanding from director
#				lack of commitment to product auditing and continuous improvements
		#		does not do enough to promote continuous improvement
		#		N/A
		#		none
#				excess unnecessary detail, low empowerment, output related bonus
#				loss of flexibility for product change
#				maintenance of such widespread system
#				inadequate commitment
	#			inflexibility, paperwork
#				no real direction from the top, pilot programs in continuous improvement
		#		not accredited
		#		paperwork, additional task to pressurized people.
#				administration to maintain the system
	#			cannot source all purchased items from QA sources at the present time
			#	proactive time waste
			#	lack commitment/knowledge by some staff
#				Production pressure
#				lack of feedback on performance , lack senior commitment to achieve continuous improvement
	#			cost
			#	Process operators feel outside system
	#			man-hours expended in up keep
			#	system can be rigid, not all customers recognize the value of iso9000
#				lack senior mgt commitment
			#	too bureaucratic, hard to keep changes in place and practiced
#				different sections organize qty in different ways, not all workforce as a tool for improvement
		#		suspicious of employees. acceptance of responsibility by employees
#				
#				process capability does not reach satisfactory level
#				planning and information
	#			integrating with other ICI system
		#		high admin. cost, in terms manpower and mgt time. corrective actions which do not obviously improve customer assurance
		#		initially feeling there is too many paperwork, now solved
		#		
	#			none
		#		the newness of the document system
	#			unsure yet
		#		none
			#	N/A
	#			company is young and we are on learning curve
	#			
#				need total commitment
	#			paperwork
	#			restrictive in sense that recognition by one std
			#	
		#		not proactive, insufficiently comprehensive
	#			costing blame
#				getting staff to adopt the system
			#	lack of commitment from senior mgt
	#			not tailored to construction activity
			#	set up time and cost, paperwork
			#	administration
	#			mgt and system maintenance
	#			none
		#		too many thing has to remember to be completed
	#			cost and increased lead time
	#			thought of as technical dept's duty only not everyone
		#		admin. time, no system to show real benefits from QA
			#	none
		#		hard to keep on. local govt. structures e.g. standing order
			#	
			#	individualism and unjustifiable free-lance attitudes amongst all actors in the organization
		#		paperwork, document control process
	#			lack of time

MANUFACTURING		SERVICES		DRAWBACKS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
		#		
#				lack of understanding, paperwork
		#		a limiting perceived more than genuine of managerial initiative
		#		too early to identify the drawbacks
	#			
#				maintaining accuracy of system
		#		N/A
#				identification of improvement measures have proved difficult at times
			#	paperwork
	#			cannot fully assess cost of quality, waste reduction, standardization througnout cellular development
	#			audits check the paperwork system and not the product, paperwork
#				qualification/measurement of improvement
	#			time usage
		#		not fully developed to reflect precisely the work undertaken
	#			limited resources conflicts with QM disciplines
	#			to please customers making it fragmented
#				paperwork
	#			time, cost, paperwork causes adverse reaction from staff
			#	documentation, cost of external audit
		#		not totally committed
		#		needs total commitment, anything less can cause problems, need constant appraisal
		#		getting people to follow and laid down the procedure
	#			justification of mgt decisions
#				
	#			co.-operation, teamwork and preventative maintenance
			#	
		#		cost, bureaucracy
	#			not known yet
#				paperwork
#				individual's talents and abilities are not encouraged in a strongly proceduralised system
#				cost, adherence to understanding
#				too bureaucratic
#				cost from audit body
		#		difficulty in keeping up in pace of change in method and practice (externally controlled)
#				not get everyone on board, hard to convince
#				
	#			complicated
#				lack of ownership by employees, risk of being locked into outdated and ineffective procedures
		#		no taken seriously, something would be achieved by staff without the QMS
		#		
#				TPM not fully implemented
#				commitment of leader
#				just starting, the main priorities to achieve breakthrough
#				paperwork . does not see benefit yet
#				too much paper
#				different function at different stage of the agreed program, too reactive, not totally participate
			#	
	#			too busy to make it work
	#			impossible to practice what one/ others preach-situations change dramatically
		#		slow operation due to size of company and centralization
		#		
	#			unreliability of computer systems even thought they are brand new systems
	#			not leading to sufficient, qty improvement, bureaucratic, paperwork
#				fast growing and changing co. to maintain the system is difficult
			#	extra cost, work less competitive
	#			maintain
#				too many buzz words
	#			too bureaucratic
	#			
#				insufficient involvement from production
#				poor control of suppliers
	#			firefighting still limits total time spent on the process of improvement
	#			not enough time, difficult to control and handle all the products and variables to everyone satisfaction, keep record up to date and amendment
#				iso 9002 was started in production and still seen as mainly production based
#				inspection require in need of improvement
#				paperwork, view as for manufacturing only
		#		paperwork and perception of paper
	#			yet rather young to comment
#				middle mgt unwillingness to reflect operational changes in the documented system
		#		
	#			bureaucratic
#				too many procedures, very bureaucratic
			#	too many reproductions requires condensing
#				BS5750 is seen as an obstacle to most people outside the QA dept.
#				iso 9002 is seen as a production system
	#			none
#				inflexibility, lack emphasis on process and support activities, lack alignment to customers requirement and continued improvement
#				lack commitment from senior mgt
	#			paperwork
#				bureaucracy, increase cost
		#		deployment of developed approaches
	#			not sufficient ownership of concept, better leadership is required
	#			procedures to complex, too much changing as co. structure evolves

MANUFACTURING		SERVICES		DRAWBACKS
Large Manu.	S/M Manu.	Large Services	S/M Services	
>=300	<300	>=150	<150	
	#			lack of involvement and interest of general workforce
			#	
#				inspection based, lack of ownership, production focus
#				extra procedures
#				inflexibility
#				still too much paperwork associated with it
	#			increase admin.
	#			paperwork
		#		none
		#		cost of implementation
	#			paperwork
	#			danger of operating for the benefit of the ISo9000 and not the benefit of the business
#				middle mgt
#				getting individual to take ownership of manuals & procedures
	#			none
		#		
	#			paperwork & red tape (BS5750)
	#			under funded and under recognized
	#			change required to system, to comply with "BS standards" changes of 1994
		#		does not always reflect practice
	#			done more on the system sales
	#			unwidely to amend
			#	paperwork
	#			fortress mentality
		#		extremely traditional organization and rigid culture
	#			tend to be let to the qty dept. and not shared by others. communication between dept. could be better
			#	paperwork, waste paper
			#	lack of time, paperwork
		#		time, paperwork
	#			overheads
#				more administrative, health and safety practices are documented and controlled
#				lack of commitment
#				not fully coordinated
#				documentation
		#		
#				knowledge of system at grass roots
#				obtaining ownership of qty procedure from dept. head
		#		
	#			insufficient development time, expensive learning curve
	#			paperwork, cost and time
	#			maintaining awareness, bureaucracy of system and labor support
			#	every job is different.
	#			lack of ownership envelopment
	#			
#				duplication of systems in some areas, no method of measuring qty improvement except NCR's audits
#				resources, ownership particularly at sharp end level
	#			administrative overhead
	#			paperwork
			#	time
	#			time headed to audit
#				lack of ownership shown by staff, paperwork
#				inspection of product tends to take away the responsibility of the manufacturer to get it right in the first place
		#		N/A
			#	bureaucracy, heavy reliance on customers system, restricts freedom to change own system to improve it
#				
	#			addition cost
#				old establish family firm & people are not always receptive to change-middle mgt
		#		time
	#			none
			#	paperwork
			#	none
#				bulky, not user friendly
		#		bureaucratic paperwork over burden
			#	std is not written for stock and some of the requirements are difficult to maintain
		#		cumbersome, large
#				duplication level of documentation
		#		costs
#				
			#	difficult to alter existing practices
	#			occasionally unwieldy

Large Manufacturing

------------ F A C T O R   A N A L Y S I S ------------

Analysis number 1   Replacement of missing values with the mean

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .76064

Bartlett Test of Sphericity = 2532.5264, Significance = .00000

Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	1.00000	*	1	8.90827	21.2	21.2
VAR00017	1.00000	*	2	5.59290	13.3	34.5
VAR00018	1.00000	*	3	3.47036	8.3	42.8
VAR00019	1.00000	*	4	3.10955	7.4	50.2
VAR00020	1.00000	*	5	1.79754	4.3	54.5
VAR00021	1.00000	*	6	1.63041	3.9	58.4
VAR00022	1.00000	*	7	1.45984	3.5	61.8
VAR00023	1.00000	*	8	1.32799	3.2	65.0
VAR00024	1.00000	*	9	1.24441	3.0	68.0
VAR00025	1.00000	*	10	1.15781	2.8	70.7
VAR00026	1.00000	*	11	1.03264	2.5	73.2
VAR00027	1.00000	*	12	.93121	2.2	75.4
VAR00028	1.00000	*	13	.79317	1.9	77.3
VAR00031	1.00000	*	14	.74723	1.8	79.1
VAR00032	1.00000	*	15	.74295	1.8	80.8
VAR00033	1.00000	*	16	.67606	1.6	82.4
VAR00034	1.00000	*	17	.60986	1.5	83.9
VAR00035	1.00000	*	18	.59099	1.4	85.3
VAR00036	1.00000	*	19	.55913	1.3	86.6
VAR00037	1.00000	*	20	.50959	1.2	87.8
VAR00038	1.00000	*	21	.49840	1.2	89.0
VAR00041	1.00000	*	22	.45372	1.1	90.1
VAR00042	1.00000	*	23	.44411	1.1	91.2
VAR00043	1.00000	*	24	.37169	.9	92.0
VAR00044	1.00000	*	25	.34797	.8	92.9
VAR00045	1.00000	*	26	.32243	.8	93.6
VAR00046	1.00000	*	27	.30331	.7	94.4
VAR00047	1.00000	*	28	.27943	.7	95.0
VAR00048	1.00000	*	29	.26094	.6	95.7
VAR00049	1.00000	*	30	.22547	.5	96.2
VAR00050	1.00000	*	31	.20477	.5	96.7
VAR00051	1.00000	*	32	.19451	.5	97.1
VAR00052	1.00000	*	33	.18079	.4	97.6
VAR00053	1.00000	*	34	.15845	.4	97.9
VAR00054	1.00000	*	35	.15415	.4	98.3
VAR00055	1.00000	*	36	.14330	.3	98.7
VAR00056	1.00000	*	37	.12242	.3	98.9
VAR00057	1.00000	*	38	.11020	.3	99.2
VAR00058	1.00000	*	39	.10241	.2	99.5
VAR00059	1.00000	*	40	.08607	.2	99.7
VAR00060	1.00000	*	41	.08014	.2	99.8
VAR00061	1.00000	*	42	.06338	.2	100.0

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- - - - - - - - - - -   F A C T O R   A N A L Y S I S   - - - - - - - - - - -
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Hi-Res Chart # 1:Factor scree plot

PC extracted 11 factors.

VARIMAX rotation 1 for extraction 1 in analysis 1 - Kaiser Normalization.

VARIMAX converged in 12 iterations.

Rotated Factor Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00042	.87024				
VAR00051	.84925				
VAR00044	.84853				
VAR00041	.83432				
VAR00049	.81959				
VAR00050	.81045				
VAR00047	.77050				
VAR00043	.75475				
VAR00045	.69716				
VAR00048	.69400				
VAR00046	.68091				
VAR00056		.81511			
VAR00061		.81286			
VAR00059		.77071			
VAR00053		.76214			
VAR00060		.70128			
VAR00055		.69471			
VAR00052		.69069			
VAR00058		.61989			
VAR00057					
VAR00036			.81527		
VAR00037			.78742		
VAR00034			.78177		
VAR00038			.68773		
VAR00032					
VAR00033					
VAR00031				.78030	
VAR00035				.65811	
VAR00054					

------------ F A C T O R   A N A L Y S I S ------------

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00018					.80803
VAR00017					.75504
VAR00019					
VAR00021					
VAR00025					
VAR00024					
VAR00016					
VAR00020					
VAR00027					
VAR00028					
VAR00022					
VAR00023					
VAR00026					

	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
VAR00042					
VAR00051					
VAR00044					
VAR00041					
VAR00049					
VAR00050					
VAR00047					
VAR00043					
VAR00045					
VAR00048					
VAR00046					
VAR00056					
VAR00061					
VAR00059					
VAR00053					
VAR00060					
VAR00055					
VAR00052					
VAR00058					
VAR00057					
VAR00036					

FACTOR ANALYSIS

	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
VAR00037					
VAR00034					
VAR00038					
VAR00032					
VAR00033					
VAR00031					
VAR00035					
VAR00054					
VAR00018					
VAR00017					
VAR00019					
VAR00021					
VAR00025	.84291				
VAR00024	.70692				
VAR00016		.82985			
VAR00020		.73286			
VAR00027			.85088		
VAR00028			.78558		
VAR00022				.77324	
VAR00023					
VAR00026					.81658

	Factor 11
VAR00042	
VAR00051	
VAR00044	
VAR00041	
VAR00049	
VAR00050	
VAR00047	
VAR00043	
VAR00045	
VAR00048	
VAR00046	
VAR00056	
VAR00061	

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------------ F A C T O R   A N A L Y S İ S ------------

              Factor 11

VAR00059
VAR00053
VAR00060
VAR00055
VAR00052
VAR00058
VAR00057

VAR00036
VAR00037
VAR00034
VAR00038
VAR00032
VAR00033

VAR00031
VAR00035
VAR00054

VAR00018
VAR00017
VAR00019
VAR00021

VAR00025
VAR00024

VAR00016
VAR00020

VAR00027
VAR00028

VAR00022
VAR00023

VAR00026
```

Final Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
VAR00016	.81345	*	1	8.90827	21.2	21.2
VAR00017	.80713	*	2	5.59290	13.3	34.5
VAR00018	.72860	*	3	3.47036	8.3	42.8
VAR00019	.72604	*	4	3.10955	7.4	50.2
VAR00020	.77980	*	5	1.79754	4.3	54.5
VAR00021	.69231	*	6	1.63041	3.9	58.4
VAR00022	.75458	*	7	1.45984	3.5	61.8
VAR00023	.73119	*	8	1.32799	3.2	65.0
VAR00024	.70369	*	9	1.24441	3.0	68.0
VAR00025	.78917	*	10	1.15781	2.8	70.7
VAR00026	.73424	*	11	1.03264	2.5	73.2
VAR00027	.82664	*				
VAR00028	.76036	*				
VAR00031	.80757	*				
VAR00032	.72281	*				
VAR00033	.67280	*				
VAR00034	.72289	*				
VAR00035	.76823	*				
VAR00036	.80426	*				
VAR00037	.74635	*				
VAR00038	.66929	*				
VAR00041	.74522	*				
VAR00042	.80080	*				
VAR00043	.65207	*				
VAR00044	.79389	*				
VAR00045	.69089	*				
VAR00046	.69526	*				
VAR00047	.70582	*				
VAR00048	.66175	*				
VAR00049	.73851	*				
VAR00050	.71625	*				
VAR00051	.79763	*				
VAR00052	.71217	*				
VAR00053	.74870	*				
VAR00054	.66265	*				
VAR00055	.73423	*				
VAR00056	.75332	*				
VAR00057	.45590	*				
VAR00058	.67336	*				
VAR00059	.78605	*				
VAR00060	.70113	*				
VAR00061	.74470	*				

Small & Medium Manufacturing

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Analysis number 1   Replacement of missing values with the mean

Kaiser-Meyer-Olkin Measure of Sampling Adequacy =  .80823

Bartlett Test of Sphericity = 3140.5894, Significance =      .00000

Extraction   1 for analysis   1, Principal Components Analysis (PC)

Initial Statistics:
```

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	1.00000	*	1	13.07638	31.1	31.1
VAR00017	1.00000	*	2	5.43238	12.9	44.1
VAR00018	1.00000	*	3	2.58780	6.2	50.2
VAR00019	1.00000	*	4	2.11305	5.0	55.3
VAR00020	1.00000	*	5	1.70022	4.0	59.3
VAR00021	1.00000	*	6	1.45591	3.5	62.8
VAR00022	1.00000	*	7	1.40989	3.4	66.1
VAR00023	1.00000	*	8	1.16866	2.8	68.9
VAR00024	1.00000	*	9	1.04111	2.5	71.4
VAR00025	1.00000	*	10	.99303	2.4	73.8
VAR00026	1.00000	*	11	.87663	2.1	75.3
VAR00027	1.00000	*	12	.74025	1.8	77.6
VAR00028	1.00000	*	13	.69087	1.6	79.3
VAR00031	1.00000	*	14	.68021	1.6	80.9
VAR00032	1.00000	*	15	.65723	1.6	82.4
VAR00033	1.00000	*	16	.63370	1.5	83.9
VAR00034	1.00000	*	17	.59084	1.4	85.4
VAR00035	1.00000	*	18	.53856	1.3	86.6
VAR00036	1.00000	*	19	.52700	1.3	87.9
VAR00037	1.00000	*	20	.47785	1.1	89.0
VAR00038	1.00000	*	21	.41269	1.0	90.0
VAR00041	1.00000	*	22	.40114	1.0	91.0
VAR00042	1.00000	*	23	.38398	.9	91.9
VAR00043	1.00000	*	24	.33310	.8	92.7
VAR00044	1.00000	*	25	.31941	.8	93.4
VAR00045	1.00000	*	26	.31789	.8	94.2
VAR00046	1.00000	*	27	.29514	.7	94.9
VAR00047	1.00000	*	28	.27847	.7	95.6
VAR00048	1.00000	*	29	.25236	.6	96.2
VAR00049	1.00000	*	30	.21550	.5	96.7
VAR00050	1.00000	*	31	.20518	.5	97.2
VAR00051	1.00000	*	32	.19853	.5	97.6
VAR00052	1.00000	*	33	.16705	.4	98.0
VAR00053	1.00000	*	34	.15657	.4	98.4
VAR00054	1.00000	*	35	.13794	.3	98.7
VAR00055	1.00000	*	36	.11391	.3	99.0
VAR00056	1.00000	*	37	.09640	.2	99.2
VAR00057	1.00000	*	38	.08845	.2	99.4
VAR00058	1.00000	*	39	.08417	.2	99.6
VAR00059	1.00000	*	40	.05926	.1	99.8
VAR00060	1.00000	*	41	.05615	.1	99.9
VAR00061	1.00000	*	42	.03516	.1	100.0

PC extracted 9 factors.

VARIMAX rotation 1 for extraction 1 in analysis 1 - Kaiser Normalization.

VARIMAX converged in 21 iterations.

Rotated Factor Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00056	.85959				
VAR00053	.83590				
VAR00058	.75719				
VAR00054	.75590				
VAR00055	.74487				
VAR00052	.74303				
VAR00057	.72825				
VAR00059	.72386				
VAR00061	.69511				
VAR00060					
VAR00051		.85010			
VAR00042		.83093			
VAR00044		.80869			
VAR00046		.79284			
VAR00041		.77817			
VAR00050		.74468			
VAR00049		.66766			
VAR00045		.65419			

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	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00048					
VAR00047					
VAR00018			.83050		
VAR00017			.79288		
VAR00019			.73022		
VAR00020					
VAR00016					
VAR00022				.73701	
VAR00023				.71748	
VAR00025				.60991	
VAR00024					
VAR00031					.78009
VAR00035					.76919
VAR00038					.60357
VAR00028					
VAR00027					
VAR00026					
VAR00036					
VAR00037					
VAR00034					
VAR00032					
VAR00043					
VAR00021					
VAR00033					

	Factor 6	Factor 7	Factor 8	Factor 9
VAR00056				
VAR00053				
VAR00058				
VAR00054				
VAR00055				
VAR00052				
VAR00057				
VAR00059				
VAR00061				
VAR00060				

F A C T O R   A N A L Y S I S

	Factor 6	Factor 7	Factor 8	Factor 9
VAR00051				
VAR00042				
VAR00044				
VAR00046				
VAR00041				
VAR00050				
VAR00049				
VAR00045				
VAR00048				
VAR00047				
VAR00018				
VAR00017				
VAR00019				
VAR00020				
VAR00016				
VAR00022				
VAR00023				
VAR00025				
VAR00024				
VAR00031				
VAR00035				
VAR00038				
VAR00028	.87139			
VAR00027	.81915			
VAR00026	.67629			
VAR00036		.69549		
VAR00037				
VAR00034				
VAR00032				
VAR00043			.68128	
VAR00021				.69541
VAR00033				

Final Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	.61816	*	1	13.07638	31.1	31.1
VAR00017	.74281	*	2	5.43238	12.9	44.1
VAR00018	.78705	*	3	2.58780	6.2	50.2
VAR00019	.67846	*	4	2.11305	5.0	55.3
VAR00020	.61194	*	5	1.70022	4.0	59.3
VAR00021	.74761	*	6	1.45591	3.5	62.8
VAR00022	.64266	*	7	1.40989	3.4	66.1
VAR00023	.68115	*	8	1.16866	2.8	68.9
VAR00024	.70062	*	9	1.04111	2.5	71.4
VAR00025	.65401	*				
VAR00026	.64753	*				
VAR00027	.72874	*				
VAR00028	.81671	*				
VAR00031	.73520	*				
VAR00032	.65816	*				
VAR00033	.64671	*				
VAR00034	.70887	*				
VAR00035	.76102	*				
VAR00036	.76613	*				
VAR00037	.75961	*				
VAR00038	.59205	*				
VAR00041	.70621	*				
VAR00042	.79351	*				
VAR00043	.74033	*				
VAR00044	.83496	*				
VAR00045	.73223	*				
VAR00046	.68108	*				
VAR00047	.69146	*				
VAR00048	.60696	*				
VAR00049	.68957	*				
VAR00050	.76226	*				
VAR00051	.84649	*				
VAR00052	.67848	*				
VAR00053	.75677	*				
VAR00054	.70943	*				
VAR00055	.75493	*				
VAR00056	.82762	*				
VAR00057	.68269	*				
VAR00058	.69729	*				
VAR00059	.63032	*				
VAR00060	.77846	*				
VAR00061	.69913	*				

Large Services

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Analysis number 1   Replacement of missing values with the mean

Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .71916

Bartlett Test of Sphericity = 2094.9473, Significance = .00000

Extraction 1 for analysis 1, Principal Components Analysis (PC)

Initial Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	1.00000	*	1	13.20099	31.4	31.4
VAR00017	1.00000	*	2	4.79144	11.4	42.8
VAR00018	1.00000	*	3	2.89314	6.9	49.7
VAR00019	1.00000	*	4	2.70887	6.4	56.2
VAR00020	1.00000	*	5	2.18640	5.2	61.4
VAR00021	1.00000	*	6	1.86569	4.4	65.8
VAR00022	1.00000	*	7	1.43916	3.4	69.3
VAR00023	1.00000	*	8	1.25911	3.0	72.2
VAR00024	1.00000	*	9	1.10840	2.6	74.9
VAR00025	1.00000	*	10	.98010	2.3	77.2
VAR00026	1.00000	*	11	.82723	2.0	79.2
VAR00027	1.00000	*	12	.73644	1.8	80.9
VAR00028	1.00000	*	13	.72509	1.7	82.7
VAR00031	1.00000	*	14	.65303	1.6	84.2
VAR00032	1.00000	*	15	.61300	1.5	85.7
VAR00033	1.00000	*	16	.60655	1.4	87.1
VAR00034	1.00000	*	17	.55379	1.3	88.4
VAR00035	1.00000	*	18	.48878	1.2	89.6
VAR00036	1.00000	*	19	.46914	1.1	90.7
VAR00037	1.00000	*	20	.43726	1.0	91.8
VAR00038	1.00000	*	21	.37309	.9	92.7
VAR00041	1.00000	*	22	.34328	.8	93.5
VAR00042	1.00000	*	23	.30734	.7	94.2
VAR00043	1.00000	*	24	.27082	.6	94.9
VAR00044	1.00000	*	25	.24312	.6	95.4
VAR00045	1.00000	*	26	.22618	.5	96.0
VAR00046	1.00000	*	27	.21271	.5	96.5
VAR00047	1.00000	*	28	.20189	.5	97.0
VAR00048	1.00000	*	29	.16457	.4	97.3
VAR00049	1.00000	*	30	.15282	.4	97.7
VAR00050	1.00000	*	31	.15093	.4	98.1
VAR00051	1.00000	*	32	.14234	.3	98.4
VAR00052	1.00000	*	33	.12011	.3	98.7
VAR00053	1.00000	*	34	.10002	.2	98.9
VAR00054	1.00000	*	35	.08908	.2	99.1
VAR00055	1.00000	*	36	.08414	.2	99.3
VAR00056	1.00000	*	37	.07349	.2	99.5
VAR00057	1.00000	*	38	.06419	.2	99.7
VAR00058	1.00000	*	39	.05026	.1	99.8
VAR00059	1.00000	*	40	.03683	.1	99.9
VAR00060	1.00000	*	41	.03437	.1	100.0
VAR00061	1.00000	*	42	.01481	.0	100.0

PC extracted 9 factors.

VARIMAX rotation 1 for extraction 1 in analysis 1 - Kaiser Normalization.

VARIMAX converged in 18 iterations.

Rotated Factor Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00043	.84746				
VAR00051	.84530				
VAR00044	.84046				
VAR00042	.83996				
VAR00041	.83760				
VAR00049	.83012				
VAR00050	.77995				
VAR00046	.76348				
VAR00047	.75004				
VAR00048	.66769				
VAR00045	.61936				
VAR00055		.84615			
VAR00056		.83940			
VAR00053		.78943			
VAR00054		.78035			
VAR00052		.77914			
VAR00059		.77121			
VAR00057		.70922			

---------- F A C T O R   A N A L Y S I S ----------

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00058		.70802			
VAR00061		.65288			
VAR00060		.63944			
VAR00034			.85777		
VAR00035			.76190		
VAR00037			.75750		
VAR00033			.72757		
VAR00036			.68676		
VAR00032					
VAR00031					
VAR00038					
VAR00026				.86713	
VAR00027				.86221	
VAR00028				.78280	
VAR00025					.82770
VAR00024					.82044
VAR00023					.67852
VAR00018					
VAR00019					
VAR00017					
VAR00021					
VAR00022					
VAR00016					
VAR00020					

	Factor 6	Factor 7	Factor 8	Factor 9
VAR00043				
VAR00051				
VAR00044				
VAR00042				
VAR00041				
VAR00049				
VAR00050				
VAR00046				
VAR00047				
VAR00048				
VAR00045				

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	Factor 6	Factor 7	Factor 8	Factor 9
VAR00055				
VAR00056				
VAR00053				
VAR00054				
VAR00052				
VAR00059				
VAR00057				
VAR00058				
VAR00061				
VAR00060				
VAR00034				
VAR00035				
VAR00037				
VAR00033				
VAR00036				
VAR00032				
VAR00031				
VAR00038				
VAR00026				
VAR00027				
VAR00028				
VAR00025				
VAR00024				
VAR00023				
VAR00018	.84703			
VAR00019	.67111			
VAR00017				
VAR00021		.76575		
VAR00022				
VAR00016			.75142	
VAR00020				

Final Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	.63205	*	1	13.20099	31.4	31.4
VAR00017	.77194	*	2	4.79144	11.4	42.8
VAR00018	.78567	*	3	2.89314	6.9	49.7
VAR00019	.51472	*	4	2.70887	6.4	56.2
VAR00020	.77654	*	5	2.18640	5.2	61.4
VAR00021	.67731	*	6	1.86569	4.4	65.8
VAR00022	.67475	*	7	1.43916	3.4	69.3
VAR00023	.73637	*	8	1.25911	3.0	72.2
VAR00024	.76527	*	9	1.10840	2.6	74.9
VAR00025	.77769	*				
VAR00026	.79640	*				
VAR00027	.77109	*				
VAR00028	.75723	*				
VAR00031	.70283	*				
VAR00032	.77602	*				
VAR00033	.84295	*				
VAR00034	.79650	*				
VAR00035	.74925	*				
VAR00036	.72931	*				
VAR00037	.71195	*				
VAR00038	.76991	*				
VAR00041	.88511	*				
VAR00042	.82805	*				
VAR00043	.81153	*				
VAR00044	.82878	*				
VAR00045	.71404	*				
VAR00046	.75886	*				
VAR00047	.62594	*				
VAR00048	.62114	*				
VAR00049	.79747	*				
VAR00050	.81336	*				
VAR00051	.79781	*				
VAR00052	.72564	*				
VAR00053	.70241	*				
VAR00054	.69446	*				
VAR00055	.81115	*				
VAR00056	.83089	*				
VAR00057	.69615	*				
VAR00058	.77072	*				
VAR00059	.77041	*				
VAR00060	.75048	*				
VAR00061	.70312	*				

Small & Medium Services

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Extraction   1 for analysis   1, Principal Components Analysis (PC)

