Implementation of Quality Management in the Manufacturing Industry

by

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This thesis is submitted to Dublin City University as the fulfilment of the requirement for the award of the degree of

Doctor of Philosophy

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August, 1998

DECLARATION

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of *Doctor of Philosophy*, is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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Reflection

The damaging and evil effects of globalization materialized in the Asian crisis must make a mockery of the age old adage that it is the hard work of the working people that shapes their own destiny when in actual fact it is the hands of the few, the mighty, the greedy, and the rich far away that manipulate, monopolize and determine rags or riches, dependent or independent, freedom or slavery.

Acknowledgement

I would like to express my sincere thanks and gratitude to Professor M.S.J. Hashmi for his supervision, encouragement, valuable suggestions and friendly advice throughout the period of this study.

I would like to thank the administrative staffs of the Universiti Putra Malaysia and especially the bursar's office for taking care of monthly scholarships and course fees. I would also like to take this opportunity to thank the Lembaga Biasiswa dan Cuti Belajar (LBCB) in awarding this scholarship to me under the SLAB program.

I would also like to thank Mr. Liam Dominican in the matters of procurement of computer hardware and software and Michelle in the supply of stationery and use of office equipment.

I must also thank my spouse, Aisyah for her continuous support and encouragement and to my children who have always provided the balance between work and play.

Finally may all praise be to God Almighty, the Creator and Sustainer of the Worlds Who is Perfect in Wisdom and Knowledge for taking care of my needs and enabling me to complete this work.

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Implementation of Quality Management in the Manufacturing Industry

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Abstract

This study is a research programme on the implementation of quality management in the manufacturing industry culminating in an implementation framework detailing the order in which certain tools and techniques should be implemented. It is intended as a guideline to the industry in general and to the small and medium sized enterprises (SMEs) in particular. Many companies, especially SMEs, are confused and unable to decide where to start, what and when to implement certain tools and techniques in their total quality journey. With a quality initiatives' implementation plan, the short and long term training needs are automatically identified and its implementation mechanisms designed. It is acknowledged that given the uniqueness of each potential organisation, there is a need for a customised implementation through the critical diagnosis of its present strengths, weaknesses, opportunities and threats.

The study involved designing of a postal-survey questionnaire and mailing it to 1800 manufacturing companies in the Republic of Ireland. Questions were designed to capture information about the quality management practices and business results from supplier to manufacturing system to customer. Variables were categorised into seven items as used in the Malcolm Baldrige 1997 award criteria and scored using the scoring system practised by the award.

The key findings point to the existence of a linear relationship between practice and performance. From the perspective of competitive advantage, firms are better off being big rather than small and with foreign partnership. Competitive sectors and those with larger export markets have better quality management practices and resulting performance are above industry average. Accreditation to ISO 9000 shows immediate short-term tangible benefits.

IMPLEMENTATION OF QUALITY MANAGEMENT IN THE MANUFACTURING INDUSTRY

Contents

KEY TERMS

Accreditation

The process of signifying the competence of a certification body to act within a defined scope.

Benchmarking

An improvement process in which a company measures its performance against the best-in-class companies, determines how those companies achieved their performance levels and use the information to improve its own performance. The subjects that can be benchmarked include strategies, operations, processes and procedures.

Certification

The authoritative act of documenting compliance with requirements*(e.g. documenting that an organization is complying with the requirements of ISO 9000).

Certification Body

An impartial body, governmental or non-governmental, possessing the necessary competence and integrity to operate a certification system, and on which the interests of parties concerned with the functioning of the system are represented.*

Champion(s) of Quality

This is typically an individual who plays an important role in managing, or assisting others in implementing the quality activities in the organization.

Competition/Competitiveness

According to Collins English Dictionary:

'Competition is an activity involving two or more firms, in which each firm tries to get people to buy its goods in preference to the other firms' goods'. Thus the word competitiveness as used in the context of this study not only means possessing the capability to make the right goods and services of the right quality, at the right price, and at the right time but also must include the ability to add value above and beyond what it can already produce. The key to competitiveness must be in an organization's ability to indulge in continuous improvement.

Continuous Improvement

The unending betterment of a process based on constant measurement and analysis of results produced by the process and use of that analysis to modify the process.

Correlation Coefficient, *r*

Correlation coefficient is a measure of the closeness of relationship between two variables. It is a quantitative expression of the commonly observed similarity between two variables. The correlation coefficient ranges in value from -1 to +1. A value of 0 indicates that there is no linear relationship between the two variables. A value of +1 means that the two variables are perfectly related, while a value of -1 means that the variables are perfectly related but as the values of one variable increase, the values of the other decrease.

Inspection

Activities such as measuring, examining, testing, gauging one or more characteristics of a product or service and comparing those with specified requirements to determine conformity.

ISO 9000 Series Standards

A set of five individual but related standards on quality management and quality assurance developed to help companies effectively document the quality system elements to be implemented to maintain an efficient quality system. The standards, initially published in 1987, are not specific to any particular industry, product or service. The standards were developed from BS 5750 by the International Standards Organization (ISO), a specialised international agency for standardisation composed of the national standards bodies of 91 countries.

Just-in-Time (JIT)

A management philosophy aimed at eliminating waste from every aspect of manufacturing and it's related activities. It refers to producing only what is needed, when it is needed, in just the amount needed.

Performance

In a competitive market, traditional measures of success, like profit, often provide useful information too late. Performance refers to the company's business results in key business areas like product and service quality, productivity and operational effectiveness, supply quality etc., as described in Malcolm Baldrige award criteria.

Practice

Practice refers to the established processes installed in a company to conduct its activity. It can include from supplier to manufacturing system to customer. It can cover from incoming inspection to reward system to tools and techniques, training and education, ISO etc.

Quality

The totality of features and characteristics of a product or service that bear on its ability to satisfy stated or implied needs.*

Quality Assurance

All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.*

Quality Audit

A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.*

Quality Control

The operational techniques and activities that are used to fulfil requirements for quality.

Quality Costs

The British Standard BS 6143 describes it as consisting of prevention costs, appraisal costs, and internal and external failure costs.

Quality Function Deployment

Quality function deployment is defined by the American Supplier Institute as a system for translating consumer requirements into appropriate company requirements at every stage, from research, through product design and development, to manufacture, distribution, installation and marketing, sales and service.

Quality Improvement

The British Standard BS 7850; Part 2 of 1992, describes it as actions taken throughout the organization to increase the effectiveness and efficiency of activities and processes to provide added benefits to both the organization and its customers.

Quality Management

That aspect of the overall management function that determines and implements the quality policy.*

Quality Manual

A document stating the quality policy, quality system and quality practices of an organization.*

Quality Policy

The overall quality intentions and direction of an organization as regards quality as formally expressed by top management.*

Self-Assessment

A process by which an organization assesses its own quality performance, in connection either with its own management requirements or with the requirements of an external party. Self-assessment may be carried out against the criteria of ISO 9000, of an established quality award or of some other systematic approach to measuring quality.

Small and Medium Sized Enterprises (SMEs)

The Government of Ireland task force on small business defines small business as an industrial or services enterprise that has no more than 50 employees, with annual turnover less than £3M. Medium-sized enterprise - between 50-250 employees, annual turnover less than £16M. Large-sized enterprise - more than 250 employees.

Supplier Evaluation

British Standard BS 4778 defines supplier evaluation as an assessment of a supplier's control of quality, carried out after placing orders.

Supplier Rating

British Standard BS 4778 defines a supplier rating as an index of the actual performance of a supplier.

Team-Based Reward System

This is a reward system given to groups/teams meeting the company's quality requirement. It can be in the form of anything from non-financial like saying thank you to financial prizes.