Initial Statistics:
```

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	1.00000	*	1	9.33852	22.2	22.2
VAR00017	1.00000	*	2	8.37108	19.9	42.2
VAR00018	1.00000	*	3	4.03152	9.6	51.8
VAR00019	1.00000	*	4	2.80253	6.7	58.4
VAR00020	1.00000	*	5	2.57535	6.1	64.6
VAR00021	1.00000	*	6	2.23596	5.3	69.9
VAR00022	1.00000	*	7	1.85142	4.4	74.3
VAR00023	1.00000	*	8	1.50230	3.6	77.9
VAR00024	1.00000	*	9	1.28781	3.1	80.9
VAR00025	1.00000	*	10	1.18883	2.8	83.8
VAR00026	1.00000	*	11	1.02003	2.4	86.2
VAR00027	1.00000	*	12	.91231	2.2	88.4
VAR00028	1.00000	*	13	.81611	1.9	90.3
VAR00031	1.00000	*	14	.66863	1.6	91.9
VAR00032	1.00000	*	15	.61128	1.5	93.4
VAR00033	1.00000	*	16	.49396	1.2	94.5
VAR00034	1.00000	*	17	.42389	1.0	95.6
VAR00035	1.00000	*	18	.37601	.9	96.4
VAR00036	1.00000	*	19	.32138	.8	97.2
VAR00037	1.00000	*	20	.27694	.7	97.9
VAR00038	1.00000	*	21	.24652	.6	98.5
VAR00041	1.00000	*	22	.18373	.4	98.9
VAR00042	1.00000	*	23	.13708	.3	99.2
VAR00043	1.00000	*	24	.10840	.3	99.5
VAR00044	1.00000	*	25	.07501	.2	99.7
VAR00045	1.00000	*	26	.04681	.1	99.8
VAR00046	1.00000	*	27	.04472	.1	99.9
VAR00047	1.00000	*	28	.02322	.1	99.9
VAR00048	1.00000	*	29	.01745	.0	100.0
VAR00049	1.00000	*	30	.01119	.0	100.0
VAR00050	1.00000	*	31	.00000	.0	100.0
VAR00051	1.00000	*	32	.00000	.0	100.0
VAR00052	1.00000	*	33	.00000	.0	100.0
VAR00053	1.00000	*	34	.00000	.0	100.0
VAR00054	1.00000	*	35	.00000	.0	100.0
VAR00055	1.00000	*	36	.00000	.0	100.0
VAR00056	1.00000	*	37	.00000	.0	100.0
VAR00057	1.00000	*	38	.00000	.0	100.0
VAR00058	1.00000	*	39	.00000	.0	100.0
VAR00059	1.00000	*	40	.00000	.0	100.0
VAR00060	1.00000	*	41	.00000	.0	100.0
VAR00061	1.00000	*	42	.00000	.0	100.0

F A C T O R   A N A L Y S I S

Rotated Factor Matrix:

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00042	.93080				
VAR00041	.91876				
VAR00043	.91708				
VAR00049	.91475				
VAR00044	.91240				
VAR00050	.90979				
VAR00045	.83216				
VAR00051	.82275				
VAR00046	.78172				
VAR00048	.71951				
VAR00047	.70326				
VAR00053		.88017			
VAR00056		.85916			
VAR00055		.85596			
VAR00052		.85375			
VAR00061		.84417			
VAR00057		.83500			
VAR00054		.77990			
VAR00060		.77879			
VAR00059		.75498			
VAR00032					
VAR00058					
VAR00036			.85816		
VAR00034			.84972		
VAR00035			.78059		
VAR00037					
VAR00020				.73601	
VAR00017				.73268	
VAR00018				.71539	
VAR00016				.68125	
VAR00028					.92830
VAR00027					.83570
VAR00023					
VAR00024					
VAR00025					
VAR00022					

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	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
VAR00021					
VAR00026					
VAR00033					
VAR00038					
VAR00031					
VAR00019					

	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
VAR00042					
VAR00041					
VAR00043					
VAR00049					
VAR00044					
VAR00050					
VAR00045					
VAR00051					
VAR00046					
VAR00048					
VAR00047					
VAR00053					
VAR00056					
VAR00055					
VAR00052					
VAR00061					
VAR00057					
VAR00054					
VAR00060					
VAR00059					
VAR00032					
VAR00058					
VAR00036					
VAR00034					
VAR00035					
VAR00037					
VAR00020					
VAR00017					
VAR00018					
VAR00016					

- - - - - - - - - - - F A C T O R   A N A L Y S I S - - - - - - - - - - -

	Factor 6	Factor 7	Factor 8	Factor 9	Factor 10
VAR00028					
VAR00027					
VAR00023	.85568				
VAR00024	.79686				
VAR00025	.73999				
VAR00022		.78927			
VAR00021			-.74470		
VAR00026			.64758		
VAR00033					
VAR00038				.85702	
VAR00031					.66717
VAR00019					

	Factor 11
VAR00042	
VAR00041	
VAR00043	
VAR00049	
VAR00044	
VAR00050	
VAR00045	
VAR00051	
VAR00046	
VAR00048	
VAR00047	
VAR00053	
VAR00056	
VAR00055	
VAR00052	
VAR00061	
VAR00057	
VAR00054	
VAR00060	
VAR00059	
VAR00032	
VAR00058	

----------- F A C T O R A N A L Y S I S -----------

	Factor 11
VAR00036	
VAR00034	
VAR00035	
VAR00037	
VAR00020	
VAR00017	
VAR00018	
VAR00016	
VAR00028	
VAR00027	
VAR00023	
VAR00024	
VAR00025	
VAR00022	
VAR00021	
VAR00026	
VAR00033	
VAR00038	
VAR00031	
VAR00019	.75912

Final Statistics:

Variable	Communality	*	Factor	Eigenvalue	Pct of Var	Cum Pct
		*				
VAR00016	.83621	*	1	9.33852	22.2	22.2
VAR00017	.82353	*	2	8.37108	19.9	42.2
VAR00018	.84653	*	3	4.03152	9.6	51.8
VAR00019	.83136	*	4	2.80253	6.7	58.4
VAR00020	.81284	*	5	2.57535	6.1	64.6
VAR00021	.81191	*	6	2.23596	5.3	69.9
VAR00022	.68568	*	7	1.85142	4.4	74.3
VAR00023	.83928	*	8	1.50230	3.6	77.9
VAR00024	.83789	*	9	1.28781	3.1	80.9
VAR00025	.84821	*	10	1.18883	2.8	83.8
VAR00026	.90953	*	11	1.02003	2.4	86.2
VAR00027	.89540	*				
VAR00028	.95126	*				
VAR00031	.82751	*				
VAR00032	.86219	*				
VAR00033	.81368	*				
VAR00034	.85038	*				
VAR00035	.87868	*				
VAR00036	.86722	*				
VAR00037	.78392	*				
VAR00038	.89254	*				
VAR00041	.92555	*				
VAR00042	.95514	*				
VAR00043	.91870	*				
VAR00044	.95552	*				
VAR00045	.86422	*				
VAR00046	.90512	*				
VAR00047	.87101	*				
VAR00048	.89508	*				
VAR00049	.89178	*				
VAR00050	.89795	*				
VAR00051	.90122	*				
VAR00052	.88859	*				
VAR00053	.90371	*				
VAR00054	.81063	*				
VAR00055	.89043	*				
VAR00056	.86797	*				
VAR00057	.82390	*				
VAR00058	.79925	*				
VAR00059	.79524	*				
VAR00060	.89396	*				
VAR00061	.84464	*				

Large Manufacturing

* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Agglomeration Schedule using Centroid Method

Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	33	34	98.000000	0	0	3
2	15	16	115.000000	0	0	10
3	33	37	130.500000	1	0	4
4	33	42	110.333336	3	0	5
5	33	36	112.062500	4	0	7
6	17	19	132.000000	0	0	12
7	33	41	135.320007	5	0	9
8	22	32	149.000000	0	0	11
9	33	35	154.638901	7	0	10
10	15	33	141.076538	2	9	13
11	22	24	157.250000	8	0	16
12	17	20	159.000000	6	0	18
13	15	38	159.037033	10	0	14
14	15	39	157.819992	13	0	18
15	23	25	162.000000	0	0	16
16	22	23	146.722229	11	15	22
17	7	8	163.000000	0	0	20
18	15	17	167.520676	14	12	19
19	15	18	157.132645	18	0	29
20	1	7	184.750000	0	17	21
21	1	11	163.777786	20	0	27
22	22	28	196.520004	16	0	23
23	22	26	202.805557	22	0	24
24	22	30	201.714294	23	0	25
25	22	31	193.687500	24	0	32
26	4	5	213.000000	0	0	27
27	1	4	195.375000	21	26	28
28	1	13	209.416672	27	0	29
29	1	15	236.756226	28	19	30
30	1	12	212.192154	29	0	31
31	1	2	226.315674	30	0	33
32	22	29	243.148132	25	0	33
33	1	22	230.932266	31	32	34
34	1	14	260.875458	33	0	35
35	1	9	292.266937	34	0	36
36	1	3	298.255432	35	0	37
37	1	10	320.621643	36	0	38
38	1	40	393.863556	37	0	39
39	1	21	395.719269	38	0	40
40	1	27	414.230591	39	0	41
41	1	6	431.197540	40	0	0

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* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Dendrogram using Centroid Method

                         Rescaled Distance Cluster Combine

    C A S E      0         5        10        15        20        25
  Label     Num  +---------+---------+---------+---------+---------+
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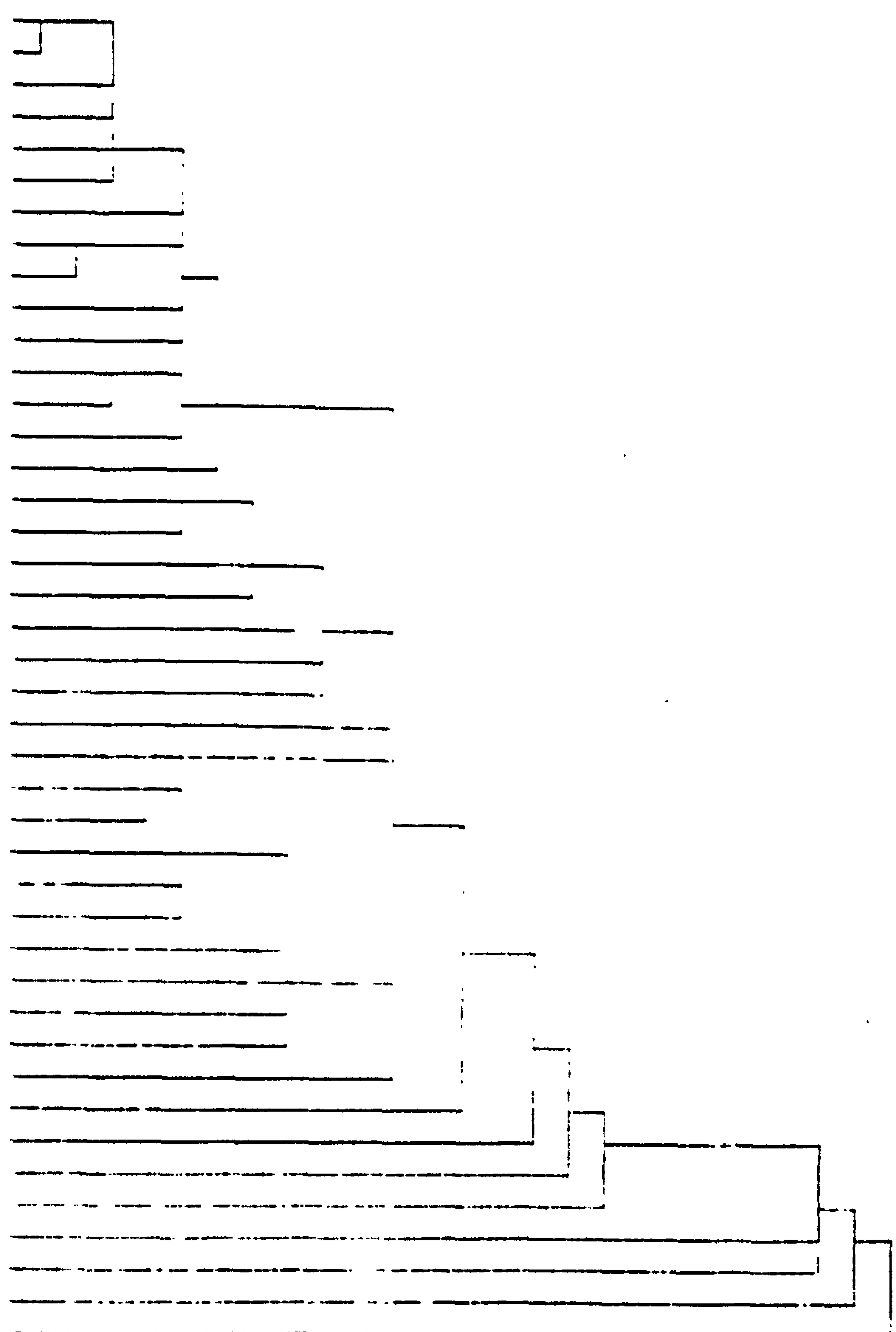

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  VAR00052   33
  VAR00053   34
  VAR00056   37
  VAR00061   42
  VAR00055   36
  VAR00060   41
  VAR00054   35
  VAR00032   15
  VAR00033   16
  VAR00057   38
  VAR0C058   39
  VAR00034   17
  VAR00036   19
  VAR00037   20
  VAR00035   18
  VAR00022    7
  VAR00023    8
  VAR00016    1
  VAR00026   11
  VAR00019    4
  VAR00020    5
  VAR00028   13
  VAR00027   12
  VAR00017    2
  VAR00041   22
  VAR00051   32
  VAR00043   24
  VAR00042   23
  VAR00044   25
  VAR00047   28
  VAR00045   26
  VAR00049   30
  VAR00050   31
  VAR00048   29
  VAR00031   14
  VAR00024    9
  VAR00018    3
  VAR00025   10
  VAR00059   40
  VAR00038   21
  VAR00046   27
  VAR00021    6
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Small & Medium Manufacturing

* * * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * * *

Agglomeration Schedule using Centroid Method

Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	33	34	124.000000	0	0	4
2	15	16	127.000000	0	0	8
3	22	23	129.000000	0	0	16
4	33	35	130.000000	1	0	5
5	33	36	122.444450	4	0	6
6	33	42	135.375000	5	0	7
7	33	37	125.040001	6	0	8
8	15	33	139.416672	2	7	10
9	2	3	140.000000	0	0	25
10	15	41	163.421875	8	0	11
11	15	20	173.234573	10	0	12
12	15	38	173.319992	11	0	17
13	1	7	178.000000	0	0	14
14	1	8	168.500000	13	0	15
15	1	5	159.888901	14	0	20
16	22	25	178.250000	3	0	28
17	15	39	180.876038	12	0	22
18	12	13	188.000000	0	0	21
19	31	32	193.000000	0	0	29
20	1	11	199.937500	15	0	21
21	1	12	211.559998	20	18	22
22	1	15	213.901108	21	17	23
23	1	14	191.512466	22	0	24
24	1	29	215.139999	23	0	25
25	1	2	221.519272	24	9	26
26	1	9	222.799622	25	0	27
27	1	4	220.036453	26	0	31
28	22	30	231.222229	16	0	29
29	22	31	231.562485	28	19	32
30	17	19	247.000000	0	0	31
31	1	17	252.175598	27	30	32
32	1	22	266.067261	31	29	33
33	1	18	268.303040	32	0	34
34	1	24	278.046722	33	0	35
35	1	26	328.242371	34	0	36
36	1	40	338.648895	35	0	37
37	1	10	348.780090	36	0	38
38	1	6	362.506897	37	0	39
39	1	28	368.847443	38	0	40
40	1	21	400.585632	39	0	41
41	1	27	483.063660	40	0	0

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* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Dendrogram using Centroid Method

                         Rescaled Distance Cluster Combine

    C A S E       0         5        10        15        20        25
  Label     Num   +---------+---------+---------+---------+---------+

  VAR00052   33
  VAR00053   34
  VAR00054   35
  VAR00055   36
  VAR00061   42
  VAR00056   37
  VAR00032   15
  VAR00033   16
  VAR00060   41
  VAR00037   20
  VAR00057   38
  VAR00058   39
  VAR00027   12
  VAR00028   13
  VAR00016    1
  VAR00022    7
  VAR00023    8
  VAR00020    5
  VAR00026   11
  VAR00031   14
  VAR00048   29
  VAR00017    2
  VAR00018    3
  VAR00024    9
  VAR00019    4
  VAR00034   17
  VAR00036   19
  VAR00050   31
  VAR00051   32
  VAR00041   22
  VAR00042   23
  VAR00044   25
  VAR00049   30
  VAR00035   18
  VAR00043   24
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  VAR00021    6
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  VAR00046   27
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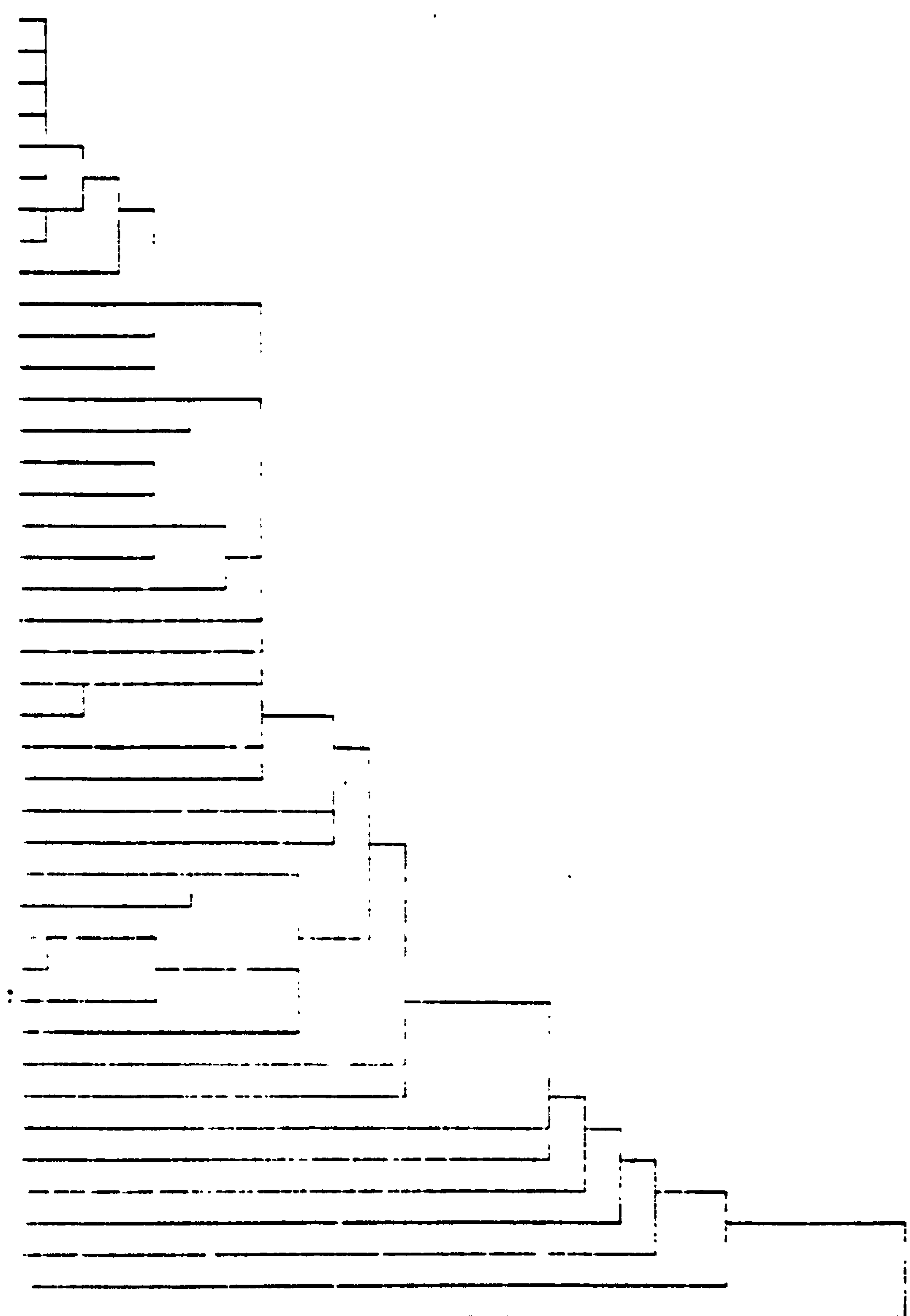


Large Service

* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

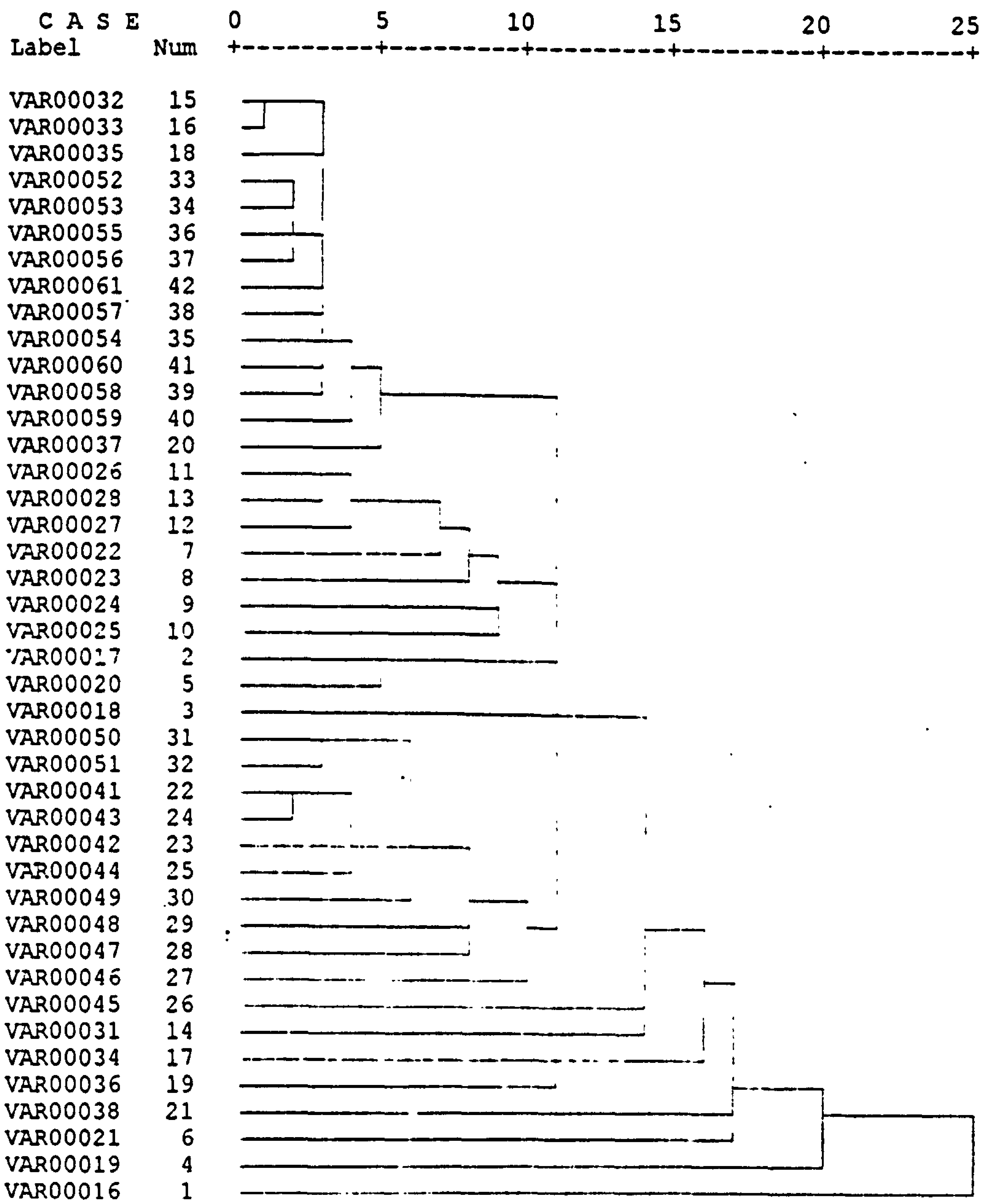
Agglomeration Schedule using Centroid Method

	Clusters	Combined		Stage Cluster	1st Appears	Next
Stage	Cluster 1	Cluster 2	Coefficient	Cluster 1	Cluster 2	Stage
1	15	16	66.000000	0	0	6
2	33	34	80.000000	0	0	3
3	33	36	70.000000	2	0	4
4	33	37	77.777779	3	0	9
5	22	24	82.000000	0	0	16
6	15	18	85.500000	1	0	12
7	31	32	87.000000	0	0	21
8	11	13	87.000000	0	0	15
9	33	42	89.250000	4	0	10
10	33	38	78.120003	9	0	11
11	33	35	78.583336	10	0	12
12	15	33	84.734703	6	11	13
13	15	41	86.520004	12	0	14
14	15	39	91.413231	13	0	18
15	11	12	96.750000	8	0	23
16	22	23	101.500000	5	0	17
17	22	25	98.777779	16	0	21
18	15	40	101.812500	14	0	20
19	2	5	112.000000	0	0	30
20	15	20	113.520721	18	0	32
21	22	31	116.687500	17	7	22
22	22	30	121.611115	21	0	24
23	7	11	132.333344	0	15	26
24	22	29	135.632660	22	0	25
25	22	28	134.343750	24	0	29
26	7	8	140.437500	23	0	28
27	9	10	143.000000	0	0	28
28	7	9	142.430008	26	27	31
29	22	27	151.814819	25	0	33
30	2	3	163.000000	19	0	31
31	2	7	161.410446	30	28	32
32	2	15	149.862671	31	20	33
33	2	22	143.934937	32	29	35
34	17	19	170.000000	0	0	37
35	2	26	191.519012	33	0	36
36	2	14	193.674286	35	0	37
37	2	17	214.119614	36	34	38
38	2	21	220.568588	37	0	39
39	2	6	219.325439	38	0	40
40	2	4	249.846268	39	0	41
41	1	2	304.295135	0	40	0

* * * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * * *

Dendrogram using Centroid Method

Rescaled Distance Cluster Combine



Small & Medium Services

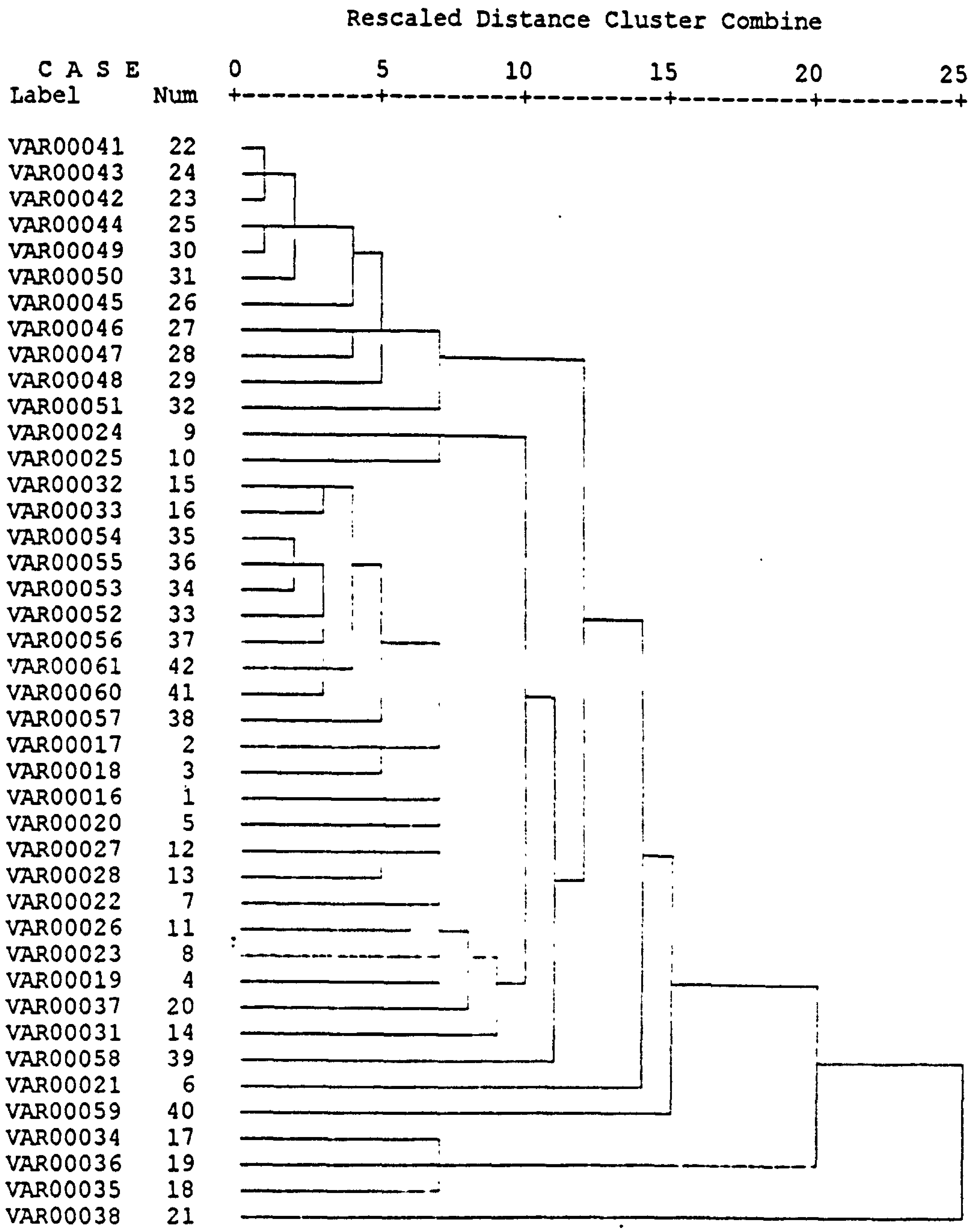
* * * * * * H I E R A R C H I C A L C L U S T E R A N A L Y S I S * * * * * *

Agglomeration Schedule using Centroid Method

Stage	Clusters Combined Cluster 1	Cluster 2	Coefficient	Stage Cluster 1st Appears Cluster 1	Cluster 2	Next Stage
1	22	24	9.000000	0	0	2
2	22	23	12.250000	1	0	6
3	25	30	17.000000	0	0	6
4	35	36	24.000000	0	0	5
5	34	35	24.000000	0	4	9
6	22	25	24.361111	2	3	7
7	22	31	24.320002	6	0	14
8	15	16	27.000000	0	0	13
9	33	34	28.000000	0	5	10
10	33	37	25.750000	9	0	11
11	33	42	27.880001	10	0	12
12	33	41	32.027775	11	0	13
13	15	33	35.566326	8	12	19
14	22	26	37.555557	7	0	16
15	27	28	38.000000	0	0	16
16	22	27	41.948982	14	15	18
17	12	13	43.000000	0	0	29
18	22	29	45.432098	16	0	22
19	15	38	46.209881	13	0	25
20	2	3	49.000000	0	0	25
21	7	11	54.000000	0	0	29
22	22	32	57.599998	18	0	37
23	17	19	59.000000	0	0	28
24	9	10	60.000000	0	0	35
25	2	15	62.279999	20	19	26
26	1	2	57.750004	0	25	27
27	1	5	63.591713	26	0	30
28	17	18	64.750000	23	0	40
29	7	12	64.750000	21	17	30
30	1	7	61.090561	27	29	31
31	1	8	64.851860	30	0	32
32	1	4	65.520775	31	0	33
33	1	20	69.032501	32	0	34
34	1	14	77.471649	33	0	35
35	1	9	89.088837	34	24	36
36	1	39	97.151047	35	0	37
37	1	22	99.697716	36	22	38
38	1	6	120.511574	37	0	39
39	1	40	122.274651	38	0	40
40	1	17	169.982315	39	28	41
41	1	21	210.970840	40	0	0

* * * * * * H I E R A R C H I C A L   C L U S T E R   A N A L Y S I S * * * * * *

Dendrogram using Centroid Method



THE UNITED KINGDOM

CU1 A Microelectronics Company (Employees: about 17,000)

CSF: Team approach to problem solving and supplier partnerships

For a number of years the company has been developing and implementing a TQM program based on KAIZEN. Each site has a site steering team comprising senior managers to develop and manage the site TQM roadmap along the lines of the corporate strategy. The company has a numbers of QCCs, a suggestion scheme, and a QMS for the whole operation including design and development. The company recognises that a cultural change is necessary to foster a co-operative approach and identify the needs and problems. For instance, the role of Buyers is to pull together the elements of the supply chain for continuous improvement and remove non value-added activities. This would require the breaking down of barriers, a team approach to problem solving and supplier partnership. The company believes that continuous improvement should start with the recognition of problems and this can be achieved by a good suggestion scheme and QCCs. The company has also developed an innovative approach to supplier integration which they call "Partnership Excellence Program" (PEP). Through this program, they have developed extremely close links with their key suppliers in order to help them to improve. The PEP has been running for three years and it incorporates five TQM principles:

- Management commitment
- Employee empowerment
- Fact based decision making
- Continuous improvement
- Customer focus

CU2 A Construction Firm (Employees: about 300)

CSF: Customer Satisfaction

In November 1991 the company became the first building and construction company to win the British Quality Award 'for outstanding achievement in implementing a total quality process in the building and construction industry to the satisfaction of customers and with the involvement of employees and subcontractors.' In 1990 its turnover was over £1.5 billion. It is one of the top construction, housing, mechanical and civil engineering groups in the UK offering a range of traditional and specialist contracting services for large and small scale contracts.

The company approach to quality is based on achieving customer satisfaction, control of quality and continual improvement. Their quality management system has been founded on the commitment of senior management and improved quality awareness and training programmes for employees at all levels in the organisation; co-operation with suppliers also formed a vital part of the total quality approach. This has created a Company culture of business efficiency combined with employee benefits and concern for the wider environment, which has been widely recognised.

The success of the quality improvement of the company is a result of its quality policy aimed to:

- Achieve customer satisfaction by completing contracts in the most effective manner and by providing products and services that meet the specified requirements and are in accordance with the need and expectations of customers.
- Develop and maintain an economical, practical and documented Quality Management System for each of our Divisions and operating businesses.
- Maintain and improve the quality, safety and performance of our products and services, leading to enhanced reputation before clients and the public.
- Ensure we manage quality as effectively as we manage time and cost.
- Organise and arrange our affairs in such a way that the factors affecting the quality of contract, product and services provided by the company are always under control.
- Develop and implement a Group-wide quality improvement process directed at creating committed customers, improving productivity, reducing costs and increasing employee participation in this process.
- Use our high standards in Quality Management to increase profitability and market share.

As an important step towards TQM, the company registered itself under the ISO 9000 quality management system in the late 1980's. This demonstrates their commitment towards quality and satisfying the needs of their customers. The evidence of customer satisfaction is measured through a variety of methods such as the number of repeated business, the use of postal customer questionnaires, direct interviewing, and third-party surveys. This includes internal as well as external customers. The ideas of building models of their new design homes in the warehouse and asking previous purchasers to come along and critically assess these models have been extremely beneficial.

The company cannot survive without satisfying their customers. The results of which are the number of awards they are consistently gaining -- such as Manager of the Year awards, Apprentice of the Year awards, Construction Industry Supreme Awards, Contractor of the Year awards, House builder of the Year awards.

CU3 A Chemical Distribution Company (Employees: about 30)

CSF: Good Quality Management System

The firm began its Quality Assurance programme four years ago. Because of the nature of its organisation, ISO 9000 accreditation was approached on two fronts.

The Manufacturing Division sought registration of its operations in total, i.e. raw material sourcing, through production, to distribution to customers. It received accreditation to BS 5750 Part II on 1 May 1989. It is primarily a manufacturer and supplier of inorganic chemicals based on chlor-alkali technology.

The chemical distribution activities have been treated somewhat differently. Primarily, this was because they were treading new ground in seeking BSI accreditation. Their policy has been to seek accreditation for the provision of a service of sourcing, procurement, storage, re-packaging and distribution of a range of inorganic, organic and hygiene chemicals, both liquids and solids, and in bulk or packaged form, the blending, mixing and dilution of other chemicals.

In September 1989, their Glasgow depot achieved ISO 9002 - the first in Europe for such distribution activities. The techniques and lessons learned at Glasgow are being applied throughout their operations, with other depots seeking accreditation by mid 1994.

The Glasgow sites fulfil the basis requirements of their Quality System Model and operate defined purchasing, goods inwards and good despatch inspection and recording systems. In addition, they have completed a comprehensive review of suppliers (both products and services).

Comprehensive documentation detailing how each site control its quality system has been produced.

The company hopes that the progress through ISO 9002 represents the first step in the introduction of TQM system and philosophy. The company thinks that the TQMEX model is a good and simple model to follow.

CU4 A Chemicals and Polymers Company (Employees: about 280)

CSF: Commitment to ISO 9002

The company established their cleaning technology business about 10 years ago. It is committed to the principles set out in its Quality Policy. The business has obtained and maintained quality assurance systems in order to ensure that the customers' requirements are fully and consistently met. It is the responsibility of every individual and manager to know his/her part to play in the QA System and what procedures are relevant to him/her; with the ultimate objective of improving continuously their products and services in agreement with their customers.

CU5 A Glass Manufacturer (Employees: about 200)

CSF: Continuous improvement via continuous training

The company operates a Total Quality Programme. This programme requires commitment from everyone within the Company to agree with the concept of total quality. Every employee is encouraged to accept responsibility for the quality of his/her output and to regard him/herself as a customer or a supplier to colleagues in adjacent functions. This applies internally within the company as well as externally with the customer.

The object of the programme is to achieve complete customer satisfaction every time at minimum cost whether the customer be internal or external. The total quality programme has involved the training or re-training of everyone in the company. The programme has also developed quality awareness and teamworking within natural work groups. It has emphasised the importance of the customers and the importance of recognising and meeting their requirements. The programme also provides each work group the opportunity to complete two quality improvement studies every year.

CU6 An aircraft Manufacturer (Employees: about 8,500)

CSF: Employee Involvement, Customer Focus, Measurement and Benchmarking

The company is the largest industrial employer in Northern Ireland. The company has been engaged in the aviation business for over 90 years and its activities include the design and production of civil and military aircraft, the design and manufacture of major components for other aerospace corporations and the design and production of close air defence weapon systems.

The company launched a total quality programme in 1987; this signalled a period of unrivalled change within the company. Now, six years further on, the company can corroborate over £64 million worth of financial benefit to the organisation, can highlight a 50% involvement from their employees and in recent years have won a National Training Award (1989) for their total quality training, a commendation in the Northern Ireland Quality Award (1991) and both the Northern Ireland and British Quality Awards in 1992. The most significant was the establishment of a Total Quality Centre and associated staff, to facilitate the programme and the changes required within the company.

The role of the Centre was very clear:

To develop a total quality strategy for the company to achieve its business objective;
To develop initiatives which would enable the Divisions to support the Quality Councils and Functional Quality Teams;
To act as a focal point for total quality education and training;
To research and provide expertise on a range of quality improvement tools and techniques; and
To co-ordinate publicity for total quality activities.

The key strategic issues which have been identified as those which will improve the business are: Employee Involvement, Customer Focus, Measurement and Benchmarking. These four key elements form part of an overall continuous improvement strategy based on the European Quality Framework for Total Quality. Each member of the Total Quality Centre staff is assigned a responsibility for maintaining an awareness or working knowledge or an expertise on one of the following areas:

- Statistical Process Control
- Quality Circles / Natural Teams
- Taguchi Methodology
- Suggestion Schemes
- Quality Costs
- Benchmarking
- Customer Focus
- Quality Function Deployment

CUK7 A Bank (Employees: about 6,000)

CSF: ISO 9000, Quality Improvement Programme

The bank was established in 1968 as a basic money transmission service and in two decades has developed into a major **clearing bank** with an account base of over two million personal and corporate customers and nearly 600,000 credit card holders. The bank employs some 6000 staff in 18 locations in the UK and each week handles over 8 million transactions and 250,000 customer contacts.

Since 1987, The bank has been involved in implementing a TQM programme. The strategy has focused on three principal activities -- quality improvement, customer care and quality assurance. The initiative started in the bank's processing area, which is regarded as the bank's factory or back office, and was progressively introduced into other areas of the bank, including accounts management which interfaces directly with the external customer.

The critical elements of the bank's approach to TQM are a triple focus on:

1. **A quality improvement programme** which concentrates on a broad range of improvement activities embracing:
   - The identification, elimination and prevention of errors, rework and wastage via a systematic audit process;
   - The design control of all processes, products and services;
   - The development of mutually beneficial partnerships with all suppliers;
   - A shift in 'culture' values so that the whole of the workforce becomes active and effective 'change agents' in meeting business goals.
2. **A customer care programme** which focuses on problems perceived principally by the external customer but also embraces internal customer relationships and directs action towards activities which affect these customer perceptions, including:
   - market research to identify customer needs, priorities and current perceptions of service achievement;
   - staff attitude research, for it is their basic interaction with customers that will primarily determine customer perceptions;
   - an effective complaints-handling system supported by a high degree of customer responsiveness;
   - effective customer care training, particularly in the areas of product knowledge and the 'charm school' courtesies;
   - effective customer communication and product presentation;
   - ensuring that the resourcing and technological aspects of the customer response infrastructure are fit for purpose.

3. **A quality assurance programme** which sets standards for performance and implements a quality management system (ISO 9000) which ensures compliance to these standards. This system should ensure that all the benefits gained from the previous two processes are held and assured against decay.

Some of the benefits achieved so far are covered below:

- Errors by keyboard operators have been reduced by 52% to 0.008%.
- Post Office errors have been reduced by 65% to 0.06%.
- Customer complaints have been reduced by 25%.
- Inventory has been reduced by 38%.
- Savings from quality improvement projects exceed £6 million.
- Savings achieved from implementing staff suggestions total £2.6 million.
- BSI Registered Firm.
- British Quality Award Winner in 1991.
- Customer perception on 'Quality of Service' has consistently improved over the past three years against the national measurement.

CU8 A chemists (Employees: about >4000) [Peratec, 1994]

CSF: Business Process Re-engineering

The Boots Chemists is the largest chemists retail chain in the UK and has branches in Europe and other part of the world. Unique among UK multiple retailers, Boots has maintained a substantial inhouse facility to provide and maintain the company's infrastructure. The Boots Store Planning Department has a staff of 350, responsible for all of the company's fixed assets. Its activities include creative design, planning, project management and implementation of a substantial capital development programme, store cleaning and a facilities management service for a property portfolio in excess of 2000 sites.

Before BPR implementation, the Department faced a major problem -- a reputation for being 'big, slow, expensive and inscrutable'. The Department's senior management team saw BPR as a vehicle for change. After analysing their business in great depth, they built up a step change improvement.

The Department first identified and traced the key processes across the business of Boots. This analysis highlighted the need for simplification in store planning processes. Prime goals were improved customer focus, strengthened project management, the creation of performance measures and regular benchmarking -- all to improve the bottom line.

Further contributions to the case for change were made by an analysis of the total Cost of Quality -- the cost of quality conformance plus the cost of non-conformance, such as the abortive work, errors and rework. This amounted to a staggering £2.5m, or 25% of Department's cost base, and 17% of this cost was due to non-conformance.

Having defined these goals and identified the key value-adding processes needed to reach its targets, the Department restructured its entire operation. A Store Design Concept for clients has been defined and standard 'models' applied in place of expensive, bespoke technical solutions. Project management processes have been established, a post-scheme 'after-care' system set in place and cost control re-evaluated.

Some of the major achievements attributed to the BPR initiative are:

- The department has relocated, and reduced its size by 13%.
- There are now fewer management layers within the department.
- Staff are empowered through Continuous Improvement Teams.
- The Department's services are now 'indispensable' and 'value-adding' according to its customers.
- The infrastructure is now in place to ensure continuous improvement.

CU9 A Photocopier Manufacturer (Employees 1800)[DTI, 1994]

CSF: Benchmarking

Rank Xerox is part of Xerox Corp., a multinational company that found itself in deep trouble in the late-1970s. From the mid-1960s to the mid-1970s its profits rose 20% a year, not least because it had a near-monopoly on photocopier technology. By 1980 it saw its market share halve, as aggressive competitors moved in and beat it on price, quality and other important measures.

Xerox's solution was to benchmark the way its photocopiers were built, the cost of each stage of production, the cost of selling, the quality of the servicing it offered, and many other aspects of its business against its competitors and against anyone else from whom it could learn. Whenever it found something that someone else did better, it insisted that the level of performance became the new base standard in its own operations.

BPB has now become an every day activity for every department in Xerox and Rank Xerox. The guiding principle is: 'Anything anyone else can do better, we should aim to do at least equally well'. It is closely tied into the company's quality management programme, because BPB is one of the most important ways of identifying where quality improvements are needed. Not only has Xerox world-wide improved its financial position and stabilised its market share, but it has increased customer satisfaction by 40% in the past four years.

Typical of the way Rank Xerox uses BPB is a recent study of distribution, as explained by John Welch, Quality Manager. "We compared our distribution against 3M in Dusseldorf, Ford in Cologne, Sainsbury's regional depot in Hertfordshire, Volvo's parts distribution warehouse in Gothenburg and IBM's International warehouse and French warehouse. We found, for example, by comparing with the best that:

- We had an extra stocking echelon, which could be removed (i.e., we had international, national, regional; they had only international and regional.)
- We took one extra day in information flow between the field and centre, so we need to update our systems.
- They had transport logistics as a board level function.
- Warehouses became efficient not through a high level of automation but through efficient manual routines.
- 'First Pick' availability of parts averaged 90% in the best warehouses; we made only 83%.

Now we are putting those lessons to work, in upgrading our operations to be at least as good."

CU10 A Tele-communication company (Employees 240,000)

CSF: Total Quality Marketing and BPR

In 1987, British Telecom (BT) introduced a full scale **TQMar Programme.** The convergence of telecommunications, computers, and consumer electronics technologies has led to new telephone product applications in final markets. These opportunities, coupled with the liberalisation of telecommunications and the subsequent privatisation of the company, have had profound implications for the corporate culture of BT. It had to move from an essentially engineering based company, with an administrative style of management, to one which is market-led, with a commercially responsive style of management. Changes in corporate culture are the most difficult thing for a large company to achieve. BT is a company of about 240,000 employees.

The company began the TQMar Programme in an attempt to commercialise its workforce from the top management down to the operational level staff. This programme involved several parts:

1. Spreading BT's mission, based on a full explanation throughout the company of end-user requirements from BT service. The mission statement incorporated customer service, product quality, the involvement of suppliers and attainment of a positive market position, the welfare of staff, and involvement in the community at large.

2. The use of cross-functional training and workshops, to involve participants from every level of the company.

3. A full discussion of the purpose of the Programme, its concept and need, how one's work relates to that of others, the techniques required to facilitate working together, and how to obtain commitment over time. These sessions involve a series of stages to guide discussion and work to suggest answers to two basic strategic questions:

    - Where do we want to be?
    - What do we want to achieve?

4. The determination of acceptable levels of failure, and review progress.

The emphasis of the TQMar Programme is on quality of service achieved through everyone rather than on the old supervisory techniques or quality control. The idea is to implement planning and management through the use of team work, and by so doing, creates an understanding which leads to a greater spread or responsibility, and proactivity. BT hopes these things will eventually improve its customer service and contacts and lead to a better corporate image.

To some extent these ideas are no more than an exercise of improving internal public relations. TQMar aims to making this process continuous by involving people who not only understand the reasons behind the scene but are eager to change their actions and accept new, proactive working habits.

CU11 Hydrapower Dynamics Ltd. of Birmingham [DTI, 1992, Mar]

CSF: QCC and TQM

Hydrapower Dynamics of Birmingham was established in 1983, and is an expanding company producing and servicing hydraulic hoses and fittings for use in industry, agriculture, construction, shipping, aerospace and other areas of application. With 18 employees, the company was revitalised by a management buyout in 1989, and began a TQM programme in October 1990, instigated by the Managing Director who led the buyout. His rationale was that Hydrapower Dynamics had attained ISO 9002 and that a Total Quality Programme was the next logical step to ensuring premium performance and satisfied staff and customers.

The first step was to brief all staff on the concepts of TQM and QCC. A seminar was arranged for employees and key suppliers at which a presentation was made by the company's Quality Manager, together with the National Society for Quality through Teamwork (NSQT). The Managing Director then approached the Birmingham Economic Development Unit for advice, and was put in touch with one of their QCC consultants. The Unit sponsored 100 hours of the consultant's time to be devoted to designing and initiating a QCC programme. Under the consultant's guidance, all staff members undertook training in carrying out QCC activities. The training consisted of video material, brainstorming and problem solving sessions. As suggestions were worked on, the advantages of a TQM programme soon became clear to production staff and management, and many of the changes that have been adopted sprang from shopfloor suggestions for improvement.

Hydrapower were not able to organise normal QCCs because of the disruption it would have caused. With just 18 people it didn't make sense to spend working hours discussing ways and means of improving production and delivery because these activities, being unattended in that period, would inevitably be slowing down. QCC meetings still took place on a voluntary basis after the official working hours. The company formed 'Action Teams', who could rely on their experience for instant problem solving without having to first consult other departments.

The Managing Director is enthusiastic about the results: "From a management point of view they have been tremendous, totally vitalising." Management is now more aware of the need to involve staff in decision making, and our staff are far more participatory and enthusiastic about their work and the company as a whole.' Since QCCs were formed, there have been substantial improvements in all areas of operation. New benches were designed to their own specifications by the workers using them, new test safety features have been incorporated into the testing of high pressure hoses and a new telephone system has been installed to the company's specification. QCCs have researched the time factor between ordering and delivery, and their resulting recommendations have been implemented with very satisfactory results.

Through the TQM programme improvements have been made in customer services with Hydrapower's trade counter excelling in meeting customers' instant needs. Perhaps the best indicator of Hydrapower's achievement in realising its quality goals is reflected in the BSI Inspectorate. Unable to find enough discrepancies, they have reduced their audits by 50 per cent.

CU12 BPR at Co-op Bank -- Improving Personal Customer Service [Dignan, 1995]

CSF: BPR

The Co-operative Bank strategy of encouraging its customers to telephone or write to its account management centre, rather than the branches, proved successful. The Co-operative Bank has over 100 branches across the UK, and the country's largest telephone banking operation, serving the needs of its 1.5 million account holders. It is a member of the LINK organisation which provides a network of over 6,000 cash dispensers nation-wide. The bank has long had a reputation for innovation with many of its products and services being "first" on the UK banking scene.

Volumes grew rapidly, placing pressure on service quality resulting in lost telephone calls, correspondence backlogs and duplication of effort as work was handed off to other areas. A project team was formed to re-engineer fundamentally business processes and to realign the organisation, leading to improvement in customer service. Account Management Centre employs some 600 staff, in an operation accessible by telephone 24 hours a day 365 days per year. It receives over 4 million calls, and processes over 5 million pieces of paper a year. The project commenced in 1993, looking at training, process improvement and control, customer care, account opening, work-flow management, benefits tracking, communication and infrastructure. The project was concluded in May 1994 when the last of 34 multi-skilled customer-service teams pulled out. Recent research found that among high street banks Co-operative Bank had the highest customer satisfaction rating scoring 94% among its customers.

CU13 DTI Import Licensing Branch Goes for ISO 9000 [DTI, 1994, Mar.]

CSF: ISO 9000

On 1 May 1991, the Import Licensing Branch (ILB) of the DTI was the first DTI division to be awarded a Certificate of Registration for ISO 9002. The ILB is one of six Government departments to issue import licenses.

Martin Maclean, Director of ILB, explains: 'With such a large scale of application processing, with mandatory targets and with interface with our customers being vital to our success, we were faced with a difficult task. The need for a quality standard was an important part of our response. In consultation with our staff we decided to go for ISO 9002 certification. The team spirit was high and the commitment of the staff so great that we achieved the standard in only 6 months.'

The process involved updating procedures, establishing and documenting an effective quality system and introducing a formal monitoring programme. The benefits for ILB have been a more disciplined approach, a greater concern for quality of service and a sound base for future improvements in efficiency.

CU14 Praxis Software Engineering Company Goes for ISO 9000 [DTI, 1994, Mar.]

CSF: ISO 9000

Praxis is a software engineering company whose Bath office, in 1986, was the first independent software house to achieve certification to ISO 9001, and whose operating units in Warwick and Staines also achieved registration in 1990.

Praxis' approach is based on TQM aimed at securing client satisfaction and continuous improvement. Every year the Board identifies key aims and measurable objectives for the company. This approach is carried throughout the organisation with detailed objectives for each member of staff, who seek ways to improve their performance. If necessary, Quality Improvement Teams are established to tackle particular problems and to bring about improvements in process. When the process has been improved and its objectives are being met, the team updates the relevant written procedures before being disbanded, or re-directed to work on an even stiffer objective.

CU15 Short Brothers Plc Wins the British Quality Award in 1992 [McBride, 1993]

CSF (BPR and QCC)

Short Brothers Plc **(Shorts)** is the largest industrial employer in Northern Ireland with some 8,500 personnel. The company has been engaged in the aviation business for over 90 years and its activities include the design and production of civil and military aircraft, the design and manufacture of major components for other aerospace corporations and the design and production of close air defence weapon systems.

Shorts launched a total quality programme in 1987; this signalled a period of unrivalled change within the company. Now, six years further on, Shorts can corroborate over £64 million worth of financial benefit to the organisation, can highlight a 50% involvement from their employees and in recent years have won a National Training Award (1989) for their total quality training, a commendation in the Northern Ireland Quality Award (1991) and both the Northern Ireland and British Quality Awards in 1992. The most significant was the establishment of a Total Quality Centre and associated staff, to facilitate the programme and the changes required within the company.

The role of the Centre was very clear:

- To develop a total quality strategy for the company to achieve its business objective;
- To develop initiatives which would enable the Divisions to support the Quality Councils and functional Quality Teams;
- To act as a focal point for total quality education and training;
- To research and provide expertise on a range of quality improvement tools and techniques; and
- To coordinate publicity for total quality activities.

The key strategic issues which have been identified as those which will improve the business are: Employee Involvement, Customer Focus, Measurement and Benchmarking. These four key elements form part of an overall continuous improvement strategy based on the European Quality Framework for Total Quality. Each member of the Total Quality Centre staff is assigned a responsibility for maintaining an awareness or working knowledge or an expertise on one of the following areas:

- Statistical Process Control
- Quality Circles / Natural Teams
- Taguchi Methodology
- Suggestion Schemes
- Quality Costs
- Benchmarking
- Customer Focus
- Quality Function Deployment

As a further means of performing research and acquiring new and relevant information, a member of the Total Quality Centre staff has been seconded to the University of Ulster as the Short Senior Fellow in Quality Management. This two-year post allows the job-holder to perform research identified as being key to the Shorts total quality strategy. The post also offers Shorts long-term benefits as the total quality teaching modules introduced on various degree courses at the University ensure that future employees of the company understand the concepts and practicalities of continuous improvement.

CU16 Rover Group Wins the First UK Quality Award [Hakes, 1995]

CSF: Total Quality Improvement Programme

Business results shown by **Rover Group**, with sales of £4.3 billion in 1993, were related to its Total Quality Improvement programme started in mid-1987. While the European motor industry has been in a record post-war recession, Rover was the only car company to increase its sales in Europe -- up 8% in 1993 and 23% in the first half of 1994. Corresponding world-wide sales increases were 9% and 16%. Growth in productivity over five years was evidenced by average revenue per employee rising from £86,400 in 1989 to £126,000 in 1994.

A wide range of methods has been used by Rover to track customer satisfaction with its products and dealer networks, with significant increases reported year by year since 1990 and confirmed by external surveys. Product quality improvements have led to major reductions in warranty costs, while customer confidence is now backed by the opportunity to return or exchange new vehicles within 30 days.

Rover's UK workforce stands at 34,000. Since 1986 Rover has conducted opinion surveys every other year among its employees, with findings acted upon through a structured feedback process. In the 1994 survey, 92% of people said they were proud to work for Rover, compared with 69% in 1990.

HONG KONG

CHK1 An Electronic Company (Employees: about 300)

CSF: 5-S implementation

The Company was established in 1986 by three Taiwanese immigrants in the USA. By 1990, the company was an award-winning printed circuit board contractor with annual turnover of US$13.5 million and had built a good reputation among clients like IBM, Sun Microsystems and Silicon Graphics.

In 1991, the demand for high-tech hardware plummeted. At that time, the only way to survive was to cut costs. Nevertheless, the company decided not to reduce staff since the management treated the employees as their biggest asset. In the attempt to cut costs, they turned to the Japanese experience.

In August 1991, the managing director and five managers visited Miyoshi Electronic, a Japanese company engaged in a similar business. There they were astonished by the cleanliness and neatness of the factory floor and the impact of overall organisation on employees' performance. The secret was in the 5-S system, the principles of which are basic for further quality improvement. The workers understood the importance of instilling the 5-S in their personal lives as well. It all contributed to improvement of interpersonal relationships across the company.

The team from the company was impressed and decided to launch the same practice back in their own company. Although there was a certain amount of scepticism towards the 5-S, a typical reaction of an individualistic culture, the results were encouraging. One of the assembly line workers explained the impact of the 5-S implementation as "Before, I'd have to wait around for my supervisor to tell me what to do. Now, I know what to do when I arrive in the morning. I have a schedule, and I keep records of all my work. This is a good system. Everybody knows what the problems are and how to fix them." They all emphasised the importance of organisation, cleanliness and discipline for a good atmosphere and mutual support in the factory. The 5-S system set different sets of rules from the previous practice but it made people more of a team. As another worker stated "Before the 5-S, we just worked. Now, I try to improve my work."

Just two years after the 5-S came to the company, productivity has skyrocketed by over 26%, with turnover exceeding HK$200 million. This result proves that the 5-S culture is universal and can be related to any working environment if there is a commitment to the common objective.

CHK2 A Sauce Manufacturer (Employees: about 1100)

CSF (Continuous improvement via 5-S, BPR, TPM and ISO)

The legend of this company began in 1888 when Mr. Lee Kum Sheung started an Oyster Sauce business in Nam Shui, a small village in China's southern Guangdong province. Where oysters were in abundance. Enjoying natural advantages, Mr. Lee's products soon gained wide recognition from customers and the company was born.

The company expend and relocated to Macau in 1902, establishing a distribution network spanning Guangdong and Hong Kong. In 1932, the company moved to Hong Kong and had soon expanded substantially to meet the increasing demands of overseas markets.

Now the head-quartered in Hong Kong, the company owned a 330,000-sq. ft production plant equipped with the state-of-the-art manufacturing facilities. Their wide range of products comprising different types of condiments and sauces are distributed all over the world.

The vision and mission statement of the company are to build the company name "Lee Kum Kee" into a symbol for quality and trust. The vision is to globalised its products to reach every family around the world. To achieve this goal by placing great emphasis on quality and seek breakthroughs in every aspect of their business. Every member of the company will contribute his/her best and deliver optimum performance to reach for new heights with solidarity.

The company, like may other companies, operate quality with a detection mentality, put a great effort to inspecting, screening and testing. A Quality Assurance Division was introduced to the company in 1990. In the past, although the company valued quality as an essential factors to success and secure market place, there was no dedicated unit to ensure quality throughout the production process. Employees relied on experience and company's secret methodology of production.

As the living standard of the population increased the requirements of consumers also increase. People are more aware of the health and hygiene factors. After understanding these changes and requirement, the company used different quality methods for improving product quality.

5-S was first introduced, all workers have to carry out their own cleaning activities everyday. This soon became part of everyday activities. 5-S teams were established to audit different parts of the factory and discuss ideas for improvements. One suggestion was to asked workers to carried out their own equipment testing and minor maintenance activities. Like the Chinese saying, "To achieve good results, good equipment and facilities are essential". To cater for overseas market expansion as well as requirements of purchasing, production, technical services, marketing, finance and administration functions, the company have computerised its operations and standardise its procedures for efficient manufacturing of consistently high quality products. In addition, the state-of-the-art computer-control production facilities are used to manufacture products under the strictest health standards. The management also realised that best equipment also requires best attention in order to maximise efficiency. TPM was then introduced, all equipment are now regularly tested and maintenance activities are carried out according to plan to ensure that they are in their best working conditions.

In 1994, the company was awarded the "Hong Kong Q-Mark for Qualtiy" by the Federation of Hong Kong Industries and "1994 Governor's Award for Industry: Quality" by the Industry Department, Hong Kong Government. In the same year, the company decided to put all the good practices together and documented into an ISO 9000 quality management system.

CHK3 An Electronic Company (Employees: about 200)

CSF: The use of QC Tools

The manufacturer had a plant in Sian, China. There were two in-line ovens. One of them was used to preheat the aluminium circuit board assemblies for powder epoxy coating. Curdling was carried out later in another oven.

One day, the engineer in Hong Kong received a fax from the plant manager in China. He asked for help in the case of three explosions during the injection of powder epoxy. Although no one was hurt, they had seriously disturbed the production process and led to low quality of products. The engineer was experienced in the production line as he was looking after similar lines in Hong Kong. Moreover, he had just finished commissioning a new automatic production line to replace the old one.

He used the QC problem solving to establish 8 hypotheses. Finally, the evidence confirmed that it was the power failure before the explosions that caused the ventilation system to break down. Thus, the oven temperature was raised too high and caused the explosion of the epoxy. The decision process suggested two measures to be taken:

1. Ask for schedule of electricity stoppage.
2. Replace the conventional system by a fully automated system.

Then the process continued with potential problem analysis, and implementation and corrective action. Through the rational process, the company managed to install the automatic system in their China plant with very high confidence.

CUK4 Total Quality in Purchasing [Wong, 1995]

CSF: The importance of BPR

In 1994 Wong surveyed purchasing professionals in Hong Kong business organisations in order to find out the TQPur practices. There were 314 questionnaires sent to the purchasing managers of publicly listed companies and 673 questionnaires were sent to the members of the Hong Kong Institute of Purchasing and Supply. The questionnaire consisted of four parts: the first part asked the respondents for basic information concerning their companies and the purchasing department; the second part tapped respondents' view on their orientation to quality; the third part aimed to assess respondents' opinions towards the results of TQPur; the last part to find out from the respondents the present practices between their purchasing department and their suppliers. The 193 responded questionnaires resulted in a 20% response rate. The results are summarised as follows:

1. Information about the company and purchasing department

Most of the companies were in the medium to large size category (above 500 employees). 38% of the companies have adopted a TQM system. Regarding the reasons for the adoption, the most frequently chosen response was higher quality demands by customers (78%), followed by quicker response to the market (47%) and quality is a selling point (40%).

2. Orientation to Quality

In determining the award of business to suppliers, respondents were asked to rate the importance of five factors on a scale of 1 (most important) to 5 (least important). The respondents ranked quality as the most important factor with an average of 1.45, followed by price .78, reliability 1.85, delivery 2.03 and service 2.17. Moreover, the analyses revealed that 66% of the respondents was willing to pay higher prices for higher quality materials.

3. Results of Total Quality Purchasing

Respondents were asked to express on a 5-point scale their views of the results of quality of materials purchased. The responses indicated that they considered quality materials as important in achieving 'good quality product', 'quicker delivery time', 'less inventory' and 'higher profit'. Moreover most respondents circled Strongly Agree for 'good quality product'.

4. Present practices with suppliers

Respondents were asked to give information about present practices in the relationships with suppliers. More than half of the respondents are practising the basic features of a quality approach to suppliers which include: multiple sourcing, obtaining suggestions from suppliers for quality improvement, sharing information with suppliers, involving suppliers in product design, reducing the number of suppliers, and partnering with some suppliers. On the other hand, a relatively smaller percentage practises the more advanced features of partnership relationship such as: giving quality awards to suppliers (26.4%), single sourcing (30.5%), giving quality training to suppliers (33.7%), and requiring supplier certification (34.7).

5. Differences between TQM companies and non-TQM companies

The TQM companies have more faith in the benefits of quality purchasing. Furthermore, a higher proportion of TQM companies (50%) have applied the more advanced features of the quality approach compared with the non-TQM companies (20%).

The responses to this exploratory survey indicate that, despite the severe competitive nature of doing business in Hong Kong, the purchasing professionals put more emphasis on quality than price. This takes the trend away from the past practice of awarding business on price, and leads towards a new quality orientation.

CHK5 A Plastic Injection Moulding Factory (Employees: about 200)

CSF: The importance of 5-S and QCC problem solving

The factory had five plunger-operated injection moulding machines with a rigid structure. Each of them carried a mould locking mechanism at one end and a heated cylinder for softening the thermo-setting plastic material at the other. One day, an operator of Machine B found that there were some sink marks and voids on each product produced. The engineer came in to investigate the cause.

The first thing he did was to compare the readings of all machines. He runs the Machine B and was surprised to find that the cylinder temperature was much lower than with other machines. After investigation, it was found that the thermocouple was malfunctioning. So he replaced the old thermocouple with a new one and ran the machine again. The extent of sink marks and voids were greatly reduced but still appeared. So he thought that there was still something wrong in Machine B. He finally found another distinctive factor -- the mould temperature was lower in Machine B than in all other machines. Out of the several alternatives, it was confirmed to be the dirt in cooling channels. After cleaning, the machine started to produce good quality parts again.

To prevent future problems from arising again, the engineer suggested that there should be a team of fitters responsible for the maintenance of all the machines. Special care was taken that no dirt, dust and granules were to be entered into the injection moulding machines. Further, there should be daily check on hydraulic oil levels, lubrication, leaks on pressure lines, hose connections, and electrical wire, including thermocouple leads. Every week the machines were to be cleaned thoroughly and the oil checked.

Finally, the management has ensured smooth implementation of the newly installed equipment.

CHK6 A Construction Company (Employees: 400)

CSF: The TQMEX Model

Please refer to S.6.1.4

JAPAN

CJ1 A Machine Manufacturing Company (Employees: about 8,000) *[Senju, 1992]*

CSF: Implementation of TPM

According to the president of the Fujikoshi, Mr. K. Owada, the company's guiding principle is to ensure that they are producing quality products that meet the changing needs of society. As a general machine manufacturer, Fujikoshi has to be involved in the most basic fields of the machine industry, and it seeks to develop machine designs, processing technology, production systems, and new materials. Its main factory has about 5,000 employees. The company also has 35 affiliated sales and production companies with about 3,000 employees.

Particularly impressive was the company-wide human resources training initiative ranging from top management to the programme promotion staff and the front-line workers in the factories. It was this initiative that enabled Fujikoshi to implement such a sophisticated TPM programme so successfully. The programme brought out all of the workers' potential, and this should be invaluable for strengthening the company and promoting future developments.

Fujikoshi uses five basic policies incorporating both the company's operating policies and the problems discovered during the preliminary survey were announced for the TPM kick-off:

1. Raise overall equipment efficiency as much as possible through the full participation of all employees.

2. Enhance equipment reliability and maintainability, and seeking to build quality into the equipment and to improve productivity.

3. Develop the most economical and efficient equipment, and equipment management for the entire life of the equipment.

4. Train people to be competent with the equipment.

5. Create a lively work environment through autonomous maintenance.

While the trend is to go from TQM to TPM, Fujikoshi has done the opposite. As they developed quality education and training, the innovation suggestion system, and QCC, there was a tendency from many of the programme's vocal promoters to avoid the dirty work. this was disastrous for company morale. By implementing the TPM programme early on, Fujikoshi had all employees make actual improvements on the equipment and get their hands dirty. Their TPM programme resulted in cutting the number of stoppages to 1/150 of their former level, raising equipment efficiency by more than 30%, and reducing nonconformance to 1/3 of what it had been. Along with this, value-added productivity improved by 30%.

CJ2 A Car Manufacturing Company [Senju, 1992]

CSF: TPM and TQM

According to the President of Toyota Auto Body, 'Quality first' is a central tenet of his company's basic company-wide operating policy. Management has always put quality at the top of its priority list. These efforts resulted in Toyota Auto Body's receiving the Deming Prize in 1970, the Japan Quality Control Prize in 1980, and the PM Excellence Award in 1986. In order to achieve the PM Excellence Award, Toyota adopted a TPM programme to improve the management of equipment and an OPM (Office Productivity Maximisation) programme to streamline paperwork in the administrative and staff divisions.

The following points were emphasised in the TPM programme by improving process capability, eliminating all losses, and raising operating rates, to create a more productive assembly line that can turn out reliable products that will win customer trust:

1. Simplify processes so that quality is not impaired by worker reassignments.

2. Build equipment so that lower production volumes do not result in higher per-vehicle energy consumption.

3. Build flexible equipment that can be adapted to model changes with only minimum investment.

4. Improve equipment reliability and life despite the greater automation and complexity.

5. Develop production technologies that solve these problems and reduce costs at the same time.

A programme of OPM Streamlining staff operations was adopted that sought to improve the quality of work to make the entire system more efficient by returning to the basics, defining work goals clearly, and reorganising the office system in line with the concept of purposeful work. The OPM activities sought two goals:

1. To improve the quality and efficiency of administrative and staff work.

2. To reassign staff to strengthen technology development and in anticipation of new work requirements.

CJ3 An Electrical / Electronic Appliance Manufacturer [Matsushita, 1988]

CSF: 5S, BPR, QCC, ISO9000, TPM, TQM

Matsushita Electric is the world's largest home electrical/electronic appliance manufacturer. It was founded by Konosuke Matsushita in 1918. Even back in 1932, he believed that the objective of manufacturing is to produce good quality products which can meet the needs of the customers at an affordable price, so that everyone can get it just like tap water.

Matsushita established the PHP (Peace and Happiness through Prosperity) Institute in 1946, just after the Japanese defeat in the Second World War. As the name implies, PHP is charged with the mission to "bring peace and happiness to the 20th century through prosperity". Matsushita used the idea of 'tap-water philosophy' because when the supply of goods is abundant, the society will become prosper and people become happier.

PHP continues to help the industries and society to improve the quality of work and life. In so doing, PHP publishes many of the books and videos which are considered important to achieve its mission. The publication is heavily focused on TQM. An analysis of their recent publications confirms once again that the TQMEX is an important model. Each of the elements of the Model has been published as a video seminar by PHP. Some of the titles are:

5-S: 5S: Five Steps to Shaping Up the Shop Floor
In-depth 5S - Questions, Answers, and Examples
5S for the Office
Visual Control Systems

BPR: Just-in-Time Case Studies
Techniques for Streamlining Production

QCC: Invitation to QC
Mastering the Tools of QC
The Power of the Suggestion System

ISO: Understanding the ISO 9000 Standards

TPM: This is TPM: Total Productive Maintenance
Zero Breakdowns
Zero Set-up Losses

TQM: You and Your Job: Having the Right Attitude
Teamwork on the Shop Floor: Key Points for Energising the Workplace

CJ4 A Food Retailer [Peppard, 1993]

CSF: Use of Quality Control Tools

7-Eleven, with 4,000 convenience stores, is Japan's largest food retailer, and is separately owned from the American company of the same name. Mostly owned by franchise-holders, 7-Eleven has the highest profitability and return on equity among Japanese retailers. The parent, a subsidiary of a Japanese retailer, owns only about 5% of the stores, a figure which is declining. However, 7-Eleven owns a sophisticated computer network which collects sales data and orders goods directly from the distributors.

Each store is equipped with a point-of-sale system. When something is purchased, the point-of-sale records its brand name, the manufacturer, the price, and details about the buyer. Sales of products can then be plotted against the time of day, day of the week. The quality control tools used in the analysis include: Check Sheet, Histogram, Pareto Analysis, Scatter Diagram and Control Charts.

7-Eleven, the parent company, can aggregate data from many stores. It then collates and sells this data to manufacturers about the sales of their own products. These statistics also allow 7-Eleven to advise their franchise holders on what to sell and when -- important considering the average shelf space of only 10 square metres and over 3,500 products. The shelves are filled with a mix of goods according to the time of day.

CJ5 A Machine Tools Manufacturing Firm (Employees: about 1,000)

CSF: QCC Suggestion Scheme

The company is a world's leading manufacturer of computer controlled machine tools and manufacturing systems. The company has been a pioneer in the development of production technology since it was established in 1919 in Japan. A new plant has been set-up in UK 1987 and represents the most advanced machine tool manufacturing plant in the whole of Europe.

Since their operation began in 1987, quality is the prime concern of the company. A TQM programme is the driving force to ensuring premium performance and satisfied staff and customers. The first step was to brief all staff on the concepts of TQM and QCC. A seminar was arranged for employees and key suppliers at which a presentation was made by the company's Quality Director from Japan. A QCC programme was established. All staff members undertook training in carrying out QCC activities. The training consisted of video material, brainstorming and problem solving sessions. As suggestions were worked on, the advantages of a TQM programme soon became clear to production staff and management, and many of the changes that have been adopted sprang from shop-floor suggestions for improvement.

The Quality Director is enthusiastic about the results: "From a management point of view they have been tremendous, totally vitalising. Management are now more aware of the need to involve staff in decision making, and their staff are far more participatory and enthusiastic about their work and the company as a whole." Since QCCs were formed, there have been substantial improvements in all areas of operation. New benches were designed to their own specifications by the workers using them, new test safety features have been incorporated into the testing of high pressure hoses. QCCs have researched the time factor between ordering and delivery, and their resulting recommendations have been implemented with very satisfactory results. Through the TQM programme, improvements have also been made in customer and supplier relationship. If there is a problem with supplier's products, they were ask to join in with the QCC in solving their problems together. Supplier became more willing to learn from their mistake. Therefore problems are no long the responsibility of an individual.

A measure of the esteem in which the UK plant is held for its efficiency, productivity and overall quality are evidenced by the number of prestigious industrial awards bestowed on the company, including the Queen's Award for Export Achievement and ISO 9001 quality awards.

CJ6 A Car Manufacturing Company (Employees: about 3,500)

CSF: QCC and TPM

This is a UK based Japanese company established in early 1984. The plant has an integrated manufacturing facility. Since their operation began, the company has never lost one car against production target, and the quality of the product was at least equal to that of their sister plant in Japan. This has consistently been the case since that time. The secret is to eliminate the waste and losses hidden in the factory environment by TPM activities. TPM can help to maximise output and increase the productivity of plant and equipment. The company acknowledge the central role of human workers in managing the production process. No matter how thoroughly plants are automated or how may robots are installed, people are ultimately responsible for equipment operation and maintenance. To achieve a high level of maintenance activities the company followed five developmental activities:

1. Improving the effectiveness of individual pieces of equipment
2. Autonomous (operator) maintenance
3. Planned or scheduled maintenance in the maintenance department
4. Training to increase operation and maintenance skill
5. Early equipment management (maintenance prevention and maintenance-free design)

Through the above five activities, the company not only eliminate the chance of six big losses, but establish a more effective relationship between operators and machines, and maintain equipment in the best possible condition.

QCCs also operate in parallel with TPM. It is their belief that to improve the company's performance,it must use all the resources available to the workers and that the person who knows the job best is the one that does it every day. Autonomous maintenance environment has been created through the use of QCC. For example, during one of their regular QCC meeting, a worker makes an improvement suggestion. The group decided to provide all the necessary resources to let him make the necessary modifications himself. The outcome shew that the worker was more motivated and committed to make it work. This encouraged other staffs to make more suggestions. The company also realise their staffs have infinite potential. To utilise this resource the company also introduced a reward scheme for the worker who make the best suggestion.

The company concluded that TPM must:

1. Involve all employee
2. Give a high level of problem ownership to the user
3. Be in line with the corporate strategy of developing people to their maximum potential
4. Ensure that the company's assets are maintained and its investments recouped.

<u>**CJ7 A Construction Company**</u> (Employee 300)

CSF: ISO 9000

Please refer to S.6.3

CJ8 Quality Improvement Storyboard at Komatsu Company [Vroman, 1994]

CSF: QCC & Problem Solving Tools

The storyboard is an elaborate problem-solving process. Japanese firms originated this comprehensive approach. Since then, many firms in Japan and America have initiated variations on this process. The intent is to insure that problems are fully investigated, solved, and implemented. One sure way of attaining a high level of complete problem solving is to have a work force trained and experienced in a comprehensive approach.

Kaizen results in constant diagnosis which, in turn, results in many problems to address. Establishing priorities, selecting candidates, and determining problem-solving approaches are decisions to be made. Counter-measures to problems are proposed that result in minimising sources of variation. When solutions are successful, permanent changes are proposed and implemented. The evaluation phase determines what problem area to take up next. The steps automatically support the firm's commitment to continuing improvement.

The Quality Improvement Storyboard originated with the Komatsu Company, a winner of the Deming Prize during the 1970s. Mr. Nogawa, president of Komatsu, named the process QI, for quality improvement. Florida Power & Light adapted the QI storyboard as the basis for their continuing improvement effort. They eventually become the first Deming Prize winner outside Japan

Manufacturing

CM1 Zytec Electronic[Ross, 1993]

CSF: Implements Deming's 14 Points

Zytec designs and manufactures electronic power supplies and repairs power supplies and monitors. They were the 1991 Malcolm Baldrige National Quality Award winner for 1991. **Mini-Case** 9.1 has briefed how they managed to win the Award. This Mini-Case will focus deeper into their Leadership (Category 1), Strategic Quality Planning (Category 3), and Human Resource Utilisation (Category 4) to find out how they made use of Deming's 14 Points.

MBNQA Category 1: Leadership

When Zytec started its quality improvement in January 1984, it chose Quality, Service, and Value as its focus. These developed into the company's Mission Statement as follows:

- Zytec is a company that competes on value, it provides technical excellence in its products and believes in the importance of execution.
- We believe in a simple form and a lean staff, the importance of people as individuals, and the development of productive employees through training and capital investment.