Technology

It is the knowledge, tools, techniques, and actions to transform organizational inputs into outputs. It is the organizational transformation process, and includes machines, employee education and skill, and work procedures used in that transformation process.

Total Productive Maintenance (TPM)

A concept of productive maintenance aimed at achieving overall effectiveness of the production system through the involvement of all the people in the organization

Total Quality Management (TQM)

A management philosophy embracing all activities through which the needs and expectations of the customer and the community, and the objectives of the organization, are satisfied in the most efficient and cost effective way by maximising the potential of all employees in a continuing drive for improvement.*

Vendor Appraisal

British Standard BS 4778 defines vendor appraisal as an assessment of a potential supplier's capability of controlling quality, carried out before placing orders.

*Definition taken from BS 4778: Part 1, 1987; ISO 8402, 1986

Chapter 1

INTRODUCTION

1.1 Background to the Research

1.1.1 Effects of Globalization on Competitiveness

The globalization of markets to some producers may mean opening up and capturing larger markets for their manufactured goods but to many others it may mean that competitors are at their door step. This is in the form of fierce competition in the domestic market with local and foreign competitors. Globalized market means having to compete with an expanding range of lower priced and high quality sophisticated goods, often at the leading edge of technology [1, 2]. The Irish government task force set-up to formulate strategy into the 21st century acknowledged that globalization has established the importance of achieving national competitiveness [3]. The task force identified future competition coming from central and eastern European nations aside from Asian countries and maintained that the country has reached a stage where its firms find it difficult to compete in industries where labour costs are the most significant factor in competitiveness.

In this respect the competitiveness of the Irish manufacturing industry is not determined by the standards set by a few leading companies, but by the average. This could be one of the reasons the Irish Business and Employers Confederation (IBEC) called on the Government to set up the national competitive council [4]. They stressed that competitiveness, both at the firm and the national level must be the central driving force behind the enterprise strategy. Competitive businesses recognise that whether they choose to market their products or services in the international or local markets, they face competition from world class suppliers. To stay competitive they must strive to be world class. According to Beckendorf [5] only total quality management (TQM) can produce world-class suppliers.

Industries that can compete in today's global market will be those that can win in global competition, not those that the nation shelters in the form of tariff protection against foreign manufacturers [6, 7]. These reactive measures, as has often been the case, have had far more damaging consequences to those protected than it's intended benefits.

Intense competition is pushing multinational corporations to the far east regions where the labour is cheap and readily available to stay competitive [7, 8, 9]. Bryden [10] stressed that European companies faced stiff challenge from low labour costs and lesser environmental constraints' industries especially in the third world countries.

Modern technology has made it possible to build modern factories anywhere in the world. The impact has been to raise the quality of life of people in that region. This has resulted in an increase in the demand for higher quality lower priced goods and services with shorter delivery times. In addition manufacturers in developed nations faced higher labour costs, reduced profit margin, tighter government regulations, increasing product diversity, and shorter product life cycles. All these increase the need for firms to be more efficient in their operations. In the business language of today, becoming more efficient means changing and focusing on the quality culture [11].

1.1.2 National Recognition of Total Quality in Western Economies

Voicing deep concern on their declining competitiveness, the chief executives of America's leading corporations emphasized that the only way to stay competitive is through total quality [12]. In its study on quality management SEPSU [13] reported that quality plays a major role in the competitive equation and in the prosperity of a nation. A UK government white paper [14] encourages companies to be more productive, flexible and responsive to changing market conditions. This can only be achieved through total quality involving everyone in the company hierarchy [15].

The European Commission [1] encourages companies to produce products of much higher standards of quality and reliability, be flexible to change and establish closer working relationship between firms to ensure effective technology transfer. Bennett and McCoshan [16] advocates the same virtues.

1.1.3 Adopting Total Quality in Leading Companies

There is ample evidences to show that leading multi-national companies, are adapting and adopting total quality in their business operations. These companies with resources at their disposal are investing heavily in training and education, equipment and facilities to implement and sustain total quality with the hope to improve their global competitiveness. Rehder and Ralston [17] conducted a survey of leading Japanese, American and European companies around the world and observed that greater employee involvement, a shift to customer focus in a never ending process of continuous improvement are the major factors that lead to top quality.

1.1.4 Prospects for Small and Medium Sized Enterprises (SMEs)

While there can be no doubt that the big companies are embarking and embracing total quality in their businesses, the same cannot be said of the SMEs. According to a survey on SMEs, only 20 per cent are planning for total quality and that only one company has been practising total quality for five years [18]. A majority of those surveyed believed that it is only for large companies. There is a tremendous need to address this misconception so that they can implement total quality in their operation. However this is easier said than done. In practice there are a wide variety of quality management initiatives and with its accompanying complexity, even the large and relatively resource-rich companies are facing implementation problems [19].

This is certainly a major cause for concern since SMEs are considered to be the greatest potential job creator. They provide 70 per cent of the EC employment, generate 70 per cent of its turnover, and account for 99.9 per cent of the total number of enterprises and almost 80 per cent of the employment [20, 21].

1.1.5 Important Factors to Successful Implementation

McQuater et al [19] classified five important factors singly or in combination that have a contributing effect to the success or failure of implementing quality initiatives. These are management, education, training, resources and experience. As these factors are actually management's prerogative, there is little or no surprise that most SMEs are at a complete disadvantage in embracing and focusing on quality. This is because many lack the range of management expertise necessary to run a business [3]. They faced a lot of difficulties to stay competitive and to gain from the advancement in technology and sophisticated management techniques than large companies [1].

1.2 A Malaysian Vision

SMEs play an important role in both developed and developing economies. They are the backbone of the economy and they are the biggest employer. Their continued strengths play a significant role in the road to the development of a strong private sector-led economy. About 90 per cent of the number of enterprises in the manufacturing sector are SMEs.

One of the striking resemblance, apart from the many differences between the Republic of Ireland and Malaysia, is in their relentless effort to diversify and transform their respective economies from a traditionally agricultural-based economy into an industrial economy, and in the problems associated with it upon achieving independence from Great Britain. The former in 1926 and the latter in 1957. Both had faced with persistent problems in the transfer of technology from large foreign-based companies to the smaller and often technology-stricken indigenous industry; of being made an 'assembly-station' by larger companies operating from nearby countries. The former in a European scenario the nearest of which is Great Britain and the latter in an Asian scenario the nearest of which is Singapore.

With a relatively small domestic market, population of 20 million (approximately six times the population of the Republic of Ireland), Malaysia has traditionally been an agriculture-based economy. Since the middle of nineteen eighties, the government has been playing a major role in diversifying and changing its agriculture-based economy into an industrial-based economy. This change has been widely acknowledged as a success by many around the world. The country realised that for it to be a continuing success, the SMEs must develop a competitive edge. They must invest in new technology, improve efficiency and increase product quality. The country realised that only the best survive in the highly competitive global market.

The development of SMEs was pivotal to this continuing success. Various development programme were launched specifically to provide assistance in diversified areas including technical support and R&D. A few big corporations in the electric and electronic industry participated in the vendor development programme. A number of financial and technology development institutions were also involved. In addition the government is observing and examining the experiences of developed countries on various aspects related to the development of technology and these support institutions.

In short, the government is intensifying efforts through financial, research institutions, and technology support institutions to administer necessary assistance to the SMEs. What the government does is planning to overcome the problems others (industrialized countries) had gone through in the best possible ways, and in the least possible time. Thus this research on the quality management practises of the manufacturing industry in general and in the SMEs in particular, will contribute to these efforts in many ways.

1.3 Aims of the Research

A survey of the literature has indicated that little work has been done to study the quality management practices or the lack of it and its relationship to performance in the manufacturing industry. In addition owing to the large variety and complexity of the quality management methods, tools and techniques (initiatives), little is known about its effects either singly or in combination on various organizational characteristics in big firms and especially among the SMEs. No research has been undertaken to answer how companies should introduce these quality initiatives and whether there is any particular order for companies to introduce these quality initiatives with regard to organizational characteristics, or their level of quality development etc. The kind of relationships if any which may exist between the organizational characteristics, its level of quality development and the order of its implementation is also of interest.

Dale and Lascelles [22] reported difficulty in this area. Their research was intended to answer such questions but they concluded that it was not possible to come up with a comprehensive quality initiatives' implementation plan because of the different starting points and various reasons for introducing them. Nevertheless it is hoped that a quality initiatives' implementation plan could still be developed to aid companies in its implementation. If such a plan is available, it will help companies to successfully and cost effectively implement total quality. The successful implementation of such initiatives will have far reaching implications in their competitive ability. Many would become leaders in their industries and many others would be able to stay competitive in the fierce global competition.

The objectives of the study are:

1. To examine the quality management practices or the lack of it in the industry.
2. To develop a quality initiatives implementation guidelines for potential companies.

Central to this thesis is the view that survival of companies in the future means that they should not leave change to chance, or wait until they are in a weak position, or forced to implement total quality initiatives.

1.4 Research Hypothesis

The research hypothesis was that a quality management initiatives' implementation plan can be developed for SMEs, identified and qualified with regard to quality position; taking into consideration the organizational characteristics. The central hypothesis of the practice-performance model is that adoption of best practices will result in strong operational performance. Several research areas need to be investigated to develop this implementation strategy as summarised below. The implementation strategy can be developed that considers:

1. correlationship between practice and performance,
2. effects of organizational characteristics,
3. effects of ISO 9000 and TQM implementation,
4. use of selected techniques,
5. technique implementation order.

1.5 Method of Research

1.5.1 Preliminary Research

This is the starting point of the research. A continuous literature search in the University's library on the subject quality management from inspection, to control, to assurance, to ISO 9000, to TQM was actively conducted throughout the research programme. This was later followed by frequent visits to the National Standards Authority of Ireland (NSAI) which happens to be within 20 minutes walking distance from the University. From these two sources, and from the researcher's exposure with various SMEs dealing with the National Car Industry in Malaysia, the need for an implementation plan was determined.

1.5.2 Designing the Survey

The preliminary research effort assists in determining the areas that need to be addressed in designing of the implementation framework. Following this, the most important phase of the research work that will have a significant bearing on its success or failure comes next, the designing of the survey. This topic will be covered in greater depth in chapter three but some of the most important aspects of the survey design are:

- objectives and resources.
- coverage.
- collection of data.
- questionnaires.
- errors.
- processing and analysis.
- documents.
- timing, cost and staffing

1.5.3 Pre-tests, Pilot and Main Surveys

At the very heart of this research effort is the main survey. It is acknowledged that by its nature, the survey methodology selected to carryout this fact-finding or collection of information is difficult to administer bearing in mind the many factors to be considered in carrying out a sound survey. Thus, in accordance with standard practice of professional survey bodies and due to its wide use in research surveys, pre-tests and pilot surveys are carefully carried out in this research. More of this will be dealt with in chapter three.

1.5.4 Scoring System

One of the most important outcome in studying the quality management practices and performance of respondents or the lack of it in the manufacturing industry is the interest in the quality picture of the industry as a whole. This is a snap shot of the state of quality in the manufacturing industry at the time of survey. This obviously requires some sort of a scoring system based on the responses of each firm.

1.5.5 Effects of Organizational Characteristics and Quality Practices on Performance

Using the scoring system, an in-depth study of the organizational characteristics and quality practices and its effects on performance is carried out. This will involve investigation into several research areas identified in section 1.4.

1.5.6 Development of Quality Initiatives Implementation Strategy

From the literature review and from the results of the survey and analysis conducted, a quality management initiative implementation framework is designed. This will be dealt with thoroughly in chapter six.

1.6 Chapter Summary

This chapter has provided a brief introduction on the effects of globalization on competitiveness, recognition of the importance of total quality in increasing competitiveness, the prospects of implementing total quality in SMEs and identified several factors for its successful implementation. It also identified the background of the research, its aims and describes the methodology for achieving them.

Chapter 2

LITERATURE REVIEW

2.1 Quality Management: An Overview

2.1.1 Introduction

The British Standards Institution in BS 4778 defines quality management as

> 'that aspect of the overall management function that determines and implements the quality policy'.

By this generic definition, it is understood to include approaches from the very basic inspection quality to control quality, to assurance quality, ISO 9000 quality, and finally to the latest name in quality management, the TQM approach. There is a large amount of literature on this subject. Many have written on this subject from practising managers and engineers, consultants, chemists, psychologists, sociologists, statisticians, behaviourists, journalists, quality Guru's themselves, professors in academia and research students in universities and colleges and by commissions appointed by governments.

Some attempt to show the link between quality and performance, others provide overviews and reviews, still others merely restate or focus or approach from different angle, and the rest attempt to provide generic guidelines on how to implement quality initiatives.

There has been an increase in the number of experts offering off-the-shelf packages on small and large firms [13]. There is also the problem with misconception of the ISO quality system standard, its expectations and what it can offer, and of rising fees for registration and maintenance. This has led some quarters to question its very existence. There are many reports of failures in the implementation of quality programme and as a result many are concerned in initiating further quality drive. There is a need to study the relationship between quality practices and performance and to develop a quality management tools and techniques implementation plan to help the industry in its quality drive.

2.1.2 Evolution of Quality

No work on the subject of quality management would be complete without including the many and varied definitions of quality from various quarters. Some of these definitions from various quality experts can be found in the literature and these are as shown below:

> Quality is conformance to requirements - Crosby.
>
> Quality is fitness for use - Juran.

Quality is a predictable degree of uniformity and dependability, at low cost and suited to the market - Deming.

Quality is the (minimum) loss imparted by the product to society from the time the product is shipped - Taguchi.

Quality is correcting and preventing loss, not living with loss - Hoshin.

Quality is in its essence a way of managing the organization - Feigenbaum.

Quality is the totality of features and characteristics of a product, service or process, which bear on its ability to satisfy a given need; from the customer's viewpoint - BS 4778.

Quality is a dynamic state associated with products, services, people, processes, and environments that meets or exceeds expectations - Goetsch [23].

It can be observed that quality means different things to many people, including the quality Gurus. One thing is certain, quality has changed gradually over the years as a result of changes in customer needs. Thus the definition offered by BS 4778 and Goetsch [23] is considered most appropriate in light of these circumstances

The history of modern methods of quality dates back to Dr. Walter Schewhart's statistical quality control in Bell Laboratories. Some writers regard the beginning of the interest in quality with Frederick Taylor's scientific management. The emphasis then changed from one of detection of defects to control of quality through analysis and prevention of quality problems. A focus on meeting the needs of the consumer brings about further developments in the approaches to quality and product performance. With this, the traditional approach of inspecting out defects was replaced with a prevention-based approach from design down to production.

Figure 2.1 shows the evolution of the quality concept from the first generation's 'meeting the customer requirements' to the present generation of 'doing it right first time, everytime' [24]. According to this reference, there are already some in the industry leading into the third and fourth generations of quality understanding.