- We focus on what we know best, thereby making a fair profit on current operations to meet our obligations and perpetuate our continued growth.

To carry out this mission, Zytec's senior executives decided to embrace Dr. W. Edwards Deming's 14 Points for Management as the cornerstone of the company's quality improvement culture. They established the Deming Steering Committee to guide the Deming process and championed individual Deming Points, acted as advisors to the three Deming Implementation Teams, and developed the Zytec Total Quality Commitment statement.

Meetings were held with every Zytec employee to increase knowledge of Deming's Points, and many employees have attended half-day, two-day, and four-day Deming seminars. As a result, Deming's 14 Points for Management guide Zytec's actions, from Long Range Strategic Planning (LRSP) to employee empowerment to leadership. The effect of their compliance to the 14 Points is visible in their submission document for the MBNQA.

MBNQA Category 3: Strategic Quality Planning

Zytec's planning process takes the quality and service needs of customers and drives them through the organisation and to its suppliers. The process involves three steps:

- Data is gathered.
- Goals are set by LRSP cross-functional teams.
- Detailed action plans to implement these goals are developed by department 'Management By Planning' teams.

The Deming approach to setting objectives and developing plans for quality leadership requires that planning is based on data. Zytec collects this data by soliciting customer feedback, conducting market research, and benchmarking customers, suppliers, competitors, and industry leaders.

Because of the broad involvement and cross-functional development of the LRSP and management by planning, Zytec's direction for the future, both short- and long-range, has broad consensus and support. It exemplifies Dr. Deming's 14th Point: "Put everybody in the company to work to accomplish the transformation. The transformation is everybody's job."

MBNQA Category 4: Human Resource Utilisation

Human resource planning is guided by Dr. Deming's 14 Points and the LRSP. The results of a recent planning cycle provide an example of how these are translated into short- and long-term objectives:

- Deming's Point 7: Institute leadership. The aim of leadership should be to help people and machines and gadgets do a better job. Leadership of management is in need of overhaul, as well as leadership of production workers.
- LRSP: Implement self-managed work groups in which employees make most day-to-day decisions while management focuses on coaching and process improvement.

The results of training, involvement, and empowerment are that Zytec's employees believe Dr. Deming's 14 Points are more than vague guidelines. Since 1984, Zytec has surveyed employees seven times to gauge how effectively the company has implemented Deming's Points.

<u>CM2 Employee Empowerment at Lyondell Petrochemical</u> [George and Weimerskirch, 1994]

CSF: MBNQA Criteria

Lyondell Petrochemical is one of those American companies who were granted the title of Malcolm Baldrige National Quality Award (see Chapter 9 for details on Baldrige), its employee involvement being the key factor for their success. It all started with the change in managerial paradigm of being prepared to 'give employees control over their activities, freedom to make important decisions, and responsibility for their actions - forever'. The transition to employee involvement was a painful process in this company because they had had a long tradition of having clear lines drawn between management and the work force. They managed to communicate the idea of 'integration through quality' by training employees to accept responsibility, giving feed-back, and establishing criteria for rewards and recognition.

To be able to accept responsibility, people need to be trained in their new roles, given opportunities to succeed, supported, and encouraged. The problem Lyondell faced along this route was that some people were scared of their own empowerment because they did not want additional responsibility, and quite a few never made it. One of those who did, a laboratory technician says, "If I see something that needs to be done, I do it or find someone who can. That's empowerment to me."

In this company, managers and supervisors are trained in giving on-the-spot and monthly feedback. There is an established code of behaviours against which every employee's annual performance is evaluated and improvements result in merit pay.

CM3 Bowater Containers Southern Goes for ISO 9000 [Dawson, 1988]

CSF: ISO 9000

The benefits of the standard are not only received by the companies that implement the standard but also by their customers. Reed Corrugated Cases sees advantages both in cost and image in the market place. *Advantage to their customers was in the reduction of product price because the company was able to reduce cost and rejects.* Bowater Containers Southern claimed that benefits to customers are fourfold:

Regular checks of incoming goods can be replaced with a random audit.

Large amounts of stocks no longer need to be held as a safeguard against the quality of the supplier's next delivery.

Tight packaging specifications are maintained for clients that have their own automated plant.

Improved communications with all its suppliers.

Services

SC1 Implementing 5-S at the Standards and Industrial Research Institute of Malaysia [Ho, 1994]

CSF: 5-S

The SIRIM is the Government organisation in Malaysia responsible for the industrialisation programmes for Malaysian economy. It is one of the largest set-ups of this kind in the world, encompassing the functions of national standardisation, technology transfer and quality and productivity improvement consultancy. Apart from the Head-office in Shah Alam, SIRIM has seven branch offices throughout the country. At its head-office, there are over 30 blocks of buildings with nearly a thousand employees.

SIRIM has decided to implement the 5-S itself. This was necessary as SIRIM saw its benefits and also wanted to set example for industries. The training was a kick-off in a big way. The Director General of SIRIM announced a Saturday as the SIRIM 5-S Day. Before that day, I took some live videos of the 5-S audits conducted at the SIRIM head-quarters.

On the 5-S Day, the Director General took the lead and put on his sportswear. I gave a 40-minute seminar about 5-S to some 80 senior staff, including the 20-minute 5-S audit video presentation. At the same time, all remaining 900 staff were given a one page guideline to "throw away the rubbish and do all-together cleaning". At 1 p.m., when the 5-S Day was over, three lorry-loads of rubbish were thrown out of the 30 blocks of buildings. More interesting was that a week after the 5-S Day more rubbish came out of the buildings including steel file cabinets which were not suitable for the 'transparency' requirement of the 5-S.

Since the 5-S Day, many individual sections have requested in-depth workshops on each aspect of the 5-S practice. I started training a group of facilitators who has been actively carrying out the 5-S activities. There has been continuous requests from industries for consultancy service from the SIRIM's Industrial Extension Unit regarding implementation of the 5-S. As a result of the high demand for 5-S consultancy service, the Unit has been allocated additional human resources to satisfy this need.

CS 2 The School of Quality [Bonstingl, 1995]

CSF: Four Pillars of Schools of Quality

American educators are beginning to realise that current systems of instruction do not encourage, or in some cases even permit, quality education. Many of them are now examining TQM as a possibly workable philosophy to create a new type of schools -- Schools of Quality -- which are based upon a way of schooling that better suits the imperatives of the 21st century than the factory-model system of schooling currently practised in many parts of the world.

What are such 'Schools of Quality' like? How do they differ from today's schools? Schools of Quality are grounded in four fundamental assumptions which Bonstingl called Four Pillars of Schools of Quality.

The first Pillar of Schools of Quality is a **customer-supplier focus.** The entire school organisation must be dedicated to meeting human needs by building relationships of mutual support with people inside and outside the school. The role of a student is dual. As a worker, the student's product is his personal growth and continuous improvement that he presents to teachers or future employers (customers). As a customer he expects high quality teaching, security, and care from the school staff (workers/suppliers). Satisfaction of customers in both cases is required. This may not be fully symbolised by letter or number grades. Marks, in fact, detract from the prime objective of education which is developing young people's sense of taking pride in successfully completed job. In Schools of Quality, tests and other assessments are much more an indication of the teacher's success through the success of their students.

The second Pillar is a personal dedication by everyone to **continuous improvement,** little by little, day by day, within one's sphere of influence. For instance, student groups and teacher groups might form Support Teams to provide mutual support in academic and personal matters on a regular basis. Continuous improvement is much easier to integrate into operations if people interact and share experience.

The third Pillar is a **process/system approach.** Deming has hypothesised that as much as 80% of all things that go wrong in any organisation are not entirely attributable to individuals, but rather to the system in which they work. In schools, teachers and students combine efforts to continuously improve the system of teaching and learning, as teachers and administrators work together to improve the system of rules, expectations, policies, and other factors which constitute the operational culture of the school. Parents, families, business leaders, and the people of the community are invited to join this collaborative work for the long-term benefit of the young people and generations to follow.

The final Pillar is **consistent quality leadership.** This is the most crucial of the four Pillars. The ultimate success of the ongoing quality transformation is the responsibility of top management, and can only be achieved over time through constant dedication to the principles and practices of TQM. Leaders must construct fearless work environments in which coercion is set aside to permit risk-taking and temporary failures leading to continuous improvement. Consequently, school management should encourage the design of innovative curriculum, the use of new teaching methods, and more joint projects with external organisations and potential employers of the students.

A decade ago, Americans were shocked by a report on the condition of education. The report was titled "A Nation At Risk" [DoE, 1982]. Today, educators have the opportunity to combine efforts with one another, with students and their families, with businesses and community people, and with others whose common future depends to some extent upon what is done in our schools. We have the opportunity today to transform our Nation At Risk into a Nation of Quality, beginning with Schools of Quality that are grounded in the philosophy of TQM.

H.K. AND U.K. CONSTRUCTION ANOVA RESULT

5S	5.9	4.1	4.1	4.8	5.5	
	4.9	4.1	3.9	4.7	5.0	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	24.4	4.88	0.662		
Row 2	5	22.6	4.52	0.242		
Column 1	2	10.8	5.4	0.5		
Column 2	2	8.2	4.1	0		
Column 3	2	8	4	0.02		
Column 4	2	9.5	4.75	0.005		
Column 5	2	10.5	5.25	0.125		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.324	1	0.324	3.97546	0.116934	7.70865
Columns	3.29	4	0.8225	10.09202	0.022918	6.388234
Error	0.326	4	0.0815			
Total	3.94	9				
BPR	3.8	5.9	5.5	4.5	5.7	
	3.6	5.3	4.7	4.8	4.9	
Anova: Two-Factor Without Replication						
SUMMARY	*Count*	*Sum*	*Average*	*Variance*		
Row 1	5	25.4	5.08	0.802		
Row 2	5	23.3	4.66	0.403		
Column 1	2	7.4	3.7	0.02		
Column 2	2	11.2	5.6	0.18		
Column 3	2	10.2	5.1	0.32		
Column 4	2	9.3	4.65	0.045		
Column 5	2	10.6	5.3	0.32		
ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.441	1	0.441	3.972973	0.117018	7.70865
Columns	4.376	4	1.094	9.855856	0.023893	6.388234
Error	0.444	4	0.111			
Total	5.261	9				

H.K. AND U.K. CONSTRUCTION ANOVA RESULT

QCC	5.8	4.9	5.5					
	4.6	5.0	4.7					
Anova: Two-Factor Without Replication								
SUMMARY	*Count*	*Sum*	*Average*	*Variance*				
Row 1	3	16.2	5.4	0.21				
Row 2	3	14.3	4.766667	0.043333				
Column 1	2	10.4	5.2	0.72				
Column 2	2	9.9	4.95	0.005				
Column 3	2	10.2	5.1	0.32				
ANOVA								
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*		
Rows	0.601667	1	0.601667	2.714286	0.241213	18.51276		
Columns	0.063333	2	0.031667	0.142857	0.875	19.00003		
Error	0.443333	2	0.221667					
Total	1.108333	5						
ISO	4.4	4.9	5.2	3.7	4.2	3.8	4.4	3.4
	4.5	4.7	4.6	3.7	4.1	4.5	5.1	4.4
Anova: Two-Factor Without Replication								
SUMMARY	*Count*	*Sum*	*Average*	*Variance*				
Row 1	8	34	4.25	0.371429				
Row 2	8	35.6	4.45	0.171429				
Column 1	2	8.9	4.45	0.005				
Column 2	2	9.6	4.8	0.02				
Column 3	2	9.8	4.9	0.18				
Column 4	2	7.4	3.7	0				
Column 5	2	8.3	4.15	0.005				
Column 6	2	8.3	4.15	0.245				
Column 7	2	9.5	4.75	0.245				
Column 8	2	7.8	3.9	0.5				
ANOVA								
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*		
Rows	0.16	1	0.16	1.076923	0.333899	5.59146		
Columns	2.76	7	0.394286	2.653846	0.110591	3.787051		
Error	1.04	7	0.148571					
Total	3.96	15						

H.K. AND U.K. CONSTRUCTION ANOVA RESULT

TPM	5.2	4.6	4.5	4.4	4.5	3.9	4.5	5.5	3.9	3.5	3.6
	4.6	3.8	4.5	4.1	3.4	3.3	3.4	5.1	3.8	4.3	3.7

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	11	48.1	4.372727	0.386182
Row 2	11	44	4	0.33
Column 1	2	9.8	4.9	0.18
Column 2	2	8.4	4.2	0.32
Column 3	2	9	4.5	0
Column 4	2	8.5	4.25	0.045
Column 5	2	7.9	3.95	0.605
Column 6	2	7.2	3.6	0.18
Column 7	2	7.9	3.95	0.605
Column 8	2	10.6	5.3	0.08
Column 9	2	7.7	3.85	0.005
Column 10	2	7.8	3.9	0.32
Column 11	2	7.3	3.65	0.005

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.764091	1	0.764091	4.833237	0.052578	4.964591
Columns	5.580909	10	0.558091	3.53019	0.029549	2.97824
Error	1.580909	10	0.158091			
Total	7.925909	21				

TQM	4.6	4.8	4.3	4.3	3.8	4.5	4.2	3.5	4.1	4.6
	4.8	4.8	4.8	4.8	3.8	4.5	3.9	3.9	4.4	4.7

Anova: Two-Factor Without Replication

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
Row 1	10	42.7	4.27	0.155667
Row 2	10	44.4	4.44	0.176
Column 1	2	9.4	4.7	0.02
Column 2	2	9.6	4.8	0
Column 3	2	9.1	4.55	0.125
Column 4	2	9.1	4.55	0.125
Column 5	2	7.6	3.8	0
Column 6	2	9	4.5	0
Column 7	2	8.1	4.05	0.045
Column 8	2	7.4	3.7	0.08
Column 9	2	8.5	4.25	0.045
Column 10	2	9.3	4.65	0.005

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	0.1445	1	0.1445	4.327787	0.067229	5.117357
Columns	2.6845	9	0.298278	8.933444	0.001599	3.178897
Error	0.3005	9	0.033389			
Total	3.1295	19				

App. 6.2: 5-S Implementation Plan

Company: ____________________ **Dept./Section:** ________________

Issue No.: _____ **Issued By:** ________________ **Issue Date:** __________

<== MONTH ==>

Step	5-S ACTIVITY	Person (s) Responsible	1st	2nd	3rd	4th	5th	6th
1	Get top-management commitment, establish status quo and implementation plan.	CEO & 5-S Champion (5-SC)	●					
2	5-S Workshop for 5-S Facilitators	5-SC	●					
3	1st 5-S Day -- Organisation (e.g., Throw away things you do not need.) *	5-SC, Facilitators & CEO		●				
4	Daily 5-S activities by everyone	Facilitators		●	●	●	●	●
5	2nd 5-S Day -- Neatness (e.g., Name everything and assign locations.) *	5-SC, Facilitators & CEO			●			
6	3rd 5-S Day -- Cleaning (e.g., All-together housecleaning) *	5-SC, Facilitators & CEO				●		
7	4th 5-S Day -- Standardisation (Visual management & transparency for things) *	5-SC, Facilitators & CEO					●	
8	5th 5-S Day -- Discipline (e.g., Seeing-is-believing) *	5-SC, Facilitators & CEO						●
9	Grand Prize Presentation for best 5-S department/section	CEO & 5-SC						●
10	Review and plan for next 5-S Campaign	5-SC & Facilitators						●

* *Individual prizes (gold, silver and bronze) should be given to the top three 5-S winners for the Day. They should be presented by the CEO.*

App. 6.3: BPR Implementation Plan

The implementation steps are as follows.

Step 1: Gain commitment to change through the organisation of the top team.

Step 2: Develop a shared vision and mission of the business and of what change is required.

Step 3: Define the measurable objectives, which must be agreed by the team, as being the quantifiable indicators of success in terms of the mission.

Step 4: Develop the mission into its Critical Success Factors (CSFs) to coerce and move it forward.

Step 5: Break down the CSFs into the key or critical business processes and gain process ownership.

Step 6: Break down the critical processes into sub-processes, activities and task and form the teams around these.

Step 7: Re-design, monitor and adjust the process-alignment in response to difficulties in the change process.

Step 1: Gain top level commitment

|

V

Step 2: Identify mission and change required

|

V

Step 3: Define measurable objectives

|

V

Step 4: Develop mission into CSFs

|

V

Step 5: Develop CSFs into critical processes

|

V

Step 6: Develop critical processes into sub-processes

|

V

Step 7: Re-align process if problems arise

Top-down Approach to Business Process Re-engineering

App. 6.4: QCC Implementation Plan

Experience shows that the size of a company is not important to a programme's success but it significantly affects the support structure and organisation. The steps of implementation are:

1. Management is made aware of the QCC process through a management briefing.
2. The feasibility of the QCCs are analysed.
3. A steering committee is formed.
4. Co-ordinator and in-house instructor is selected.
5. Potential area for initial circles is selected.
6. QCC presentations are made to first-line supervisors in identified areas, divisions or departments.
7. Co-ordinators and middle management receive extensive training on the process and their roles.
8. Supervisors who are interested volunteer and receive training.
9. Following training, QCC presentations are made to the employees who report to the newly trained supervisors.
10. Employees volunteer to be members of a circle and receive training.
11. A circle is formed and begins work.
12. Additional circles are formed as interest broadens.
13. Circles work in a systematic way in solving problems, not just discussing them.
14. Management must ensure that solutions achieve a quick implementation once they have been accepted.
15. Circles are not paid directly for their solutions, but management must ensure appropriate and proper recognition.

In order to implement QCC successfully, the following guidelines have been considered:

- Participation is voluntary.
- Management is supportive.
- Employee empowerment is required.
- Training is integral part of programme.
- Members work as a team.
- Members solve problems not just identify them.

App. 6.5: ISO 9000 Implementation Plan

There are 9 **essential steps** to be followed through in order to implement ISO 9000 successfully.

Step 1: Top Management Commitment
Step 2: Establish Implementation Team
Step 3: Assess Current Quality System Status
Step 4: Create a Documented Implementation Plan
Step 5: Provide Training
Step 6: Create Documentation
Step 7: Document Control
Step 8: Monitor Progress
Step 9: Review -- Pitfalls to Effective Implementation

←Week→

Step	5-S ACTIVITY	Person (s) Responsible	1	2	3	4	5	6	7	8
1	Review of existing quality management system	Management representative (MR)	●							
2	Preparation of quality manual	Quality manager QM		●						
3	3.1Study of existing QMS 3.2Training on ISO9000 requirements 3.3Finalise quality manual to aim at simplicity & effectiveness (AS&E) 3.4Training on documenting quality system 3.5Draft operational procedure (AS&E) Part 1	MR + all responsible staff			●					
4	4.1 Draft operational procedure Part 2 4.2 Review of records and forms basing on draft QMS 4.3 Implementation of draft QMS (day1) 4.4 Implementation of draft QMS (day2) 4.5 Review & Improvement of draft QMS	Facilitators				●				
5	5.1 Implementation of revised QMS (day1) 5.2 Implementation of revised QMS (day2) 5.3 Training on IQA & techniques 5.4 Planning and conducting in-company IQA 5.5 Conducting IQA and presentation of IQA result	MR + all responsible staff					●			
6	6.1 Implementing corrective actions 6.2 Planning for achieving compliance audit & management review meeting 6.3 Mock compliance audit 6.4 Feedback to management rep. With further action plan 6.5 Summaries action plan, conclusion and closing meeting	MR + all responsible staff						●		
7	7.1 Review of QMS and audit implementation of corrective/ preventive actions by all concern before the adequacy audit	MR + all responsible staff							●	
8	8.1 Review of QMS and audit implementation of corrective/ preventive actions arise from the adequacy audit before the compliance audit. 8.2 Additional training on compliance audit and techniques	MR + all responsible staff								●
9	Documentation work and review	MR & QM								●

App. 6.6: TPM Implementation Plan

TPM implementation plan consists of **six major activities:**

1. *Elimination of six big losses* based on project teams organised by the production, maintenance, and plant engineering departments.
2. *Planned maintenance* carried out by the maintenance department
3. ***Autonomous maintenance*** carried out by the production department in seven steps.
   Step 1: Initial cleaning
   Step 2: Actions to address the causes and effects of dust and dirt
   Step 3: Cleaning and lubrication standards
   Step 4: General inspection training
   Step 5: Autonomous inspection
   Step 6: Workplace organisation standards
   Step 7: Full implementation of autonomous maintenance
4. *Preventive engineering* carried out mainly by the plant engineering department
5. *Easy-to-manufacture product design* carried out mainly by the product design department
6. *Education and training* to support the above activities

Step	Name	Types of Activities
1	Initial clean-up	Clean up dust and dirt on the equipment; lubricate and adjust machine parts; and detect and repair equipment malfunctions
2	Measures against sources of outbreaks	Prevent causes of dust, dirt, and scattering make places that are difficult to clean and lubricate more accessible; and reduce the time required for clean up and lubrication
3	Formulation of clean-up and lubrication standards	Formulate behavioural standards to maintain clean up, lubrication, and machine part adjustment in a short period of time. (It is necessary to indicate a time framework that can be used daily or periodically)
4	General inspection and training	Training in check-up skills through manuals; detect and repair minor equipment defect through overall checkups
5	Autonomous inspection	Formulate and implement autonomous check up sheets
6	Orderliness and tidiness standard	Standardise various on-the-job management items and devise complete system for upkeep management; i.e Standards for clean-up and lubrication, Standards for physical distribution in the workplace, standardisation of data records, stnadardisation of management of dies, jigs, and tools.
7	Fully autonomous management	Develop corporate policies and goals. Make improvement activities routine: steadily record of mean time between failure, analyse the findings and make equipment improvements.

These steps include all of the 5-S. At each step, the worker is evaluated by a manager or a technical staff member and, upon qualifying, he is given a certificate and proceeds to the next step.

Leicester Business School

TQM

Integrated Approach Internet System (TQMIAIS)

Developed by Christopher Fung

Introduction

TQMIAIS is developed based on a conceptual model called TQMEX standing for Total Quality Management EXcellence model. The TQMEX Model advocates an integrated approach in order to support the transition to systems management, an ongoing process of continuous improvement that begins when the company commits itself to managing by quality. The Model illuminates the elements that form a base to the understanding of TQM philosophy and implementation of the process.

The aim of this web programme is to provide an interactive graphic forum for those who want to know the contemporary development in TQM and to identify those steps that are of particular importance to TQM implementation. The objectives of the TQMIAIS are:

1. To introduce the TQMEX model by using graphical presentation, concise summaries and short quizzes to refresh memories.
2. To encourage participation in the "Forum For Discussion" through the sharing of experiences, problems solving, success/ failure stories, research outputs or just the exchange of ideas and thoughts on activities in TQM.
3. To benchmark your TQM status quo using an advisory service in the form of an Expert System based on the research findings in Hong Kong, Japan and the UK by the author.
4. To validate whether the TQMEX model is a sound management method which advocates good quality practices based on the feedback from the professionals in the field.

Press O.K to continue OK

Last updated on Thursday, January 18 1996

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TQM

An Integrated Approach Internet System

Developed by Christopher Fung

Registration Form

Please complete the following registration document. Completion of items marked with an asterisk (*) is optional.

If you have already registered, please click here.

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Surname:
Position:
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 Postcode:
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Key area of interest:

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If you have any suggestions or comments of this software please send to Mr. Christopher Fung *Thank you!*

1.0 Introduction to Quality

1.1 What is Quality?

Quality can be interpret as "Customer's expressed and implied requirements are met fully". This is a core statement from which some eminent definitions of quality have been derived. They include: "the totality of features and characteristics of a product or service that bears on its ability to meet a stated or implied need" [ISO, 1994], "fitness for use" [Juran, 1988], and "conformance to requirement" [Crosby, 1979]. It is important to note that satisfying the customers' needs and expectations is the main factor in all these definitions. Therefore it is an imperative for a company to identify such needs early in the product/service development cycle. The ability to define accurately the needs related to design, performance, price, safety, delivery, and other business activities and processes will place a firm ahead of its competitors in the market. In 1992 Crosby broadened his definition for quality adding an integrated notion to it: "Quality meaning getting everyone to do what they have agreed to do and to do it right the first time is the skeletal structure of an organisation, finance is the nourishment, and relationships are the soul." Some Japanese companies find that "conformance to a standard" too narrowly reflects the actual meaning of quality and consequently have started to use a newer definition of quality as "providing extraordinary customer satisfaction". There is a trend in modern day competition among Japanese companies to give you rather more in order to 'delight' you. So when you buy a lamp bulb which has a 'mean time between failure' of 1,000 hours, the Japanese manufacturer will try their best to ensure that you can get at least 20% more. Likewise, when you buy a Japanese brand video tape specifying 180 minutes, it can normally record up to 190 minutes. When you buy a 'mink' coat from a department store in Japan, they would invite you to store the fur coat in their temperature-control room during the hot summer season free-of-charge. They call these extra little things as 'extra-ordinary customer satisfaction' or 'delighting the customers'

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1.2 Definition of Quality

Despite being in use for nearly 50 years, the term TQM still poses problems of definition for writers on quality, and consequently often remain a rather abstract term. There are a number of well-known quality definitions. ISO 8402 [ISO, 1986] defines quality as "the totality of features and characteristics of a product or service that bears on its ability to meet a stated or implied need". [Crosby, 1979] defines quality as "conformance to requirement". [Juran, 1988] defines quality as "fitness for use". Japanese companies found the old definition of quality "the degree of conformance to a standard" too narrow and consequently have started to use a new definition of quality as "user satisfaction" [Wayne, 1983]. Table below defines quality from the view point of different quality professionals and to provide a conceptual scheme for the discussion of TQM. This can be classified in three sections: Customer-base, Service and Manufacturing-base, and Value-based definition.

Quality Definition

Customer-based Definitions

- Edwards [1968] Quality consists of the capacity to satisfy wants...
- Gilmore [1974] Quality is the degree to which a specific product satisfies the wants of a specific consumer.
- Kuehn & Day [1962] In the final analysis of the marketplace, the quality of a product depends on how well it fits patterns of consumer preferences.
- Juran [1988] Quality is fitness for use.
- Oakland [1989] The core of a total quality approach is to identify and meet the requirements of both internal and external customers.

Manufacturing & Service-based definitions

- Crosby [1979] Quality [means] conformance to requirements
- Price [1985] Do it right first time

Value-based definitions

- Broh [1982] Quality is the degree of excellence at an acceptable price and the control of variablity at an acceptable cost.
- Feigenbaum [1983] Quality is the degree to which a specific product conforms to a design or specification
- Newell & Dale [1991] Quality must be achieved in five basic areas: people, equipment, methods, materials and the environment to ensure customer's need are met.
- Kanji [1990] Quality is to satisfy customers' requirements continually; TQM is to achieve quality at low cost by involving everyone's daily commitment.

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1.3 Why is there a need for TQM?

"In order to compete in a global economy, our products, systems and services must be of a higher quality than our competition. Increasing Total Quality is our number one priority here at Hewlett-Packard."

– John Young, President of Hewlett-Packard

From the two examples of corporate visions and mission statements below, it is apparent that all these companies want to provide good quality goods and services to their customers. The end result is that they will enjoy prosperity and long-term growth.

Example 1: **Matsushita Electric (by K. Matsushita, Founder)**
Vision:

"Profits are linked to growth and that investments which promote growth will eventually pay off in the long term."
Mission Statement:

- National service through industry,
- Fairness,
- Harmony and co-operation,
- Strive for betterment,
- Courtesy and humility,
- Assimilation to the society, and
- Gratitude.

Example 2: **Leicester Business School, De Montfort University (by J. Coyne, Head of School)**
Vision:
"By the year 2000 we want to be recognised amongst the leading Business School in Britain. With our critical mass and full range, full function approach to Business we aim to be 'The Best of the Big.'"
Mission Statement:

- To be recognised as a major provider of high quality teaching, research, management development and consultancy, servicing clients regionally, nationally and internationally.
- To provide a supportive working environment, with staff and students enjoying facilities of the highest standards attainable within the resources available.
- To contribute fully to the creation of a major international University of the Year 2000.

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Self-Assessment: Quality Consciousness Checklist

Quality begins with an awareness of some basic quality concepts. For example, as a consumer, you probably have developed a 'quality consciousness' over the years. Remember how you liked the mint-green toothpaste better than the white colour, because it gave you an additional mint smell after brushing your teeth. Later you made many life choices based on quality: where you lived and worked, who your friends were, what lifestyle you wanted. The following exercise is to help you to identify your quality consciousness. Please consider each of the following statements and mark it True or False based on your current awareness of quality at work and in your personal life.

true false	Quality is preventing problems rather than picking up the pieces afterward.
true false	Quality can always be improved.
true false	The KISS (Keep It Short and Simple) method is the best way to ensure quality.
true false	The most important reason for a quality programme at work is to have satisfied customers.
true false	Constant attention to quality is unnecessary.
true false	First impressions aren't important in creating a quality environment.
true false	Quality is the little things as well as the big things.
true false	A quality programme must have management support to be successful.
true false	Quality guidelines are best communicated by word-of-mouth.
true false	Most people want to do quality work.
true false	Customers pay little attention to quality.
true false	A quality programme must integrate with the organisation's goals and profit plans.
true false	Quality means conformance to standards.
true false	Quality should operate in all parts of a business.
true false	Personal quality standards and business quality standards have little in common.
true false	Quality requires commitment.
true false	Quality relates to the process as much as to the goal.
true false	People who talk about quality are idealists.

Please fill in the details again before submission:

First Name:

Surname:

Email-address:

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2.0 TQM Gurus' Ideas

	Dr. Edward W. Deming (managment philodsophy and systems)
	Dr. Joseph M. Juran (quality trilogy)
	Dr. Philip Crosby (zero defects and cost of quality)
	Dr. Kaoru Ishikawa (simple tools, QCC, company-wide quality)
	Dr. Shigeo Shingo (Fool-proofing)
	Dr. Yoshio Kondo (four steps for making creative and quality work

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2.1 Deming's Message

Deming encouraged the Japanese to adopt a systematic approach to problem solving, which later became known as the Deming or Plan-Do-Check-Act (PDCA) Cycle Fig.2.1. Deming, however, referred to it as the Shewhart Cycle, named after his teacher W. A. Shewhart [1931]. He subsequently replaced "Check" by "Study", as that word reflects the actual meaning more accurately. Therefore an alternative abbreviation for the Deming Cycle is PDSA Cycle. Deming also pushed senior managers to become actively involved in their company's quality improvement programmes. His greatest contribution to the Japanese is the message regarding a typical business system. It explains that the consumers are the most important part of a production line. Meeting and exceeding the customers' requirements is the task that everyone within an organisation needs to accomplish. Furthermore, the management system has to enable everyone to be responsible for the quality of his output to his internal customers.

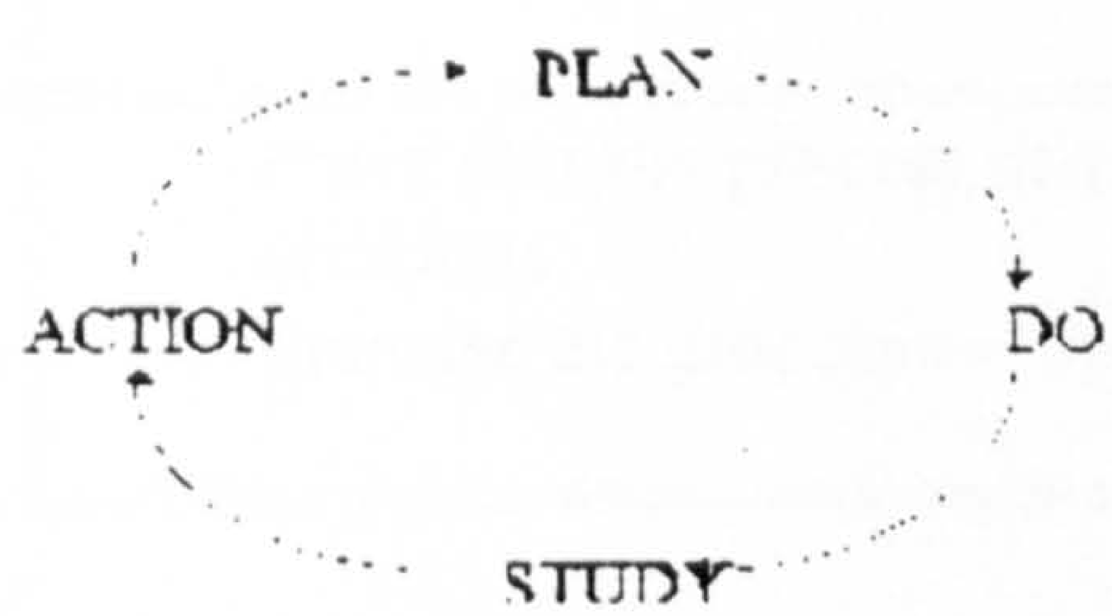

Fig 2.1 PDCA Cycle

Deming's thinking in the late 1980's can best be expressed as Management by Positive Co-operation. He talks about the New Climate (organisational culture) which consists of three elements.

- Joy in Work,
- Innovation, and
- Co-operation.

He has referred to this New Climate as 'Win: Win', as opposed to the 'I Win: You Lose' attitude engendered by competition. In his seminars in America in the 80's, he spoke of the need for 'the total transformation of Western Style of Management'. He produced his 14 Points for Management [Deming, 1989], in order to help people understand and implement the necessary transformation. Deming said that adoption of and action on the 14 points are a signal that management intend to stay in business. They apply to both small and large organisations, and to service industries as well as to manufacturing.

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2.2 Juran's Message

Juran developed the idea of **quality trilogy:** quality planning, quality improvement and quality control. These three aspects of company-wide strategic quality planning are further broken down in Juran's 'Quality Planning Road Map', into following key elements:

Quality Planning	☐ Identify who are the customers. ☐ Determine the needs of those customers. ☐ Translate those needs into our language. ☐ Develop a product that can respond to those needs. ☐ Optimise the product features so as to meet our needs and customer needs.
Quality Improvement	☐ Develop a process which is able to produce the product. ☐ Optimise the process.
Quality Control	☐ Prove that the process can produce the product under operatingc onditions. ☐ Transfer the process to Operations.

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2.3 Crosby's Message

Crosby's name is best known in relations to the concepts of **Do It Right First time** and **Zero Defects.** He considers traditional quality control, acceptable quality limits and waivers of sub-standard products to represent failure rather than assurance of success. Crosby therefore defines quality as conformance to the requirements which the company itself has established for its products based directly on its customers' needs. He believes that since most companies have organisations and systems that allow deviation from what is really required, manufacturing companies spend around 20% of their revenues doing things wrong and doing them over again. According to Crosby this can be 35% of operating expenses for service companies.

He does not believe that workers should take prime responsibility for poor quality; the reality, he says, is that you have to get management straight. In the Crosby scheme of things, management sets the tone on quality and workers follow their example; whilst employees are involved in operational difficulties and draw them to management's attention, the initiative comes from the top. Zero defects means that the company's objective is 'doing things right first time'. This will not prevent people from making mistakes, but will encourage everyone to improve continuously.

In the Crosby approach the Quality Improvement message is spread by creating a core of quality specialists within the company. There is strong emphasis on the top-down approach, since he believes that senior management is entirely responsible for quality.

The ultimate goal is to train all the staff and give them the tools for quality improvement, to apply the basic precept of Prevention Management in every area. This is aided by viewing all work as a process or series of actions conducted to produce a desired result. A process model can be used to ensure that clear requirements have been defined and understood by both the supplier and the customer. He also views quality improvement as an ongoing process since the work 'programme' implies a temporary situation. Crosby's Quality Improvement Process is based upon the

Four Absolutes of Quality Management

1. Quality is defined as conformance to requirements, not as 'goodness' or 'elegance'.
2. The system for causing quality is prevention, not appraisal.
3. The performance standard must be Zero Defects, not "that's close enough".
4. The measurement of quality is the Price of Nonconformance, not indices.

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2.4 Ishikawa's Message

Ishikawa's biggest contribution is in simplifying statistical techniques for quality control in industry. At the simplest technical level, his work has emphasised good data collection and presentation, the use of Pareto Diagrams to prioritise quality improvements and Ishikawa Diagrams.

Ishikawa sees the Cause-and-Effect Diagram (or Ishikawa Diagram), like other tools, as a device to assist groups or quality circles in quality improvement. As such, he emphasises open group communication as critical to the construction of the diagrams. Ishikawa diagrams are useful as systematic tools for finding, sorting out and documenting the causes of variation of quality in production and organising mutual relationships between them. Other techniques Ishikawa has emphasised include the seven Quality Control tools.

Other than technical contributions to quality, Ishikawa is associated with the *Company-wide Quality Control (CWQC)* Movement that started in Japan during the period 1955--60 following the visits of Deming and Juran. Ishikawa sees the CWQC as implying that *quality does not only mean the quality of product, but also of after sales service, quality of management, the company itself and the human life*. The outcomes of such an approach are:

1. Product quality is improved and becomes uniform. Defects are reduced.
2. Reliability of goods is improved.
3. Cost is reduced.
4. Quantity of production is increased, and it becomes possible to make rational production schedules.
5. Wasteful work and rework are reduced.
6. Technique is established and improved.
7. Expenses for inspection and testing are reduced.
8. Contracts between vendor and vendee are rationalised.
9. The sales market is enlarged.
10. Better relationships are established between departments.
11. False data and reports are reduced.
12. Discussions are carried out more freely and democratically.
13. Meetings are operated more smoothly.
14. Repairs and installation of equipment and facilities are done more rationally.
15. Human relations are improved.

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2.5 Shingo's Message

In terms of quality, Shingo's paramount contribution was his development in the 1960s of Poka-Yoke and source inspection systems. These developed gradually as he realised that statistical quality control methods would not automatically reduce defects to zero.

The basic idea is to stop the process whenever a defect occurs, define the cause and prevent the recurring source of the defect. This is the principle of the JIT production system. No statistical sampling is therefore necessary. A key part of this procedure is that source inspection is employed as an active part of production to identify errors before they become defects. Error detection either stops production until the error is corrected, or it carries adjustment to prevent the error from becoming a defect. This occurs at every stage of the process by monitoring potential error sources. Thus defects are detected and corrected at source, rather than at a later stage.

Following a visit to Yamada Electric in 1961, Shingo started to introduce simple, mechanical devices into assembly operations, which prevented parts from being assembled incorrectly and immediately signalled when a worker had forgotten one of the parts. These mistake-proofing or 'Poka-Yoke' devices had the effect of reducing defects to zero.

In 1967 Shingo further refined his work by introducing source inspections and improved Poka-Yoke systems which actually prevented the worker from making errors so that defects could not occur. Associated advantages were that statistical sampling was no longer necessary, and that workers were more free to concentrate on more valuable activities such as identifying potential error sources.

Having learned about and made considerable use of statistical QC in his 40s, it was some 20 years later, in 1977, that Shingo observed that the Shizuoko plant of Matsushita's Washing Machine Division had succeeded continuously for one month with zero defects on a drain pipe assembly line with involvement of 23 workers. He realised that statistical QC is not needed for zero-defect operations. This was achieved principally through the installation of Poka-Yoke devices to correct defects and source inspection to prevent defects occurring. Together these techniques constitute Zero Quality Control, which, Shingo argues, can achieve what may have been impossible using statistical quality control methods.

Shingo advocated the practical application of zero defects by good engineering and process investigation, rather than slogans and exhortations that have been associated with the quality campaigns of many American and Western companies. Shingo, like Deming and Juran, argued that such American approaches of displaying defects statistics were misguiding and demoralising. Instead, the results of improvement should be announced and displayed.

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2.6 Kondo's Message

Kondo emphasises the interrelationship between quality and people. He sees humanity as the essence of motivation. He endorses that human work should always include the following three components:

- Creativity -- the joy of thinking
- Physical activity -- the joy of working with sweat on the forehead
- Sociality -- the joy of sharing pleasure and pain with colleagues

He further points out that the elements of creativity and sociality are involved in company-wide quality control as well as physical activity, since the aim of CWQC is to ensure the superior quality of manufactured products and service through the stages of marketing, designing and manufacturing and, in so doing, to promote customer satisfaction. In other words, there is no basic contradiction between CWQC activities and humanity.

The major problems lie in the stages of designing the manufacturing process and evaluating the results of the work. When manufacturing is conducted only by standardising and simplifying the work and by separating planning from actual execution and when the results of the work are judged only in terms of money, how can we motivate workers by offering them meaningful jobs?

In his book Human Motivation - A Key Factor for Management published in 1989, Kondo advocates that making work more creative is important for motivation. He suggests four points of action in support of such a process:

1. **When giving work instruction, clarify the true aims of the work.**
   Instead of explaining clearly what the aim of a job is, people tend to concentrate on the methods and means to be used for achieving that aim. However, every job has an aim, and it goes without saying that achieving this aim is the most important thing. Aside from mandatory restrictions related to safety and quality assurance, information concerning means and methods should be given for reference only, and we should encourage people to devise their own best ways of achieving the objectives.

2. **See that people have a strong sense of responsibility towards their work.**
   This is related to the previous point. As we know well, human beings are often weak and irrational and tend to try to shift responsibility onto someone else when their work goes wrong, complaining or being evasive. It is, therefore, necessary to devise ways of nipping such excuses in the bud whenever they seem likely to appear. The 'mandatory objectives, optional means' approach described in Point 1 above serves this purpose, and techniques such as the stratification of data, the correction of data by mean value or by regression, and the application of the orthogonal principle in the design of experiments [Taguchi, 1986] are all effective devices for putting a stop to excuses.

3. **Give time for the creation of ideas.**

Once people start feeling such a strong sense of responsibility, they will go back to the essence of the problem and think about it deeply. This will result in flashes of inspiration and the creation of new ideas. Excellent ideas are most easily generated during those times when we have pondered the problem deeply and have arrived at a detached, meditative state of mind. An ancient Chinese proverb tells us that this kind of time occurs when we are horseback riding, lying down and relaxing. The times at which ideas come most readily are different for every individual. The important thing is to give people the time to be creative.

4. **Nurture ideas and bring them to fruition.**
   New-born ideas created in this way are extremely fragile. If they are examined critically with the intention of picking them to pieces or squashing them down, it is very easy to obliterate them completely. However, to find out whether such ideas are really good or not, or to develop them in superior ways, they must be allowed to grow. There is no objection during this stage of growth to allowing an idea to change gradually from its original form into a better one. It is often said that the main enemies of new product development are found within the company itself. This means that people are more concerned about going around stepping on new ideas than about encouraging their development. A new born idea is like a new-born baby, and raising it to maturity always requires someone to look after its interest and act as a loving parent. In most cases, those in positions of authority are the only ones who can play this role. In other words, managers should not go around throwing cold water on new ideas but should become their patrons and encourage their growth.

Kondo concludes that only by addressing all four points will it be possible for work to be reborn as a creative activity. If ideas are created and fostered, those concerned will come to feel a real sense of self-confidence. This is an extremely valuable experience from the standpoint of motivation.

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Self-Assessment: #4.1.1 Understanding Gurus' Ideas

Match the different ideas with the quality gurus by selecting the appropriate box.

SECTION	IDEAS	Deming	Juran	Crosby
4.1	Spiral of progress in quality			
4.2	14 Points			
4.3	Zero Defect			
4.4	Profound Knowledge			
4.5	PDCA Cycle			
4.6	Quality is free			
4.7	Chain reaction			
4.8	Quality trilogy			
4.9	14 Step quality improvement programme			
4.10	Quality is fitness for use			

Please fill in your details again before submission:

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3.0 The TQM Model

(Total Quality Management Excellence Model)

3.1 INTRODUCTION: The Need for a Model in TQM

At the century close, the creation of the global market, international orientation of management that sweeps national boundaries, introduction of new technologies, and shift towards customer focused strategies, make the competition stronger than ever. The criteria for success in this global, internationally oriented market have been changing rapidly. In order to expand business, enter new markets, and set realistic, competitive long-term objectives, excellence became an imperative. Management's effort has been directed towards discovering what makes a company excellent.

To achieve excellence, companies must develop a corporate culture of treating people as their most important asset and provide a consistent level of high quality products and services in every market in which they operate. Such an environment has supported the wide acceptance of Total Quality Management (TQM) which emerged recently as a new, challenging, marketable philosophy. It involves three spheres of changes in an organisation -- people, technology and structure.

There is also a need for a systematic approach so that each element of TQMEX can be bonded together smoothly. Oakland [1989] originated the idea of a 3-cornerstone model. The proposed 4-pillar model (Figure 3.1) brings the customer's requirement into the system. This makes the approach to TQM more complete. The additional pillar -- satisfying customers -- is vital because it explicitly addresses customers requirements. Without it TQM would have no objective.

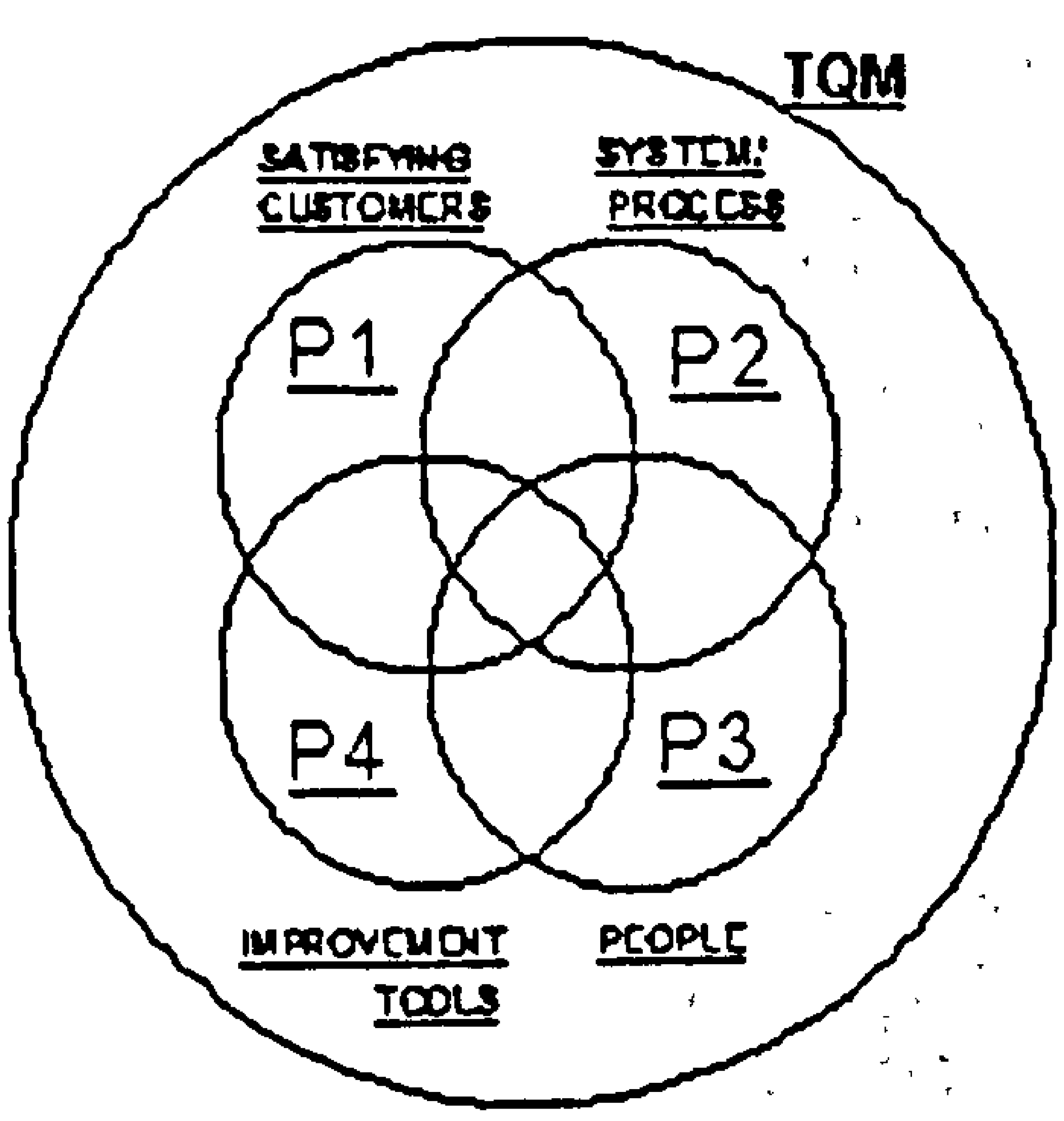

Fig. 3.1 The Four Pillars of TQM

The role of top management in implementation of total quality is crucial and its input on people far-reaching. TQM, therefore, should be understood as management of the system through systems thinking, which means understanding all the elements in the company and putting them to work together towards the common goal. The TQMEX Model advocates an integrated approach in order to support the transition to systems management which is an ongoing process of continuous improvement that begins when the company commits itself to managing by quality. The Model illuminates the elements that form a base to the understanding of TQM philosophy and implementation of the process company-wide.

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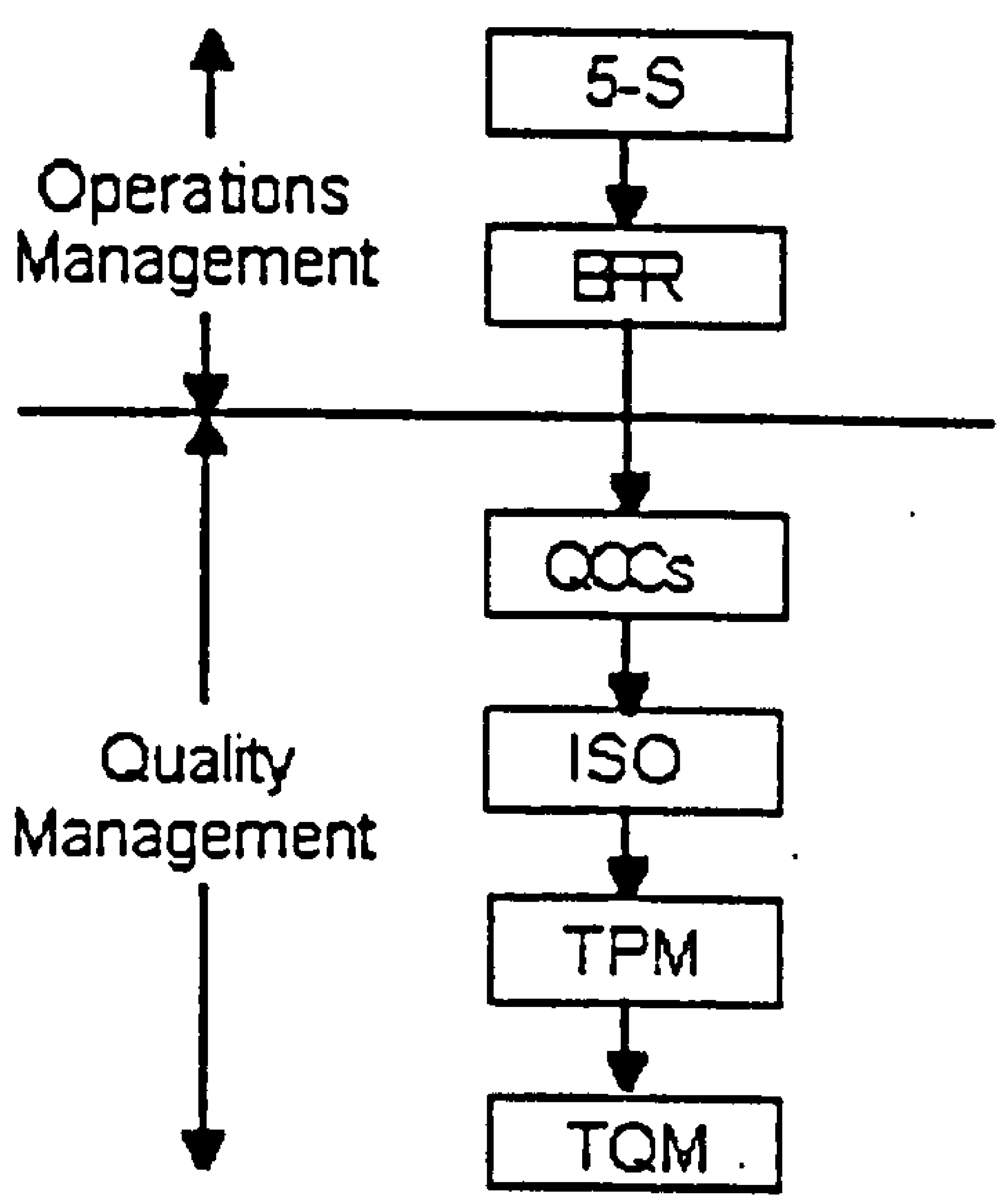
3.2 The Structure of TQMEX



5-S = Seiri, Seiton, Seiso,Seiketsu, Shitsuke
BPR = Business Process Re-engineering
QCCs = Quality Control Circles
ISO = ISO 9001/2 Quality Management System
TPM = Total Productive Maintenance
TQM = Total Quality Management

Fig. 3.2 The TQMEX Model

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3.3 The Logic of TQMEX

In order to have a systematic approach to TQM, it is necessary to develop a conceptual model. Generally, a model is a sequence of steps arranged logically to serve as a guideline for implementation of a process in order to achieve the ultimate goal. The model should be simple, logical and yet comprehensive enough for TQM implementation. It also has to sustain the changes in business environment of the new era. The Model also reflects teachings of the contemporary quality gurus. The idea was to develop a universally applicable step-by-step guideline by including recognised practices in TQM:

- ☐ Japanese 5-S Practice (5-S)
- ☐ Business Process Re-engineering (BPR)
- ☐ Quality Control Circles (QCCs)
- ☐ ISO 9001/2 Quality Management System (ISO)
- ☐ Total Productive Maintenance (TPM)

As Osada pointed out, 5-S is the key to total quality environment. Therefore, it should be the first step. BPR is concerned with re-defining and designing your business process in order to meet the needs of your customers effectively. It is more concerned with the business objectives and systems, and should follow as Step 2. QCCs are concerned with encouraging the employees to participate in continuous improvement and guide them through. They improve human resources capability to achieve the business objectives. Therefore, this should be Step 3. ISO 9000 is to develop a quality management system based on the good practices in the previous three steps. TPM is a result of applying 5-S to equipment based on a sound quality management system. In fact ISO 9001 requires procedures for process control and inspection and testing equipment which are part of TPM. Therefore TPM should be implemented in Step 5.

If the above five steps have been implemented successfully, the organisation is already very close towards achieving TQM.

TQMEX is a sequential model which is easy to remember and simple to implement. This is in line with the quality principle of Keep It Short and Simple (KISS), although it is not simple to make a model simple!

Companies starting to implement TQM should follow TQMEX step-by-step. Companies which have already gone through some degree of improvement using some of the steps should review what have not been done and do it as their next step of improvement. In order to maximise your benefits from TQMEX, you have to start early too.

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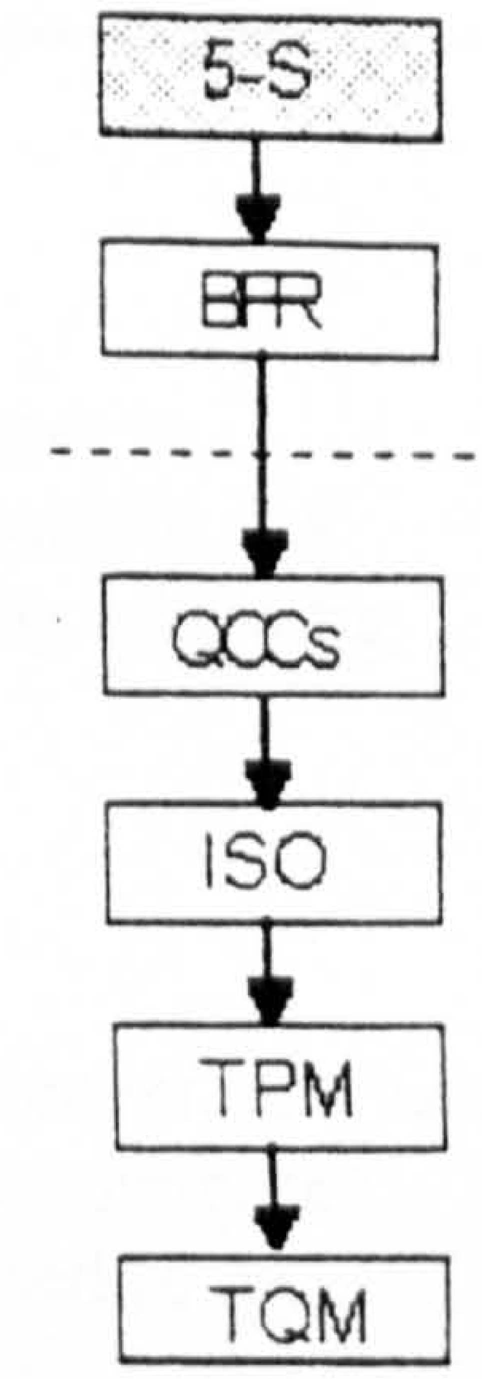
3.3.1 5-S



Introduction to 5-SM

The 5-S practice is a technique used to establish and maintain quality environment in an organisation. The name stands for five Japanese words: Seiri, Seiton, Seiso, Seiketsu and Shitsuke [Osada, 1991]. The English equivalent, their meanings and typical examples are shown in the following table:

JAPANESE	ENGLISH	MEANING	TYPICAL EXAMPLE
Seiri	Structurise	Organisation	Throw away rubbish
Seiton	Systemise	Neatness	30-second retrieval of a document
Seiso	Sanitise	Cleaning	Individual cleaning responsibility
Seiketsu	Standardise	Standardisation	Transparency of storage
Shitsuke	Self-discipline	Discipline	Do 5-S daily

The 5-S technique has been widely practised in Japan. Most Japanese 5-S practitioners consider 5-S useful not just for improving their physical environment, but also for improving their thinking processes too. Apparently the 5-S can help in all stratas of life. Many of the everyday problems could be solved through adoption of this practice. Unfortunately, unlike other quality tools and techniques, this basic but powerful technique for quality improvement has not been known to the western world. More detailed discussion of 5-S will be found in the next Chapter.

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5-S in Detail

The following sections will explain each of the constituents of the 5-S practice in appropriate depth to enable practitioners to get the maximum benefit from its implementation, yet not making it too complicated to understand.

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How to Implement the 5-S?

5-S implementation requires commitment from both the top management and everyone in the organisation. It is also important to have a 5-S Champion to lead the whole organisation towards 5-S implementation step-by-step. If you decide to be the 5-S Champion of your organisation, the following steps will help you to achieve success.

Step 1: Get Top Management Commitment and be Prepared

You have to sell the idea of the 5-S to the most senior executive of your organisation. Moreover, and like any other quality programme, it is no good to get just his lip-service. He needs to be 100% committed; not just in announcing the start of the 5-S practice in the promoting campaign, but committed to give resources for training and improvements. Then you need to get prepared yourself.

In promoting the 5-S activities, the important thing is to do them one at a time and to do each thoroughly. Even the little things have to be taken seriously if they are to make any meaningful impact. This process can be stratified as follows:

1. Make a decision and implement it (e.g., the decision to get rid of everything you do not need, the decision to have a major housecleaning, and the decision to have 5-minute clean-up periods).
2. Make tools and use them (e.g., special shelves and stands for things, instructional labels, and placement figures).
3. Do things that demand improvements as prerequisites (e.g., covers to prevent filings from scattering and measures to prevent leakage).
4. Do things that require help from other departments (e.g., fixing defective machinery, changing the layout, and preventing oil leakage).

Step 2: Draw up a Promotional Campaign

The first thing to do for a promotion campaign is to set up a timetable. In general, the plan can be broken down into 10 key activities:

1. Get top-management commitment, assess status quo and establish implementation plan.
2. 5-S Workshop for 5-S Facilitators -- based on the 5-S Audit Worksheet in Annex 4.1, identify the key 5-S activities, one from each of the 5-S for the first cycle of implementation.
3. 1st 5-S Day -- Organisation (e.g., Throw away things you do not need.)
4. Daily 5-S activities by everyone.
5. 2nd 5-S Day -- Neatness (e.g., Name everything and assign locations.)
6. 3rd 5-S Day -- Cleaning (e.g., All-together housecleaning)
7. 4th 5-S Day -- Standardisation (Visual management & transparency for things)
8. 5th 5-S Day -- Discipline (e.g., Do your own 5-S Audit)
9. Grand Prize Presentation for the best 5-S department/section
10. Review and plan for next 5-S Campaign

Step 3: Keeping Records

It is important to keep records not only of decisions made but also of the problems encountered, actions taken and results achieved. Only if past practice has been recorded people will have a sense of progress and improvement over time. There are a number of tools for keeping records,these are:

2. **Photographs**
3. **Videos**
4. **Quantification**
5. **Museum Rooms**

Step 4: 5-S Training

The 5-S activities are all directed at eliminating waste and effecting continuous improvement in the workplace. Right from the beginning there will seem to be lots of 5-S activities to be done. As you go on, you will notice that there are always additional 5-S problems to solve. They are not insurmountable, though, if considered and solved one at a time.

It is essential in the 5-S activities that you train people to be able to devise and implement their own solutions. Progress that is not self-sustaining -- progress that always has to rely upon outside help -- is not real progress. It is important that your people know, for example, how to use the computer to do charts and graphs, even if it is not part of their job description. They need to study maintenance techniques. And oddly enough, the more problems they are capable of solving, the more problems they will spot.

Training should also include section-wide or company-wide meetings where people can announce their results. Not only does this provide incentive, but the exchange of ideas and information is often just what you need to keep everybody fresh.

Step 5: Evaluation

As with so many other things, it is very easy to get into a routine with 5-S activities -- particularly because they demand constant everyday attention to routine details. At the same time, because the individual tasks appear minor even though they have great cumulative impact, it is easy to think that you can put them off. Everybody is busy, and it is difficult to make alert 5-S activities a part of the daily routine. Workplace evaluations and other means are needed to keep everyone abreast of what is happening and to spot problems before they develop into major complications. In essence, you need to devise ways that will get everybody competing in a friendly but no less intense manner. Your evaluation tools are the key and it is as simple as using the 5-S Audit Worksheet as your evaluation criteria.

Patrols and Cross-evaluations

Two other techniques that you can adopt to promote the 5-S activities are patrols and cross-evaluations. Patrols can go around to the various workshops and offices and point out problems. This is similar to 'managing by walking around', but the patrol members do not even need to be management personnel. They simply need to know what to look for and have the authority to point out problems that need to be worked on. They simply need to know what questions to ask.

Cross-evaluations are a variation on this theme in that they involve having teams working on similar problems offering advice to other teams. One advantage of doing this is the exchange of ideas and mutual learning.

The objectives of the evaluation is to ensure that the 5-S implementation will lead to a conducive total quality environment.

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What is Organisation (Seiri)?

Organisation is about separating the things which are necessary for the job from those that are not and keeping the number of the necessary ones as low as possible and at a convenient location. An example of good and bad organisation are shown in **Fig. 1a** and **Fig. 1b** below.

In those times when the land was poor and supply of goods was naturally restricted, people would hold on to the least little thing because it seemed such a waste, almost a sin to throw anything away. Yet today, when there is an abundance of goods, services, and information, sorting through these things has almost become the art or rare skill. By looking at information alone, there is a whole new career field called information management that does nothing but sort through information and organise it. It is important to save things, but it is just as important to throw things out . And most important of all is knowing what to discard, what to save, and how to save things so that they can be accessed later.

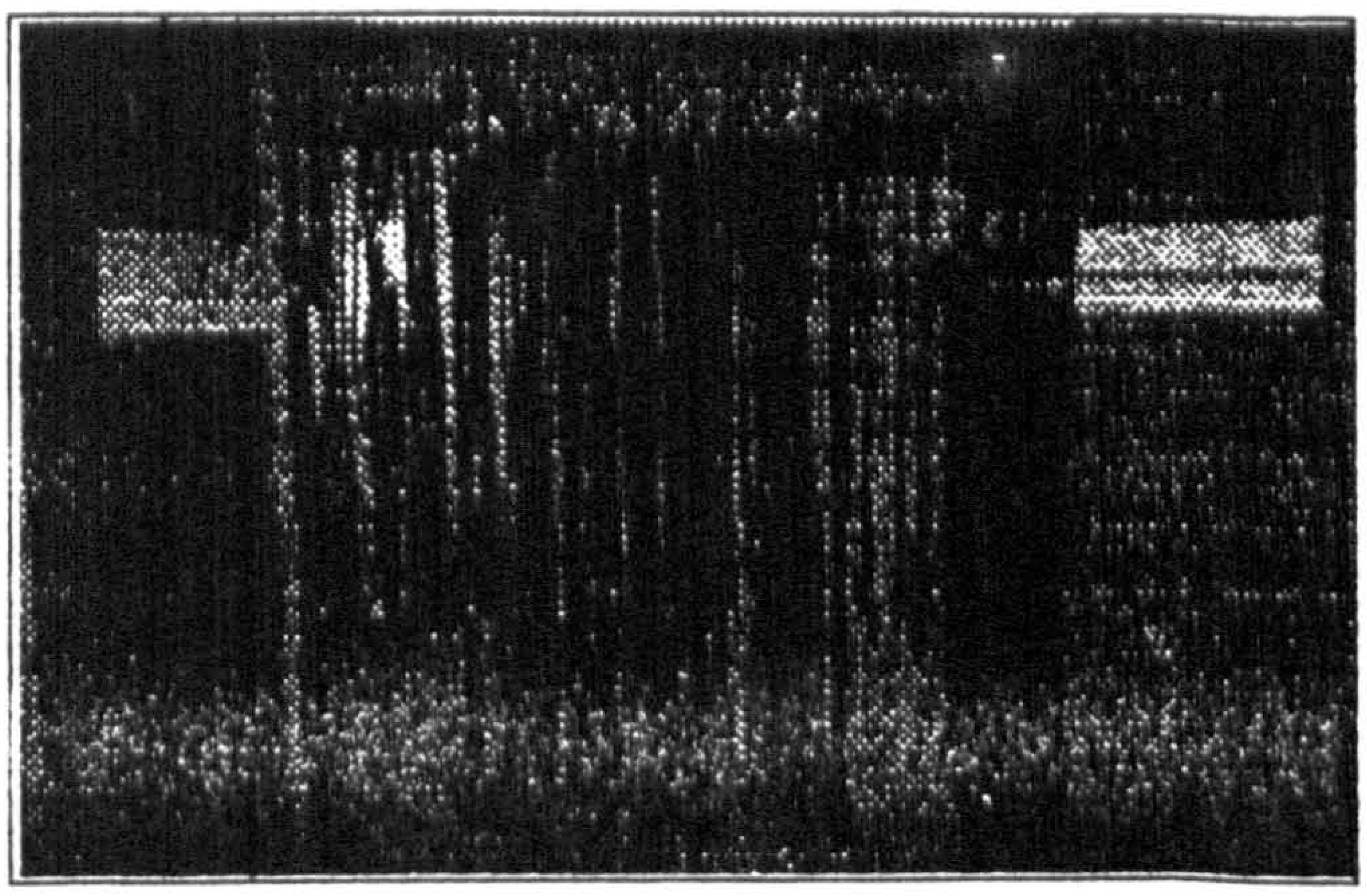

Fig. 1a Good Example of Organisation -- storage of parts

Fig. 1b Bad Example of Organisation -- Throw away rubbish

go back

What is Neatness (Seiton)?

Neatness is a study of efficiency. It is a question of how quickly you can get the things you need and how quickly you can put them away. Just making an arbitrary decision on where things go is not going to make you any faster. Instead, you have to analyse why getting things out and putting them away takes so long. You have to study this for both the people using the things frequently and those who seldom use them. You have to devise a system that everyone can understand. An example of good and bad Neatness are shown in **Fig. 2a** and **Fig. 2b** below.

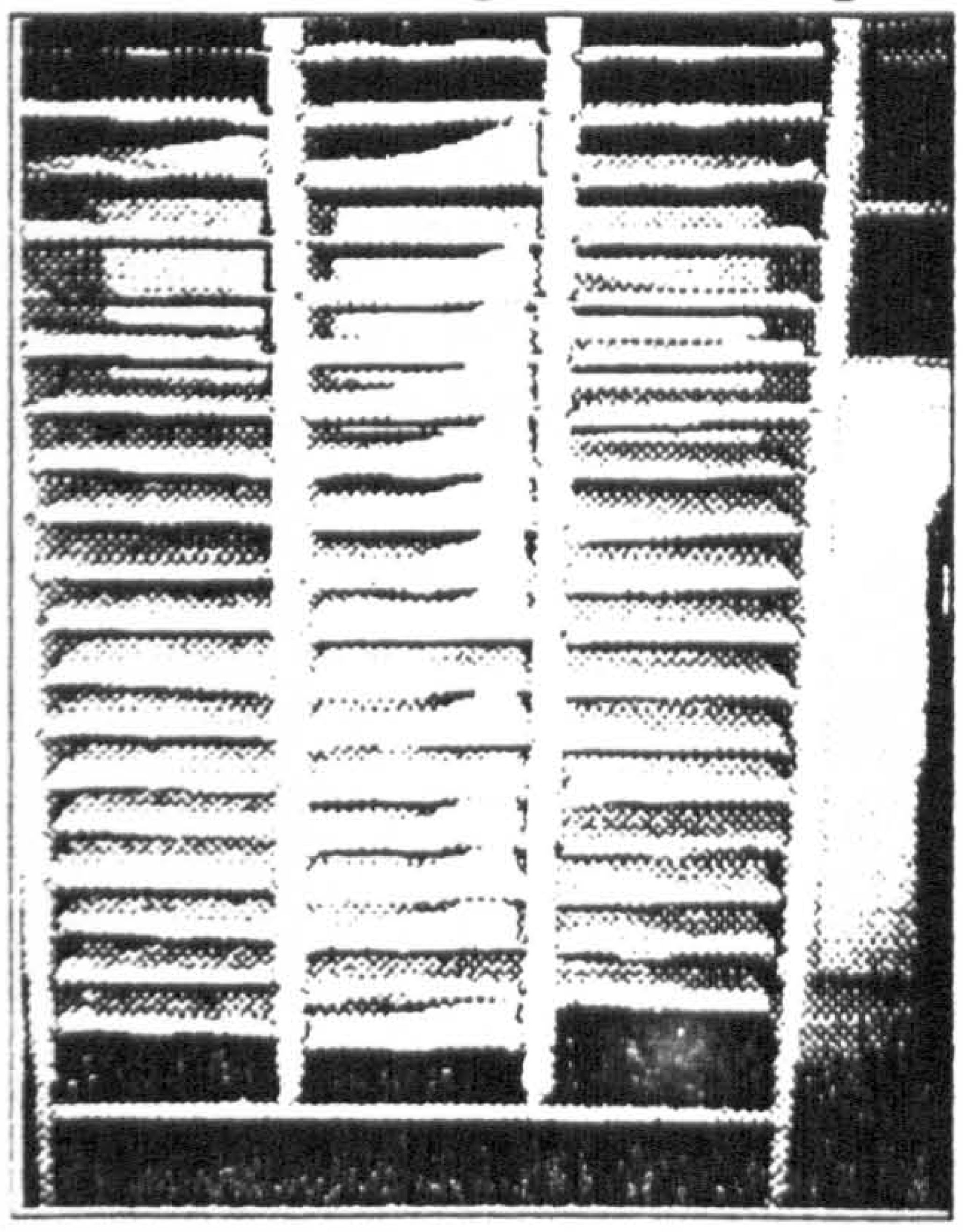

Fig. 2a Good Example of Neatness -- 30 second retrieval

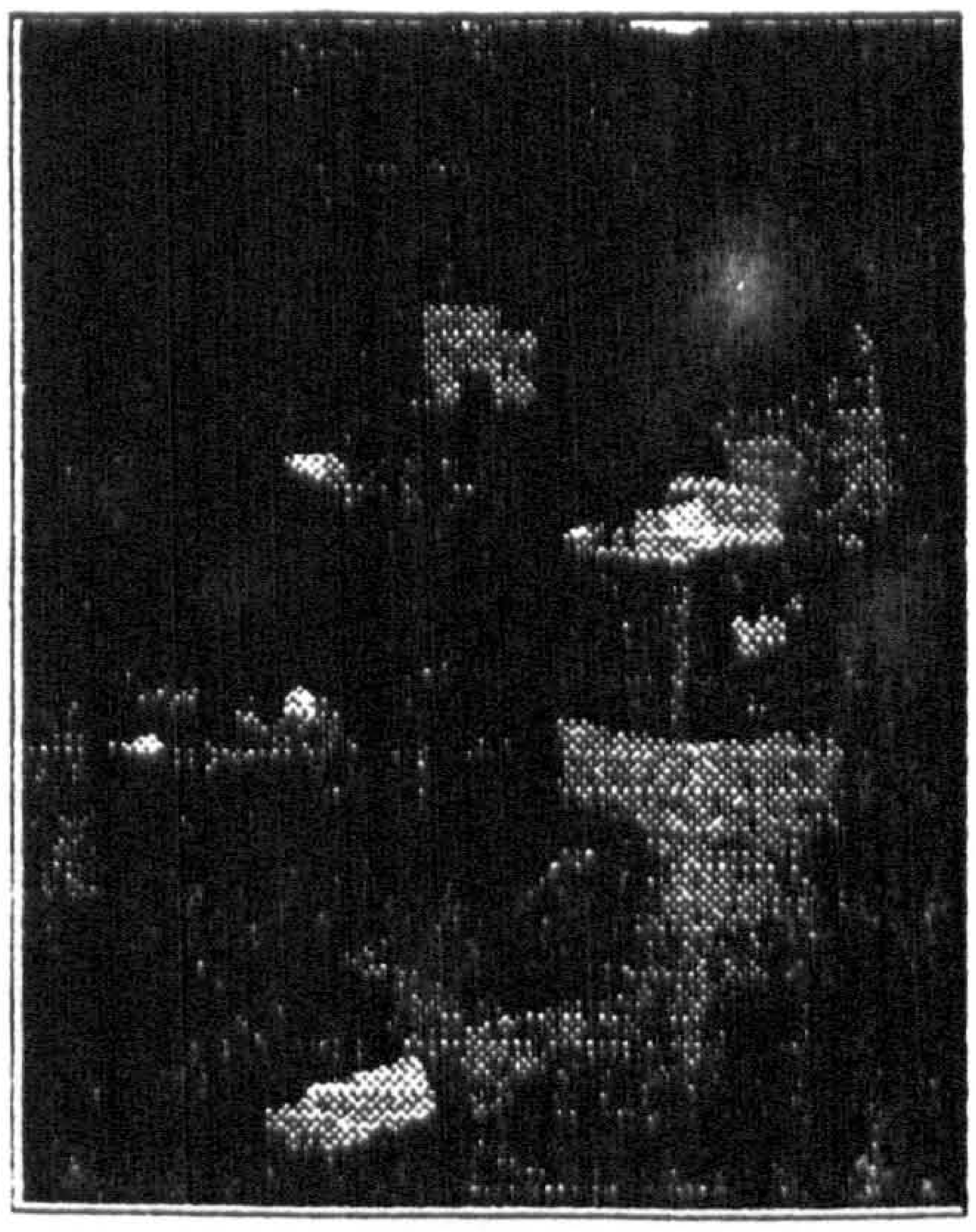

Fig. 2b Bad Example of Neatness -- Home for everything

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What is Cleaning (Seiso) ?

'Everyone is a Janitor' -- Cleaning should be done by everyone in the organisation, from the managing director to the cleaner. This is why in Japan, they do not need street cleaners in residential areas. Every family is responsible for cleaning the pavement in front of their houses. Therefore, what they need are rubbish collectors. The Japanese believe that while they are doing cleaning, they are cleaning their minds, too. If you have done your annual cleaning at home before the New Year, you would probably have this feeling of freshness.

In an office or a factory, you might start by graphing out the individual areas of responsibility. In doing this, it is important that all assignments be absolutely clear and that there is no undefined, unallocated, or grey areas. Unless each and every person takes these admonitions to heart and accepts personal responsibility, you are not going to get anywhere. An example of good and bad cleaning are shown in Fig. 3a and 3b below:

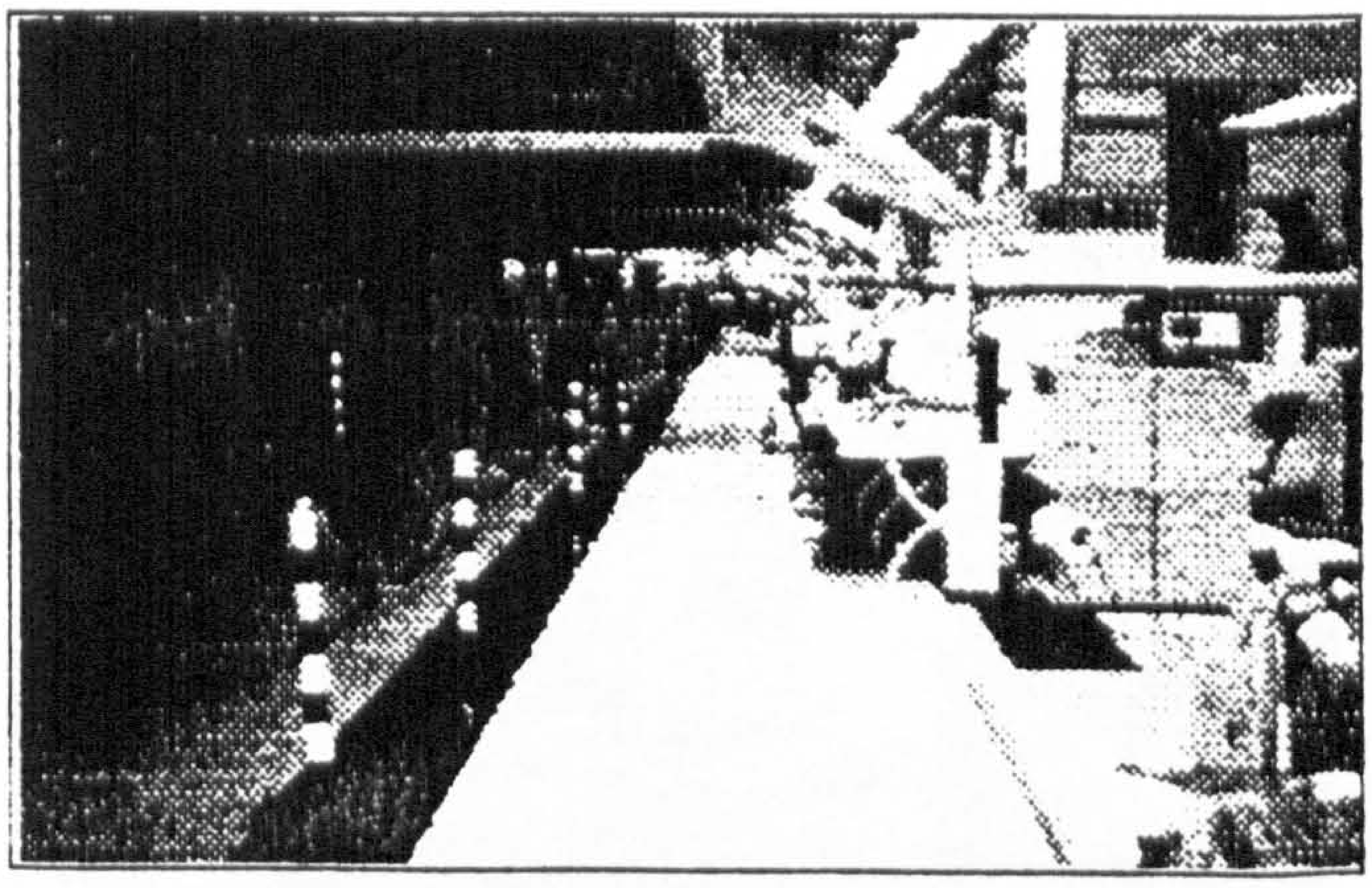

Fig. 3a Good Example of Cleaning -- Sparkling clean campaign

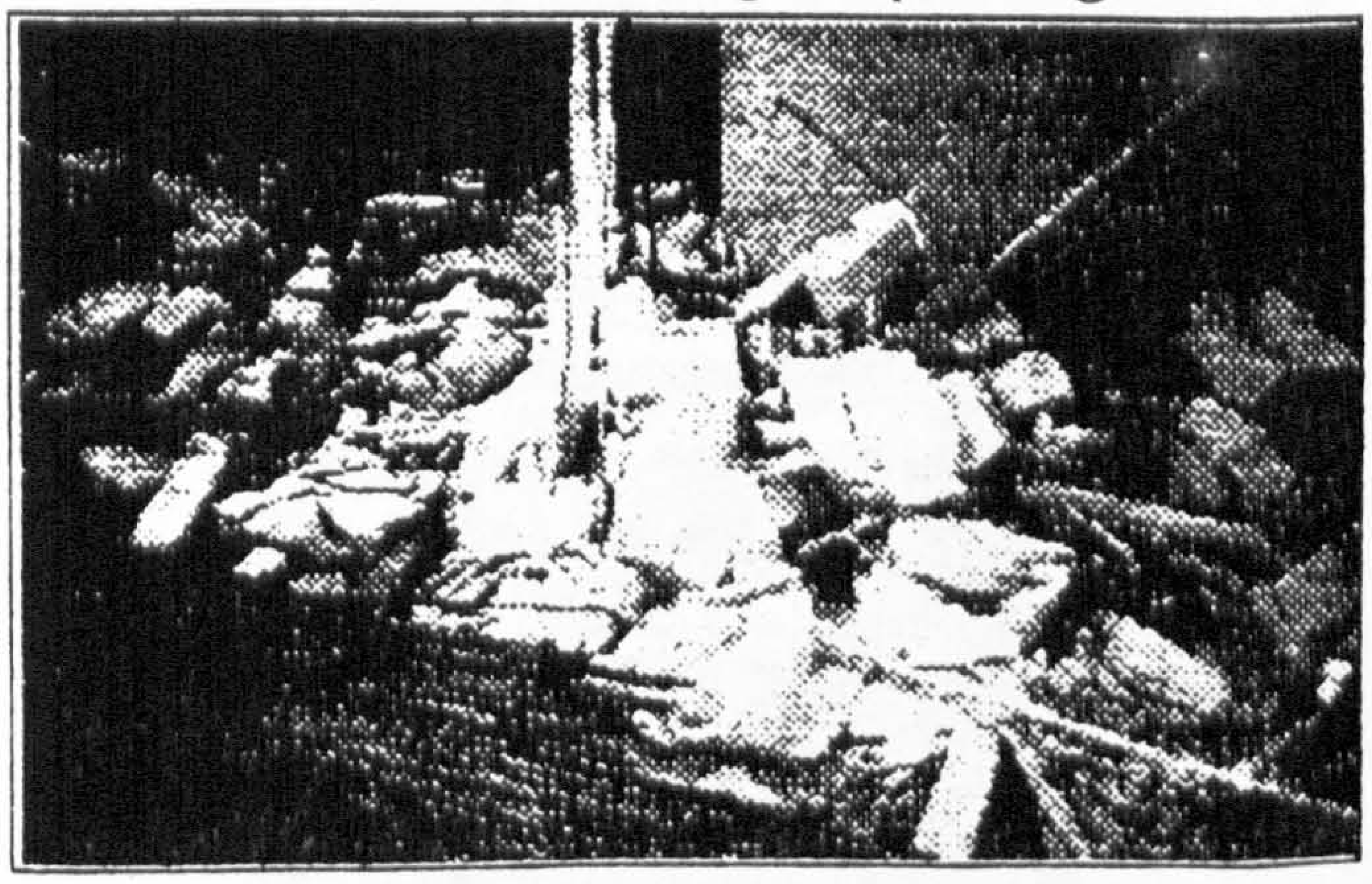

Fig. 3b Bad Example of Cleaning -- individual cleaning responsibility

go back

What is Standardation (Seiketsu) ?

What is Standardisation (Seiketsu)? Standardisation means continually and repeatedly maintaining your organisation, neatness and cleaning. As such, it embraces both personal cleanliness and the cleanliness of the environment. The emphasis here is on visual management and 5-S standardisation. Innovation and total visual management are used to attain and maintain standardised conditions so that you can always act quickly.

Visual management has recently come into the limelight as an effective means of continuous improvement. It has been used for production, quality, safety, and customer services. Colour management has also come in for considerable attention lately. This has been used not only for colour-coding, but also to create a more pleasant work environment. There are more and more workers opting for white and other light-coloured clothes. Because these clothes show the dirt quickly, they provide a good indicator of how clean the workplace is. They highlight the need for cleaning. An example of good and bad standardisation are shown in Fig. 4a and 4b below:

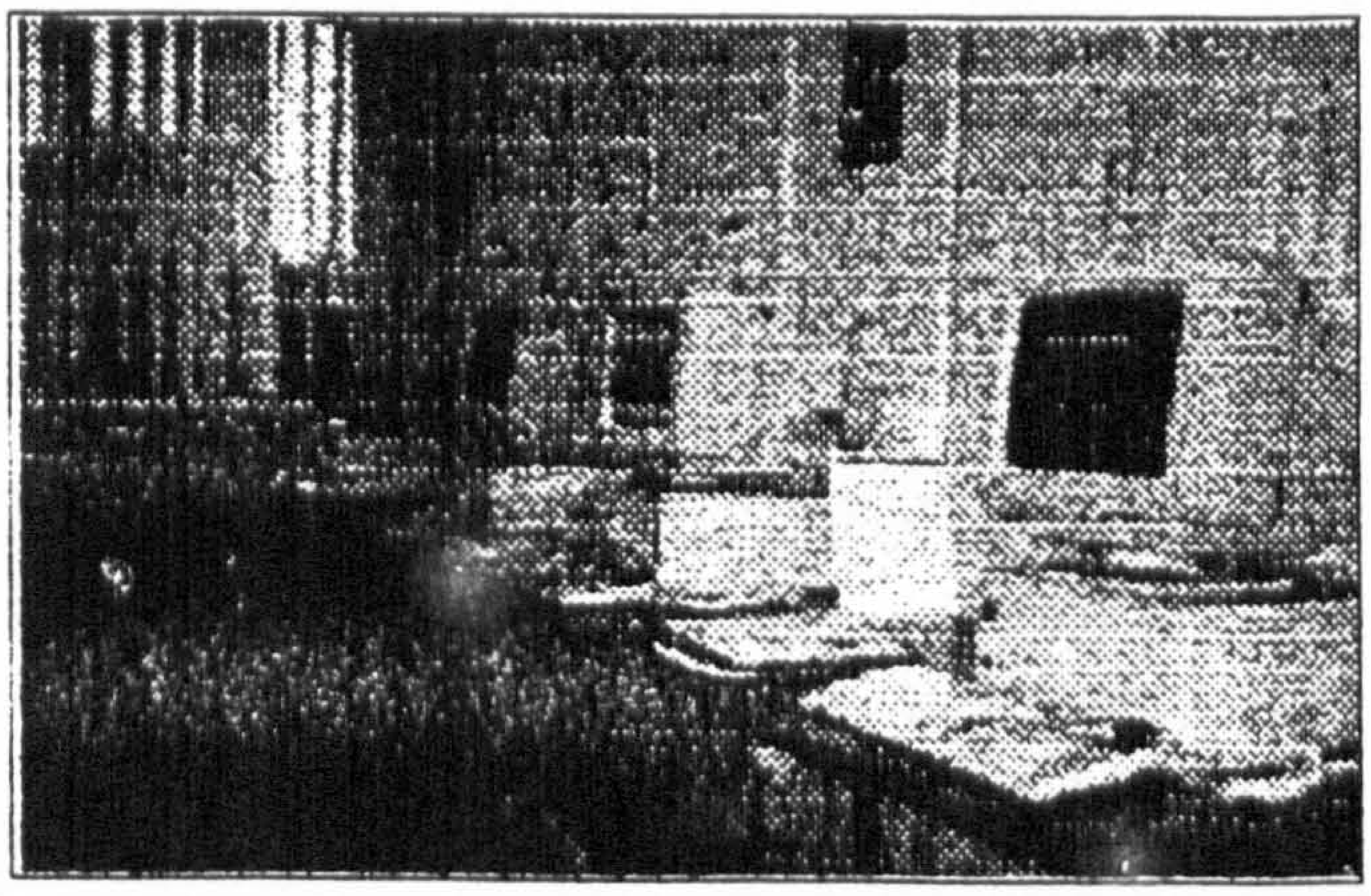

Fig. 4a Good Example of Standardation

Fig. 4b Bad Example of Standardisation -- Junk behind the door due to lack of transparency

go back

What is Discipline (Shitsuke) ?

Discipline means instilling the ability of doing things the way they are supposed to be done. The emphasis here is on creating a workplace with good habits. By teaching everyone what needs to be done and having everyone practising it bad habits are broken and good ones are formed. This process helps people form habits of making and following the rules.

Self-discipline is important because it reaches beyond discipline. If a person is 'disciplined' to do something at one time there is a chance that he may not be disciplined next time. However, self-discipline guarantees the continuity of a daily routine. The Japanese are a very self-disciplined race: they have one of the lowest crime rates in the world and are well-known as 'obedient' tourists.An example of good and bad discipline are shown in Fig. 5a and 5b below:

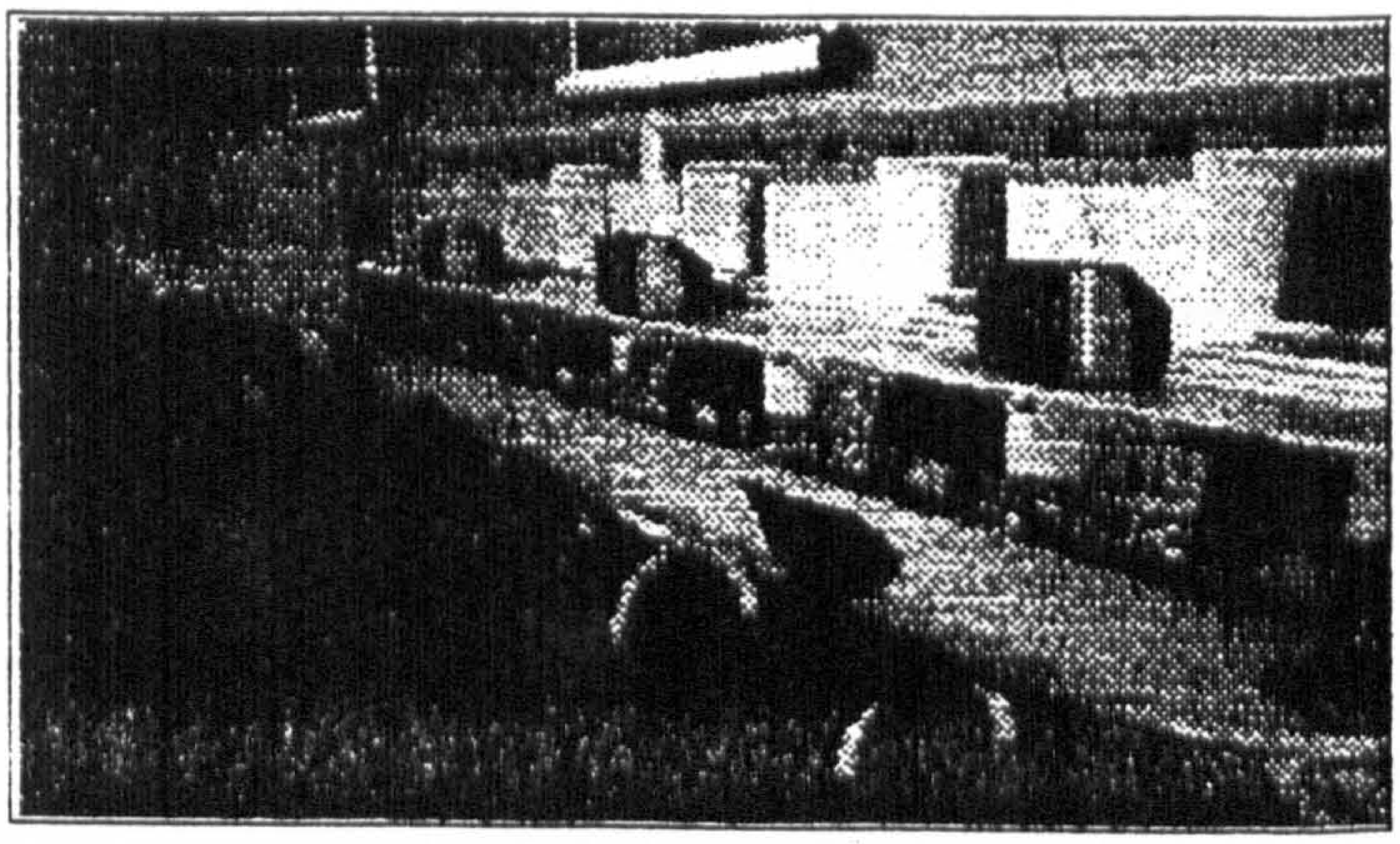

Fig. 5a Good Example of Discipline – Seeing is believing

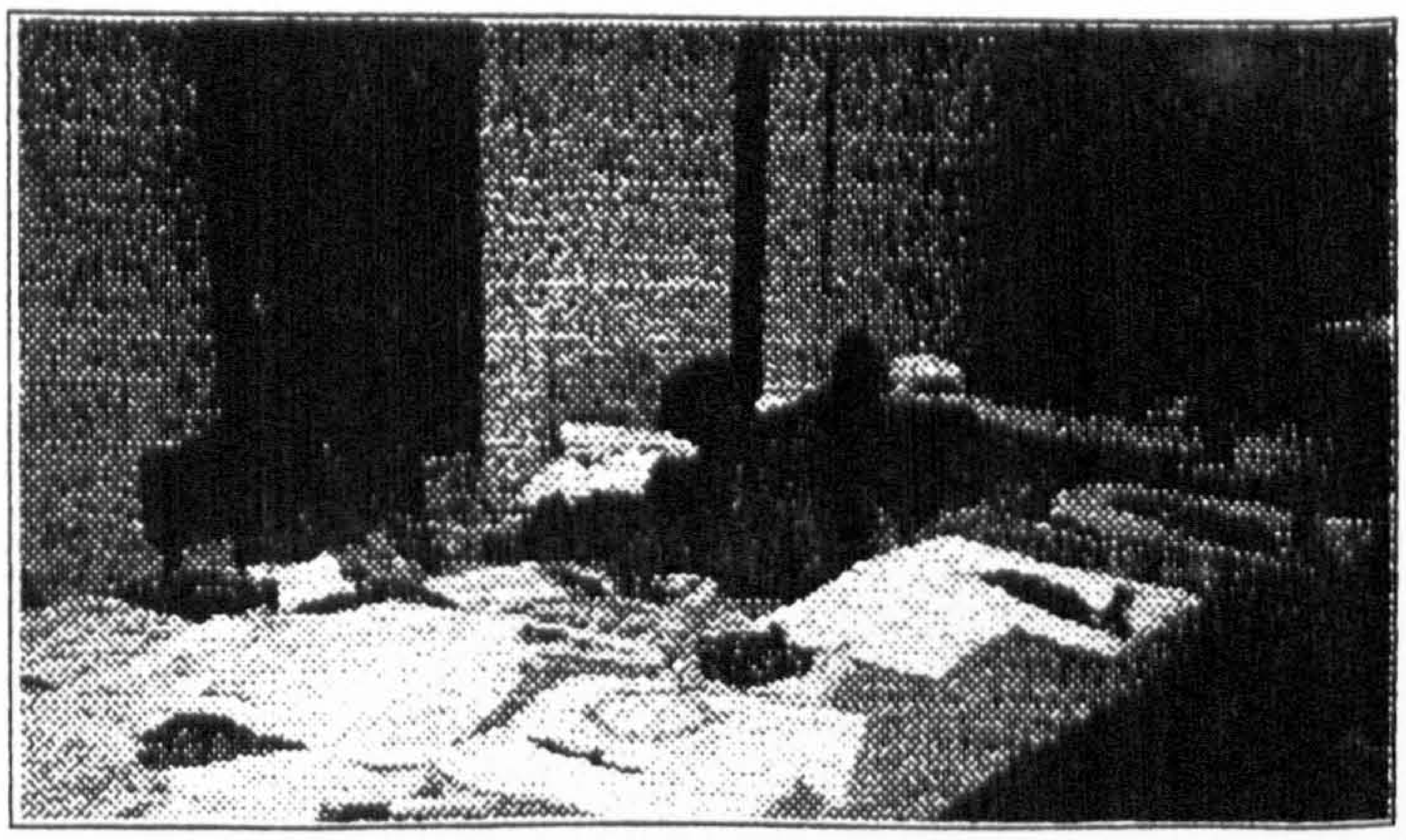

Fig. 5b Bad Example of Discipline -- Individual responsibility

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Self-Assessment #3.3.1: 5-S

Based on the explaination & photographs above, try to establish two areas of improvement at your home for each of the 5-S.

Organisation Neatness Cleaning Discipline Standardisation

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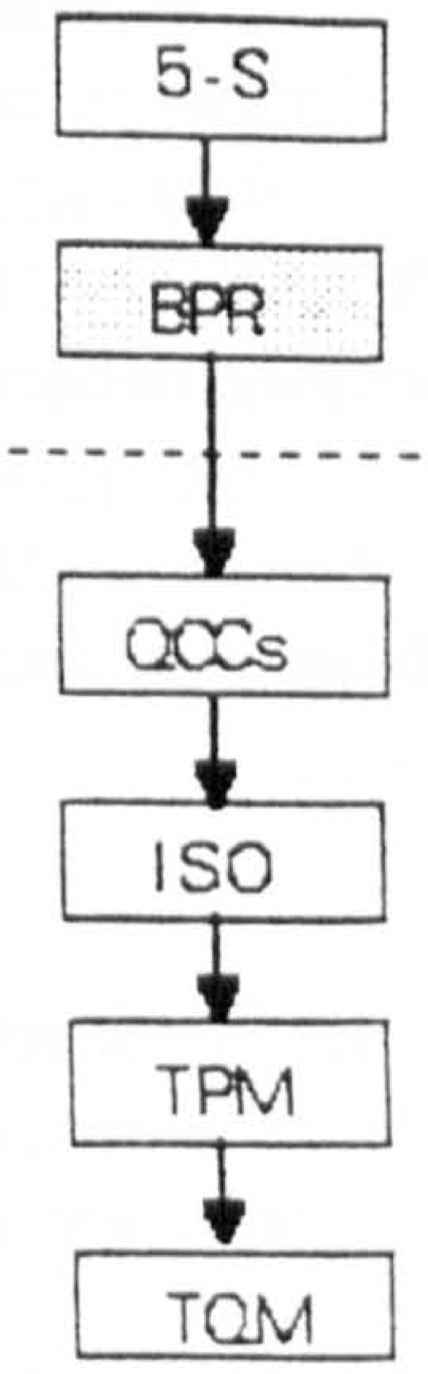
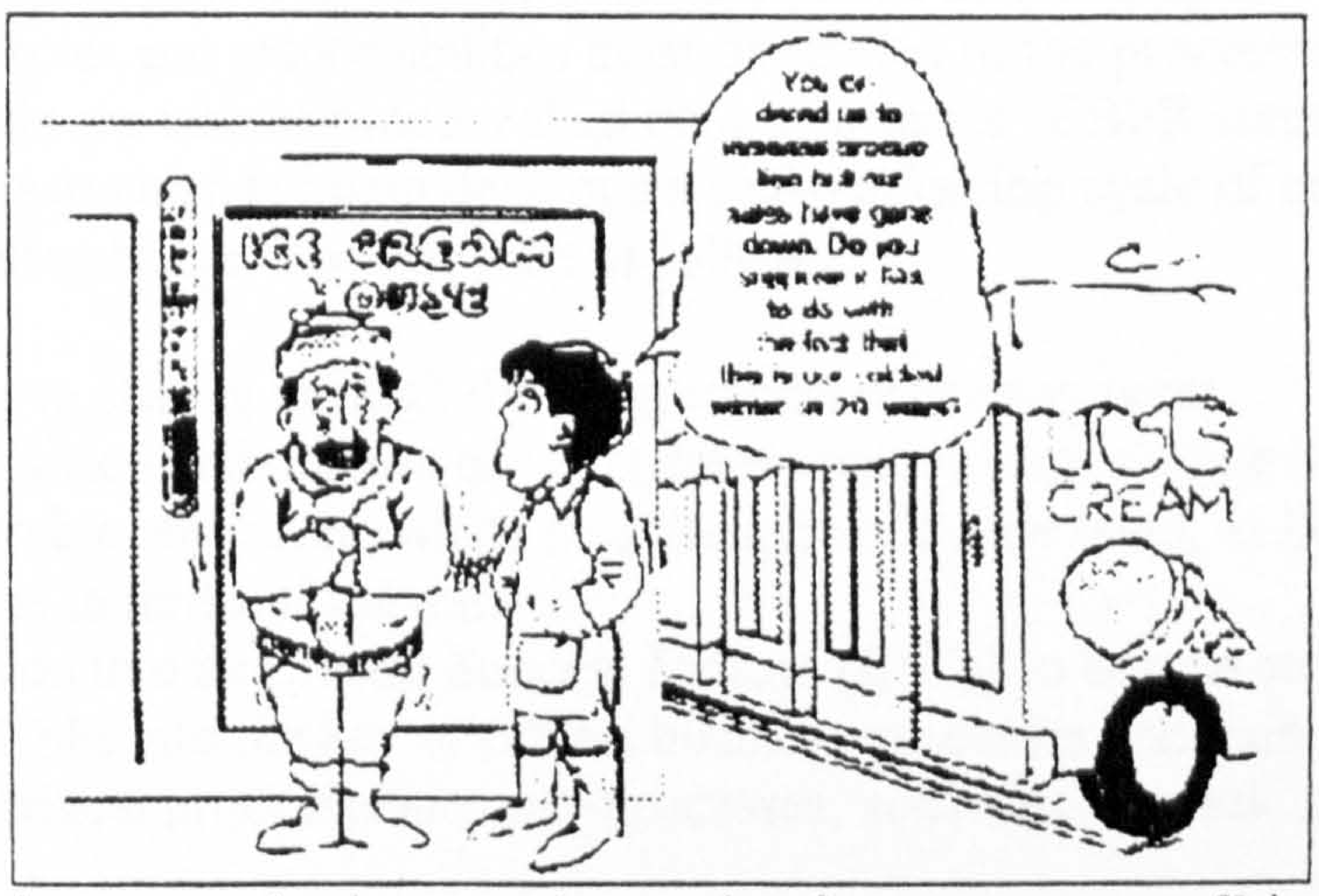
3.3.2 Business Process Re-engineering (BPR)



Introduction to Business Process Re-eingineering (BPR)

BPR is a management process used to re-define the mission statement, analyse the critical success factors, re-design the organisational structure and re-engineer the critical processes in order to improve customer satisfaction. BPR challenges managers to rethink their traditional methods of doing work and commit themselves to a customer-focused process. Many outstanding organisations have achieved and maintained their leadership through BPR [Oakland, 1995]. Companies using these techniques have reported significant bottom-line results, including better customer relations, reductions in cycle time to market, increased productivity, fewer defects/errors and increased profitability. BPR uses recognised techniques for improving business results and questions the effectiveness of the traditional organisational structure. Defining, measuring, analysing and re-engineering work processes to improve customer satisfaction pays off in many different ways.



Re-engineer your business to the needs of your customers [Lip, 1989]

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Why is BPR Useful?

Improvements in business performance of, say, 10-15 per cent can be achieved in most companies using conventional consultancy techniques. Where quantum leaps are required -- for example, where the old needs to be completely replaced with the new -- then re-engineering is a good way forward. The key to grasping the way BPR differs from other improvement studies lies in understanding the focus, breadth and duration of the re-engineering process.

The primary focus is on the customers -- those people who pay the money which keeps the business going. So if a process does not help to serve a customer then why have the process in the first instance? Although BPR requires a detailed knowledge of what the customers want it does not demand a highly detailed understanding of the tasks involved in every activity of the business. This makes BPR economical in terms of investigation time when compared with conventional methods, in which highly-detailed studies are usually undertaken before any change is made. BPR requires that those conducting the study are highly experienced in business practices and systems, and are able to identify the features of the business which are crucial to its success. A high-level in-house team, working with experienced consultants, would be able to provide the necessary expertise.

A further facet of the BPR approach concerns the speed with which changes are introduced. Conventional wisdom states that change is best brought about through an evolutionary approach. If it is required to introduce a radically changed organisation, it can be argued that it makes good sense to carry out the necessary changes quickly. Many major BPR projects have been implemented within one year [Ovenden, 1994].

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How to Implement the BPR?

Organisations will avoid the problems of 'change programmes' by concentrating on 'process alignment' -- recognising that people's roles and responsibilities must be related to the processes in which they work. Senior managers may begin the task of process alignment by a series of BPR steps that are distinct but clearly overlapped. This recommended path develops a self-reinforcing cycle of commitment, communication, and culture change. The steps are as follows.

1. : Gain commitment to change through the organisation of the top team..
2. : Develop a shared vision and mission of the business and of what change is required.
3. : Define the measurable objectives, which must be agreed by the team, as being the quantifiable indicators of success in terms of the mission.
4. : Develop the mission into its Critical Success Factors (CSFs) to coerce and move it forward.
5. : Break down the CSFs into the key or critical business processes and gain process ownership.
6. : Break down the critical processes into sub-processes, activities and task and form the teams around these.
7. : Re-design, monitor and adjust the process-alignment in response to difficulties in the change process.

BPR creates change. Change must create something that did not exist before, namely a 'learning organisation' capable of adapting to a changing competitive environment. A learning organisation aims to create a self-perpetuating momentum which changes the culture of the organisation. That is to say, the aim is that the norms, values and attitudes underpinning behaviours be changed towards continual questioning and continual improvement. It embraces human resources development on the one hand, and systems development (including BPR) on the other. For without addressing the systems of an organisation, from communication and information systems to reward and recognition systems, you are building your houses on sand, foundationless.

The organisation must also learn how to continually monitor and modify its behaviour to maintain the

Self-Assessment #3.3.2: Kaizen vs BPR (Differences)

Classify the following activities into two groups:

```
Key:  1 = Continuous Improvement (Kaizen)
      2 = BPR
```

Strategy	Continuous small steps
	Infrequent big leaps
Approach	Start with'clean sheet'
	Start with what you have
Methodology	Forget and start again
	Change what you have and learn
Process	Simultaneous processes
	Selective, one at a time
Value Added	Eliminate non-value added processes
	Minimise inputs, add value to outputs
Human Resource	BPR project team
	People involved in the operations
Technology	More technology required
	Less technology required

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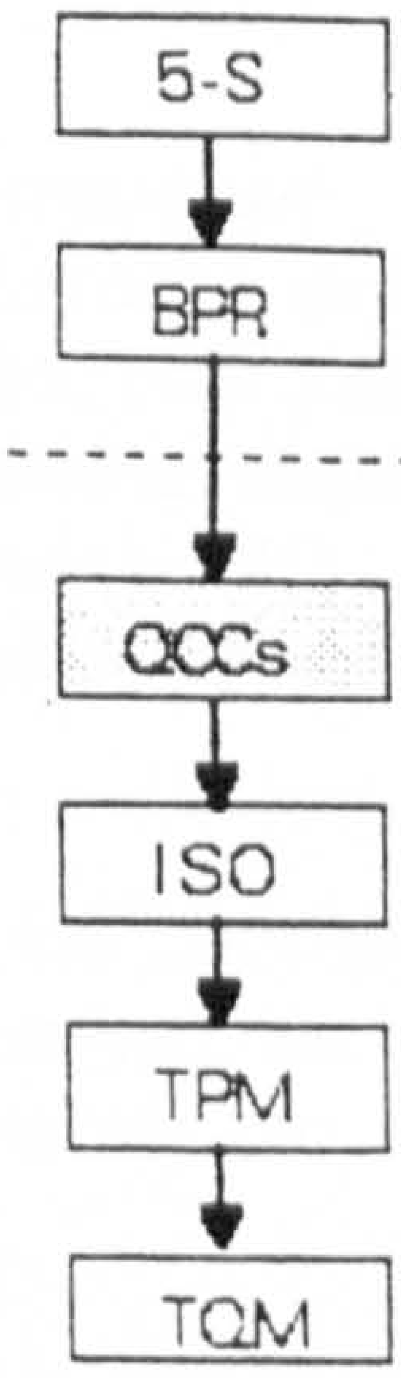
3.3.3 Quality Control Circle



Introduction to Quality Control Cycle(QCCs)

A QCC is a small group of staff working together to contribute to the improvement of the enterprise, to respect humanity and to build a cheerful workgroup through the development of the staff's infinite potential.

A quality control circle (QCC) team of people usually coming from the same work area who voluntarily meet on a regular basis to identify, investigate, analyse and solve their work-related problems.

It has been the Japanese experience that 95% of the problems in the workshop can be solved with simple quality control methods such as the 7 quality control tools [Ishikawa, 1986]. They are: Pareto diagrams, cause-and-effect diagrams, stratification, check sheets, histograms, scatter diagrams, and graphs & control charts. These tools will help QCCs to do brain-storming systematically and to analyse the problems critically. Then, through logical thinking and experience, most problems can be solved.

QCC requires Recognition

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Why is QCC Useful?

Programmes which are based on QCC practices have been introduced for a variety of reasons, but firms invariably find that the quality of product and service is improved as a result of QCC activities. QCCs reveal all sorts of faults that prevent good practices, thus improving job satisfaction and contributing to pride in workmanship. This leads to higher quality of products, increased awareness of quality, and continuous improvement.

Another benefit is an improved two-way communication. The management becomes more concerned with the staff problems and, in turn, the staff becomes aware of the day-to-day problems of running an organisation. Communication between departments also improves. While QCCs work on their own area's problems, their systematic approach often reveals previously unsuspected causes of difficulties in related processes of the production flow. A QCC programme in general requires the same framework as ISO 9000 quality standards regarding the management structure and in-company training. Therefore, QCCs should be part of any company's Total Quality Programme.

Everyone's commitment to improvement imposed by a QCC programme also helps to establish customer confidence. Although some companies do not set out to achieve a pure financial return, most find that the financial benefits considerably overrun the costs. Some have experienced ten-fold savings, taking into consideration the gains cumulated year after year.

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How to Implement the QCC?

Companies with the most successful QCC programmes have spent time in the early stages making sure that everyone in the company is properly informed and consulted before any QCC activity begins. Often an outside specialist will have assisted with the first awareness presentations. Once established, a typical programme will have QCCs operating in all parts of the company -- in offices, service operations and manufacturing. Experience shows that the size of a company is not important to a programme's success but it significantly affects the support structure and organisation. The steps of implementation are:

1. Management is made aware of the QCC process through a management briefing.
2. The feasibility of the QCCs are analysed.
3. A steering committee is formed.
4. Co-ordinator and in-house instructor is selected.
5. Potential area for initial circles is selected.
6. QCC presentations are made to first-line supervisors in identified areas, divisions or departments.
7. Co-ordinators and middle management receive extensive training on the process and their roles.
8. Supervisors who are interested volunteer and receive training.
9. Following training, QCC presentations are made to the employees who report to the newly trained supervisors.
10. Employees volunteer to be members of a circle and receive training.
11. A circle is formed and begins work.
12. Additional circles are formed as interest broadens.
13. Circles work in a systematic way in solving problems, not just discussing them.
14. Management must ensure that solutions achieve a quick implementation once they have been accepted.
15. Circles are not paid directly for their solutions, but management must ensure appropriate and proper recognition.

In order to implement QCC successfully, the following guidelines have to be considered:

- Participation is voluntary.
- Management is supportive.
- Employee empowerment is required.
- Training is integral part of programme.
- Members work as a team.
- Members solve problems not just identify them.

QCC Nominal Group Technique

This is a technique for increasing contributions from individuals in a group setting. It is designed to overcome social and interpersonal barriers between people from different levels, social status, or competencies involved in solving a common problem. It is structured so that people generate a list of solutions to a problem individually. For example, a question might be "What are the limiting factors to this company delivering a product on time?" Each participant would write his own list of limitations. All the lists of limitations are collected and made public without comment and criticism. This exercise is completed before anyone talks, thus eliminating any inhibiting factors to influence the problem solving process. The process shares this characteristic with brainstorming. After a period of discussion to clarify limitations and to omit duplications, a vote is taken to prioritise the limitations left on the list. The priority list becomes the basis for further problem solving. During the brainstorming session the leader should consider the following questions:

- Is everyone thinking about the same problem?
- Are all ideas (good and bad) encouraged?
- Are all ideas recorded?
- Do all members have equal chance to participate?

QCC Code of Conduct

In general, the following code of conduct for QCC discussion applies:

- Criticise ideas, not persons.
- The only stupid question is the one that is not asked.
- Everyone in the team is responsible for team progress.
- Be open to the ideas of others.
- Pay, terms of employment and other negotiable items are excluded.

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Self-Assessment #3.3.3: QCC

Explain in around 50 words the relationship between QCC & TQM.

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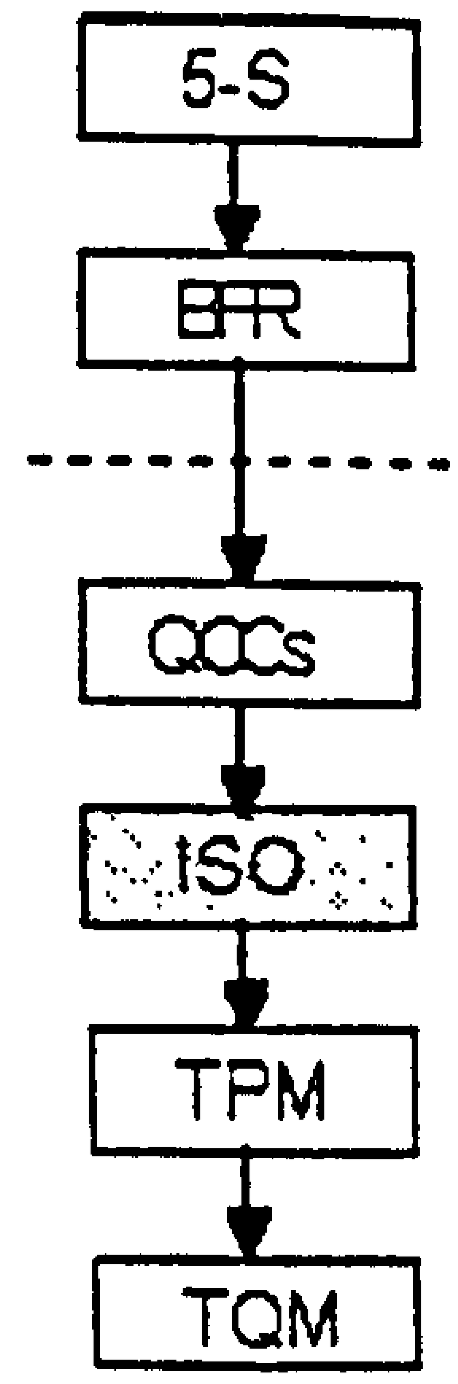
3.3.4 ISO 9000



- Introduction to ISO 9000
- Why is ISO 9000 Useful?
- How to Implement the ISO 9000?
- Self Assesment #3.3.4

Introduction to ISO

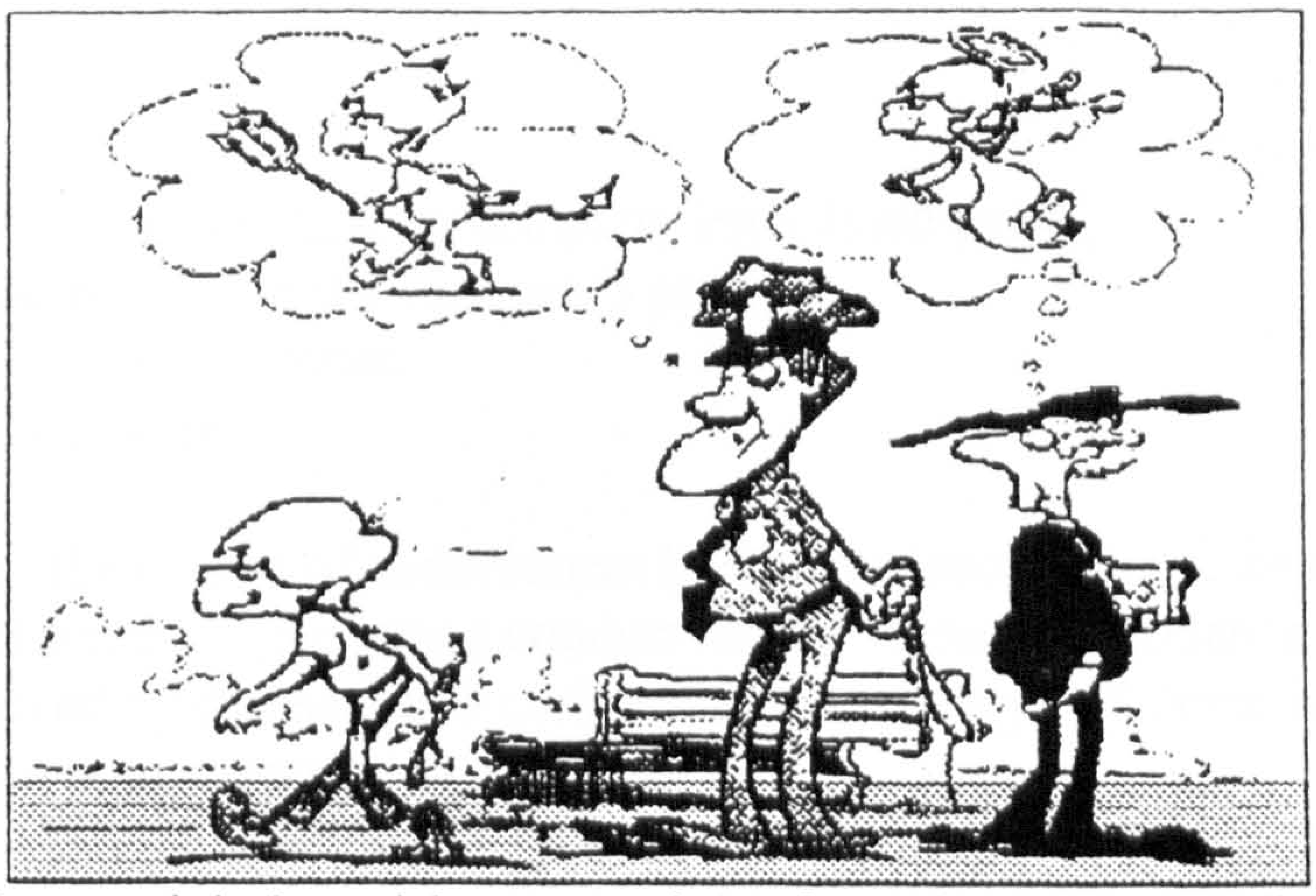
The ISO 9000 series is a family of quality management and quality assurance standards developed by the International Organisation for Standardisation. It comprises of 17 different standards. Out of these 17 standards, only the ISO 9001, ISO 9002 and ISO 9003 are quotable standards, i.e., can be audited against. The others are guidelines only. ISO 9002 and ISO 9003 are sub-sets of ISO 9001. Most of the registered firms are registered under ISO 9001 or ISO 9002. Therefore, **ISO 9001:1994** will be used as the framework for quality management system in TQMEX, together with ISO 9004-4:1993 as a guideline.

ISO 9001 is the Quality systems -- Model for quality assurance in design, development, production, installation and servicing. It is the most comprehensive model of quality systems offered by ISO.

As quoted from the Scope of the ISO 9001:1994, this International Standard specifies quality system requirements for use where a supplier's capability to design and supply conforming product needs to be demonstrated. The requirements specified are aimed primarily at achieving customer satisfaction by preventing nonconformity at all stages from design through to servicing. This International Standard is applicable in situations when

1. design is required and the product requirements are stated principally in performance terms, or they need to be established; and
2. confidence in product conformance can be attained by adequate demonstration of a supplier's capabilities in design, development, production, installation and servicing.

ISO 9004-4:1993 is the Quality management and quality system elements -- Part 4: Guidelines for quality improvement. It gives suggestions for effective quality management, helps organisations in building their quality systems, so that they can develop quality improvement practices for TQM.



ISO 9000 can minimise misinterpretation of requirements [Migliore, 1992]

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Why is ISO Useful?

Irvine [1991] points out that many companies are now seeking registration to quality standard ISO 9000 to demonstrate that they are in control of their business, and have proved it to a certification body. ISO 9000 registration is a good way of measuring progress and monitoring maintenance of the standard. It brings marketing benefits, but should be regarded as the beginning of a continuous improvement process rather than the end.

The EC Council Resolution on a global approach to conformity assessment [DTI, 1990] provides three reasons why companies should implement a quality system based on ISO 9000.

- To improve awareness of quality and have the standard for UK products,
- To reduce the need for customer supplier demonstration of quality assurance procedures by introducing third party Quality Assurance certificate,
- To open markets outside the UK by ensuring that ISO 9000 is compatible with EEC and USA quality procedures.

Whittington [1988] in his study to assess the interest for organisations in implementing ISO 9000 and the difficulties they faced, discovered four different reasons for implementing the standard.

- Due to pressure from large customers,
- To maintain contracts with existing customers,
- To use the constraints of the standard to prevent scrap,
- To reduce auditing of the quality system by customers.

Failure to implement the standard for the right reason may prevent companies from gaining the potential benefits from the system. Two of the companies studied by Whittington claimed that ISO 9000 costs much money to implement and maintain, and that their product quality is no better than before the system was implemented. He also found that there was no reduction in assessment and auditing as claimed by much of the literature. Inappropriate reasons for implementing the standard, according to Whittington, are:

- To make reference to the standard on company letter-head paper,
- To get the kitemark symbol on the company's product,
- To enforce discipline on employees,
- To retain existing customers.

Besides the right reasons, the degree of commitment by top management will determine the success of the system. Top management needs to generate a conducive environment to enhance the development of the system. This can be achieved by developing a company quality policy and objectives. This will enable all the employees to work towards the same quality goal.

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How to Implement the ISO?

Implementation of ISO 9000 **affects the entire organisation** right from the start. If pursued with total dedication, it results in 'cultural transition' to an atmosphere of continuous improvement. How difficult is the process of implementing ISO 9000? The answer depends on:

- The sophistication of your existing quality programme
- The size of your organisation
- The complexity of your process

There are 9 **essential steps** to be followed through in order to implement ISO 9000 successfully. Step 1: Top Management Commitment
Step 2: Establish Implementation Team
Step 3: Assess Current Quality System Status
Step 4: Create a Documented Implementation Plan
Step 5: Provide Training
Step 6: Create Documentation
Step 7: Document Control
Step 8: Monitor Progress
Step 9: Review -- Pitfalls to Effective Implementation

STEP 1: Top Management Commitment

Without Chief Executive Officer's (CEO) commitment, no quality initiative can succeed. Where does this type of top management commitment come from? Many ISO 9000 registered companies find that the commitment comes from some, if not all of the following points.

- Direct marketplace pressure: requirements of crucial customers or parent conglomerates.
- Indirect marketplace pressure: increased quality levels and visibility among competitors.
- Growth ambitions: desire to exploit EC market opportunities.
- Personal belief in the value of quality as a goal and quality systems as a means of reaching that goal.

STEP 2: Establish Implementation Teams

ISO 9000 is implemented by people. The first phase of implementation calls for the commitment of top management - the CEO and perhaps a handful of other key people. The next step is to create a personnel structure to plan and oversee implementation.

The first component of this personnel structure is the Management Representative **(MR)**. In the context of the standard, the MR is the person within the organisation who acts as interface between organisation management and the ISO 9000 registrar.

His role is, in fact, much broader than that. The MR should also act as the organisation's **"quality system champion,"** and must be a person with:

1. total backing from the CEO,
2. genuine and passionate commitment to quality in general and the ISO 9000 quality system in particular,
3. the dignity - resulting from rank, seniority, or both - to influence managers and others of all levels and functions,
4. detailed knowledge of quality methods in general and ISO 9000 in particular.

STEP 3: Assess Current Quality System Status

ISO 9000 does not require duplication of effort, redundant systems, or make-work. The goal of ISO 9000 is to create a quality system that conforms to the standard.. This does not preclude incorporating, adapting, and adding onto quality programmes already in place.

So the next step in the implementation process is to compare the organisation's existing quality programmes -- and quality system, if there is one -- with the requirements of the standard. Programme assessment can be done internally, if the knowledge level is there. Or a formal pre-assessment can be obtained from any one of a large number of ISO 9000 consulting, implementing, and registration firms.

STEP 4: Create a Documented Implementation Plan

Once the organisation has obtained a clear picture of how its quality system compares with the ISO 9000 standard, all nonconformances must be addressed with a documented implementation plan. This plan may be created by an ad hoc committee under the authority of the QSC. Usually, the plan calls for setting up procedures to make the organisation's quality system fully in compliance with the standard. Procedures which affect high-level policy elements of the quality system may be handled by the council itself, or by designated members. Others may be handed down to various QATs for development.

The implementation plan should be thorough and specific, detailing:

1. Procedures to be developed
2. Objective of the system
3. Pertinent ISO 9000 section
4. Person or team responsible
5. Approval required
6. Training required

7. Resources required
8. Estimated completion date

These elements should be organised into a detailed GANTT chart, to be reviewed and approved by the QSC. Once approved, the plan and its GANTT chart should be controlled by the MR. The chart should be reviewed and updated at each QSC meeting as the implementation process proceeds.

STEP 5: Provide Training

The ISO 9000 implementation plan will make provision for training in various functional areas of the quality system. Certain training needs will depend on the nonconformances addressed. The QATs should take responsibility for providing specific training in their respective functional areas.

Since the ISO 9000 quality system affects all areas and all personnel in the organisation, it is wise to provide basic orientation in the quality system standard to all employees. This can be a one-day programme which informs personnel about quality system in general and the ISO 9000 quality system in particular.

The training programme should emphasise the benefits that the organisation expects to realise through its ISO 9000 quality system. The programme should also stress the higher levels of participation and self-direction that the quality system renders to employees. Such a focus will go far to enlist employee support and commitment.

STEP 6: Create Documentation

As noted earlier, documentation is the most common area of non-conformance among organisations wishing to implement ISO 9000 quality systems. As one company pointed out: "When we started our implementation, we found that documentation was inadequate. Even absent, in some areas. Take calibration. Obviously it's necessary, and obviously we do it, but it wasn't being documented. Another area was inspection and testing. We inspect and test practically every item that leaves here, but our documentation was inadequate."

There is no way around it: documentation is mandatory. It is essential to the ISO 9000 registration process because it provides objective evidence of the status of the quality system. The two basic rules of ISO documentation are:

- Document what you do.
- Do what you document.

Many organisations find that their existing documentation is adequate in most respects. To bring it into full ISO conformance, they implement control procedures to ensure that documentation is available as needed and is reviewed, updated, stored, and disposed of in a planned, orderly manner.

STEP 7: Document Control

Once the necessary quality system documentation has been generated, a documented system must be created to control it. As noted in the Technical Requirements and Guidelines sections, control is simply a means of managing the creation, approval, distribution, revision, storage, and disposal of the various types of documentation. Document control systems should be as simple and as easy to operate as possible -- sufficient to meet ISO requirements and that is all.

The principle of ISO 9000 document control is that employees should have access to the documentation and records needed to fulfil their responsibilities. Ironically, direct access can often result in certain employees having less record-keeping and documentation to deal with -- and can be a cause of resistance. The organisation's quality manual is a primary example. "We got minor resistance from some major players who were used to having the quality manual, but who didn't really need to have their own copy of it," says Jim Ecklein of Augustine Medical [Johnson, 1993]. "We solved that by having a master quality manual, with references to sub-manuals for each organisation area. That way, people had what they needed, but we weren't passing quality manuals out to people who didn't really need it and wouldn't use it."

STEP 8: Monitor Progress

When the procedures have been completed and the quality system fleshed out, it is time to put the quality system into effect. In this extremely important phase, management must pay close attention to results to make sure that the elements of the quality system are logical and effective.

Effective monitoring is what makes or breaks ISO 9000 implementation. It is also the ultimate measure of how well -- or poorly -- organisation management lives up to its responsibilities, as described in the Management Responsibility section of the standard. In particular, management at all levels should watch out for gaps and assumptions in procedures and steps which are difficult, ineffective, or impractical.

Many such problems can be dealt with by the QATs. Resulting changes should, of course, be documented and approved in accordance with procedures provided for in the quality system.

Management, up to the level of the Quality Action Council, should simultaneously carry out its review function as prescribed by the standard and its own documented procedures. These activities include:

- Internal quality audits
- Formal corrective actions
- Management reviews

STEP 9: Review - Pitfalls to Effective Implementation

Here is a brief checklist of the most significant barriers to effective ISO 9000 quality system implementation.

1. ***Lack of CEO commitment.*** As Lorcan Mooney says, "If senior management consists of four or five people, and two of them are not committed, over time they can be won over. But if the CEO is not committed, then in no way are you going to win in the long run."
2. ***Failure to involve everyone in the process.*** Ownership and empowerment are the keys to effective implementation. To help employees feel like owners of their activity, make them responsible for developing and documenting their procedures.
3. ***Failure to monitor progress and enforce deadlines.*** People in organisations have their routine work to do. If progress is not monitored, ISO 9000 can never be implemented effectively because programmes just drag on.

All three pitfalls are directly traceable to management -- or lack of it.

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Self-Assessment: #3.3.4 Understanding ISO 9000

Identify the different between ISO 9001, 9002 and 9003 by selecting the appropriate box.

SECTION	TITLE	9001	9002	9003
4.1	Management Responsibility			
4.2	Quality System			
4.3	Contract review			
4.4	Design control			
4.5	Document & data control			
4.6	Purchasing			
4.7	Control of customer-supplied product			
4.8	Product identification & traceability			
4.9	Process control			
4.10	Inspection & testing			
4.11	Control of inspection, measuring and test equipment			
4.12	Inspection & test status			
4.13	Control of nonconforming product			
4.14	Corrective action			
4.15	Handling, storage, packaging & delivery			
4.16	Control of quality records			
4.17	Internal quality audits			
4.18	Training			
4.19	Servicing			
4.20	Statistical techniques			

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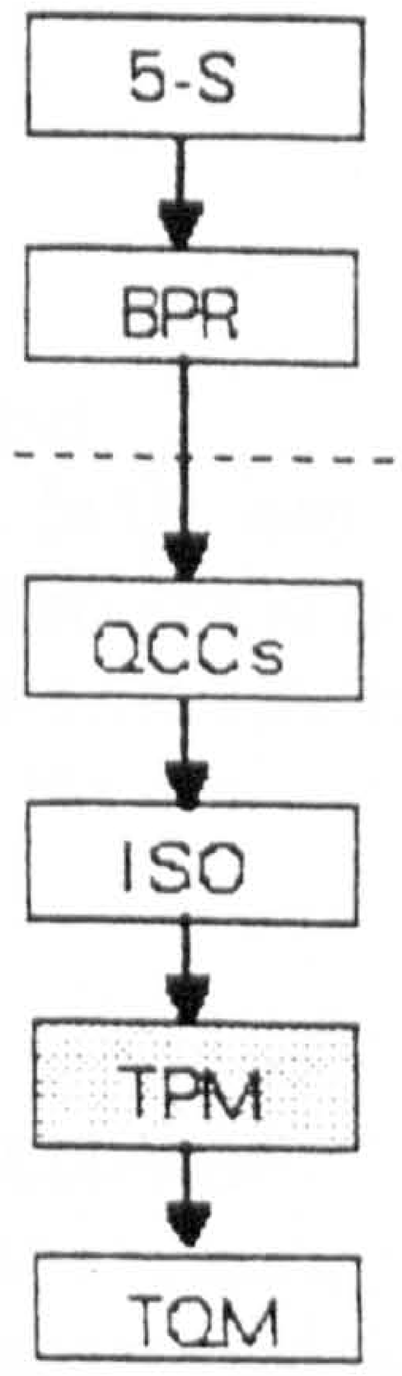
3.3.5 Total Productive Maintenance (TPM)

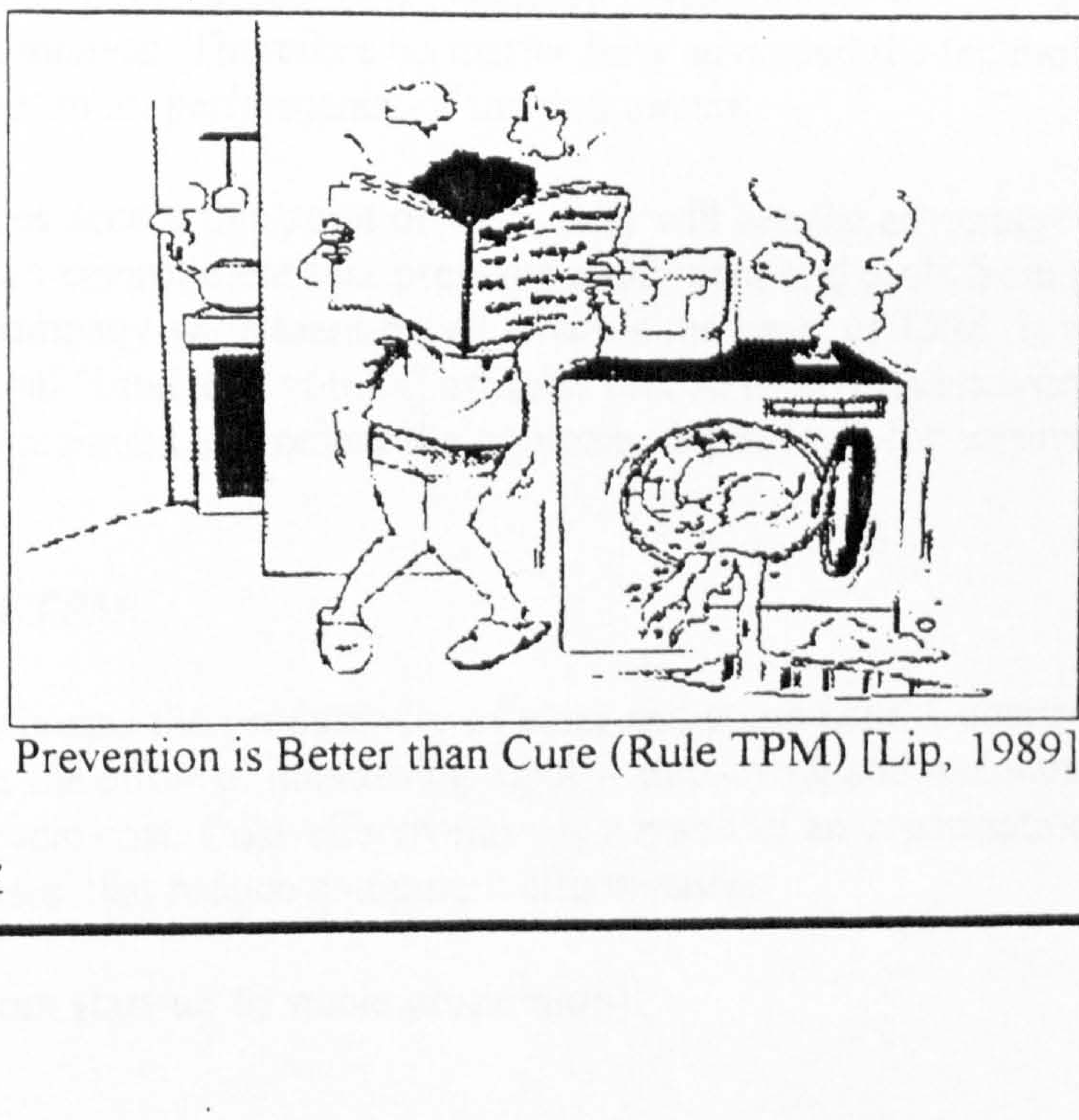


Introduction to Total Productive Maintenance (TPM)

In 1971, the Japan Institute of Plant Maintenance (JIPM) defined TPM as a system of maintenance covering the entire life of the equipment in every division including planning, manufacturing, and maintenance. Because of its targeted achievement to increase productivity out of the equipment, the term TPM is sometimes known as Total Productivity Management.

The JIPM runs the annual PM Excellence Award and they provide a checklist for companies applying for the award. There are 10 main items in the checklist:

- Policy and objectives of TPM
- Organisation and operation
- Small-group activities and autonomous maintenance
- Training
- Equipment maintenance
- Planning and management
- Equipment investment plans and maintenance prevention
- Production volumes, scheduling, quality, and cost
- Safety, sanitation, and environmental conservation
- Results and assessments.



Prevention is Better than Cure (Rule TPM) [Lip, 1989]

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Why is TPM Useful?

In modern day manufacturing and service industries, improved quality of products and services increasingly depend on the features and conditions of organisations' equipment and facilities. In the late 70's, there was heavy snow in Sapporo, the northern-most island of Japan. Because the workers could not get to work, Matsushita's vacuum cleaner factory stood still. Mr. Matsushita thought, 'Can we not rely on our workers for production?' A year later, the first unmanned-factory in the world was born. As the production relied 100% on equipment, TPM became mandatory.

Today, there are many similar examples such as Fujitsu-Fanuc, the world's most advanced unmanned-factory, which uses reliable computer controllers for manufacturing automation. Likewise super-computers run 24 hours a day all over the world to provide uninterrupted services to the banking, finance, air-flight, hotel, tourist, telecommunication and other service industries. However, this would not be possible without TPM.

TPM is a programme for fundamental improvement that involves the entire human resource. When implemented fully, TPM dramatically improves productivity and quality and reduces costs. As automation and labour-saving equipment take production tasks away from humans, the condition of production and office equipment increasingly affects output, quality, cost, delivery, health and safety, and employee morale. In a typical factory, however, many pieces of equipment are poorly maintained. Neglected equipment results in chronic losses and time wasted on finding and treating the causes.

Equipment Effectiveness is Everyone's Responsibility

Both operations and maintenance departments should accept responsibility of keeping equipment in good conditions. To eliminate the waste and losses hidden in a typical factory environment, we must acknowledge the central role of workers in managing the production process. No matter how thoroughly plants are automated or how many robots are installed, people are ultimately responsible for equipment operation and maintenance. Every aspect of a machine's performance, whether good or bad, can be traced back to a human act or omission. Therefore no matter how advanced the technology is, people play a key role in maintaining the optimum performance of the equipment.

When company employees accept this point of view, they will see the advantage of building quality into equipment and building an environment that prevents equipment and tools from generating production or quality problems. This company-wide team-based effort is the heart of TPM. It represents a dramatic change from the traditional "I make -- you fix" attitude that so often divides workers. Through TPM, everyone co-operates to maintain equipment the company depends on for survival and ultimately for profitability.

Goals and Objectives of TPM

The goal of TPM is to increase the productivity of plant and equipment. Consequently, maximised output will be achieved through the effort of minimising input -- improving and maintaining equipment at optimal levels to reduce its life cycle cost. Cost-effectiveness is a result of an organisation's ability to eliminate the causes of the 'six big losses' that reduce equipment effectiveness:

- ☐ Reduced yield (from start-up to stable production)

- ☐ Process defects
- ☐ Reduced speed
- ☐ Idling and minor stoppages
- ☐ Set-up and adjustment
- ☐ Equipment failure

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How to Implement the TPM?

Implementation plans for TPM vary from company to company depending on the level of maintenance and particular plant requirements. TPM consists of six major activities:

1. Elimination of six big losses based on project teams organised by the production, maintenance, and plant engineering departments.
2. Planned maintenance carried out by the maintenance department
3. Autonomous maintenance carried out by the production department in seven steps.
   Step 1: Initial cleaning
   Step 2: Actions to address the causes and effects of dust and dirt
   Step 3: Cleaning and lubrication standards
   Step 4: General inspection training
   Step 5: Autonomous inspection
   Step 6: Workplace organisation standards
   Step 7: Full implementation of autonomous maintenance
4. Preventive engineering carried out mainly by the plant engineering department
5. Easy-to-manufacture product design carried out mainly by the product design department
6. Education and training to support the above activities

TPM can be successful in achieving significant results only with universal co-operation among all constituents involved with the six activities listed above. Once a decision has been made to initiate TPM, company and factory leadership should promote all six of these activities despite excuses that may come from various quarters.

Through these activities, the company can gradually eliminate the losses, establish a more effective relationship between operators and machines, and maintain equipment in the best possible condition.

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Self-Assessment #3.3.5: Understand Maintenance Activities

Classify the following activities into the most suitable group:

```
Improvement Maintenance (IM),
Preventive Maintenance (PM) and
Corrective Maintenance (CM).
```

Activities	IM	PM	CM
Modification of process			
Scheduled Maintenance			
Unscheduled Maintenance			
Redesign			
Change order of system setting			
Emergency repair			
Remedial			
Process monitoring			
Statistical predictive trend analysis			
Diagnostic fault detection			
Control limits			
Activities	**IM**	**PM**	**CM**

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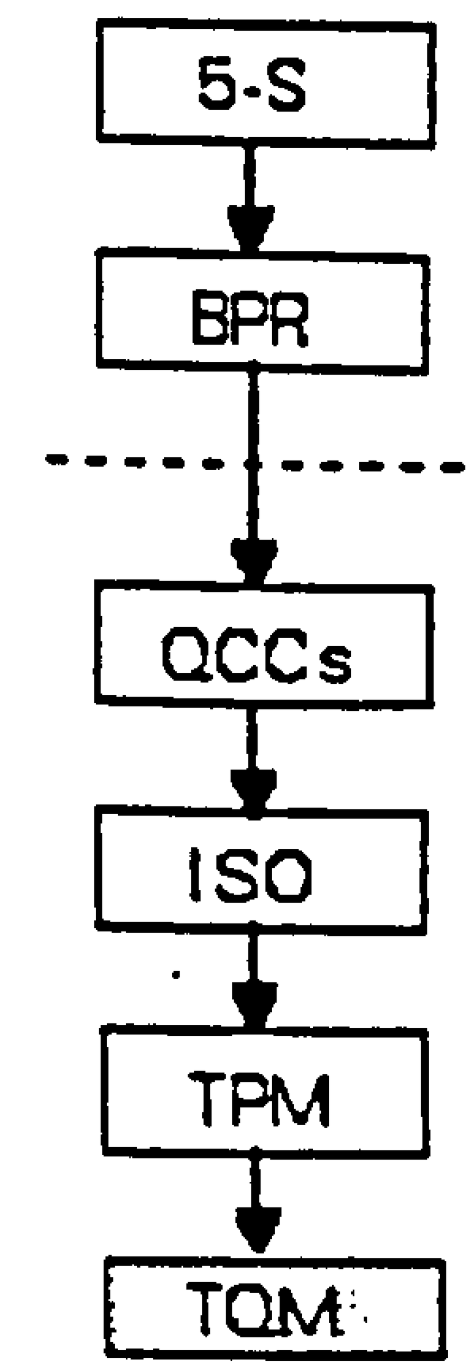
3.3.6 Total Quality Management



Introduction to TQM

TQM provides the overall concept that fosters continuous improvement in an organisation. The TQM philosophy stresses a systematic, integrated, consistent, organisation-wide perspective involving everyone and everything. It focuses primarily on total satisfaction for both the internal and external customers, within a management environment that seeks continuous improvement of all systems and processes. TQM emphasises use of all people, usually in multifunctional teams, to bring about improvement from within the organisation. It stresses optimal life cycle costs and uses measurement within a disciplined methodology in achieving improvements. The key aspects of TQM are the prevention of defects and emphasis on quality in design. TQM is a necessity. It is a journey. It will never end. It makes Japanese industry a miracle. It is the way to survive and succeed. What does it entail, then? TQM is the totally integrated effort for gaining competitive advantage by continuously improving every facet of an organisation's activities. If we look at the meaning of each word, TQM can be defined as:

Total - Everyone associated with the company is involved in continuous improvement (including its customers and suppliers if feasible),
Quality - Customers' expressed and implied requirements are met fully,
Management - Executives are fully committed.

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Why is TQM Useful

It is apparent that all companies have implemented TQM want to provide good quality goods and services to their customers. The end result is that they will enjoy prosperity and long-term growth. Once you have gone through all the five stages of the TQMEX model, your organisation is likely to have built a very strong basis and a proactive environment for the final stage -- TQM. There are clear business objectives and effective processes installed, with empowered employees committed to quality; ISO 9000 quality management system is in place to demonstrate the disciplined approach to quality improvement and all equipment and facilities are in good condition and utilisation consistently. This is the right time for the management of an organisation to consider obtaining a nationally or internationally recognised quality standard registration.

In developing the European model of Corporate Excellence, the EFQM wanted to ensure that it not only reflected current thinking on best practice measures but also included some ideas of what a world class organisation would be measuring and achieving in the future. To reach a consensus, EQA Steering Committee was established to arrive at the model and the weightings within it. The result was a framework which had built in the strengths of its forerunners but added improvements with a distinctly European dimension (see framework in Figure 3.3.6a).

Fig. 3.3.6a The European/UK Quality Award Framwork (1-5 are the Enabling Factors; 6-9 are the Result Factors)

1. LEADERSHIP (10%)		
2. Policy and Strategy (8%)	3. People Management (9%)	4. Resources (9%)
5. PROCESS (14%)		
6. People Satisfaction (9%)	7. Customer Satisfaction (20%)	8. Impact on Society (6%)
9. RESULT (15%)		

European Quality Award Results

The first European Quality Award was presented in 1992 to Rank Xerox Ltd. Each year, the jurors also selected some applicants to receive European Quality 'Prizes'. Fig. 3.3.6b shows a summary of the winners since the EQA was launched.

EQA Winners, Prize Holders and Finalists

Year	EQA Winner	Price Awarded	Finalists
1992	Rank Xerox Ltd	□ BOC Ltd, Special Gases □ Industrias de Ubierna SA - UBISA □ Milliken European Division	--
1993	Milliken European Division	□ ICL Manufacturing Division	□ Cablelettra Spa (Italy) □ Varian-TEM Ltd
1994	D2D Ltd	□ IBM SEMEA (South Europe, Middle East and Africa) □ Ericsson, Spain	□ SCEMM, France □ Texas Instruments Europe

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How to Implement the TQM?

If an organisation has already implemented ISO 9000, it should still go back to the first step, the 5-S practices, in order to develop a total quality environment. One task of the 5-S is to throw away the rubbish, including the obsolete documents and paperwork generated from the ISO 9000 system. The 5-S keeps on insisting to look into the root of the problem - why there are so much wasteful documents created in the first instance?

Then BPR will help to re-focus the business, making it more customer-oriented. This should then be built into the ISO 9000 system during management review meetings.

QCCs will contribute continuous improvement by mobilising everybody in quality initiatives. The 5-S provide good agenda for improvement. Furthermore, QCCs are good organisations to review the effectiveness of the ISO 9000 system and help communicate and understand the requirements of the Standard. This will lead to simplification of the quality manual. TPM, when developed, will improve quality and productivity dramatically. This will be an important help towards TQM. If you walk into an efficient factory or office with conducive environment, you do not have to look at their ISO 9000 system before you can tell whether it is a quality organisation.

Finally, TQM is a process, not a destination. As Deming said, "We have to do it forever." When TQM is built upon 5-S, BPR, QCC, ISO and TPM, it will guarantee continuous improvement and customer satisfaction, no matter how demanding that could be.

Firms can acquire the TQMEX Model through a series of training and implementation programmes. Figure 10.20 shows a rough-cut estimate of the time of the resource person who may be an experienced quality manager of the organisation or a quality consultant. The size of the organisation is assumed to be medium. The larger the organisation, the longer will be the time required for training.

The TQMEX Training & Implementation Programme is a proven approach to achieve TQM. It also provides an important opportunity for firms to improve themselves. Organisations which have gone through some stages of improvement can tailor the programme to their special needs.

TQMEX Training/Implementation Programme

	Brief Description	Man-days (*)
A.	A.1 Training/Consultancy Requirement Studies	5
	A.2 Establish Quality Council	5
B.	Conduct Training & Implementation on:-	
	B.1 Housekeeping Through 5-S Practices	5
	B.2 Business Process Re-engineering	5
	B.3 Quality Data Collection & Seven QC Tools	5
	B.4 QCC & Problem Solving	5
	B.5 ISO 9000 Quality Manual Documentation	5
	B.6 Internal Quality Audit	5
	B.7 TPM Implementation	5
	B.8 TQM Implementation	10
C.	Documenting & Implementing ISO 9001/2 QMS	20

(*) This is a rough estimate of the time of the resource person who may be an experienced quality manager of the organisation or a quality consultant.

Self-Assessment#3.3.6: TQM Consciousness Checklist

Just like Quality, TQM begins with an awareness of some basic TQM concepts. The following exercise is to help you to identify your TQM consciousness. Please consider each of the following statements and mark it True (T) or False (F) based on your current awareness of TQM at work.

true false	A philosophy
true false	A quick fix.
true false	Goodness
true false	Conformance to perfection standards (such as 'zero defect')
true false	Prevention
true false	Merely inspection
true false	Following specific guidelines
true false	A 'close enough' attitude
true false	A motivational programme
true false	A lifelong process
true false	Commitment
true false	Coincidence
true false	Supported by upper management
true false	A positive attitude
true false	A watchdog mentality
true false	Agreement
true false	Randomly adopted
true false	Do your own thing

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4.0 Validation

4.2 Conclusion

TQMEX is a systematic model encompassing the essential TQM methodologies to achieve excellence. It consists of the following elements:

- Japanese 5-S practice
- Business process re-engineering
- Quality control circles
- ISO 9001/2
- Total productive maintenance
- Total quality management

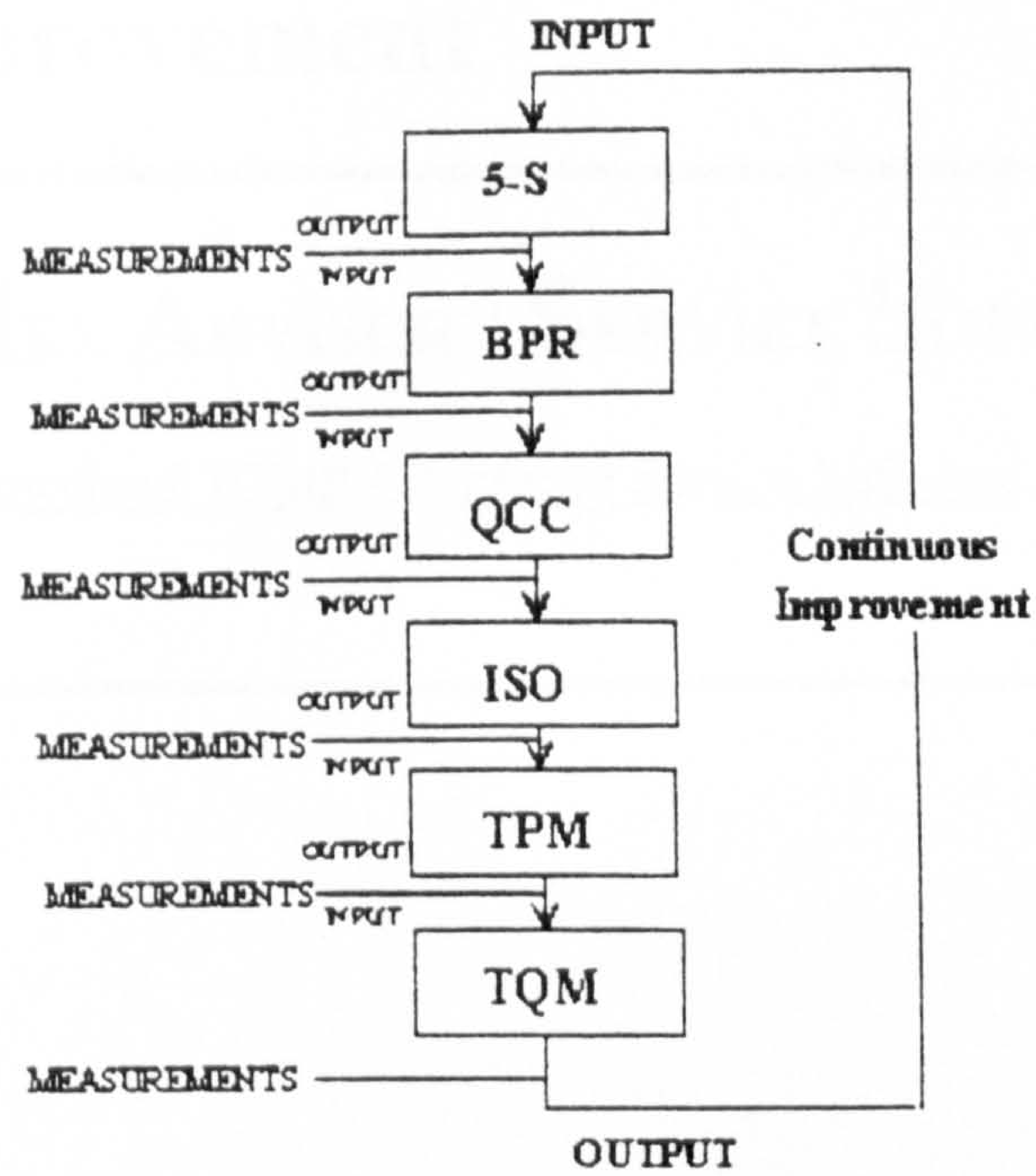
The TQM EXcellence Model is based on sound TQM principles and logically presented. TQMEX is needed in order to satisfy customers consistently.

Dr. Deming used to say, "TQM will last forever." Therefore it is important to understand that the TQMEX implementation should not be a programme in its own right. It should be a continuous process, subject to improvement cycle. The Deming Cycle should be followed at each stage of the TQMEX implementation. There should also be measurable inputs and outputs, so that the changes can be identified for further improvement. The following steps serve as the guidelines:

- Establish appropriate measures
- Define measurable inputs and outputs
- Define and document current procedures and working practice
- Identify problems that cause errors and reduce productivity
- Develop and implement corrective actions.
- Standardise the procedure
- Repeat activities for continuous improvement

and finally,

"I hear and I forget, I see and I remember, I do and I learn."
– Confucius, Chinese philosopher, 500BC.



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4.3 Source of Information and Advice

TQM An Integrated Approach

British Quality Foundation

Bristish Standards Institution

Institute of Quality Assurance

National Society for Quality through Teamwork

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4.1 Future Improvement

DOWNLOAD TQMEX ADVISORY SERVICE SOFTWARE

Download TQMEX Advisory Service Software

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Validation of TQM Integrated Approach Internet System

Question 1: This software is easy to use.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 2: The contents of the software is easy to understand.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 3: The breadth of the contents are appropriate.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 4: The depth of the contents are appropriate.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 5: The visual display (color and graphics) is attractive.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 6: The software can help to understand more about TQM requirement.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 7: The software can be used as a training package for practising TQM.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 8: The software can provide a step-by-step framwork for implementing TQM.
Strongly disagree Strongly agree
1 2 3 4 5 6 7

Question 9: What overall rating would you give the software.
Poor Excellence
1 2 3 4 5 6 7

Question 10: What are the major merits of the software?

Question 11: What are the major drawbacks of the software?

Question 12: What change would you suggest should be made to improve the software?

Question 13: Any other comments?

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** THANK YOU FOR YOUR INTEREST AND CO-OPERATION **

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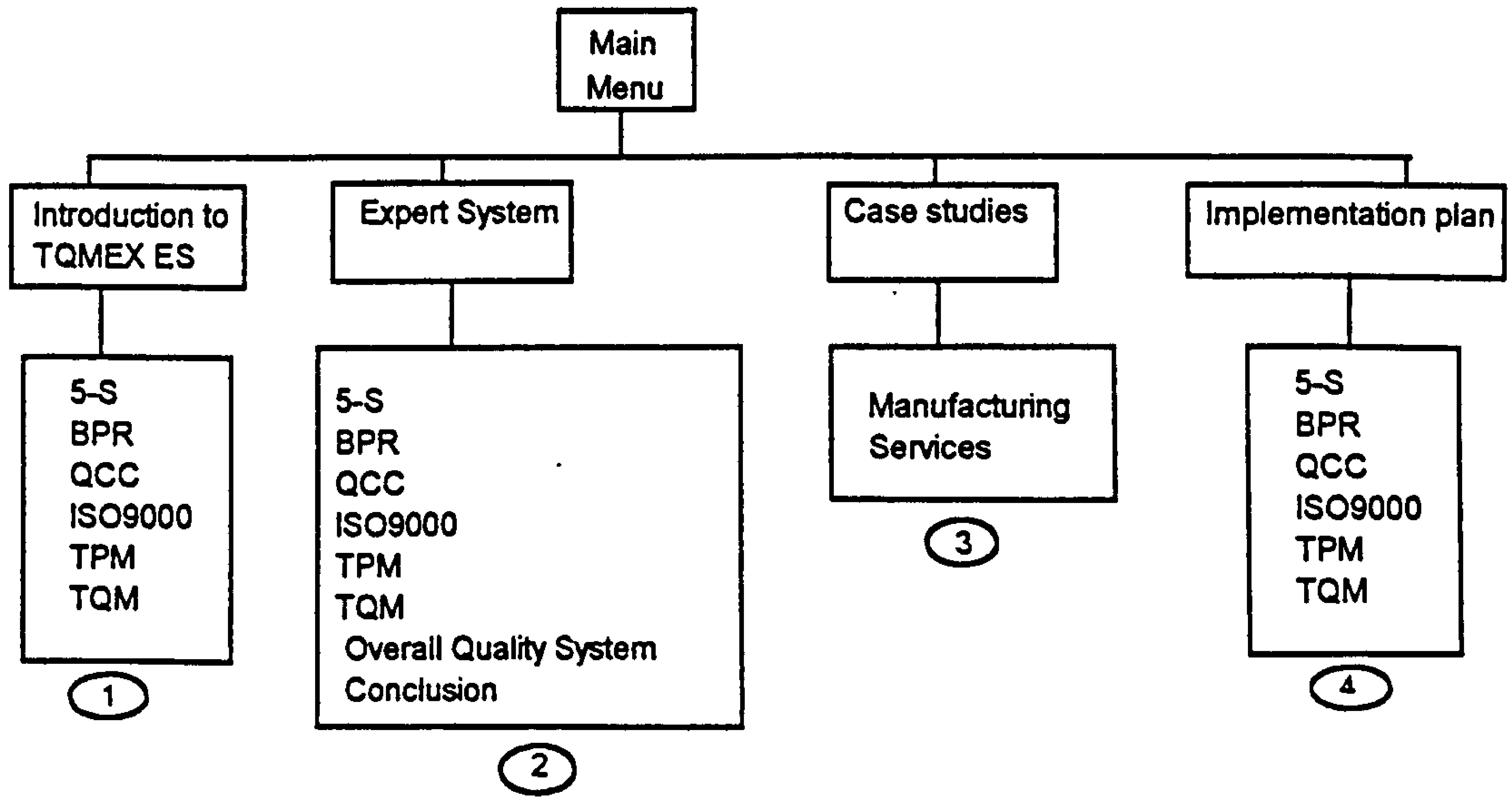

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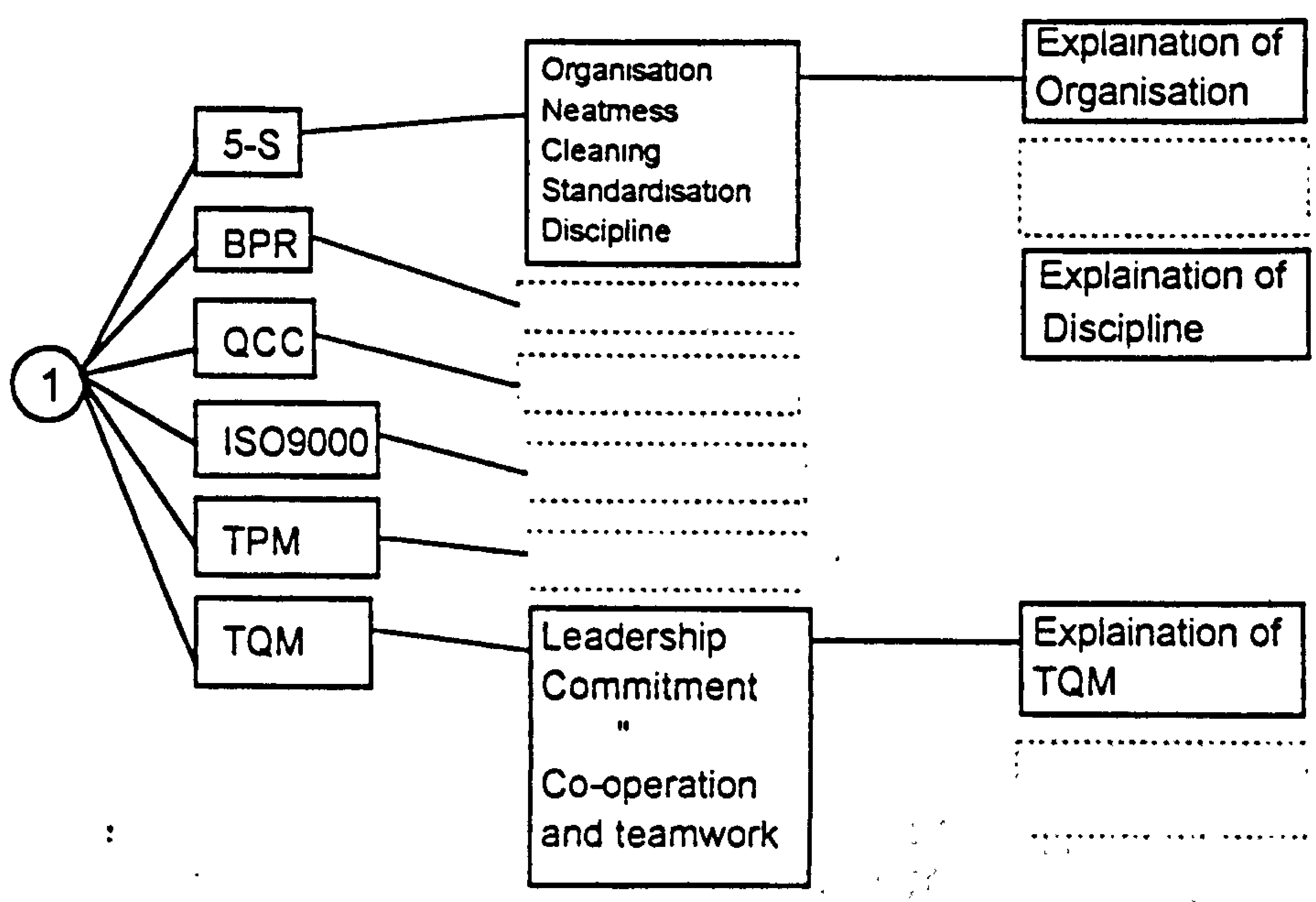

1
5-S
BPR
QCC
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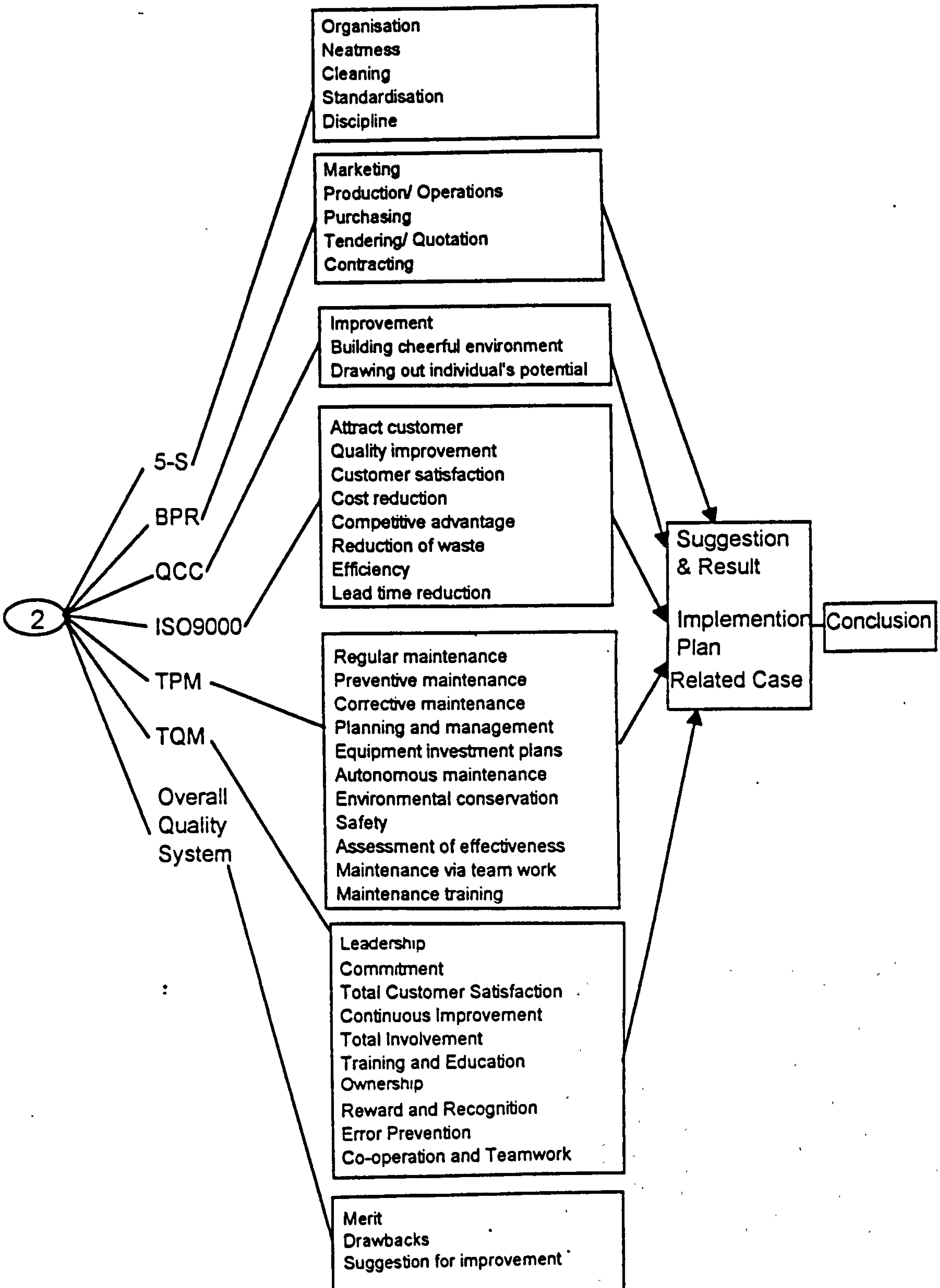
TPM
TQM
Organisation
Neatness
Cleaning
Standardisation
Discipline
Explaination of Organisation
Explaination of Discipline
Leadership
Commitment
"
Co-operation and teamwork
Explaination of TQM


Organisation
Neatness
Cleaning
Standardisation
Discipline
Marketing
Production/ Operations
Purchasing
Tendering/ Quotation
Contracting
Improvement
Building cheerful environment
Drawing out individual's potential
Attract customer
Quality improvement
Customer satisfaction
Cost reduction
Competitive advantage
Reduction of waste
Efficiency
Lead time reduction
Regular maintenance
Preventive maintenance
Corrective maintenance
Planning and management
Equipment investment plans
Autonomous maintenance
Environmental conservation
Safety
Assessment of effectiveness
Maintenance via team work
Maintenance training
Leadership
Commitment
Total Customer Satisfaction
Continuous Improvement
Total Involvement
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2
5-S
BPR
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TQM
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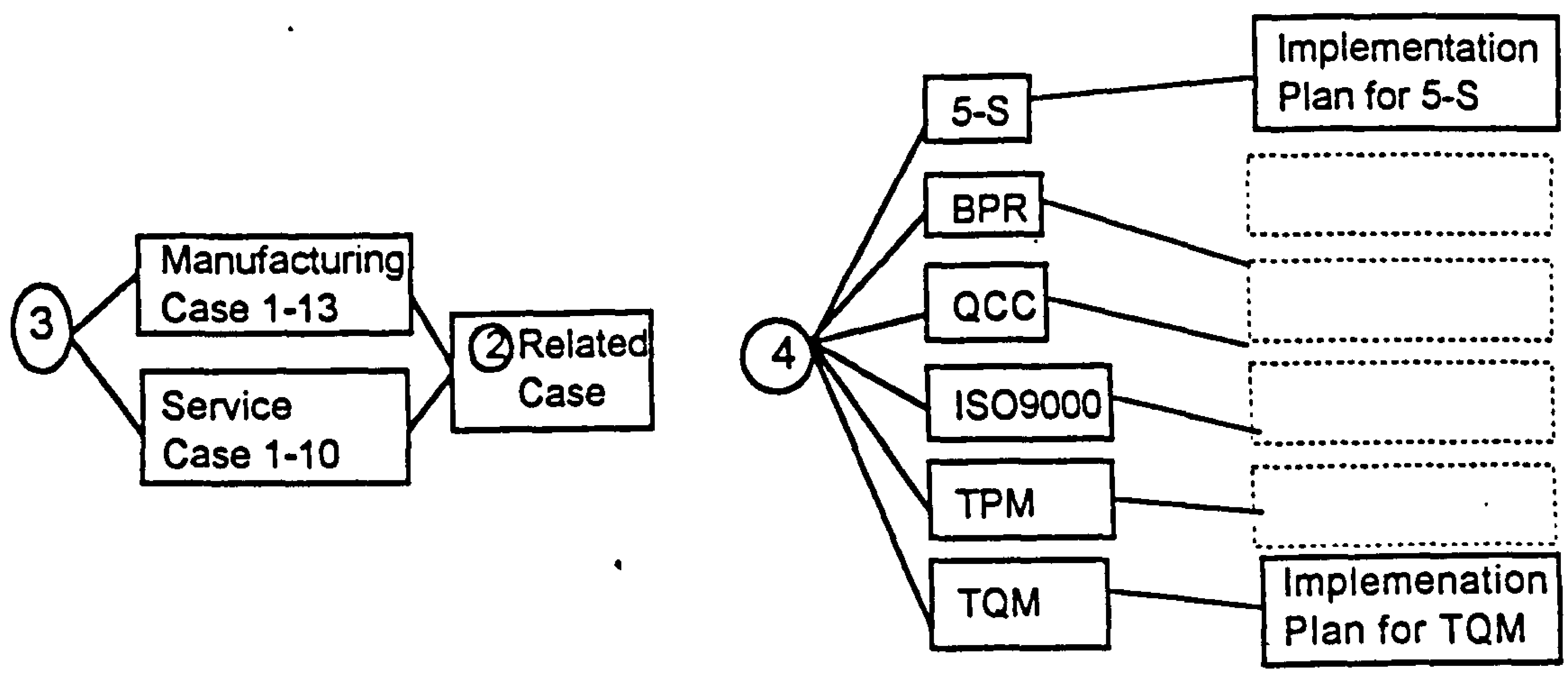
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5-S

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Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub

Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    s1_lmanu_limit = 4.8
    s2_lmanu_limit = 3.6
    s3_lmanu_limit = 3.9
    s4_lmanu_limit = 4.1
    s5_lmanu_limit = 4.2
    s1_smanu_limit = 5
    s2_smanu_limit = 3.4
    s3_smanu_limit = 3.5
    s4_smanu_limit = 3.8
    s5_smanu_limit = 4.3
    s1_lserv_limit = 4.8
    s2_lserv_limit = 4
    s3_lserv_limit = 3.9
    s4_lserv_limit = 3.8
    s5_lserv_limit = 4.3
    s1_sserv_limit = 4.9
    s2_sserv_limit = 4.3
    s3_sserv_limit = 4.3
    s4_sserv_limit = 4.3
    s5_sserv_limit = 5
    s1_lmanu_mean = 5.8
    s2_lmanu_mean = 4.9
    s3_lmanu_mean = 5.1
    s4_lmanu_mean = 5.4
    s5_lmanu_mean = 5.4
    s1_smanu_mean = 6
    s2_smanu_mean = 4.9
    s3_smanu_mean = 4.9
    s4_smanu_mean = 5.2
    s5_smanu_mean = 5.5
    s1_lserv_mean = 5.9
    s2_lserv_mean = 5.1
    s3_lserv_mean = 5.2
    s4_lserv_mean = 5.3
    s5_lserv_mean = 5.5
    s1_sserv_mean = 6.1
    s2_sserv_mean = 5.5
    s3_sserv_mean = 5.4
    s4_sserv_mean = 5.8
    s5_sserv_mean = 5.9
    s1 = 0
    s2 = 0
    s3 = 0
    s4 = 0
    s5 = 0
    s1_mean = 0
    s2_mean = 0
    s3_mean = 0
    s4_mean = 0
    s5_mean = 0
    s1_limit = 0
```

```
        s2_limit = 0
        s3_limit = 0
        s4_limit = 0
        s5_limit = 0
    If frmES.optsector(1).Value = True Then
        If frmES.optemp(1).Value = True Then 'Large Manufacturing
            s1_limit = s1_lmanu_limit
            s2_limit = s2_lmanu_limit
            s3_limit = s3_lmanu_limit
            s4_limit = s4_lmanu_limit
            s5_limit = s5_lmanu_limit
            s1_mean = s1_lmanu_mean
            s2_mean = s2_lmanu_mean
            s3_mean = s3_lmanu_mean
            s4_mean = s4_lmanu_mean
            s5_mean = s5_lmanu_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
            s1_limit = s1_smanu_limit
            s2_limit = s2_smanu_limit
            s3_limit = s3_smanu_limit
            s4_limit = s4_smanu_limit
            s5_limit = s5_smanu_limit
            s1_mean = s1_smanu_mean
            s2_mean = s2_smanu_mean
            s3_mean = s3_smanu_mean
            s4_mean = s4_smanu_mean
            s5_mean = s5_smanu_mean
        End If
    ElseIf frmES.optsector(1).Value = False Then
        If frmES.optemp(1).Value = True Then 'Large Services
            s1_limit = s1_lserv_limit
            s2_limit = s2_lserv_limit
            s3_limit = s3_lserv_limit
            s4_limit = s4_lserv_limit
            s5_limit = s5_lserv_limit
            s1_mean = s1_lserv_mean
            s2_mean = s2_lserv_mean
            s3_mean = s3_lserv_mean
            s4_mean = s4_lserv_mean
            s5_mean = s5_lserv_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Services
            s1_limit = s1_sserv_limit
            s2_limit = s2_sserv_limit
            s3_limit = s3_sserv_limit
            s4_limit = s4_sserv_limit
            s5_limit = s5_sserv_limit
            s1_mean = s1_sserv_mean
            s2_mean = s2_sserv_mean
            s3_mean = s3_sserv_mean
            s4_mean = s4_sserv_mean
            s5_mean = s5_sserv_mean
        End If
    End If
    End Sub

    Private Sub cmdCont_Click() 'proceed to next question set
        frmES.Visible = True
        frmES.cmdBPR.Enabled = True 'allow user to go onto next test
        Me.Visible = False
    End Sub

    Private Sub cmdScore_Click() ' calculate the score
    cmdScore.Caption = "&Update score"
    For i = 1 To 8
        If opt5S1(i).Value = True Then p1 = Int(opt5S1(i).Index)
    Next
```

```
For i = 1 To 8
    If opt5S2(i).Value = True Then p2 = Int(opt5S2(i).Index)
Next
For i = 1 To 8
    If opt5S3(i).Value = True Then p3 = Int(opt5S3(i).Index)
Next
For i = 1 To 8
    If opt5S4(i).Value = True Then p4 = Int(opt5S4(i).Index)
Next
For i = 1 To 8
    If opt5S5(i).Value = True Then p5 = Int(opt5S5(i).Index)
Next
'test if user have answer all questions
If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Or (p4 < 1) Or (p5 < 1) Then
    message = "You must answer all questions!"
    dialogtype = vbExclamation
    response = (MsgBox(message, dialogtype))
    Exit Sub
End If
cmdCont.Enabled = True
Call plot(p1, p2, p3, p4, p5)
Call overall_mean(p1, p2, p3, p4, p5)
End Sub

Private Sub overall_mean(p1, p2, p3, p4, p5)
'work out 5s overall mean
i = 0 'initialise i to 0
If p1 <> 8 Then i = i + 1
If p2 <> 8 Then i = i + 1
If p3 <> 8 Then i = i + 1
If p4 <> 8 Then i = i + 1
If p5 <> 8 Then i = i + 1
If p1 = 8 Then p1 = 0
If p2 = 8 Then p2 = 0
If p3 = 8 Then p3 = 0
If p4 = 8 Then p4 = 0
If p5 = 8 Then p5 = 0
If (p1 + p2 + p3 + p4 + p5 > 0) Then
        s_mean = (p1 + p2 + p3 + p4 + p5) / i
    Else
        s_mean = 0
End If
End Sub

Private Sub plot(p1, p2, p3, p4, p5)
frm5sGraph.Show
Me.Enabled = False
'show if not equal to "na"
If p1 <> 8 Then frm5sGraph.Shape(1).Visible = True
If p2 <> 8 Then frm5sGraph.Shape(2).Visible = True
If p3 <> 8 Then frm5sGraph.Shape(3).Visible = True
If p4 <> 8 Then frm5sGraph.Shape(4).Visible = True
If p5 <> 8 Then frm5sGraph.Shape(5).Visible = True

'work out s1-s5 value
If (p1 < s1_limit) Then
    s1 = 0
ElseIf (p1 = 8) Then
    s1 = 3
ElseIf (p1 >= s1_limit) And (p1 <= s1_mean) Then
    s1 = 1
ElseIf (p1 > s1_mean) Then
    s1 = 2
End If
'
If p2 < s2_limit Then
```

```
    s2 = 0
ElseIf (p2 = 8) Then
    s2 = 3
ElseIf (p2 >= s2_limit) And (p2 <= s2_mean) Then
    s2 = 1
ElseIf (p2 > s2_mean) Then s2 = 2
End If
'
If p3 < s3_limit Then
    s3 = 0
ElseIf (p3 = 8) Then
    s3 = 3
ElseIf (p3 >= s3_limit) And (p3 <= s3_mean) Then
    s3 = 1
ElseIf (p3 > s3_mean) Then s3 = 2
End If
'
If p4 < s4_limit Then
    s4 = 0
ElseIf (p4 = 8) Then
    s4 = 3
ElseIf (p4 >= s4_limit) And (p4 <= s4_mean) Then
    s4 = 1
ElseIf (p4 > s4_mean) Then s4 = 2
End If
'
If p5 < s5_limit Then
    s5 = 0
ElseIf (p5 = 8) Then
    s5 = 3
ElseIf (p5 >= s5_limit) And (p5 <= s5_mean) Then
    s5 = 1
ElseIf (p5 > s5_mean) Then s5 = 2
End If
'plot red if less than lower limit
'plot cyan higher than standard mean
If p1 < s1_limit Then frm5sGraph.Shape(1).BackColor = QBColor(12)
If p2 < s2_limit Then frm5sGraph.Shape(2).BackColor = QBColor(12)
If p3 < s3_limit Then frm5sGraph.Shape(3).BackColor = QBColor(12)
If p4 < s4_limit Then frm5sGraph.Shape(4).BackColor = QBColor(12)
If p5 < s5_limit Then frm5sGraph.Shape(5).BackColor = QBColor(12)
If p1 > s1_mean Then frm5sGraph.Shape(1).BackColor = QBColor(11)
If p2 > s2_mean Then frm5sGraph.Shape(2).BackColor = QBColor(11)
If p3 > s3_mean Then frm5sGraph.Shape(3).BackColor = QBColor(11)
If p4 > s4_mean Then frm5sGraph.Shape(4).BackColor = QBColor(11)
If p5 > s5_mean Then frm5sGraph.Shape(5).BackColor = QBColor(11)
frm5sGraph.Shape(1).Top = 9 - p1
frm5sGraph.Shape(2).Top = 9 - p2
frm5sGraph.Shape(3).Top = 9 - p3
frm5sGraph.Shape(4).Top = 9 - p4
frm5sGraph.Shape(5).Top = 9 - p5
'print suggestions
frm5sGraph.CurrentX = 0 'col 5
frm5sGraph.CurrentY = 11 'row 6
If (s1 = 3) And (s2 = 3) And (s3 = 3) And (s4 = 3) And (s5 = 3) Then
    frm5sGraph.Print Tab(8); "If 5-S is not applicable to your company, "
    frm5sGraph.Print Tab(8); "please move on to the next stage."
ElseIf (s1 = 0) And (s2 = 0) And (s3 = 0) And (s4 = 0) And (s5 = 0) Then
    frm5sGraph.Print Tab(8); "According to the graph above,  all activities "
    frm5sGraph.Print Tab(8); "are below  the lower  control limit.  For 5-S "
    frm5sGraph.Print Tab(8); "to work effectively, it is vital  for company "
    frm5sGraph.Print Tab(8); "to have a good quality environment.           "
ElseIf (s1 >= 2) And (s2 >= 2) And (s3 >= 2) And (s4 >= 2) And (s5 >= 2) Then
    frm5sGraph.Print Tab(8); "Well done! "
    frm5sGraph.Print Tab(8); "According  to the  graph above,  all activities "
    frm5sGraph.Print Tab(8); "are  above the  standard.  However,  it is time "
```