<table>
<tr><td>Fourth generation</td><td colspan="3">Greater flexibility/customised products</td></tr>
<tr><td>Third generation</td><td>Do the right things</td><td></td><td></td></tr>
<tr><td>Second generation</td><td>Do it right first time</td><td></td><td></td></tr>
<tr><td>First generation</td><td colspan="2">Conformance to requirement</td><td></td></tr>
<tr><td>Foundation</td><td colspan="2">Management commitment</td><td></td></tr>
</table>

Figure 2.1 Evolution of Quality Concepts

The third generation of quality awareness aims to reduce or eliminate wasteful or unnecessary operations company-wide. This is equivalent to Merli's [25] description of his second generation total quality approach with breakthrough management proposed as the third generation total quality. According to Lesley and Malcolm [24] producing the right things first time is not enough. They observed that the fourth generation of quality shorten the time taken to market new products. They added that the US Malcolm Baldrige National Quality Award (MBNQA) winners internalised the fourth generation quality concept of 'delighting the customer' in their business process.

2.1.3 ISO 9000

A lot has been said about the advantages and disadvantages of ISO 9000. ISO 9000 is about quality systems, documentation and about consistency. It does not assure product quality. This is where the misconception arises. It was designed to satisfy customers about their suppliers' quality standards rather than to meet the suppliers' needs. It does not determine the quality of the product or service the customer may obtain through a purchasing contract. According to Strawbridge [26], it is only a measure of the supplier's capability to meet internationally specified standards. The SEPSU [13] study was highly critical with the administration and implementation of ISO 9000 and its negative effects on the quality management system in the UK. O'Connor [27] strongly advocates downgrading ISO 9000 to a mere guidance document providing description of a minimal quality system. He suggested that the whole infrastructure that currently supports and prospers from its existence be abolished.

According to some, ISO 9000 would be equivalent to the early Japanese TQC that is a subset of company-wide quality control covering the first three stages [28, 29, 30]. It could probably be in the early stage of humanism if training is included as one of the key clauses in ISO 9001 as described in British Standard, Part 1 (1987) in BS 5750.

While controversies surrounding the usefulness of ISO 9000 with regard to assuring and achieving of high quality are very much alive in the developed countries, the other side of the world seems unaware to all these problems. Data from reference [31] indicated that while the number of certificates awarded in the UK has been declining as shown in Figure 2.2 below, those awarded to the newly-industrialised-countries (NICs), and future NICs in the region have been increasing rapidly.

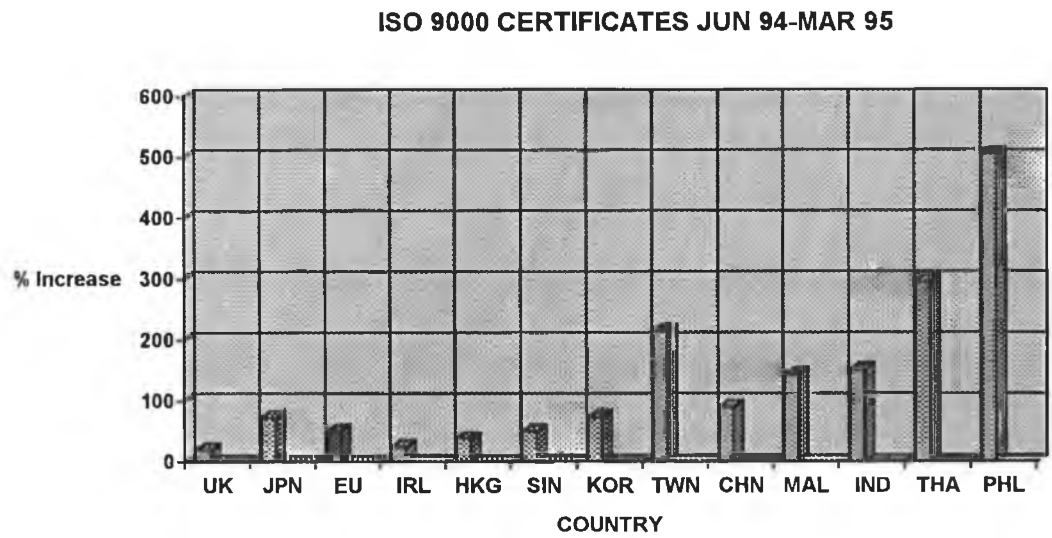

Figure 2.2 ISO 9000 certification in UK, Eire and Asia

The graph above is merely to drive home a point that there is plenty of room for investment and improvement in quality systems in the less developed countries in the Far East region. The rush to getting an ISO 9000 certification is only catching on lately. Whether this growth comes as a result of customer pressure, or genuine interest to improve its quality system remains to be seen. It will certainly take some years for those industries in the region to realise the benefits of ISO 9000 certification and to come to terms with circumstances already facing the western European countries today.

The phenomenal increase in ISO 9000 registration from low labour cost in third world countries may mean that there is an ever increasing number of potential competitors entering the international market from this region. This is a reality today when companies in the third world countries with low costs can install modern factories coupled with quality management system suited to their needs [32].

Planning and preparing for ISO 9000 certification would start with management owning responsibility and looking at the existing system as a whole. This must be followed by designing authority and responsibility for all functions in the organization. It involved documenting every step of the manufacturing processes and procedures employed from the supplier to the finished product whereby any wasteful action or procedures would have been exposed and dealt with [33]. According to Seal [34], the standard does not impose uniformity for everybody. On the contrary the standard leaves room for organizations to define the needs to suit their operation. The main reason for certification to ISO 9000 is the customer link and this is confirmed by various surveys and studies. The second reason is that the standard will give a marketing edge [33-36].

According to Guerin and Rice [37] supplier firms in the forest products sector in the US are not gaining a competitive marketing advantage yet even though they are registered to ISO 9000. This may be because importers in the UK, Germany and the Netherlands perceived ISO 9000 registration does not ensure high quality products.

They added that the situation could change in the near future as pressure from the governments and other customers increases.

One of the main contributing factor leading to unsatisfactory result with ISO 9000 system installed in the company is due to the lack of employee involvement in the implementation and installation stages [38]. The costs of operating and maintaining it and the bureaucracy associated with assessment and registrations are some of the sources of dissatisfaction with the standards.

The quality system requirement of ISO 9001 has 20 clauses which stipulated the conduct for a good quality management system. They are:

1 Management responsibility	11 Inspection, measuring and test equipment
2 Quality system	12 Inspection and test status.
3 Contract review	13 Control of nonconforming product.
4 Design control	14 Corrective action.
5 Document control	15 Handling, storage, packaging and delivery.
6 Purchasing	16 Quality records.
7 Purchaser supplied product	17 Internal quality audits.
8 Product identification	18 Training.
9 Process control	19 Servicing.
10 Inspection and testing	20 Statistical techniques.

There is a possibility in the near future that as more and more firms gain registration, the novelty of having a certified quality system standard would lose its competitive marketing advantage. Increasingly, customers may not be willing to pay a premium for products just because the suppliers are registered to ISO 9000.

2.1.4 Total Quality Management (TQM)

A review of the literature on TQM would lead to the conclusion that TQM means different things to different people. According to Rossler [39], there is nothing new in TQM. He believed that it is an extension of an old line of thinking with a new name accompanied by several new tools and techniques. Some regard TQM as a journey without a destination since the improvement process continues on [40, 41]. According to Wason and Bhalla [42], it is essentially composed of the tools to reduce variation and a humanistic view of employees as in McGregor's [43] theory Y, with the goal of meeting customers' needs. Burney [44] found that the key to TQM success depends on the use of statistics and empowerment of employees. Vanfleet and Smith [45] emphasised on employee involvement and empowerment through small group activities to change their traditional culture. According to Hayes [46], higher levels of empowerment in TQM are associated with higher job satisfaction. Grandzol and Gershon [47] reported the use of employee involvement group to increase employee involvement and the use of a multiple criterion's decision making tool to reduce variation.

As with the various definitions of quality put forward by many including quality professionals and non-quality professionals alike, the same can be said with the definition of total quality management. Some, like Flood [48] and Witcher [49] adopt a more careful approach by starting and building the definition from the word quality to total quality to total quality management. According to Flood [48], quality means,

> 'meeting customer's (agreed) requirements, formal and informal, at lowest cost, first time every time'.

By adding the word total, it means that every employee, at all levels and across all functions in the organization should be involved. Finally, by adding the word management, to the total quality definition, it becomes the responsibility of everyone to manage their jobs. This includes managers and workers and anyone else associated with the organization.

The main theme of TQM is that the organization clearly identifies its customers and what products and services the organization provides to them. This leads to such concept as internal and external customers. The whole organization is structured to provide for the needs and wants of its customers. Customer and employee satisfaction are the key results criteria of TQM. Employees should be made aware of and committed to quality customer service. They should recognise that they play an important role in meeting customer needs and wants. Thus the backbone of TQM is the concept of internal and external customers, continuous improvement and employee involvement in a customer-led market. Hoexter and Julien [50] reported the introduction of TQM in a service organization who defines the internal and external customers and list problems that require systems improvements and tackling the most important first by assigning teams and use of tools.

There is no doubt that TQM is important to the continued existence of businesses. But a productivity survey reported by Mustafa [51] found that among electronics manufacturers in the USA, over 90 per cent of respondents claim TQM to be a competitive tool, but only about 15 per cent claimed to have implemented it.

Johnson et al [11] reported that implementing TQM will require a very heavy commitment of capital, time, and resources on the company. This would require a focused and committed management since significant benefits are not immediate and may take anywhere between five and ten years.

According to Akao [28], the subject and scope of TQM as is understood by non-Japanese manufacturers, are equivalent to Japanese TQC or company-wide quality control. According to Sullivan [30], the build-up of total quality occurs in seven stages. It involves after, during, and before production and quality related activities, with the last stage being the quality function deployment (QFD) which transforms the voice of the customer.

It is interesting to know at which stage is the TQM in the manufacturing industry in Ireland today, relative to the seven stages. It is possible that one of the reasons for most of the poor performances and may be the failures in implementing TQM, apart from the consequences resulting from its disappointingly long-term impact rather than short-term gains, is related to the position a company is in relative to the seven stages. That is, generally, a company at a lower level of quality management practices resulting in a relatively marginal and poor performance is more susceptible to poor performance and failure than a company at a much higher level of practices and performance.

To develop a quality management implementation strategy an assessment of what constitutes total quality was undertaken. This research methodology involved reviewing what the various quality advocates have to say about total quality [23, 52-62]. Managing change of this nature must not be left to chance.

It is observed that the number of elements and terminologies that make up total quality differs between them. Nevertheless there are several elements common to all. Further review of the literature also revealed other elements, which enhanced achievement of total quality, which are categorized under technological factors and lean production.

Tamimi [62] conducted exploratory factor analysis to a set of 50 quality management practices and extracted eight meaningful factors that can help quality practitioners in the quality transformation. Factor number seven (product and service innovation) synthesized from Deming's point number five can be interpreted as technological factor.

Drucker [63] proposed four components that the factory of the future must be built and managed. The essence of his third concept lies in the advantage of a flexible layout of machines that can cater for changes in design and product demand, and customized products in small quantities. According to Hirano [64], this type of machine layout can also adapt to changes as described by Drucker, and to changes in the product mix. Further insight into the quality management strategies of the Baldrige award winners also revealed several elements common to all. These main elements are:

1. Management commitment
2. Education and training
3. Feedback measurement
4. Total employee involvement
5. Technological factors
6. Quantitative and qualitative methods
7. Lean production

The other two main elements common in most of the total quality approach, described above, are 'customer focus' in an environment of 'continuous improvement' which are the objective and the recipe for TQM respectively.

2.1.5 Complementary Effects

Research into the practices and consequent successes of ISO 9000 and or TQM in companies has been biased by a focus on TQM or ISO 9000 individually and has failed to acknowledge the complementary effects of one on the other. Past research has focused on three aspects of ISO 9000 and TQM - namely:

1) the reasons to implement
2) the success or failure of implementation
3) implementation methodology

Much of the literature on the success stories and corresponding competitiveness of firms attributed it to TQM. According to Dale [53] and Poucke [65], ISO 9000 is a launching pad for TQM. There is also no guidance so far as to when best to implement TQM after acquiring ISO registration and whether the order is important to achieving successful implementation.

It is hoped that this research would provide answers to such questions that were not addressed previously. In the process it examines the relationship of practice and performance and the practices of total quality management and ISO 9000 in the manufacturing industry in just over a decade of its existence.

2.2 Quality Management and Performance

It has long been an accepted fact that quality holds the key to competitiveness in the global market irrespective of the size of the company. Competitiveness means possessing the capability to make the right goods and services of the right quality, at the right price, and at the right time. Several reports established conclusive evidence of the strong links that existed between total quality and competitive ability. The first is from Oakland et al [66] who reported the findings from data on 29 companies known to have implemented total quality over a period of at least five years. The second is from a statistical study of the 1994 database of over 3000 business years of data from the European and North American enterprises [20]. The third is from a study of the competitiveness of four European countries by Voss et al [67]. In a survey of manufacturing practices in Australia and New Zealand, Batley [68] observed a strong correlation between practice and performance. According to Teare et al [69] companies that have achieved competitive advantage are those who have implemented total quality management.

It is important to note that the Oakland study used hard measures of performance indicators (profit margin, return on asset, turnover per employee, profit per employee, total assets per employee, fixed assets trend, and average remuneration per year) to measure competitive ability. Whereas the second study used hard (pre-tax, pre-interest return on capital, growth of share, growth of value added to GDP) and soft (R&D efforts, speed to market, customer focus) measures to measure competitive achievement for businesses. The third study used sample from a particular roadshow and from telephone hotline. Generally the sampling data comes from trade databases, or from companies volunteering to participate or from preselected companies or from large firms only.

It is reported that most companies are dissatisfied with the level of improvement on implementing total quality in their companies. According to Fuchsberg [70], many firms may be spending a lot of money on quality improvement strategies that do not produce the intended benefits. Result of a survey on 100 UK companies showed that about 80 per cent of quality initiatives failed to bring any desirable outcomes [71]. Of significance is the observation that the 20 per cent who reported having tangible benefits measures performance indicators, are customer focused and are employee friendly in their approach.

Moore [72] reported the failure of a TQM program arising out of preoccupation with procedures rather than its goal, copying of others' TQM implementation program, underestimating the resources required and putting high expectations too early in the program. Bettman [73] identified 12 actions that can lead to positive results among these are training of employees, recognising teams for their achievement, and management support. Hanson and Voss [74] observed a high correlation between practices and performance. Zairi et al [75] reported that there is a strong impact on performance provided its introduction was well planned.

Statistics from 500 executives of US manufacturing and service organizations put the figure of those without tangible benefit from their total quality programme at about

70 per cent [76]. The Electronics Business magazine that surveyed 138 senior executives put the figure at around 70 per cent [77]. The American electronic association's survey which obtained responses from 458 members reported that the number of members with total quality programmes drops 13 per cent within 3 years [78]. Those with total quality programmes failed to obtained tangible benefits despite running the programmes for around two and three years. Sharman [79] reported that about 70 per cent of quality programme installed for a number of years failed to produce tangible benefits.

Thomas [15] reported that compared to the European community, Britain has the highest failure rate with quality initiatives implemented. About 80 per cent of these failures are caused by management focusing too much on the mechanics or the system aspects instead of addressing the human aspects. Similar report of survey results point to the fact that failures of quality initiatives are the result of concentrating transformation merely on the tools rather than focusing more on behavioural changes [80].