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frm5S - 5

    frm5sGraph.Print Tab(8); "to consider BPR as the next stage of continuous "
    frm5sGraph.Print Tab(8); "improvement. "
ElseIf (s1 >= 1) And (s2 >= 1) And (s3 >= 1) And (s4 >= 1) And (s5 >= 1) Then
    frm5sGraph.Print Tab(8); "According to  the graph above,  all activities are "
    frm5sGraph.Print Tab(8); "within the  acceptable range.  However, for 5-S to "
    frm5sGraph.Print Tab(8); "work effectively,  company must pay more attention "
    frm5sGraph.Print Tab(8); "on cleaning and neatness.                          "
Else 'If (s1 <= 2) And (s2 <= 2) And (s3 <= 2) And (s4 <= 2) And (s5 <= 2) Then
    frm5sGraph.Print Tab(8); "According to the graph above, some activities "
    frm5sGraph.Print Tab(8); "are below the lower control limit. For 5S to  "
    frm5sGraph.Print Tab(8); "work effectively,  it is vital for company to "
    frm5sGraph.Print Tab(8); "review  and balance  the emphasis on all the  "
    frm5sGraph.Print Tab(8); "activities in 5-S.                            "
End If
If s1 = 3 Then s1 = 0
If s2 = 3 Then s2 = 0
If s3 = 3 Then s3 = 0
If s4 = 3 Then s4 = 0
If s5 = 3 Then s5 = 0
End Sub
```

BPR

```
Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub
Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    b1_lmanu_limit = 2.9
    b2_lmanu_limit = 5.6
    b3_lmanu_limit = 4.5
    b4_lmanu_limit = 3.9
    b5_lmanu_limit = 4.4
    b1_smanu_limit = 3.2
    b2_smanu_limit = 5.6
    b3_smanu_limit = 4.4
    b4_smanu_limit = 3.7
    b5_smanu_limit = 4.2
    b1_lserv_limit = 3.8
    b2_lserv_limit = 5.5
    b3_lserv_limit = 4.5
    b4_lserv_limit = 4.5
    b5_lserv_limit = 4.8
    b1_sserv_limit = 3.8
    b2_sserv_limit = 6
    b3_sserv_limit = 4.9
    b4_sserv_limit = 4.3
    b5_sserv_limit = 4
    b1_lmanu_mean = 4.5
    b2_lmanu_mean = 6.4
    b3_lmanu_mean = 5.7
    b4_lmanu_mean = 5.1
    b5_lmanu_mean = 5.5
    b1_smanu_mean = 4.8
    b2_smanu_mean = 6.4
    b3_smanu_mean = 5.6
    b4_smanu_mean = 5.2
    b5_smanu_mean = 5.6
    b1_lserv_mean = 5.3
    b2_lserv_mean = 6.3
    b3_lserv_mean = 5.8
    b4_lserv_mean = 5.8
    b5_lserv_mean = 5.8
    b1_sserv_mean = 5.1
    b2_sserv_mean = 6.3
    b3_sserv_mean = 6
    b4_sserv_mean = 5.3
    b5_sserv_mean = 5.1
    b1 = 0
    b2 = 0
    b3 = 0
    b4 = 0
    b5 = 0
    b1_mean = 0
    b2_mean = 0
    b3_mean = 0
    b4_mean = 0
    b5_mean = 0
    b1_limit = 0
    b2_limit = 0
```