There seems to be no lack of data to extract from the literature of the many failures and disappointments in implementing a decent quality programme. In fact, there will be more depressing statistics of failures in the future. The odds are against the businesses concern when implementing a total quality programme. The probability of failure is very high and the consequences can be very damaging to other quality endeavour in the future.

There are amazing success stories reported in the literature but these are rare. Success appears to be an exception rather than the rule. One has to be extremely cautious when coming across these reports as the circumstances may be significantly different from the average company.

One example is the often cited case of the Harley-Davidson on the edge of closure [81]. They managed to stay in the business with the help of the US Congress in the form of tariff protection against foreign motorcycles for five years. The literature has many examples of big corporations who have had to restructure and transform themselves when their very survivals are at stake [82, 83]. But they have paid a premium to survive unlike many others, less fortunate, who simply closed their businesses. This type of transformation is an exception that the average company should not hope to follow.

According to Wiggins [84] the problems faced by some winners of MBNQA indicate that finding more success could become increasingly difficult and slow.

2.3 Quality Improvement Initiatives

One of the basis of any continuous improvement effort is the use of quality management tools and techniques, methods and procedures that are referred to as quality improvement initiatives or simply quality initiatives in this study. All the quality gurus strongly advocate on its use. They vary in difficulty from the very basic like the seven old quality control tools to the much more complex like design of experiment. Some are human oriented, some are statistically based, and some are customer oriented initiatives [85].

If the understanding of quality has been the subject of much confusion in the business community, the same can be said about its accompanying quality improvement initiatives practised in the industry. Many of these misunderstandings are the result of management trying to find a quick solution to the problems facing their company. Many are ignorant to the fact that these initiatives are merely the details of improvement not the essence [39]. Wilkinson et al [86] reported that foreign-owned manufacturing companies are practising a wide variety of quality initiatives. Kanji [56] identified several techniques that can help achieve total quality. These are:

1. Customers survey
2. Cost of quality statement
3. Steering group
4. Quality co-ordinator
5. Top team workshops

Quality improvement initiatives for this study were also selected from the published works of Dale and Lascelles [22]; Mann [87]; Mann and Kehoe [88]; Roche [89] and Zaini [90] and reduced to the present number through rigorous selection involving staff and third-party assessment. These are shown below.

- **Management Commitment**

1. Quality association membership.

2. Champion(s) of quality.

3. Communicating quality.

4. Quality registration.

5. Outside help

- **Education & Training**

6. Quality campaign.

7. Outside help.

8. Quality education & training.

- **Feedback Measurement**

9. Benchmarking competitors.

10. Customer surveys.

11. Quality costing.

12. Quality feedback.

13. Supplier evaluation.

- **Total Employee Involvement**

14. Employee suggestion.

15. Empowerment (Self-directed teams).

16. Quality circles.

17. Quality improvement teams (QIT).

18. Reward system.

19. Waste elimination program.

- **Technological factors**

20. Automated inspection.

21. CNC machines.

22.Computer aided design (CAD).

- **Quantitative and Qualitative**

23.Statistical methods

  - 1.Cause & effect diagram.
  - 2.Control charts.
  - 3.Histograms.
  - 4.Pareto analysis.
  - 5.Sampling plan.
  - 6.Process capability.
  - 7.Scatter diagrams.
  - 8.Trend charts.

24.Design of experiments (DOE).

25.Quality function deployment (QFD).

- **Lean Production**

26.Phase reduction of inventory.

27.Set-up time reduction.

28.Cellular layout of machines.

29.Total productive maintenance (TPM).

Table 2.1 below compares the quality initiatives used in this study and shows its use in several other studies.

Quality initiatives	Mann [87]	Dale [22]	Moras [91]	This study
Automated Insp.				Y
Benchmarking				Y
CNC m/c				Y
Cellular layout			Y	Y
Quality champion				Y
CAD				Y
Customer survey	Y			Y
Data collection	Y			Y
DOE	Y			Y
Empowerment	Y			Y
FMEA	Y	Y		Y
Inspection		Y		Y
ISO 9000	Y			Y
QA Member				Y
Newsletter	Y			Y
Outside help				Y
Performance indicators	Y			Y
Reduce Inventory			Y	Y
Quality audits	Y			Y
Quality awards				Y
Quality campaign	Y			Y
QC circle	Y	Y		Y
QFD	Y	Y		Y
QIT		Y	Y	Y
Quality manual	Y			Y
Training	Y		Y	Y
Reward system	Y			Y
Sampling	Y			Y
Set up reduction time			Y	Y
Statistical method	Y	Y	Y	Y
Suggestion system	Y			Y
Supplier evaluation	Y	Y	Y	Y
TPMaintenance			Y	Y
Waste elimination				Y
Work instruction	Y			Y
Zero budget/quality cost	Y	Y		Y

Table 2.1 Some quality initiatives used in this study and its usage by others.

2.3.1 Management Commitment

Management is important in the change process since their support is crucial to sustain and develop long-term quality improvement drive [92, 93]. It is widely acknowledged that among other things, management must set goals, establish plans and procedures to accomplish them, make available suitable methods, set-up performance standards and measure results. Management commitment to quality improvement should not stop within the organization's boundary [69]. There is no limit to demonstrating management commitment to quality improvement. In an attempt to understand the meaning attached to 'management commitment', Goffin and Szwejczewski [92] investigated award winning firms and identified four key aspects which management should concentrate.

1. Time, effort, and enthusiasm.
2. Clear goals, organizational changes, and communications.
3. Optimizing production process.
4. Focus on staff (training and teamwork).

2.3.1.1 Quality Association Membership

It is believed that membership in a quality association will bring enormous advantage to the firm in its continuous improvement drive. It will open the door to the influx of new methods, tools and techniques, implementation guidelines etc. It can help bring the experiences and expertise of others into the firm and stimulate and motivate the implementation of quality initiatives. It can help avoid pitfalls, mistakes etc., others have made in the implementation of quality initiatives. It can bring together industries and work to their advantage in setting and maintaining industry standards. In short, firms cannot progress far without being a member of the quality association.

2.3.1.2 Champion(s) of Quality

Most SMEs have the highest level officer in the organization involved in the day-to-day management of the company [18]. In all the winners of the MBNQA the responsibility for quality has been a top concern of its highest ranking officer. Kanter [94] used the term 'individual prime movers' to describe the importance of individuals and their role in the organization as forceful figure in the change process.

2.3.1.3 Communicating Quality

In their survey, Goh and Ridgway [18] reported that many of the SMEs do not actively communicate or promote quality in their organization. There are various methods available to management to carry out this responsibility. One of the most important with regard to ISO 9000 is quality manual. Quality manual is a basic document of an organization specifying the quality management policy and its quality system. It usually defines and describes all the functions of the organization and deals with the responsibilities, procedures and processes from the customer end to the producer end.

It is normally but not necessarily associated with compliance to ISO 9000 series of quality management system standards. It is definitely a document that requires a certain degree of commitment from management to see it produced. When produced in co-operation with the people on the shopfloor or with those who actually does the work, its impact on the organization's performance can be enormous. On the other hand, if it is documented wholly through external work (consultants), it may most probably be regarded as such, another document.

2.3.1.4 Quality Registration

Much has been said about the reasons, the amount of paperwork and costs associated with the assessment and prior registration to the ISO 9000 certification. There has been much confusion as to the actual value of ISO 9000 in relation to product quality. This has been because compliance to ISO 9000 is not synonymous with attaining product or service quality nor any substitute for it. Many actually gain economic advantage through bigger markets. Many who profited, acknowledged that ISO certification provides a marketing advantage with access to not only European but American markets.