```
        b3_limit = 0
        b4_limit = 0
        b5_limit = 0
    If frmES.optsector(1).Value = True Then
        If frmES.optemp(1).Value = True Then 'Large Manufacturing
            b1_limit = b1_lmanu_limit
            b2_limit = b2_lmanu_limit
            b3_limit = b3_lmanu_limit
            b4_limit = b4_lmanu_limit
            b5_limit = b5_lmanu_limit
            b1_mean = b1_lmanu_mean
            b2_mean = b2_lmanu_mean
            b3_mean = b3_lmanu_mean
            b4_mean = b4_lmanu_mean
            b5_mean = b5_lmanu_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
            b1_limit = b1_smanu_limit
            b2_limit = b2_smanu_limit
            b3_limit = b3_smanu_limit
            b4_limit = b4_smanu_limit
            b5_limit = b5_smanu_limit
            b1_mean = b1_smanu_mean
            b2_mean = b2_smanu_mean
            b3_mean = b3_smanu_mean
            b4_mean = b4_smanu_mean
            b5_mean = b5_smanu_mean
        End If
    ElseIf frmES.optsector(1).Value = False Then
        If frmES.optemp(1).Value = True Then 'Large Services
            b1_limit = b1_lserv_limit
            b2_limit = b2_lserv_limit
            b3_limit = b3_lserv_limit
            b4_limit = b4_lserv_limit
            b5_limit = b5_lserv_limit
            b1_mean = b1_lserv_mean
            b2_mean = b2_lserv_mean
            b3_mean = b3_lserv_mean
            b4_mean = b4_lserv_mean
            b5_mean = b5_lserv_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Services
            b1_limit = b1_sserv_limit
            b2_limit = b2_sserv_limit
            b3_limit = b3_sserv_limit
            b4_limit = b4_sserv_limit
            b5_limit = b5_sserv_limit
            b1_mean = b1_sserv_mean
            b2_mean = b2_sserv_mean
            b3_mean = b3_sserv_mean
            b4_mean = b4_sserv_mean
            b5_mean = b5_sserv_mean
        End If
    End If
    End Sub
    Private Sub cmdCont_Click() 'proceed to next question set
        frmES.Visible = True
        frmES.cmdQCC.Enabled = True 'allow user to go onto next test
        Me.Visible = False
    End Sub
    Private Sub cmdScore_Click() ' calculate the score
    cmdScore.Caption = "&Update score"
    For i = 1 To 8
        If optBPR1(i).Value = True Then p1 = Int(optBPR1(i).Index)
    Next
    For i = 1 To 8
        If optBPR2(i).Value = True Then p2 = Int(optBPR2(i).Index)
    Next
```

```
For i = 1 To 8
    If optBPR3(i).Value = True Then p3 = Int(optBPR3(i).Index)
Next
For i = 1 To 8
    If optBPR4(i).Value = True Then p4 = Int(optBPR4(i).Index)
Next
For i = 1 To 8
    If optBPR5(i).Value = True Then p5 = Int(optBPR5(i).Index)
Next
'test if user have answer all questions
If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Or (p4 < 1) Or (p5 < 1) Then
    message = "You must answer all questions!"
    dialogtype = vbExclamation
    response = (MsgBox(message, dialogtype))
    Exit Sub
End If
cmdCont.Enabled = True
Call plot(p1, p2, p3, p4, p5)
Call overall_mean(p1, p2, p3, p4, p5)
End Sub
Private Sub overall_mean(p1, p2, p3, p4, p5)
'work out bpr overall mean
i = 0 'initialise i to 0
If p1 <> 8 Then i = i + 1
If p2 <> 8 Then i = i + 1
If p3 <> 8 Then i = i + 1
If p4 <> 8 Then i = i + 1
If p5 <> 8 Then i = i + 1
If p1 = 8 Then p1 = 0
If p2 = 8 Then p2 = 0
If p3 = 8 Then p3 = 0
If p4 = 8 Then p4 = 0
If p5 = 8 Then p5 = 0
If (p1 + p2 + p3 + p4 + p5 > 0) Then
        bpr_mean = (p1 + p2 + p3 + p4 + p5) / i
    Else
        bpr_mean = 0
End If
End Sub
Private Sub plot(p1, p2, p3, p4, p5)
Me.Enabled = False
frmBPRGraph.Show
'show if not equal to "na"
If p1 <> 8 Then frmBPRGraph.Shape(1).Visible = True
If p2 <> 8 Then frmBPRGraph.Shape(2).Visible = True
If p3 <> 8 Then frmBPRGraph.Shape(3).Visible = True
If p4 <> 8 Then frmBPRGraph.Shape(4).Visible = True
If p5 <> 8 Then frmBPRGraph.Shape(5).Visible = True

'work out b1-b5 value
If (p1 < b1_limit) Then
    b1 = 0
ElseIf (p1 = 8) Then
    b1 = 3
ElseIf (p1 >= b1_limit) And (p1 <= b1_mean) Then
    b1 = 1
ElseIf (p1 > b1_mean) Then
    b1 = 2
End If
'
If p2 < b2_limit Then
    b2 = 0
ElseIf (p2 = 8) Then
    b2 = 3
ElseIf (p2 >= b2_limit) And (p2 <= b2_mean) Then
    b2 = 1
```

```
ElseIf (p2 > b2_mean) Then b2 = 2
End If
'
If p3 < b3_limit Then
    b3 = 0
ElseIf (p3 = 8) Then
    b3 = 3
ElseIf (p3 >= b3_limit) And (p3 <= b3_mean) Then
    b3 = 1
ElseIf (p3 > b3_mean) Then b3 = 2
End If
'
If p4 < b4_limit Then
    b4 = 0
ElseIf (p4 = 8) Then
    b4 = 3
ElseIf (p4 >= b4_limit) And (p4 <= b4_mean) Then
    b4 = 1
ElseIf (p4 > b4_mean) Then b4 = 2
End If
'
If p5 < b5_limit Then
    b5 = 0
ElseIf (p5 = 8) Then
    b5 = 3
ElseIf (p5 >= b5_limit) And (p5 <= b5_mean) Then
    b5 = 1
ElseIf (p5 > b5_mean) Then b5 = 2
End If
'plot red if less than lower limit
'plot cyan higher than standard mean
If p1 < b1_limit Then frmBPRGraph.Shape(1).BackColor = QBColor(12)
If p2 < b2_limit Then frmBPRGraph.Shape(2).BackColor = QBColor(12)
If p3 < b3_limit Then frmBPRGraph.Shape(3).BackColor = QBColor(12)
If p4 < b4_limit Then frmBPRGraph.Shape(4).BackColor = QBColor(12)
If p5 < b5_limit Then frmBPRGraph.Shape(5).BackColor = QBColor(12)
If p1 > b1_mean Then frmBPRGraph.Shape(1).BackColor = QBColor(11)
If p2 > b2_mean Then frmBPRGraph.Shape(2).BackColor = QBColor(11)
If p3 > b3_mean Then frmBPRGraph.Shape(3).BackColor = QBColor(11)
If p4 > b4_mean Then frmBPRGraph.Shape(4).BackColor = QBColor(11)
If p5 > b5_mean Then frmBPRGraph.Shape(5).BackColor = QBColor(11)

frmBPRGraph.Shape(1).Top = 9 - p1
frmBPRGraph.Shape(2).Top = 9 - p2
frmBPRGraph.Shape(3).Top = 9 - p3
frmBPRGraph.Shape(4).Top = 9 - p4
frmBPRGraph.Shape(5).Top = 9 - p5

'print suggestions
frmBPRGraph.CurrentX = 0 'col 5
frmBPRGraph.CurrentY = 11 'row 6
If (b1 = 3) And (b2 = 3) And (b3 = 3) And (b4 = 3) And (b5 = 3) Then
    frmBPRGraph.Print Tab(8); "if BPR is not applicable to your company, "
    frmBPRGraph.Print Tab(8); "please move on to the next stage."
ElseIf (b1 = 0) And (b2 = 0) And (b3 = 0) And (b4 = 0) And (b5 = 0) Then
    frmBPRGraph.Print Tab(8); "According to the graph above,  all activities "
    frmBPRGraph.Print Tab(8); "are below  the lower  control limit.  To       "
    frmBPRGraph.Print Tab(8); "systematically enhance business processes today, there"
    frmBPRGraph.Print Tab(8); "are some strategically important questions to be asked:"
    frmBPRGraph.Print Tab(8); "1. What business are you in? "
    frmBPRGraph.Print Tab(8); "2. What are the key sucess factors customers are looking fo
    frmBPRGraph.Print Tab(8); "3. How can we effectively apply process improvement?"
ElseIf (b1 >= 2) And (b2 >= 2) And (b3 >= 2) And (b4 >= 2) And (b5 >= 2) Then
    frmBPRGraph.Print Tab(8); "Well done! "
    frmBPRGraph.Print Tab(8); "According  to the  graph above,  all activities "
    frmBPRGraph.Print Tab(8); "are  above the  standard.  Your next move is to "
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```
    frmBPRGraph.Print Tab(8); "build long-term relationship with your customers on"
    frmBPRGraph.Print Tab(8); "the basis of mutual trust to encourage them to place"
    frmBPRGraph.Print Tab(8); "repeat orders and recommend your services to others"
ElseIf (b1 >= 1) And (b2 >= 1) And (b3 >= 1) And (b4 >= 1) And (b5 >= 1) Then
    frmBPRGraph.Print Tab(8); "According to  the graph above,  all activities are "
    frmBPRGraph.Print Tab(8); "within the  acceptable range. Perhaps BPR can be use"
    frmBPRGraph.Print Tab(8); "as a method for the continuous reassesment of the"
    frmBPRGraph.Print Tab(8); "customer needs. Therefore, it is vital for company"
    frmBPRGraph.Print Tab(8); "to review and balance the emphasis with all aspects"
    frmBPRGraph.Print Tab(8); "of business functions.                             "
Else 'If (b1 <= 2) And (b2 <= 2) And (b3 <= 2) And (b4 <= 2) And (b5 <= 2) Then
    frmBPRGraph.Print Tab(8); "According to the graph above, some activities "
    frmBPRGraph.Print Tab(8); "are below the lower control limit. For BPR to "
    frmBPRGraph.Print Tab(8); "work effectively,  it is vital for company to "
    frmBPRGraph.Print Tab(8); "review  and balance  the emphaisis on quality "
    frmBPRGraph.Print Tab(8); "control for all the business functions."
End If
If b1 = 3 Then b1 = 0
If b2 = 3 Then b2 = 0
If b3 = 3 Then b3 = 0
If b4 = 3 Then b4 = 0
If b5 = 3 Then b5 = 0
End Sub
```

QCC

```
Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub

Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    q1_lmanu_limit = 5.3
    q2_lmanu_limit = 4.1
    q3_lmanu_limit = 4.7
    q1_smanu_limit = 5.1
    q2_smanu_limit = 3.9
    q3_smanu_limit = 4.1
    q1_lserv_limit = 5.5
    q2_lserv_limit = 3.9
    q3_lserv_limit = 4.8
    q1_sserv_limit = 6.1
    q2_sserv_limit = 4.6
    q3_sserv_limit = 5.2
    q1_lmanu_mean = 6.2
    q2_lmanu_mean = 5.2
    q3_lmanu_mean = 5.8
    q1_smanu_mean = 6.1
    q2_smanu_mean = 5.1
    q3_smanu_mean = 5.5
    q1_lserv_mean = 6.2
    q2_lserv_mean = 5.2
    q3_lserv_mean = 5.7
    q1_sserv_mean = 6.5
    q2_sserv_mean = 5.7
    q3_sserv_mean = 6.1
    q1 = 0
    q2 = 0
    q3 = 0
    q1_mean = 0
    q2_mean = 0
    q3_mean = 0
    q1_limit = 0
    q2_limit = 0
    q3_limit = 0
If frmES.optsector(1).Value = True Then
    If frmES.optemp(1).Value = True Then 'Large Manufacturing
        q1_limit = q1_lmanu_limit
        q2_limit = q2_lmanu_limit
        q3_limit = q3_lmanu_limit
        q1_mean = q1_lmanu_mean
        q2_mean = q2_lmanu_mean
        q3_mean = q3_lmanu_mean
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        q1_limit = q1_smanu_limit
        q2_limit = q2_smanu_limit
        q3_limit = q3_smanu_limit
        q1_mean = q1_smanu_mean
        q2_mean = q2_smanu_mean
        q3_mean = q3_smanu_mean
    End If
ElseIf frmES.optsector(1).Value = False Then
    If frmES.optemp(1).Value = True Then 'Large Services
```

```
            q1_limit = q1_lserv_limit
            q2_limit = q2_lserv_limit
            q3_limit = q3_lserv_limit
            q1_mean = q1_lserv_mean
            q2_mean = q2_lserv_mean
            q3_mean = q3_lserv_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Services
            q1_limit = q1_sserv_limit
            q2_limit = q2_sserv_limit
            q3_limit = q3_sserv_limit
            q1_mean = q1_sserv_mean
            q2_mean = q2_sserv_mean
            q3_mean = q3_sserv_mean
        End If
    End If
    End Sub

    Private Sub cmdCont_Click() 'proceed to next question set
        frmES.Visible = True
        frmES.cmdISO.Enabled = True 'allow user to go onto next test
        Me.Visible = False
    End Sub

    Private Sub cmdScore_Click() ' calculate the score
    cmdScore.Caption = "&Update score"
    For i = 1 To 8
        If optQCC1(i).Value = True Then p1 = Int(optQCC1(i).Index)
    Next
    For i = 1 To 8
        If optQCC2(i).Value = True Then p2 = Int(optQCC2(i).Index)
    Next
    For i = 1 To 8
        If optQCC3(i).Value = True Then p3 = Int(optQCC3(i).Index)
    Next
    'test if user have answer all questions
    If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Then
        message = "You must answer all questions!"
        dialogtype = vbExclamation
        response = (MsgBox(message, dialogtype))
        Exit Sub
    End If
    Call plot(p1, p2, p3)
    cmdCont.Enabled = True
    Call overall_mean(p1, p2, p3)
    End Sub

    Private Sub overall_mean(p1, p2, p3)
    'work out QCC overall mean
    i = 0 'initialise i to 0
    If p1 <> 8 Then i = i + 1
    If p2 <> 8 Then i = i + 1
    If p3 <> 8 Then i = i + 1
    If p1 = 8 Then p1 = 0
    If p2 = 8 Then p2 = 0
    If p3 = 8 Then p3 = 0
    If (p1 + p2 + p3) Then
            qcc_mean = (p1 + p2 + p3) / i
        Else
            qcc_mean = 0
    End If
    End Sub

    Private Sub plot(p1, p2, p3)
    Me.Enabled = False
    frmQCCGraph.Show
    'show if not equal to "na"
```

```
If p1 <> 8 Then frmQCCGraph.Shape(1).Visible = True
If p2 <> 8 Then frmQCCGraph.Shape(2).Visible = True
If p3 <> 8 Then frmQCCGraph.Shape(3).Visible = True

'work out q1-q5 value
If (p1 < q1_limit) Then
    q1 = 0
ElseIf (p1 = 8) Then
    q1 = 3
ElseIf (p1 >= q1_limit) And (p1 <= q1_mean) Then
    q1 = 1
ElseIf (p1 > q1_mean) Then
    q1 = 2
End If
'
If p2 < q2_limit Then
    q2 = 0
ElseIf (p2 = 8) Then
    q2 = 3
ElseIf (p2 >= q2_limit) And (p2 <= q2_mean) Then
    q2 = 1
ElseIf (p2 > q2_mean) Then q2 = 2
End If
'
If p3 < q3_limit Then
    q3 = 0
ElseIf (p3 = 8) Then
    q3 = 3
ElseIf (p3 >= q3_limit) And (p3 <= q3_mean) Then
    q3 = 1
ElseIf (p3 > q3_mean) Then q3 = 2
End If
'plot red if less than lower limit
'plot cyan higher than standard mean
If p1 < q1_limit Then frmQCCGraph.Shape(1).BackColor = QBColor(12)
If p2 < q2_limit Then frmQCCGraph.Shape(2).BackColor = QBColor(12)
If p3 < q3_limit Then frmQCCGraph.Shape(3).BackColor = QBColor(12)
If p1 > q1_mean Then frmQCCGraph.Shape(1).BackColor = QBColor(11)
If p2 > q2_mean Then frmQCCGraph.Shape(2).BackColor = QBColor(11)
If p3 > q3_mean Then frmQCCGraph.Shape(3).BackColor = QBColor(3)

frmQCCGraph.Shape(1).Top = 9 - p1
frmQCCGraph.Shape(2).Top = 9 - p2
frmQCCGraph.Shape(3).Top = 9 - p3

'print suggestions
frmQCCGraph.CurrentX = 0 'col 5
frmQCCGraph.CurrentY = 11 'row 6
If (q1 = 3) And (q2 = 3) And (q3 = 3) Then
    frmQCCGraph.Print Tab(8); "If QCC is not applicable to your company, "
    frmQCCGraph.Print Tab(8); "please move on to the next stage.   "
ElseIf (q1 = 0) And (q2 = 0) And (q3 = 0) And (q4 = 0) And (q5 = 0) Then
    frmQCCGraph.Print Tab(8); "According to the graph above,  all activities   "
    frmQCCGraph.Print Tab(8); "are below  the lower  control limit.  QCC is     "
    frmQCCGraph.Print Tab(8); "useful to facilitate process control, mutual and"
    frmQCCGraph.Print Tab(8); "self-development of employees, and improvement  "
    frmQCCGraph.Print Tab(8); "of their work place by utilising quality control"
    frmQCCGraph.Print Tab(8); "techniques.                                     "
ElseIf (q1 >= 2) And (q2 >= 2) And (q3 >= 2) Then
    frmQCCGraph.Print Tab(8); "Well done! "
    frmQCCGraph.Print Tab(8); "According  to the  graph above,  all activities  "
    frmQCCGraph.Print Tab(8); "are  above the  standard.  To further improve QCC"
    frmQCCGraph.Print Tab(8); "activities, there are many tools and techniques  "
    frmQCCGraph.Print Tab(8); "for problems solving, i.e. the QC tools and the 7"
    frmQCCGraph.Print Tab(8); "new tools of quality.                            "
ElseIf (q1 >= 1) And (q2 >= 1) And (q3 >= 1) Then
```

```
    frmQCCGraph.Print Tab(8); "According to  the graph above,  all activities are "
    frmQCCGraph.Print Tab(8); "within the  acceptable range.  Remember QCC is a  "
    frmQCCGraph.Print Tab(8); "continuous process, it can bring about cultural change"
    frmQCCGraph.Print Tab(8); "and motivate the staff to contribute to the improvement"
    frmQCCGraph.Print Tab(8); "of their work. "
Else
    frmQCCGraph.Print Tab(8); "According to the graph above, some activities are"
    frmQCCGraph.Print Tab(8); "below the lower control limit. The basic concept "
    frmQCCGraph.Print Tab(8); "behind QCC is to contribute to the improvemnt of "
    frmQCCGraph.Print Tab(8); "quality and to build cheerful work enviroment and"
    frmQCCGraph.Print Tab(8); "to draw out individual's potential."
End If
If q1 = 3 Then q1 = 0
If q2 = 3 Then q2 = 0
If q3 = 3 Then q3 = 0
End Sub
```

ISO 9000

```
Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub

Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    i1_lmanu_limit = 3.6
    i2_lmanu_limit = 4.1
    i3_lmanu_limit = 4.2
    i4_lmanu_limit = 3
    i5_lmanu_limit = 3.4
    i6_lmanu_limit = 3
    i7_lmanu_limit = 3.4
    i8_lmanu_limit = 2.7
    i1_smanu_limit = 3.8
    i2_smanu_limit = 4.3
    i3_smanu_limit = 4.4
    i4_smanu_limit = 2.8
    i5_smanu_limit = 3.2
    i6_smanu_limit = 3.2
    i7_smanu_limit = 3.3
    i8_smanu_limit = 2.4
    i1_lserv_limit = 3.6
    i2_lserv_limit = 4.1
    i3_lserv_limit = 4.2
    i4_lserv_limit = 2.8
    i5_lserv_limit = 3.8
    i6_lserv_limit = 2.9
    i7_lserv_limit = 3.7
    i8_lserv_limit = 3.6
    i1_sserv_limit = 3.8
    i2_sserv_limit = 4.3
    i3_sserv_limit = 4.5
    i4_sserv_limit = 2.5
    i5_sserv_limit = 2.8
    i6_sserv_limit = 2.7
    i7_sserv_limit = 3.9
    i8_sserv_limit = 2.5
    i1_lmanu_mean = 4.9
    i2_lmanu_mean = 5.2
    i3_lmanu_mean = 5.2
    i4_lmanu_mean = 4.2
    i5_lmanu_mean = 4.7
    i6_lmanu_mean = 4.2
    i7_lmanu_mean = 4.6
    i8_lmanu_mean = 4.1
    i1_smanu_mean = 5
    i2_smanu_mean = 5.2
    i3_smanu_mean = 5.4
    i4_smanu_mean = 4.1
    i5_smanu_mean = 4.6
    i6_smanu_mean = 4.3
    i7_smanu_mean = 4.5
    i8_smanu_mean = 3.7
    i1_lserv_mean = 4.9
    i2_lserv_mean = 5.1
    i3_lserv_mean = 5.2
```

```
    i4_lserv_mean = 4.1
    i5_lserv_mean = 4.9
    i6_lserv_mean = 4
    i7_lserv_mean = 4.8
    i8_lserv_mean = 4.4
    i1_sserv_mean = 5
    i2_sserv_mean = 5.2
    i3_sserv_mean = 5.3
    i4_sserv_mean = 3.9
    i5_sserv_mean = 4.4
    i6_sserv_mean = 4.3
    i7_sserv_mean = 4.8
    i8_sserv_mean = 4.1
    i1 = 0
    i2 = 0
    i3 = 0
    i4 = 0
    i5 = 0
    i6 = 0
    i7 = 0
    i8 = 0
    i1_mean = 0
    i2_mean = 0
    i3_mean = 0
    i4_mean = 0
    i5_mean = 0
    i6_mean = 0
    i7_mean = 0
    i8_mean = 0
    i1_limit = 0
    i2_limit = 0
    i3_limit = 0
    i4_limit = 0
    i5_limit = 0
    i6_limit = 0
    i7_limit = 0
    i8_limit = 0
If frmES.optsector(1).Value = True Then
    If frmES.optemp(1).Value = True Then 'Large Manufacturing
        i1_limit = i1_lmanu_limit
        i2_limit = i2_lmanu_limit
        i3_limit = i3_lmanu_limit
        i4_limit = i4_lmanu_limit
        i5_limit = i5_lmanu_limit
        i6_limit = i6_lmanu_limit
        i7_limit = i7_lmanu_limit
        i8_limit = i8_lmanu_limit
        i1_mean = i1_lmanu_mean
        i2_mean = i2_lmanu_mean
        i3_mean = i3_lmanu_mean
        i4_mean = i4_lmanu_mean
        i5_mean = i5_lmanu_mean
        i6_mean = i6_lmanu_mean
        i7_mean = i7_lmanu_mean
        i8_mean = i8_lmanu_mean
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        i1_limit = i1_smanu_limit
        i2_limit = i2_smanu_limit
        i3_limit = i3_smanu_limit
        i4_limit = i4_smanu_limit
        i5_limit = i5_smanu_limit
        i6_limit = i6_smanu_limit
        i7_limit = i7_smanu_limit
        i8_limit = i8_smanu_limit
        i1_mean = i1_smanu_mean
        i2_mean = i2_smanu_mean
```

```
            i3_mean = i3_smanu_mean
            i4_mean = i4_smanu_mean
            i5_mean = i5_smanu_mean
            i6_mean = i6_smanu_mean
            i7_mean = i7_smanu_mean
            i8_mean = i8_smanu_mean
        End If
    ElseIf frmES.optsector(1).Value = False Then
        If frmES.optemp(1).Value = True Then 'Large Services
            i1_limit = i1_lserv_limit
            i2_limit = i2_lserv_limit
            i3_limit = i3_lserv_limit
            i4_limit = i4_lserv_limit
            i5_limit = i5_lserv_limit
            i6_limit = i6_lserv_limit
            i7_limit = i7_lserv_limit
            i8_limit = i8_lserv_limit
            i1_mean = i1_lserv_mean
            i2_mean = i2_lserv_mean
            i3_mean = i3_lserv_mean
            i4_mean = i4_lserv_mean
            i5_mean = i5_lserv_mean
            i6_mean = i6_lserv_mean
            i7_mean = i7_lserv_mean
            i8_mean = i8_lserv_mean

        ElseIf frmES.optemp(1).Value = False Then 'S & M Services
            i1_limit = i1_sserv_limit
            i2_limit = i2_sserv_limit
            i3_limit = i3_sserv_limit
            i4_limit = i4_sserv_limit
            i5_limit = i5_sserv_limit
            i6_limit = i6_sserv_limit
            i7_limit = i7_sserv_limit
            i8_limit = i8_sserv_limit
            i1_mean = i1_sserv_mean
            i2_mean = i2_sserv_mean
            i3_mean = i3_sserv_mean
            i4_mean = i4_sserv_mean
            i5_mean = i5_sserv_mean
            i6_mean = i6_sserv_mean
            i7_mean = i7_sserv_mean
            i8_mean = i8_sserv_mean
        End If
    End If
    End Sub

    Private Sub cmdCont_Click() 'proceed to next question set
        frmES.Visible = True
        frmES.cmdTPM.Enabled = True 'allow user to go onto next test
        Me.Visible = False
    End Sub

    Private Sub cmdScore_Click() ' calculate the score
    cmdScore.Caption = "&Update score"
    For i = 1 To 8
        If optISO1(i).Value = True Then p1 = Int(optISO1(i).Index)
    Next
    For i = 1 To 8
        If optISO2(i).Value = True Then p2 = Int(optISO2(i).Index)
    Next
    For i = 1 To 8
        If optISO3(i).Value = True Then p3 = Int(optISO3(i).Index)
    Next
    For i = 1 To 8
        If optISO4(i).Value = True Then p4 = Int(optISO4(i).Index)
```

```
Next
For i = 1 To 8
    If optISO5(i).Value = True Then p5 = Int(optISO5(i).Index)
Next
For i = 1 To 8
    If optISO6(i).Value = True Then p6 = Int(optISO6(i).Index)
Next
For i = 1 To 8
    If optISO7(i).Value = True Then p7 = Int(optISO7(i).Index)
Next
For i = 1 To 8
    If optISO8(i).Value = True Then p8 = Int(optISO8(i).Index)
Next
'test if user have answer all questions
If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Or (p4 < 1) Or (p5 < 1) Or _
   (p6 < 1) Or (p7 < 1) Or (p8 < 1) Then
    message = "You must answer all question!"
    dialogtype = vbExclamation
    response = (MsgBox(message, dialogtype))
    Exit Sub
End If
cmdCont.Enabled = True
Call plot(p1, p2, p3, p4, p5, p6, p7, p8)
Call overall_mean(p1, p2, p3, p4, p5, p6, p7, p8)
End Sub

Private Sub overall_mean(p1, p2, p3, p4, p5, p6, p7, p8)
'work out ISO overall mean
i = 0 'initialise i to 0
If p1 <> 8 Then i = i + 1
If p2 <> 8 Then i = i + 1
If p3 <> 8 Then i = i + 1
If p4 <> 8 Then i = i + 1
If p5 <> 8 Then i = i + 1
If p6 <> 8 Then i = i + 1
If p7 <> 8 Then i = i + 1
If p8 <> 8 Then i = i + 1
If p1 = 8 Then p1 = 0
If p2 = 8 Then p2 = 0
If p3 = 8 Then p3 = 0
If p4 = 8 Then p4 = 0
If p5 = 8 Then p5 = 0
If p6 = 8 Then p6 = 0
If p7 = 8 Then p7 = 0
If p8 = 8 Then p8 = 0
If (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8 > 0) Then
        iso_mean = (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8) / i
    Else
        iso_mean = 0
End If
End Sub

Private Sub plot(p1, p2, p3, p4, p5, p6, p7, p8)
Me.Enabled = False
frmISOGraph.Show
'show if not equal to "na"
If p1 <> 8 Then frmISOGraph.Shape(1).Visible = True
If p2 <> 8 Then frmISOGraph.Shape(2).Visible = True
If p3 <> 8 Then frmISOGraph.Shape(3).Visible = True
If p4 <> 8 Then frmISOGraph.Shape(4).Visible = True
If p5 <> 8 Then frmISOGraph.Shape(5).Visible = True
If p6 <> 8 Then frmISOGraph.Shape(6).Visible = True
If p7 <> 8 Then frmISOGraph.Shape(7).Visible = True
If p8 <> 8 Then frmISOGraph.Shape(8).Visible = True

'work out i1-i5 value
```

```
If (p1 < i1_limit) Then
    i1 = 0
ElseIf (p1 = 8) Then
    i1 = 3
ElseIf (p1 >= i1_limit) And (p1 <= i1_mean) Then
    i1 = 1
ElseIf (p1 > i1_mean) Then
    i1 = 2
End If
'
If (p2 < i2_limit) Then
    i2 = 0
ElseIf (p2 = 8) Then
    i2 = 3
ElseIf (p2 >= i2_limit) And (p2 <= i2_mean) Then
    i2 = 1
ElseIf (p2 > i2_mean) Then
    i2 = 2
End If
'
If (p3 < i3_limit) Then
    i3 = 0
ElseIf (p3 = 8) Then
    i3 = 3
ElseIf (p3 >= i3_limit) And (p3 <= i3_mean) Then
    i3 = 1
ElseIf (p3 > i3_mean) Then
    i3 = 2
End If
'
If (p4 < i4_limit) Then
    i4 = 0
ElseIf (p4 = 8) Then
    i4 = 3
ElseIf (p4 >= i4_limit) And (p4 <= i4_mean) Then
    i4 = 1
ElseIf (p4 > i4_mean) Then
    i4 = 2
End If
'
If (p5 < i5_limit) Then
    i5 = 0
ElseIf (p5 = 8) Then
    i5 = 3
ElseIf (p5 >= i5_limit) And (p5 <= i5_mean) Then
    i5 = 1
ElseIf (p5 > i5_mean) Then
    i5 = 2
End If
'
If (p6 < i6_limit) Then
    i6 = 0
ElseIf (p6 = 8) Then
    i6 = 3
ElseIf (p6 >= i6_limit) And (p6 <= i6_mean) Then
    i6 = 1
ElseIf (p6 > i6_mean) Then
    i6 = 2
End If
'
If (p7 < i7_limit) Then
    i7 = 0
ElseIf (p7 = 8) Then
    i7 = 3
ElseIf (p7 >= i7_limit) And (p7 <= i7_mean) Then
    i7 = 1
```

```
ElseIf (p7 > i7_mean) Then
    i7 = 2
End If
'
If (p8 < i8_limit) Then
    i8 = 0
ElseIf (p8 = 8) Then
    i8 = 3
ElseIf (p8 >= i8_limit) And (p8 <= i8_mean) Then
    i8 = 1
ElseIf (p8 > i8_mean) Then
    i8 = 2
End If
'plot red if less than lower limit
'plot cyan higher than standard mean
If p1 < i1_limit Then frmISOGraph.Shape(1).BackColor = QBColor(12)
If p2 < i2_limit Then frmISOGraph.Shape(2).BackColor = QBColor(12)
If p3 < i3_limit Then frmISOGraph.Shape(3).BackColor = QBColor(12)
If p4 < i4_limit Then frmISOGraph.Shape(4).BackColor = QBColor(12)
If p5 < i5_limit Then frmISOGraph.Shape(5).BackColor = QBColor(12)
If p6 < i6_limit Then frmISOGraph.Shape(6).BackColor = QBColor(12)
If p7 < i7_limit Then frmISOGraph.Shape(7).BackColor = QBColor(12)
If p8 < i8_limit Then frmISOGraph.Shape(8).BackColor = QBColor(12)
If p1 > i1_mean Then frmISOGraph.Shape(1).BackColor = QBColor(11)
If p2 > i2_mean Then frmISOGraph.Shape(2).BackColor = QBColor(11)
If p3 > i3_mean Then frmISOGraph.Shape(3).BackColor = QBColor(11)
If p4 > i4_mean Then frmISOGraph.Shape(4).BackColor = QBColor(11)
If p5 > i5_mean Then frmISOGraph.Shape(5).BackColor = QBColor(11)
If p6 > i6_mean Then frmISOGraph.Shape(6).BackColor = QBColor(11)
If p7 > i7_mean Then frmISOGraph.Shape(7).BackColor = QBColor(11)
If p8 > i8_mean Then frmISOGraph.Shape(8).BackColor = QBColor(11)

frmISOGraph.Shape(1).Top = 9 - p1
frmISOGraph.Shape(2).Top = 9 - p2
frmISOGraph.Shape(3).Top = 9 - p3
frmISOGraph.Shape(4).Top = 9 - p4
frmISOGraph.Shape(5).Top = 9 - p5
frmISOGraph.Shape(6).Top = 9 - p6
frmISOGraph.Shape(7).Top = 9 - p7
frmISOGraph.Shape(8).Top = 9 - p8
'print suggestions
frmISOGraph.CurrentX = 0 'col 5
frmISOGraph.CurrentY = 11 'row 6
If (i1 = 3) And (i2 = 3) And (i3 = 3) And (i4 = 3) And (i5 = 3) And (i6 = 3) And _
    (i7 = 3) And (i8 = 3) Then
    frmISOGraph.Print Tab(8); "If ISO is not applicable to your company, "
    frmISOGraph.Print Tab(8); "please move on to the next stage."
ElseIf (i1 = 0) And (i2 = 0) And (i3 = 0) And (i4 = 0) And (i5 = 0) And (i6 = 0) _
    And (i7 = 0) And (i8 = 0) Then
    frmISOGraph.Print Tab(8); "According to the graph above,  all activities    "
    frmISOGraph.Print Tab(8); "are below  the lower  control limit.  Companies  "
    frmISOGraph.Print Tab(8); "often expect ISO 9000 to give them cost savings  "
    frmISOGraph.Print Tab(8); "within a short time.  Unfortunately, this benefit"
    frmISOGraph.Print Tab(8); "is not immediately achievable."
ElseIf (i1 >= 2) And (i2 >= 2) And (i3 >= 2) And (i4 >= 2) And (i5 >= 2) And _
    (i6 >= 2) And (i7 >= 2) And (i8 >= 2) Then
    frmISOGraph.Print Tab(8); "Well done! "
    frmISOGraph.Print Tab(8); "According  to the  graph above,  all activities "
    frmISOGraph.Print Tab(8); "are  above the  standard.  It is important to  "
    frmISOGraph.Print Tab(8); "consider satifying customer is the most crucial   "
    frmISOGraph.Print Tab(8); "in ISO 9000. Once the system is in place with the"
    frmISOGraph.Print Tab(8); "customer in mind, many of the benefits will follow"
ElseIf (i1 >= 1) And (i2 >= 1) And (i3 >= 1) And (i4 >= 1) And (i5 >= 1) And _
    (i6 >= 1) And (i7 >= 1) And (i8 >= 1) Then
    frmISOGraph.Print Tab(8); "According to  the graph above,  all activities are"
    frmISOGraph.Print Tab(8); "within the  acceptable range.  It is important to "
```

```
    frmISOGraph.Print Tab(8); "consider satifying customer is the most crucial   "
    frmISOGraph.Print Tab(8); "in ISO 9000. Once the system is in place with the"
    frmISOGraph.Print Tab(8); "customer in mind, many of the benefits will follow"
Else
    frmISOGraph.Print Tab(8); "According to the graph above, some activities  "
    frmISOGraph.Print Tab(8); "are below the lower control limit.  Companies  "
    frmISOGraph.Print Tab(8); "often expect ISO 9000 to give them cost savings"
    frmISOGraph.Print Tab(8); "within a short time.  Unfortunately, this benefit"
    frmISOGraph.Print Tab(8); "is not immediately achievable."
End If
If i1 = 3 Then i1 = 0
If i2 = 3 Then i2 = 0
If i3 = 3 Then i3 = 0
If i4 = 3 Then i4 = 0
If i5 = 3 Then i5 = 0
If i6 = 3 Then i6 = 0
If i7 = 3 Then i7 = 0
If i8 = 3 Then i8 = 0
End Sub
```

TPM

```
Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub

Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    tp1_lmanu_limit = 4
    tp2_lmanu_limit = 3.3
    tp3_lmanu_limit = 4.2
    tp4_lmanu_limit = 3.4
    tp5_lmanu_limit = 3.6
    tp6_lmanu_limit = 3.2
    tp7_lmanu_limit = 3.4
    tp8_lmanu_limit = 4.7
    tp9_lmanu_limit = 2.9
    tp10_lmanu_limit = 3
    tp11_lmanu_limit = 3.4
    tp1_smanu_limit = 3.4
    tp2_smanu_limit = 2.5
    tp3_smanu_limit = 4.4
    tp4_smanu_limit = 3.3
    tp5_smanu_limit = 3.2
    tp6_smanu_limit = 2.6
    tp7_smanu_limit = 3
    tp8_smanu_limit = 4.9
    tp9_smanu_limit = 3.2
    tp10_smanu_limit = 2.7
    tp11_smanu_limit = 2.3
    tp1_lserv_limit = 5.1
    tp2_lserv_limit = 4.2
    tp3_lserv_limit = 4.9
    tp4_lserv_limit = 3.7
    tp5_lserv_limit = 3.5
    tp6_lserv_limit = 3.7
    tp7_lserv_limit = 3.9
    tp8_lserv_limit = 5
    tp9_lserv_limit = 3.2
    tp10_lserv_limit = 3.6
    tp11_lserv_limit = 3.6
    tp1_sserv_limit = 4.8
    tp2_sserv_limit = 4.5
    tp3_sserv_limit = 4.9
    tp4_sserv_limit = 4.8
    tp5_sserv_limit = 4.4
    tp6_sserv_limit = 4
    tp7_sserv_limit = 4.6
    tp8_sserv_limit = 5.9
    tp9_sserv_limit = 4.4
    tp10_sserv_limit = 4.6
    tp11_sserv_limit = 3.5
    tp1_lmanu_mean = 5
    tp2_lmanu_mean = 4.4
    tp3_lmanu_mean = 5.2
    tp4_lmanu_mean = 4.6
    tp5_lmanu_mean = 4.7
    tp6_lmanu_mean = 4.1
    tp7_lmanu_mean = 4.5
```

```
tp8_lmanu_mean = 5.6
tp9_lmanu_mean = 4.1
tp10_lmanu_mean = 4.1
tp11_lmanu_mean = 4.5
tp1_smanu_mean = 4.7
tp2_smanu_mean = 4
tp3_smanu_mean = 5.4
tp4_smanu_mean = 4.4
tp5_smanu_mean = 4.5
tp6_smanu_mean = 3.8
tp7_smanu_mean = 4.4
tp8_smanu_mean = 5.8
tp9_smanu_mean = 4.3
tp10_smanu_mean = 4
tp11_smanu_mean = 3.7
tp1_lserv_mean = 4.2
tp2_lserv_mean = 4.2
tp3_lserv_mean = 5.5
tp4_lserv_mean = 4.7
tp5_lserv_mean = 4.7
tp6_lserv_mean = 4.3
tp7_lserv_mean = 4.8
tp8_lserv_mean = 5.7
tp9_lserv_mean = 4.1
tp10_lserv_mean = 4.2
tp11_lserv_mean = 4.4
tp1_sserv_mean = 5.3
tp2_sserv_mean = 5
tp3_sserv_mean = 5.4
tp4_sserv_mean = 5
tp5_sserv_mean = 4.8
tp6_sserv_mean = 4.5
tp7_sserv_mean = 5.1
tp8_sserv_mean = 6.3
tp9_sserv_mean = 4.9
tp10_sserv_mean = 4.9
tp11_sserv_mean = 4.2
tp1 = 0
tp2 = 0
tp3 = 0
tp4 = 0
tp5 = 0
tp6 = 0
tp7 = 0
tp8 = 0
tp9 = 0
tp10 = 0
tp11 = 0
tp1_mean = 0
tp2_mean = 0
tp3_mean = 0
tp4_mean = 0
tp5_mean = 0
tp6_mean = 0
tp7_mean = 0
tp8_mean = 0
tp9_mean = 0
tp10_mean = 0
tp11_mean = 0
tp1_limit = 0
tp2_limit = 0
tp3_limit = 0
tp4_limit = 0
tp5_limit = 0
tp6_limit = 0
tp7_limit = 0
```

```
        tp8_limit = 0
        tp9_limit = 0
        tp10_limit = 0
        tp11_limit = 0
    If frmES.optsector(1).Value = True Then
        If frmES.optemp(1).Value = True Then 'Large Manufacturing
            tp1_limit = tp1_lmanu_limit
            tp2_limit = tp2_lmanu_limit
            tp3_limit = tp3_lmanu_limit
            tp4_limit = tp4_lmanu_limit
            tp5_limit = tp5_lmanu_limit
            tp6_limit = tp6_lmanu_limit
            tp7_limit = tp7_lmanu_limit
            tp8_limit = tp8_lmanu_limit
            tp9_limit = tp9_lmanu_limit
            tp10_limit = tp10_lmanu_limit
            tp11_limit = tp11_lmanu_limit
            tp1_mean = tp1_lmanu_mean
            tp2_mean = tp2_lmanu_mean
            tp3_mean = tp3_lmanu_mean
            tp4_mean = tp4_lmanu_mean
            tp5_mean = tp5_lmanu_mean
            tp6_mean = tp6_lmanu_mean
            tp7_mean = tp7_lmanu_mean
            tp8_mean = tp8_lmanu_mean
            tp9_mean = tp9_lmanu_mean
            tp10_mean = tp10_lmanu_mean
            tp11_mean = tp11_lmanu_mean
        ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
            tp1_limit = tp1_smanu_limit
            tp2_limit = tp2_smanu_limit
            tp3_limit = tp3_smanu_limit
            tp4_limit = tp4_smanu_limit
            tp5_limit = tp5_smanu_limit
            tp6_limit = tp6_smanu_limit
            tp7_limit = tp7_smanu_limit
            tp8_limit = tp8_smanu_limit
            tp9_limit = tp9smanu_limit
            tp10_limit = tp10_smanu_limit
            tp11_limit = tp11_smanu_limit
            tp1_mean = tp1_smanu_mean
            tp2_mean = tp2_smanu_mean
            tp3_mean = tp3_smanu_mean
            tp4_mean = tp4_smanu_mean
            tp5_mean = tp5_smanu_mean
            tp6_mean = tp6_smanu_mean
            tp7_mean = tp7_smanu_mean
            tp8_mean = tp8_smanu_mean
            tp9_mean = tp9_smanu_mean
            tp10_mean = tp10_smanu_mean
            tp11_mean = tp11_smanu_mean
        End If
    ElseIf frmES.optsector(1).Value = False Then
        If frmES.optemp(1).Value = True Then 'Large Services
            tp1_limit = tp1_lserv_limit
            tp2_limit = tp2_lserv_limit
            tp3_limit = tp3_lserv_limit
            tp4_limit = tp4_lserv_limit
            tp5_limit = tp5_lserv_limit
            tp6_limit = tp6_lserv_limit
            tp7_limit = tp7_lserv_limit
            tp8_limit = tp8_lserv_limit
            tp9_limit = tp9_lserv_limit
            tp10_limit = tp10_lserv_limit
            tp11_limit = tp11_lserv_limit
            tp1_mean = tp1_lserv_mean
```

```
        tp2_mean = tp2_lserv_mean
        tp3_mean = tp3_lserv_mean
        tp4_mean = tp4_lserv_mean
        tp5_mean = tp5_lserv_mean
        tp6_mean = tp6_lserv_mean
        tp7_mean = tp7_lserv_mean
        tp8_mean = tp8_lserv_mean
        tp9_mean = tp9_lserv_mean
        tp10_mean = tp10_lserv_mean
        tp11_mean = tp11_lserv_mean
     ElseIf frmES.optemp(1).Value = False Then 'S & M Services
        tp1_limit = tp1_sserv_limit
        tp2_limit = tp2_sserv_limit
        tp3_limit = tp3_sserv_limit
        tp4_limit = tp4_sserv_limit
        tp5_limit = tp5_sserv_limit
        tp6_limit = tp6_sserv_limit
        tp7_limit = tp7_sserv_limit
        tp8_limit = tp8_sserv_limit
        tp9_limit = tp9_sserv_limit
        tp10_limit = tp10_sserv_limit
        tp11_limit = tp11_sserv_limit
        tp1_mean = tp1_sserv_mean
        tp2_mean = tp2_sserv_mean
        tp3_mean = tp3_sserv_mean
        tp4_mean = tp4_sserv_mean
        tp5_mean = tp5_sserv_mean
        tp6_mean = tp6_sserv_mean
        tp7_mean = tp7_sserv_mean
        tp8_mean = tp8_sserv_mean
        tp9_mean = tp9_sserv_mean
        tp10_mean = tp10_sserv_mean
        tp11_mean = tp11_sserv_mean
    End If
End If
End Sub

Private Sub cmdCont_Click() 'proceed to next question set
    frmES.Visible = True
    frmES.cmdTQM.Enabled = True 'allow user to go onto next test
    Me.Visible = False
End Sub

Private Sub cmdScore_Click() ' calculate the score
cmdScore.Caption = "&Update score"
For i = 1 To 8
    If optTPM1(i).Value = True Then p1 = Int(optTPM1(i).Index)
Next
For i = 1 To 8
    If optTPM2(i).Value = True Then p2 = Int(optTPM2(i).Index)
Next
For i = 1 To 8
    If optTPM3(i).Value = True Then p3 = Int(optTPM3(i).Index)
Next
For i = 1 To 8
    If optTPM4(i).Value = True Then p4 = Int(optTPM4(i).Index)
Next
For i = 1 To 8
    If optTPM5(i).Value = True Then p5 = Int(optTPM5(i).Index)
Next
For i = 1 To 8
    If optTPM6(i).Value = True Then p6 = Int(optTPM6(i).Index)
Next
For i = 1 To 8
    If optTPM7(i).Value = True Then p7 = Int(optTPM7(i).Index)
Next
```

```
For i = 1 To 8
    If optTPM8(i).Value = True Then p8 = Int(optTPM8(i).Index)
Next
For i = 1 To 8
    If optTPM9(i).Value = True Then p9 = Int(optTPM9(i).Index)
Next
For i = 1 To 8
    If optTPM10(i).Value = True Then p10 = Int(optTPM10(i).Index)
Next
For i = 1 To 8
    If optTPM11(i).Value = True Then p11 = Int(optTPM11(i).Index)
Next
'test if user have answer all questions
If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Or (p4 < 1) Or (p5 < 1) Or _
   (p6 < 1) Or (p7 < 1) Or (p8 < 1) Or (p9 < 1) Or (p10 < 1) Or (p11 < 1) Then
    message = "You must answer all questions!"
    dialogtype = vbExclamation
    response = (MsgBox(message, dialogtype))
    Exit Sub
End If
Call plot(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p11)
cmdCont.Enabled = True
Call overall_mean(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p11)
End Sub

Private Sub overall_mean(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p11)
'work out TPM overall mean
i = 0 'initialise i to 0
If p1 <> 8 Then i = i + 1
If p2 <> 8 Then i = i + 1
If p3 <> 8 Then i = i + 1
If p4 <> 8 Then i = i + 1
If p5 <> 8 Then i = i + 1
If p6 <> 8 Then i = i + 1
If p7 <> 8 Then i = i + 1
If p8 <> 8 Then i = i + 1
If p9 <> 8 Then i = i + 1
If p10 <> 8 Then i = i + 1
If p11 <> 8 Then i = i + 1
If p1 = 8 Then p1 = 0
If p2 = 8 Then p2 = 0
If p3 = 8 Then p3 = 0
If p4 = 8 Then p4 = 0
If p5 = 8 Then p5 = 0
If p6 = 8 Then p6 = 0
If p7 = 8 Then p7 = 0
If p8 = 8 Then p8 = 0
If p9 = 8 Then p9 = 0
If p10 = 8 Then p10 = 0
If p11 = 8 Then p11 = 0
If (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8 + p9 + p10 + p11 > 0) Then
        tpm_mean = (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8 + p9 + p10 + p11) / i
    Else
        tpm_mean = 0
End If
End Sub

Private Sub plot(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10, p11)
Me.Enabled = False
frmTPMGraph.Show
'show if not equal to "na"
If p1 <> 8 Then frmTPMGraph.Shape(1).Visible = True
If p2 <> 8 Then frmTPMGraph.Shape(2).Visible = True
If p3 <> 8 Then frmTPMGraph.Shape(3).Visible = True
If p4 <> 8 Then frmTPMGraph.Shape(4).Visible = True
If p5 <> 8 Then frmTPMGraph.Shape(5).Visible = True
```

```
If p6 <> 8 Then frmTPMGraph.Shape(6).Visible = True
If p7 <> 8 Then frmTPMGraph.Shape(7).Visible = True
If p8 <> 8 Then frmTPMGraph.Shape(8).Visible = True
If p9 <> 8 Then frmTPMGraph.Shape(9).Visible = True
If p10 <> 8 Then frmTPMGraph.Shape(10).Visible = True
If p11 <> 8 Then frmTPMGraph.Shape(11).Visible = True


'work out tp1-tp11 value
If (p1 < tp1_limit) Then
    tp1 = 0
ElseIf (p1 = 8) Then
    tp1 = 3
ElseIf (p1 >= tp1_limit) And (p1 <= tp1_mean) Then
    tp1 = 1
ElseIf (p1 > tp1_mean) Then
    tp1 = 2
End If
'
If (p2 < tp2_limit) Then
    tp2 = 0
ElseIf (p2 = 8) Then
    tp2 = 3
ElseIf (p2 >= tp2_limit) And (p2 <= tp2_mean) Then
    tp2 = 1
ElseIf (p2 > tp2_mean) Then
    tp2 = 2
End If
'
If (p3 < tp3_limit) Then
    tp3 = 0
ElseIf (p3 = 8) Then
    tp3 = 3
ElseIf (p3 >= tp3_limit) And (p3 <= tp3_mean) Then
    tp3 = 1
ElseIf (p3 > tp3_mean) Then
    tp3 = 2
End If
'
If (p4 < tp4_limit) Then
    tp4 = 0
ElseIf (p4 = 8) Then
    tp4 = 3
ElseIf (p4 >= tp4_limit) And (p4 <= tp4_mean) Then
    tp4 = 1
ElseIf (p4 > tp4_mean) Then
    tp4 = 2
End If
'
If (p5 < tp5_limit) Then
    tp5 = 0
ElseIf (p5 = 8) Then
    tp5 = 3
ElseIf (p5 >= tp5_limit) And (p5 <= tp5_mean) Then
    tp5 = 1
ElseIf (p5 > tp5_mean) Then
    tp5 = 2
End If
'
If (p5 < tp5_limit) Then
    tp5 = 0
ElseIf (p5 = 8) Then
    tp5 = 3
ElseIf (p5 >= tp5_limit) And (p5 <= tp5_mean) Then
    tp5 = 1
ElseIf (p5 > tp5_mean) Then
```

```
        tp5 = 2
    End If
    '
    If (p6 < tp6_limit) Then
        tp6 = 0
    ElseIf (p6 = 8) Then
        tp6 = 3
    ElseIf (p6 >= tp6_limit) And (p6 <= tp6_mean) Then
        tp6 = 1
    ElseIf (p6 > tp6_mean) Then
        tp6 = 2
    End If
    '
    If (p7 < tp7_limit) Then
        tp7 = 0
    ElseIf (p7 = 8) Then
        tp7 = 3
    ElseIf (p7 >= tp7_limit) And (p7 <= tp7_mean) Then
        tp7 = 1
    ElseIf (p7 > tp7_mean) Then
        tp7 = 2
    End If
    '
    If (p8 < tp8_limit) Then
        tp8 = 0
    ElseIf (p8 = 8) Then
        tp8 = 3
    ElseIf (p8 >= tp8_limit) And (p8 <= tp8_mean) Then
        tp8 = 1
    ElseIf (p8 > tp8_mean) Then
        tp8 = 2
    End If
    '
    If (p9 < tp9_limit) Then
        tp9 = 0
    ElseIf (p9 = 8) Then
        tp9 = 3
    ElseIf (p9 >= tp9_limit) And (p9 <= tp9_mean) Then
        tp9 = 1
    ElseIf (p9 > tp9_mean) Then
        tp9 = 2
    End If
    '
    If (p10 < tp10_limit) Then
        tp10 = 0
    ElseIf (p10 = 8) Then
        tp10 = 3
    ElseIf (p10 >= tp10_limit) And (p10 <= tp10_mean) Then
        tp10 = 1
    ElseIf (p10 > tp10_mean) Then
        tp10 = 2
    End If
    '
    If (p11 < tp11_limit) Then
        tp11 = 0
    ElseIf (p11 = 8) Then
        tp11 = 3
    ElseIf (p11 >= tp11_limit) And (p11 <= tp11_mean) Then
        tp11 = 1
    ElseIf (p11 > tp11_mean) Then
        tp11 = 2
    End If
    'plot red if.less than lower limit
    'plot cyan higher than standard mean
    If p1 < tp1_limit Then frmTPMGraph.Shape(1).BackColor = QBColor(12)
    If p2 < tp2_limit Then frmTPMGraph.Shape(2).BackColor = QBColor(12)
```

```
If p3 < tp3_limit Then frmTPMGraph.Shape(3).BackColor = QBColor(12)
If p4 < tp4_limit Then frmTPMGraph.Shape(4).BackColor = QBColor(12)
If p5 < tp5_limit Then frmTPMGraph.Shape(5).BackColor = QBColor(12)
If p6 < tp6_limit Then frmTPMGraph.Shape(6).BackColor = QBColor(12)
If p7 < tp7_limit Then frmTPMGraph.Shape(7).BackColor = QBColor(12)
If p8 < tp8_limit Then frmTPMGraph.Shape(8).BackColor = QBColor(12)
If p9 < tp9_limit Then frmTPMGraph.Shape(9).BackColor = QBColor(12)
If p10 < tp10_limit Then frmTPMGraph.Shape(10).BackColor = QBColor(12)
If p11 < tp11_limit Then frmTPMGraph.Shape(11).BackColor = QBColor(12)
If p1 > tp1_mean Then frmTPMGraph.Shape(1).BackColor = QBColor(11)
If p2 > tp2_mean Then frmTPMGraph.Shape(2).BackColor = QBColor(11)
If p3 > tp3_mean Then frmTPMGraph.Shape(3).BackColor = QBColor(11)
If p4 > tp4_mean Then frmTPMGraph.Shape(4).BackColor = QBColor(11)
If p5 > tp5_mean Then frmTPMGraph.Shape(5).BackColor = QBColor(11)
If p6 > tp6_mean Then frmTPMGraph.Shape(6).BackColor = QBColor(11)
If p7 > tp7_mean Then frmTPMGraph.Shape(7).BackColor = QBColor(11)
If p8 > tp8_mean Then frmTPMGraph.Shape(8).BackColor = QBColor(11)
If p9 > tp9_mean Then frmTPMGraph.Shape(9).BackColor = QBColor(11)
If p10 > tp10_mean Then frmTPMGraph.Shape(10).BackColor = QBColor(11)
If p11 > tp11_mean Then frmTPMGraph.Shape(11).BackColor = QBColor(11)

frmTPMGraph.Shape(1).Top = 9 - p1
frmTPMGraph.Shape(2).Top = 9 - p2
frmTPMGraph.Shape(3).Top = 9 - p3
frmTPMGraph.Shape(4).Top = 9 - p4
frmTPMGraph.Shape(5).Top = 9 - p5
frmTPMGraph.Shape(6).Top = 9 - p6
frmTPMGraph.Shape(7).Top = 9 - p7
frmTPMGraph.Shape(8).Top = 9 - p8
frmTPMGraph.Shape(9).Top = 9 - p9
frmTPMGraph.Shape(10).Top = 9 - p10
frmTPMGraph.Shape(11).Top = 9 - p11
'print suggestions
frmTPMGraph.CurrentX = 0 'col 5
frmTPMGraph.CurrentY = 11 'row 6
If (tp1 = 3) And (tp2 = 3) And (tp3 = 3) And (tp4 = 3) And _
   (tp5 = 3) And (tp6 = 3) And (tp7 = 3) And (tp8 = 3) And _
   (tp9 = 3) And (tp10 = 3) And (tp11 = 3) Then
    frmTPMGraph.Print Tab(8); "If TPM is not applicable to your company, "
    frmTPMGraph.Print Tab(8); "please move on to the next stage."
ElseIf (tp1 = 0) And (tp2 = 0) And (tp3 = 0) And (tp4 = 0) And _
   (tp5 = 0) And (tp6 = 0) And (tp7 = 0) And (tp8 = 0) And _
   (tp9 = 0) And (tp10 = 0) And (tp11 = 0) Then
    frmTPMGraph.Print Tab(8); "According to the graph above,  all activities "
    frmTPMGraph.Print Tab(8); "are below  the lower  control limit.  It is "
    frmTPMGraph.Print Tab(8); "evident that maintenance has been conducted in"
    frmTPMGraph.Print Tab(8); "a casual manner without real effort in trying"
    frmTPMGraph.Print Tab(8); "to incorporate all maintenance aspects. This is"
    frmTPMGraph.Print Tab(8); "mainly due to the management's negative attitudes "
    frmTPMGraph.Print Tab(8); "towards the role of maintenance. "
ElseIf (tp1 >= 2) And (tp2 >= 2) And (tp3 >= 2) And (tp4 >= 2) And _
       (tp5 >= 2) And (tp6 >= 2) And (tp7 >= 2) And (tp8 >= 2) And _
       (tp9 >= 2) And (tp10 >= 2) And (tp11 >= 2) Then
    frmTPMGraph.Print Tab(8); "Well done! "
    frmTPMGraph.Print Tab(8); "According  to the  graph above,  all activities "
    frmTPMGraph.Print Tab(8); "are  above the  standard.  However,  it is time "
    frmTPMGraph.Print Tab(8); "to consider TQM as the next stage of continuous "
    frmTPMGraph.Print Tab(8); "improvement. "
ElseIf (tp1 >= 1) And (tp2 >= 1) And (tp3 >= 1) And (tp4 >= 1) And _
       (tp5 >= 1) And (tp6 >= 1) And (tp7 >= 1) And (tp8 >= 1) And _
       (tp9 >= 1) And (tp10 >= 1) And (tp11 >= 1) Then
    frmTPMGraph.Print Tab(8); "According to  the graph above,  all activities are "
    frmTPMGraph.Print Tab(8); "within the  acceptable range.  However, for TPM to "
    frmTPMGraph.Print Tab(8); "work effectively,  company must pay more attention "
    frmTPMGraph.Print Tab(8); "to training and autonomous maintenance activities. "
Else
```

```
        frmTPMGraph.Print Tab(8); "According to the graph above, some activities "
        frmTPMGraph.Print Tab(8); "are below the lower control limit. It is evident"
        frmTPMGraph.Print Tab(8); "that maintenance has been conducted in a casual"
        frmTPMGraph.Print Tab(8); "manner without real effort in trying to incorporate"
        frmTPMGraph.Print Tab(8); "all maintenance aspects. This is mainly due to the"
        frmTPMGraph.Print Tab(8); "management's negative attitudes towards the role of "
        frmTPMGraph.Print Tab(8); "maintenance. "
    End If
    If tp1 = 3 Then tp1 = 0
    If tp2 = 3 Then tp2 = 0
    If tp3 = 3 Then tp3 = 0
    If tp4 = 3 Then tp4 = 0
    If tp5 = 3 Then tp5 = 0
    If tp6 = 3 Then tp6 = 0
    If tp7 = 3 Then tp7 = 0
    If tp8 = 3 Then tp8 = 0
    If tp9 = 3 Then tp9 = 0
    If tp10 = 3 Then tp10 = 0
    If tp11 = 3 Then tp11 = 0

    End Sub
```

```
Private Sub cmdExit_Click()
message = "Are you sure you want to quit?"
dialogtype = vbYesNo + vbQuestion
Title = "TQMEX Expert System"
response = MsgBox(message, dialogtype, Title)
If response = vbYes Then
    End
End If
End Sub

Private Sub Form_Load() 'initialise variable
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
    tq1_lmanu_limit = 3.6
    tq2_lmanu_limit = 3.7
    tq3_lmanu_limit = 3.7
    tq4_lmanu_limit = 3.8
    tq5_lmanu_limit = 3.3
    tq6_lmanu_limit = 3.6
    tq7_lmanu_limit = 3.3
    tq8_lmanu_limit = 2.6
    tq9_lmanu_limit = 3.3
    tq10_lmanu_limit = 4
    tq1_smanu_limit = 3.6
    tq2_smanu_limit = 4.1
    tq3_smanu_limit = 4.1
    tq4_smanu_limit = 3.9
    tq5_smanu_limit = 3.1
    tq6_smanu_limit = 3
    tq7_smanu_limit = 3.1
    tq8_smanu_limit = 2.6
    tq9_smanu_limit = 3.4
    tq10_smanu_limit = 3.8
    tq1_lserv_limit = 3.7
    tq2_lserv_limit = 4
    tq3_lserv_limit = 4.1
    tq4_lserv_limit = 3.9
    tq5_lserv_limit = 3.2
    tq6_lserv_limit = 3.6
    tq7_lserv_limit = 3.3
    tq8_lserv_limit = 3.2
    tq9_lserv_limit = 3.3
    tq10_lserv_limit = 4
    tq1_sserv_limit = 4
    tq2_sserv_limit = 4.4
    tq3_sserv_limit = 4.6
    tq4_sserv_limit = 4.1
    tq5_sserv_limit = 3.8
    tq6_sserv_limit = 3.6
    tq7_sserv_limit = 3.9
    tq8_sserv_limit = 2.9
    tq9_sserv_limit = 4
    tq10_sserv_limit = 4.6
    tq1_lmanu_mean = 4.8
    tq2_lmanu_mean = 4.9
    tq3_lmanu_mean = 4.9
    tq4_lmanu_mean = 5
    tq5_lmanu_mean = 4.4
    tq6_lmanu_mean = 4.8
    tq7_lmanu_mean = 4.5
    tq8_lmanu_mean = 4
    tq9_lmanu_mean = 4.6
    tq10_lmanu_mean = 5
    tq1_smanu_mean = 5
```

```
        tq2_smanu_mean = 5.3
        tq3_smanu_mean = 5.2
        tq4_smanu_mean = 5.1
        tq5_smanu_mean = 4.6
        tq6_smanu_mean = 4.4
        tq7_smanu_mean = 4.5
        tq8_smanu_mean = 4.7
        tq9_smanu_mean = 4.6
        tq10_smanu_mean = 4.9
        tq1_lserv_mean = 4.9
        tq2_lserv_mean = 5
        tq3_lserv_mean = 5.2
        tq4_lserv_mean = 5
        tq5_lserv_mean = 4.4
        tq6_lserv_mean = 4.9
        tq7_lserv_mean = 4.6
        tq8_lserv_mean = 4.3
        tq9_lserv_mean = 4.5
        tq10_lserv_mean = 5
        tq1_sserv_mean = 5
        tq2_sserv_mean = 5.3
        tq3_sserv_mean = 5.3
        tq4_sserv_mean = 5
        tq5_sserv_mean = 4.9
        tq6_sserv_mean = 4.7
        tq7_sserv_mean = 4.7
        tq8_sserv_mean = 4.4
        tq9_sserv_mean = 4.8
        tq10_sserv_mean = 5.2
        tq1 = 0
        tq2 = 0
        tq3 = 0
        tq4 = 0
        tq5 = 0
        tq6 = 0
        tq7 = 0
        tq8 = 0
        tq9 = 0
        tq10 = 0
        tq1_mean = 0
        tq2_mean = 0
        tq3_mean = 0
        tq4_mean = 0
        tq5_mean = 0
        tq6_mean = 0
        tq7_mean = 0
        tq8_mean = 0
        tq9_mean = 0
        tq10_mean = 0
        tq1_limit = 0
        tq2_limit = 0
        tq3_limit = 0
        tq4_limit = 0
        tq5_limit = 0
        tq6_limit = 0
        tq7_limit = 0
        tq8_limit = 0
        tq9_limit = 0
        tq10_limit = 0
    If frmES.optsector(1).Value = True Then
        If frmES.optemp(1).Value = True Then 'Large Manufacturing
            tq1_limit = tq1_lmanu_limit
            tq2_limit = tq2_lmanu_limit
            tq3_limit = tq3_lmanu_limit
            tq4_limit = tq4_lmanu_limit
            tq5_limit = tq5_lmanu_limit
```

```
        tq6_limit = tq6_lmanu_limit
        tq7_limit = tq7_lmanu_limit
        tq8_limit = tq8_lmanu_limit
        tq9_limit = tq9_lmanu_limit
        tq10_limit = tq10_lmanu_limit
        tq1_mean = tq1_lmanu_mean
        tq2_mean = tq2_lmanu_mean
        tq3_mean = tq3_lmanu_mean
        tq4_mean = tq4_lmanu_mean
        tq5_mean = tq5_lmanu_mean
        tq6_mean = tq6_lmanu_mean
        tq7_mean = tq7_lmanu_mean
        tq8_mean = tq8_lmanu_mean
        tq9_mean = tq9_lmanu_mean
        tq10_mean = tq10_lmanu_mean
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        tq1_limit = tq1_smanu_limit
        tq2_limit = tq2_smanu_limit
        tq3_limit = tq3_smanu_limit
        tq4_limit = tq4_smanu_limit
        tq5_limit = tq5_smanu_limit
        tq6_limit = tq6_smanu_limit
        tq7_limit = tq7_smanu_limit
        tq8_limit = tq8_smanu_limit
        tq9_limit = tq9smanu_limit
        tq10_limit = tq10_smanu_limit
        tq1_mean = tq1_smanu_mean
        tq2_mean = tq2_smanu_mean
        tq3_mean = tq3_smanu_mean
        tq4_mean = tq4_smanu_mean
        tq5_mean = tq5_smanu_mean
        tq6_mean = tq6_smanu_mean
        tq7_mean = tq7_smanu_mean
        tq8_mean = tq8_smanu_mean
        tq9_mean = tq9_smanu_mean
        tq10_mean = tq10_smanu_mean
    End If
ElseIf frmES.optsector(1).Value = False Then
    If frmES.optemp(1).Value = True Then 'Large Services
        tq1_limit = tq1_lserv_limit
        tq2_limit = tq2_lserv_limit
        tq3_limit = tq3_lserv_limit
        tq4_limit = tq4_lserv_limit
        tq5_limit = tq5_lserv_limit
        tq6_limit = tq6_lserv_limit
        tq7_limit = tq7_lserv_limit
        tq8_limit = tq8_lserv_limit
        tq9_limit = tq9_lserv_limit
        tq10_limit = tq10_lserv_limit
        tq1_mean = tq1_lserv_mean
        tq2_mean = tq2_lserv_mean
        tq3_mean = tq3_lserv_mean
        tq4_mean = tq4_lserv_mean
        tq5_mean = tq5_lserv_mean
        tq6_mean = tq6_lserv_mean
        tq7_mean = tq7_lserv_mean
        tq8_mean = tq8_lserv_mean
        tq9_limit = tq9_lserv_limit
        tq10_limit = tq10_lserv_limit

    ElseIf frmES.optemp(1).Value = False Then 'S & M Services
        tq1_limit = tq1_sserv_limit
        tq2_limit = tq2_sserv_limit
        tq3_limit = tq3_sserv_limit
        tq4_limit = tq4_sserv_limit
        tq5_limit = tq5_sserv_limit
```

```
            tq6_limit = tq6_sserv_limit
            tq7_limit = tq7_sserv_limit
            tq8_limit = tq8_sserv_limit
            tq9_limit = tq9_sserv_limit
            tq10_limit = tq10_sserv_limit
            tq1_mean = tq1_sserv_mean
            tq2_mean = tq2_sserv_mean
            tq3_mean = tq3_sserv_mean
            tq4_mean = tq4_sserv_mean
            tq5_mean = tq5_sserv_mean
            tq6_mean = tq6_sserv_mean
            tq7_mean = tq7_sserv_mean
            tq8_mean = tq8_sserv_mean
            tq9_mean = tq9_sserv_mean
            tq10_mean = tq10_sserv_mean
        End If
    End If
    End Sub

    Private Sub cmdCont_Click() 'proceed to next question set
        frmES.Visible = True
        frmES.cmdConclusion.Enabled = True 'allow user to go onto next test
        Me.Visible = False
    End Sub

    Private Sub cmdScore_Click() ' calculate the score
    cmdScore.Caption = "&Update score"
    For i = 1 To 8
        If optTQM1(i).Value = True Then p1 = Int(optTQM1(i).Index)
    Next
    For i = 1 To 8
        If optTQM2(i).Value = True Then p2 = Int(optTQM2(i).Index)
    Next
    For i = 1 To 8
        If optTQM3(i).Value = True Then p3 = Int(optTQM3(i).Index)
    Next
    For i = 1 To 8
        If optTQM4(i).Value = True Then p4 = Int(optTQM4(i).Index)
    Next
    For i = 1 To 8
        If optTQM5(i).Value = True Then p5 = Int(optTQM5(i).Index)
    Next
    For i = 1 To 8
        If optTQM6(i).Value = True Then p6 = Int(optTQM6(i).Index)
    Next
    For i = 1 To 8
        If optTQM7(i).Value = True Then p7 = Int(optTQM7(i).Index)
    Next
    For i = 1 To 8
        If optTQM8(i).Value = True Then p8 = Int(optTQM8(i).Index)
    Next
    For i = 1 To 8
        If optTQM9(i).Value = True Then p9 = Int(optTQM9(i).Index)
    Next
    For i = 1 To 8
        If optTQM10(i).Value = True Then p10 = Int(optTQM10(i).Index)
    Next
    'test if user have answer all questions
    If (p1 < 1) Or (p2 < 1) Or (p3 < 1) Or (p4 < 1) Or (p5 < 1) Or _
       (p6 < 1) Or (p7 < 1) Or (p8 < 1) Or (p9 < 1) Or (p10 < 1) Then
        message = "You must answer all question!"
        dialogtype = vbExclamation
        response = (MsgBox(message, dialogtype))
        Exit Sub
    End If
    Call plot(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10)
```

```
cmdCont.Enabled = True
Call overall_mean(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10)
End Sub

Private Sub overall_mean(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10)
'work out TQM overall mean
i = 0 'initialise i to 0
If p1 <> 8 Then i = i + 1
If p2 <> 8 Then i = i + 1
If p3 <> 8 Then i = i + 1
If p4 <> 8 Then i = i + 1
If p5 <> 8 Then i = i + 1
If p6 <> 8 Then i = i + 1
If p7 <> 8 Then i = i + 1
If p8 <> 8 Then i = i + 1
If p9 <> 8 Then i = i + 1
If p10 <> 8 Then i = i + 1
If p1 = 8 Then p1 = 0
If p2 = 8 Then p2 = 0
If p3 = 8 Then p3 = 0
If p4 = 8 Then p4 = 0
If p5 = 8 Then p5 = 0
If p6 = 8 Then p6 = 0
If p7 = 8 Then p7 = 0
If p8 = 8 Then p8 = 0
If p9 = 8 Then p9 = 0
If p10 = 8 Then p10 = 0
If (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8 + p9 + p10 > 0) Then
        tqm_mean = (p1 + p2 + p3 + p4 + p5 + p6 + p7 + p8 + p9 + p10) / i
    Else
        tqm_mean = 0
End If
End Sub

Private Sub plot(p1, p2, p3, p4, p5, p6, p7, p8, p9, p10)
Me.Enabled = False
frmTQMGraph.Show
'show if not equal to "na"
If p1 <> 8 Then frmTQMGraph.Shape(1).Visible = True
If p2 <> 8 Then frmTQMGraph.Shape(2).Visible = True
If p3 <> 8 Then frmTQMGraph.Shape(3).Visible = True
If p4 <> 8 Then frmTQMGraph.Shape(4).Visible = True
If p5 <> 8 Then frmTQMGraph.Shape(5).Visible = True
If p6 <> 8 Then frmTQMGraph.Shape(6).Visible = True
If p7 <> 8 Then frmTQMGraph.Shape(7).Visible = True
If p8 <> 8 Then frmTQMGraph.Shape(8).Visible = True
If p9 <> 8 Then frmTQMGraph.Shape(9).Visible = True
If p10 <> 8 Then frmTQMGraph.Shape(10).Visible = True

'work out tq1-tq11 value (N.B. na = 3)
If (p1 < tq1_limit) Then
    tq1 = 0
ElseIf (p1 = 8) Then
    tq1 = 3
ElseIf (p1 >= tq1_limit) And (p1 <= tq1_mean) Then
    tq1 = 1
ElseIf (p1 > tq1_mean) Then
    tq1 = 2
End If
'
If (p2 < tq2_limit) Then
    tq2 = 0
ElseIf (p2 = 8) Then
    tq2 = 3
ElseIf (p2 >= tq2_limit) And (p2 <= tq2_mean) Then
    tq2 = 1
```

```
    ElseIf (p2 > tq2_mean) Then
        tq2 = 2
    End If
    '
    If (p3 < tq3_limit) Then
        tq3 = 0
    ElseIf (p3 = 8) Then
        tq3 = 3
    ElseIf (p3 >= tq3_limit) And (p3 <= tq3_mean) Then
        tq3 = 1
    ElseIf (p3 > tq3_mean) Then
        tq3 = 2
    End If
    '
    If (p4 < tq4_limit) Then
        tq4 = 0
    ElseIf (p4 = 8) Then
        tq4 = 3
    ElseIf (p4 >= tq4_limit) And (p4 <= tq4_mean) Then
        tq4 = 1
    ElseIf (p4 > tq4_mean) Then
        tq4 = 2
    End If
    '
    If (p5 < tq5_limit) Then
        tq5 = 0
    ElseIf (p5 = 8) Then
        tq5 = 3
    ElseIf (p5 >= tq5_limit) And (p5 <= tq5_mean) Then
        tq5 = 1
    ElseIf (p5 > tq5_mean) Then
        tq5 = 2
    End If
    '
    If (p5 < tq5_limit) Then
        tq5 = 0
    ElseIf (p5 = 8) Then
        tq5 = 3
    ElseIf (p5 >= tq5_limit) And (p5 <= tq5_mean) Then
        tq5 = 1
    ElseIf (p5 > tq5_mean) Then
        tq5 = 2
    End If
    '
    If (p6 < tq6_limit) Then
        tq6 = 0
    ElseIf (p6 = 8) Then
        tq6 = 3
    ElseIf (p6 >= tq6_limit) And (p6 <= tq6_mean) Then
        tq6 = 1
    ElseIf (p6 > tq6_mean) Then
        tq6 = 2
    End If
    '
    If (p7 < tq7_limit) Then
        tq7 = 0
    ElseIf (p7 = 8) Theh
        tq7 = 3
    ElseIf (p7 >= tq7_limit) And (p7 <= tq7_mean) Then
        tq7 = 1
    ElseIf (p7 > tq7_mean) Then
        tq7 = 2
    End If
    '
    If (p8 < tq8_limit) Then
        tq8 = 0
```

```
ElseIf (p8 = 8) Then
    tq8 = 3
ElseIf (p8 >= tq8_limit) And (p8 <= tq8_mean) Then
    tq8 = 1
ElseIf (p8 > tq8_mean) Then
    tq8 = 2
End If
'
If (p9 < tq9_limit) Then
    tq9 = 0
ElseIf (p9 = 8) Then
    tq9 = 3
ElseIf (p9 >= tq9_limit) And (p9 <= tq9_mean) Then
    tq9 = 1
ElseIf (p9 > tq9_mean) Then
    tq9 = 2
End If
'
If (p10 < tq10_limit) Then
    tq10 = 0
ElseIf (p10 = 8) Then
    tq10 = 3
ElseIf (p10 >= tq10_limit) And (p10 <= tq10_mean) Then
    tq10 = 1
ElseIf (p10 > tq10_mean) Then
    tq10 = 2
End If
'plot red if less than lower limit
'plot cyan higher than standard mean
If p1 < tq1_limit Then frmTQMGraph.Shape(1).BackColor = QBColor(12)
If p2 < tq2_limit Then frmTQMGraph.Shape(2).BackColor = QBColor(12)
If p3 < tq3_limit Then frmTQMGraph.Shape(3).BackColor = QBColor(12)
If p4 < tq4_limit Then frmTQMGraph.Shape(4).BackColor = QBColor(12)
If p5 < tq5_limit Then frmTQMGraph.Shape(5).BackColor = QBColor(12)
If p6 < tq6_limit Then frmTQMGraph.Shape(6).BackColor = QBColor(12)
If p7 < tq7_limit Then frmTQMGraph.Shape(7).BackColor = QBColor(12)
If p8 < tq8_limit Then frmTQMGraph.Shape(8).BackColor = QBColor(12)
If p9 < tq9_limit Then frmTQMGraph.Shape(9).BackColor = QBColor(12)
If p10 < tq10_limit Then frmTQMGraph.Shape(10).BackColor = QBColor(12)
If p1 > tq1_mean Then frmTQMGraph.Shape(1).BackColor = QBColor(11)
If p2 > tq2_mean Then frmTQMGraph.Shape(2).BackColor = QBColor(11)
If p3 > tq3_mean Then frmTQMGraph.Shape(3).BackColor = QBColor(11)
If p4 > tq4_mean Then frmTQMGraph.Shape(4).BackColor = QBColor(11)
If p5 > tq5_mean Then frmTQMGraph.Shape(5).BackColor = QBColor(11)
If p6 > tq6_mean Then frmTQMGraph.Shape(6).BackColor = QBColor(11)
If p7 > tq7_mean Then frmTQMGraph.Shape(7).BackColor = QBColor(11)
If p8 > tq8_mean Then frmTQMGraph.Shape(8).BackColor = QBColor(11)
If p9 > tq9_mean Then frmTQMGraph.Shape(9).BackColor = QBColor(11)
If p10 > tq10_mean Then frmTQMGraph.Shape(10).BackColor = QBColor(11)

frmTQMGraph.Shape(1).Top = 9 - p1
frmTQMGraph.Shape(2).Top = 9 - p2
frmTQMGraph.Shape(3).Top = 9 - p3
frmTQMGraph.Shape(4).Top = 9 - p4
frmTQMGraph.Shape(5).Top = 9 - p5
frmTQMGraph.Shape(6).Top = 9 - p6
frmTQMGraph.Shape(7).Top = 9 - p7
frmTQMGraph.Shape(8).Top = 9 - p8
frmTQMGraph.Shape(9).Top = 9 - p9
frmTQMGraph.Shape(10).Top = 9 - p10
'print suggestions
frmTQMGraph.CurrentX = 0 'col
frmTQMGraph.CurrentY = 11 'row
If (tq1 = 3) And (tq2 = 3) And (tq3 = 3) And (tq4 = 3) And _
    (tq5 = 3) And (tq6 = 3) And (tq7 = 3) And (tq8 = 3) And _
    (tq9 = 3) And (tq10 = 3) Then
```

```
    frmTQMGraph.Print Tab(8); "If TQM is not application to your company, "
    frmTQMGraph.Print Tab(8); "please move on to the next stage."
ElseIf (tq1 = 0) And (tq2 = 0) And (tq3 = 0) And (tq4 = 0) And _
   (tq5 = 0) And (tq6 = 0) And (tq7 = 0) And (tq8 = 0) And _
   (tq9 = 0) And (tq10 = 0) Then
    frmTQMGraph.Print Tab(8); "According to the graph above,  all activities "
    frmTQMGraph.Print Tab(8); "are below  the lower  control limit.  The reason"
    frmTQMGraph.Print Tab(8); "for your low response in TQM may be because of the "
    frmTQMGraph.Print Tab(8); "lack of knowledge and understanding of TQM principle"
    frmTQMGraph.Print Tab(8); "or your company is still in the early stage of the"
    frmTQMGraph.Print Tab(8); "TQM journey."
ElseIf (tq1 >= 2) And (tq2 >= 2) And (tq3 >= 2) And (tq4 >= 2) And _
       (tq5 >= 2) And (tq6 >= 2) And (tq7 >= 2) And (tq8 >= 2) And _
       (tq9 >= 2) And (tq10 >= 2) Then
    frmTQMGraph.Print Tab(8); "Well done! "
    frmTQMGraph.Print Tab(8); "According  to the  graph above,  all activities "
    frmTQMGraph.Print Tab(8); "are  above the  standards.  However, TQM is not "
    frmTQMGraph.Print Tab(8); "a destination but a journey that will never end."
    frmTQMGraph.Print Tab(8); "It is worthwhile to choose an appropriate TQM "
    frmTQMGraph.Print Tab(8); "framework for further improvement."
ElseIf (tq1 >= 1) And (tq2 >= 1) And (tq3 >= 1) And (tq4 >= 1) And _
       (tq5 >= 1) And (tq6 >= 1) And (tq7 >= 1) And (tq8 >= 1) And _
       (tq9 >= 1) And (tq10 >= 1) Then
    frmTQMGraph.Print Tab(8); "According to  the graph above,  all activities are "
    frmTQMGraph.Print Tab(8); "within the  acceptable range.  However, TQM is not "
    frmTQMGraph.Print Tab(8); "a destination but a journey that will never end."
    frmTQMGraph.Print Tab(8); "It is worthwhile to choose an appropriate TQM "
    frmTQMGraph.Print Tab(8); "framework for further improvement."
Else
    frmTQMGraph.Print Tab(8); "According to the graph above, some activities "
    frmTQMGraph.Print Tab(8); "are below the lower control limit. The reason "
    frmTQMGraph.Print Tab(8); "for your average response in TQM may be because the "
    frmTQMGraph.Print Tab(8); "lack of knowledge and understanding of TQM principle"
    frmTQMGraph.Print Tab(8); "or your company is still in the early stage of the"
    frmTQMGraph.Print Tab(8); "TQM journey."
End If
If tq1 = 3 Then tq1 = 0
If tq2 = 3 Then tq2 = 0
If tq3 = 3 Then tq3 = 0
If tq4 = 3 Then tq4 = 0
If tq5 = 3 Then tq5 = 0
If tq6 = 3 Then tq6 = 0
If tq7 = 3 Then tq7 = 0
If tq8 = 3 Then tq8 = 0
If tq9 = 3 Then tq9 = 0
If tq10 = 3 Then tq10 = 0
End Sub
```

Expert System

```
Private Sub cmd5S_Click()
    fraEmp.Enabled = False
    fraSector.Enabled = False
    frm5S.Visible = True
    Me.Visible = False
End Sub
Private Sub cmdBPR_Click()
    frmBPR.Show
    Me.Visible = False
End Sub
Private Sub show_conclusion()  'work out score and give conclusion
lm_s_limit = 5.3 'large manufacturing mean fo mean
lm_bpr_limit = 5.4
lm_qcc_limit = 5.7
lm_iso_limit = 4.6
lm_tpm_limit = 4.6
lm_tqm_limit = 4.7
sm_s_limit = 5.3 'small & medium manufacturing mean fo mean
sm_bpr_limit = 5.5
sm_qcc_limit = 5.6
sm_iso_limit = 4.6
sm_tpm_limit = 4.4
sm_tqm_limit = 4.8
ls_s_limit = 5.4 'small & medium manufacturing mean fo mean
ls_bpr_limit = 5.8
ls_qcc_limit = 5.7
ls_iso_limit = 4.7
ls_tpm_limit = 4.5
ls_tqm_limit = 4.8
ss_s_limit = 5.7 'small & medium manufacturing mean fo mean
ss_bpr_limit = 5.5
ss_qcc_limit = 6.1
ss_iso_limit = 4.6
ss_tpm_limit = 5
ss_tqm_limit = 4.9
'
'work out total score
maxtotal = s1 + s2 + s3 + s4 + s5 + _
            b1 + b2 + b3 + b4 + b5 + _
            q1 + q2 + q3 + _
            i1 + i2 + i3 + i4 + i5 + i6 + i7 + i8 + _
            tp1 + tp2 + tp3 + tp4 + tp5 + tp6 + tp7 + tp8 + tp9 + tp10 + tp11 + _
            tq1 + tq2 + tq3 + tq4 + tq5 + tq6 + tq7 + tq8 + tq9 + tq10
'
'work out which set of mean to be used
If frmES.optsector(1).Value = True Then
    If frmES.optemp(1).Value = True Then 'Large Manufacturing
        s_limit = lm_s_limit
        bpr_limit = lm_bpr_limit
        qcc_limit = lm_qcc_limit
        iso_limit = lm_iso_limit
        tpm_limit = lm_tpm_limit
        tqm_limit = lm_tqm_limit
        sector = "Large Manaufacturing"
        maxscore = 78 'maxscore of the sector
        total = maxtotal - s4 - b1 - b3
        lowerlimit = 60
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        s_limit = sm_s_limit
        bpr_limit = sm_bpr_limit
        qcc_limit = sm_qcc_limit
        iso_limit = sm_iso_limit
        tpm_limit = sm_tpm_limit
        tqm_limit = sm_tqm_limit
        sector = "Small & Medium Manaufacturing"
        maxscore = 66 'maxscore of the sector
```

```
            total = maxtotal - s1 - s5 - i2 - i3 - i4 - i7 - tp7 - tp8
            lowerlimit = 60
        End If
    ElseIf frmES.optsector(1).Value = False Then
        If frmES.optemp(1).Value = True Then 'Large Services
            s_limit = ls_s_limit
            bpr_limit = ls_bpr_limit
            qcc_limit = ls_qcc_limit
            iso_limit = ls_iso_limit
            tpm_limit = ls_tpm_limit
            tqm_limit = ls_tqm_limit
            sector = "Large Services"
            maxscore = 72 'maxscore of the sector
            total = maxtotal - s2 - s5 - b2 - i1 - i2 - i8
            lowerlimit = 60
        ElseIf frmES.optemp(1).Value = False Then 'S & M Services
            s_limit = ss_s_limit
            bpr_limit = ss_bpr_limit
            qcc_limit = ss_qcc_limit
            iso_limit = ss_iso_limit
            tpm_limit = ss_tpm_limit
            tqm_limit = ss_tqm_limit
            sector = "Small & Medium Services"
            maxscore = 74 'maxscore of the sector
            total = maxtotal - s4 - i2 - i7 - tq7
            lowerlimit = 60
            End If
    End If
    'page 1
    frmConclusion.Show
    Me.Visible = False
    frmConclusion.text1.Text = frmES.txtName 'print company name
    frmConclusion.text2.Text = sector 'print sector
    frmConclusion.CurrentY = 1 'set current position and print date
    If total < lowerlimit Then
        frmConclusion.lblscore.ForeColor = QBColor(12)
    Else
        frmConclusion.lblscore.ForeColor = QBColor(15)
    End If
    frmConclusion.lblscore = total 'print total score
    frmConclusion.lblMaxScore = maxscore
    frmConclusion.lblMean5s = s_mean
    frmConclusion.lblMeanBPR = bpr_mean
    frmConclusion.lblMeanQCC = qcc_mean
    frmConclusion.lblMeanISO = iso_mean
    frmConclusion.lblMeanTPM = tpm_mean
    frmConclusion.lblMeanTQM = tqm_mean
    frmConclusion.lblLimit5s = s_limit
    frmConclusion.lblLimitBPR = bpr_limit
    frmConclusion.lblLimitQCC = qcc_limit
    frmConclusion.lblLimitISO = iso_limit
    frmConclusion.lblLimitTPM = tpm_limit
    frmConclusion.lblLimitTQM = tqm_limit
    'plot
    frmConclusion.Shape(1).Top = 11 - s_mean
    frmConclusion.Shape(2).Top = 11 - bpr_mean
    frmConclusion.Shape(3).Top = 11 - qcc_mean
    frmConclusion.Shape(4).Top = 11 - iso_mean
    frmConclusion.Shape(5).Top = 11 - tpm_mean
    frmConclusion.Shape(6).Top = 11 - tqm_mean
    frmConclusion.Shape(7).Top = 11 - s_limit
    frmConclusion.Shape(8).Top = 11 - bpr_limit
    frmConclusion.Shape(9).Top = 11 - qcc_limit
    frmConclusion.Shape(10).Top = 11 - iso_limit
    frmConclusion.Shape(11).Top = 11 - tpm_limit
    frmConclusion.Shape(12).Top = 11 - tqm_limit
```

```
End Sub
Private Sub cmdConclusion_Click()
    If txtName.Text = "" Then
        MsgBox "please fill in company name"
        Exit Sub
    End If
    Call show_conclusion
End Sub

Private Sub cmdContent_Click()
    frmMainMenu.Show
    Me.Visible = False
End Sub

Private Sub cmdExit_Click()
    End
End Sub

Private Sub cmdISO_Click()
    frmISO.Show
    Me.Visible = False
End Sub

Private Sub cmdQCC_Click()
    frmQCC.Show
    Me.Visible = False
End Sub

Private Sub cmdTPM_Click()
    frmTPM.Show
    Me.Visible = False
End Sub

Private Sub cmdTQM_Click()
    frmTQM.Show
    Me.Visible = False
End Sub

Private Sub Form_Load()
Me.Height = 10000
Me.Top = -50
Me.Width = 9780
Me.Left = -50
End Sub

Private Sub optemp_Click(Index As Integer)
cmd5S.Enabled = True
End Sub

Private Sub optSector_Click(Index As Integer)
    If optsector(1).Value = True Then
        optemp(1).Caption = " >= 300"
        optemp(2).Caption = " < 300"
    Else
        optemp(1).Caption = " >= 150"
        optemp(2).Caption = " < 150"

    End If
End Sub
```

Conclusion

```
Private Sub cmdBack_Click()
frmES.Visible = True
Unload Me
End Sub
Private Sub cmdDrawback_Click()
Me.Visible = False
If frmES.optsector(1).Value = True Then
    If frmES.optemp(1).Value = True Then 'Large Manufacturing
        frmDrawBackLM1.Show
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        frmDrawbackSM1.Show
    End If
ElseIf frmES.optsector(1).Value = False Then
    If frmES.optemp(1).Value = True Then 'Large Services
        frmDrawBackLS.Show
    ElseIf frmES.optemp(1).Value = False Then 'S & M Services
        frmDrawbackSS1.Show
    End If
End If

End Sub
Private Sub cmdMerit_Click()
Me.Visible = False
If frmES.optsector(1).Value = True Then
    If frmES.optemp(1).Value = True Then 'Large Manufacturing
        frmMeritLM1.Show
    ElseIf frmES.optemp(1).Value = False Then 'S & M Manufacturing
        frmMeritSM.Show
    End If
ElseIf frmES.optsector(1).Value = False Then
    If frmES.optemp(1).Value = True Then 'Large Services
        frmMeritLS.Show
    ElseIf frmES.optemp(1).Value = False Then 'S & M Services
        frmMeritSS.Show
    End If
End If
End Sub
Private Sub cmdPossImp_Click()
Me.Visible = False
frmPI1.Show
End Sub

Private Sub cmdPrint_Click()
Me.Enabled = False
frmPrint.Show
End Sub

Private Sub cmdReport_Click()
Me.Visible = False
frmReport.Show
frmReport.CurrentY = 2 'set current position
frmReport.Print Tab(6); "According to the result shown on the graph, ";
frmReport.Print "you have scored a total of "; total; " points "
If total < lowerlimit Then
    frmReport.Print Tab(6); "which is below the standard set by the Expert System. ";
    frmReport.Print "However, "
    frmReport.Print
Else
    frmReport.Print Tab(6); "which is within the standard set by the Expert System. ";
    frmReport.Print " Well done! ";
    frmReport.Print
End If
If (s_mean < s_limit) Then
    frmReport.Print Tab(6); "The mean of 5-S is on the lower side of the seven ";
    frmReport.Print "point scale. It is considered by many company      "
    frmReport.Print Tab(6); "as a key to total quality enviroment.  Therefore ";
```

```
Me.Width = 9780
Me.Left = -50
Date = Format$(Now, "mmmm dd, yyyy")
txtDate.Caption = Format$(Now, "mmmm dd, yyyy")
End Sub
```

```
    frmReport.Print "it would be worthwhile to set-up an implementation "
    frmReport.Print Tab(6); "plan. For more detail on implementing 5-S, please ";
    frmReport.Print "refer to some of the successful case (option 3) and "
    frmReport.Print Tab(6); "Implementation plan (option 4)in the main menu."
    frmReport.Print
End If
If (bpr_mean < bpr_limit) Then
    frmReport.Print Tab(6); "The mean of BPR is on the lower side of the seven ";
    frmReport.Print "point scale. BPR is considered by many companies as "
    frmReport.Print Tab(6); "one of the crucial factors for implementing TQM. ";
    frmReport.Print "Therefore it would be useful to refer to some of the "
    frmReport.Print Tab(6); "successful cases (option 3) and implementation ";
    frmReport.Print "plan (option 4) for BPR in the main menu. "
    frmReport.Print
End If
If (qcc_mean < qcc_limit) Then
    frmReport.Print Tab(6); "The mean of QCC is on the lower side of the seven ";
    frmReport.Print "point scale.  QCC is considered by many company as "
    frmReport.Print Tab(6); "the most important factor for implementing TQM. ";
    frmReport.Print "Therefore it would be useful to refer to some of "
    frmReport.Print Tab(6); "the successful case (option 3) and Implementation plan ";
    frmReport.Print "(option 4)in the main menu."
    frmReport.Print
End If
If (iso_mean < iso_limit) Then
    frmReport.Print Tab(6); "It's seems that your company see the ISO 9000 as a ";
    frmReport.Print "passport to stay in business rather than improving "
    frmReport.Print Tab(6); "quality.  The key to successful quality system is ";
    frmReport.Print "to keep it simple and short. Please refer to some "
    frmReport.Print Tab(6); "of the succesful cases (option 3) and implementation ";
    frmReport.Print "plan for (option 4) in the main menu for more detail. "
    frmReport.Print
End If
If (tpm_mean < tpm_limit) Then
    frmReport.Print Tab(6); "It is evident that maintenance activities have been ";
    frmReport.Print "conducted  in a casual manner without real effort in "
    frmReport.Print Tab(6); "trying to incorporate all maintenance aspects. This may ";
    frmReport.Print "be due to the management's negative attitudes towards the "
    frmReport.Print Tab(6); "role of maintenance in relation to other business ";
    frmReport.Print "operations. Please refer to some of the succesful cases (option 3)
    frmReport.Print Tab(6); "and implementation plan for (option 4) in the main menu "
    frmReport.Print "for more detail. "
    frmReport.Print
End If
If (tqm_mean < tqm_limit) Then
    frmReport.Print Tab(6); "Your company must be committed to TQM. If the above 5 ";
    frmReport.Print "steps have TQM is a continuous process. If the above 5 steps have "
    frmReport.Print Tab(6); "been implemented successfully your company is already ";
    frmReport.Print "very close towards achieving TQM. This is because by then "
    frmReport.Print Tab(6); "your company will have had a good quality environment, ";
    frmReport.Print "well-defined business and processes, a good quality culture, "
    frmReport.Print Tab(6); "effective quality system in place, and good equitment ";
    frmReport.Print "supports. It is a matter of choosing an appropriate TQM "
    frmReport.Print Tab(6); "framework for further improvement. "
    frmReport.Print
End If
End Sub

Private Sub print_Click()
frmConclusion.PrintForm
frmConclusion2.PrintForm
Printer.EndDoc
End Sub

Private Sub Form_Load()
Me.Top = -50
```

Name:

Quality/Discipline:

Institute:

Work Experience:

Which sector were you last worked in?

Manufacturing ☐ Services ☐ Others ____________________

Validation of TQM Advisory Service System

Score of the company consulted: __________

Question 1: This software is easy to use.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 2: This contents of the software is easy to understand.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 3: The breadth of the contents are appropriate.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 4: The depth of the contents are appropriate

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 5: The visual display (color and graphics) is attractive.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 6: The software can help to understand more about TQM requirement.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 7: The software can be used as a training package for practicing TQM.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 8: The software can provide a step-by-step framework for implementing TQM.

Strongly disagree Strongly agree

1 2 3 4 5 6 7

Question 9: What overall rating would give the software.

Poor Excellence

1 2 3 4 5 6 7

Question 10: What are the major merits of the software?

Question 11: What are the major drawbacks of the software?

Question 12: What change would you suggest should be made to improve the software?

Question 13: Any other comments?

****Thank you for your interest and co-operation!****