There can be much advantage to the firm in many other ways than can be imagined. Attaining ISO 9000 certification is secondary to the overall process, the people, the procedures and the quality manual etc. It is definitely impossible to be registered without understanding, identifying and scrutinising the activities that are happening on the shopfloor, from the start of the process to the finish line. This powerful screening procedure if done carefully will uncover any wasteful activities that had been hidden in the organization. Coupled with the involvement of all employees, it would provide a multiplication effect to the quality improvement efforts of the firm.

2.3.1.5 Outside Help

Outside help, in the context used in this study, is to mean help sought from outside the organization on matters directly or indirectly related to quality. This may be through various governments and semi-government bodies as well as the private sector. It could also be from a parent or larger organization. Being part of a larger organization is like an extension of a larger organization and is one of the reasons why Japanese companies adopt the extended family concept [53, 95-98]. The subject of supplier-development or co-makership or partnering or partnership sourcing and its virtues can be found in most literature on total quality.

2.3.1.6 Education and Training

This is the basis of a successful change from a conventional quality system to a more effective company-wide or total involvement. All levels of personnel in the organization must be trained. Extensive training of personnel involved in every step of the manufacturing of goods that is from the supplier end to the customer end must be carried out. Suitable training programs for engineers, technicians, supervisors, and operators should be developed internally or through established private consultants. McQuater et al [19] reported that the lack of education and training of employees especially related to the use of specific quality management tools and techniques as a major hindrance to its successful use. They believe that once the more basic tools are put into practice and experience gained through its usage, the more difficult tools sometimes come as a matter of course.

2.3.2 Feedback Measurement System

Feedback measurement system plays a crucial role in the continuous improvement culture if the organization is to succeed. It is very often said that

> 'you cannot manage what you do not measure'.

On the question of feedback about the quality of their products and services, many in the industry fail to measure. According to a survey, only seven per cent solicit their customers' views from customer surveys [99]. About 19 per cent said they get internal information from operational performance. The rest, about 64 per cent get information from customer complaints.

2.3.2.1 Benchmarking

Benchmarking is a relatively new concept that has excited the business population which has yet to fully understand and put into practice the real meaning of the word total in TQM. Lema and Price [100] explored the subject from its definitions, scopes, types, and its application especially in the manufacturing industry. They are strongly of the opinion that benchmarking is another tool that the businesses should take full advantage of in achieving superior performance. Without going into the definition of the word benchmarking, and its associated terminologies as can be found in Watson [101], and as researched by Lema and Price [100], it is essentially :

1.Measure

2.Compare

3.Change

Benchmarking involves an in-depth study of the best competitor's operation, technology, processes, products or services and comparing it to the organizations' on a continuous basis [101]. It is basically reverse engineering or very simply, copying from the best. According to Zairi [102] total quality organizations are more likely to use benchmarking techniques. The 1995 MBNQA award winner conducted 89 benchmarking studies in 1994, an increase of 100 per cent from the previous year [103]. All the award winner practises active benchmarking programs. A major textile company awarded the MBNQA 1989 winner, benchmark the product and services of about 400 competitors. The literature on this subject generally identified three types of benchmarking [53, 101-104].

1.Internal benchmarking: comparing the best practises of one unit against another within the same organization.

2.Generic/Functional benchmarking: compare specific functions in two or more organizations.

3.Competitive benchmarking: compare operational and strategic business performances with those of world-class competitors. These may include business indicators like market share, return on assets, customer complaint/satisfaction, employee motivation and satisfaction. The last two may be difficult to measure directly but indirect measures like absenteeism and employee turnover could be used.

Finally, benchmarking at its best only bring the user level with its competitor. To many, this is not the best answer. Being at par with the competitor can still be a risky business [105]. Once strong proponents of benchmarking, Womack and Jones [106], now believed that it is a waste of time for those who practises lean production. They stressed that it presents to the potential user with a host of data that are not easy to follow due to differences in factor costs, scale, or culture.

2.3.2.2 Customer Surveys

It is not a question of "if." In today's business climate, it is mandatory. They are an important tool to businesses. They help identify strengths and weaknesses and they let the firm know what is important to their customers. However, many survey efforts fail to get a satisfactory response. Goh and Ridgway [18] reported that the practice of customer surveys as a means of feedback to gauge customer satisfaction and needs are almost non-existent in the SMEs. Several probable reasons they do not conduct customer surveys are:

1. Lack of or no experience on how to do it.
2. Do not know what to ask.
3. Do not know how to analyse or interpret the results.
4. Do not have the time.

As a result, they do not know what is important to their customers and may be wasting money in areas that are of little interest to their clients. It could possibly be decisive information needed to increase both sales and profits. The Malcom Baldrige winners adopt customer surveys as standard operating procedure and relies heavily on its information. Knowing the wants and needs of customers and their satisfaction with products and services is necessary in a fiercely competitive market. This is but one of the avenues used in development and subsequent marketing of products superior to those of competitors. Dale [53] lists a number of systems for identifying customer wants and needs, among them:

1.Customer workshops.

2.Panels and clinics.

3.Focus groups.

4.Customer interviews.

5.Market research.

9.Product launches.

8.'Test' consumers and mystery 'shoppers'.

7.Trailing the service and products and field contacts.

6.Surveys.

2.3.2.3 Quality Costing

Results are the measures of achievement and progress [107]. It provides feedback into the continuos improvement process and must be measured regularly. The European foundation for quality management model allocates 15 per cent of the possible points to business results. Only 15 per cent of the SMEs surveyed keep detailed cost of quality and that these are communicated to their employees [18]. According to Gupta and Campbell [108], working out the cost of quality is difficult and time consuming and that only one-third of the respondents in a survey kept quality costs

Figures from surveys in the US and in the UK revealed that costs of quality are approximately 20 per cent (with failure costs amounting to about ten per cent) of annual sales turnover [99]. The 1980 survey [89] of Irish manufacturing industries reported that about 38 per cent of firms have costs of quality below ten per cent of turnover.

2.3.2.4 Quality Feedback

In a general sense, benchmarking competitors, customer surveys, quality costing and supplier evaluation provides specific feedback to the organization. In the context of this study, quality feedback also include the followings:

1.Inspection	6.Customer survey
2.Delivery time	7.Quality audits
3.Benchmarking	8.Costs of quality
4.Returned goods	9.Customer complaint
5.Machine breakdown	

2.3.2.5 Supplier Evaluation

There was a time when the practice of awarding contract to suppliers was based on the lowest bidder. This practice led to companies keeping a large supplier base for their manufacturing operation. The relationship between company and supplier then was adversarial and more often lead to lose-lose relationship. It was an arms-length contractual relationship when in fact it should be treated as extended factories [109]. But the trend today is to keep a small number of long-term supplier base that not only supplies the best but also develops in tandem with the company into the future. This includes sending staff from quality or engineering to assist their suppliers. This kind of assistance is not only limited to quality or engineering but can and should include other departments. Thus supplier evaluation is carried out regularly for the benefit of both parties. The process of evaluating a supplier for the purpose of qualifying as a sound source of supply must address vital issues like quality, productivity and competitiveness.

2.3.3 Quantitative and Qualitative Techniques

Continuous improvement is a never ending effort on a process that involves constant measurement and analysis of results produced by the process and use of that analysis to modify the process. One of the pillars of continuous improvement is through the effective use of quantitative and qualitative initiatives using information generated from within and outside the production unit. Both require the use of statistical analysis to reduce variability of process/product and improve customer satisfaction through enhanced quality. Balano [110] lists the identification and reduction of variation as number one in his ten commandments of quality. According to Stocker [111] variability reduction using statistical methods is a major component in TQM.

2.3.3.1 Statistical Methods

According to Ishikawa [29] ninety-five per cent of the problems in a company can be solved by the seven tools of quality control. These tools are not necessarily for use in manufacturing but can and should also be used in various other departments in the company. Most of the tools described below are available nowadays in statistical packages that run in a PC. Instructions are user friendly and a potential user can master its use without much difficulty.

Cause and Effect Diagram

The cause and effect diagram shows the relationship between the causal factors and the effects or the quality characteristics that is the goal of the system. Its shape resembles that of a fishbone. Hence it is also known as the fishbone diagram. It is also widely known as the Ishikawa diagram after its inventor Kaoru Ishikawa [29]. A collection of the causal factors is referred to as process. In theory there are an infinite number of causal factors. It is highly uneconomical to try to control all these cause factors if at all possible. In practice it is advisable to identify a few important factors that are critical and then try to control them. By its very nature the use of this tool requires the involvement of many people who are not only close to the process but must also be familiar. It is typically used by quality circles, quality improvement teams, or other small-group activity. Usually in a brainstorming session to seek ideas or opinions towards identifying the possible major causes of a particular problem.

Histograms

When a variable can take on many different values, the use of frequency table or bar chart is no longer adequate. From data presented in a descriptive or table format, a graphical representation can be constructed using the same data grouped into intervals and counting the frequency of occurrence within each interval. The display will show the various shapes of distribution of an individual variable. This can be normal, skewed, bimodal, etc., and shows the amount of variation within a process. Histograms should not be used for variables with no logical order to the values.

Pareto Analysis

This tool allows the identification of the most influential causal factors out of a variety of possibilities. It is a tool used to analyse and improve the quality of an ongoing process. Very often data are presented in a descriptive and sometimes table format that does not generate attention immediately. But when the same data is presented in a Pareto chart, the picture is worth a thousand words. Any person can immediately distinguish the problem few and in which particular order. This allows improvement efforts to be employed at areas that will have the greatest impact. According to Wilfredo Pareto, generally, a large proportion of the problem is caused by a small number of causes. This is the 80/20 golden rule.

Sampling Plan

Shingo [112] is against sampling inspection since it cannot eliminate defects. By its very name sampling inspection is a non-value added quality control activity to reduce defects. It is essentially an activity that concerns itself with looking for defects when those have already occurred.

Control Charts

Control charts are tools used to analyse and improve the quality of an ongoing process. Any process naturally has random variations. They help differentiate between assignable (or special) causes of variations in a process and unassignable (or common and random) causes of variations. According to McQuater et al [19], the effective use of SPC should result in increase worker involvement and a further strengthening of preventive measures rather than reactive measures. Causes can affect the manufacturing process in many ways resulting in a dispersion or a statistical distribution. The control charts can help tremendously in achieving statistical process control by monitoring and reducing variations in the processes. The control charts most frequently used are the X-Bar and s, X-Bar and R, *np*, *p*, *c*, and *u*. These charts can also be used in service processes, where the things being measured are more qualitative.

Process Capability

Process capability index is used to determine if the process can produce acceptable parts on a consistent basis [111]. Once the process is in control, the upper and lower control limits may be compared to the specification limits for the process. Generally, specification limits exist in manufacturing processes. Even if the process has an acceptable process capability continuous improvement efforts must be continued to minimize the variation further. If the control chart(s) are in statistical control, then calculate the process capability by comparing the natural tolerance of the process to the engineering tolerance of the specifications. The higher the index the smaller the process variation in relation to the tolerance specifications. If natural tolerance is less than or equals to engineering tolerance, the process is capable of meeting specifications. On the other hand, if natural tolerance is greater than engineering tolerance, then the process is not capable of meeting specifications.

Scatter Diagrams

Scatter diagram is a useful plot for identifying a potential relationship between two variables. The shape of the scatter diagram often indicates what type of relationship may be occurring between the two variables. Depending whether the relationship is linear, quadratic, or cubic, best fit line can be constructed that best fits the data points on the scatterplot. Scatter diagram is an important tool for diagnosis and problem solving and aids in the interpretation of correlation. The correlation coefficient, denoted by r, is a measure of linear association between two variables. The values of r may range from -1 to +1. A value of r close to zero signifies little, if any, linear association between the variables. Values of r close to either -1 or +1 indicates a high degree of association. Positive values of r indicate that as one variable increase, the other increases. Negative values of r indicate that as one variable increase, the other decreases. A value of +1 (-1) indicate that the data fall on a positive (negative) straight line. The correlation coefficient is a measure of linear association only. Scatter diagrams will indicate curved relationships if they exist. In addition, the correlation coefficient will be badly distorted by outlying data. It can be used to locate outliers to check for their validity. Scatter diagrams and correlation coefficients are useful for identifying potential relationships. Designed experiments must be used to verify causality.

Trend /Run Charts

Trends are patterns or shifts according to time. An upward trend, for instance, would contain a section of data points that increased as time passed. Run charts are used to analyze processes according to time or order. Run charts are useful in discovering patterns that occur over time. Run charts originated from control charts, which were initially designed by Walter Shewhart. Run charts evolved from the development of these control charts, but run charts focus more on time patterns while a control chart focuses more on acceptable limits of the process.

2.3.3.2 Design of Experiments (DOE)

Taguchi methods or experimental design enables quality to be designed into a product or process reducing its variability. Thus, one of the main technique used in Taguchi's quality control is to reduce the variation around the targeted value. According to Taguchi, the quality of a group of products can be improved by achieving its end product specification's distribution as close to the target value as possible. This concept can be realised by designing and building the quality into the product itself.

This leads to reduced wastes of unnecessary inspection, rejects, etc. resulting in shorter time from design to market.

DOE is essentially an experiment involving a large number of factors that are thought to influence the characteristics of interest. The effects of this individual quality influencing factors, are the deciding key of the control to be enforced on the product design. Analysis of variance is used to analyse the results, and to determine how much variation each quality influencing factor has contributed. By studying the main effects of each of these factors, the general trends of the influence factors, towards the product, or process, can be characterised. These characteristics can be controlled, such that a lower, or a higher value in a particular quality influencing factor produces the preferred result. Thus, the levels of influencing factors, to produce the best results, can be predicted.

2.3.3.3 Integrated Process and Product Development (IPPD)

IPPD is a system approach of bringing out a product from its inception to final marketing, such that all subprocess required to bring forth the product are integrated harmoniously. It requires use of multidisciplinary approach in the transformation of product features and customers' needs from inception to final marketing. This requires the formation of cross functional teams which in essence removes functional barriers in the organization [42, 113]. The closest resemblance of this process to date, is the QFD technique.

2.3.3.4 Quality Function Deployment (QFD)

With competition growing, it is becoming increasingly more difficult to stay ahead. Staying in touch with customers and understanding what they want is necessary to succeed over the long term. QFD is defined as a system for translating consumer requirements into appropriate company requirements at every stage, from research, through product design and development, to manufacture, distribution, installation and marketing, sales and services. This is understood to mean putting total quality management into operation. Which means involving all the functions in the organization into transforming product features and customer's needs and making sure that everything from design, to manufacture and final delivery is consolidated in that direction. QFD is an off-line phase of total quality [114]. It is one of the tools and techniques employed in total quality.

2.3.4 Total Employee Involvement

The word 'total' as used above is to differentiate between the term employee involvement, which is employed as a variable to measure the outcome of various quality initiatives in the survey, and the employee involvement approach. In the drive towards a total quality organization, top management should adopt McGregor's Theory Y that contributes to successful long-term relationship with employees [43].

Theory Y views employees as having creativity, ingenuity, and imagination and under proper conditions learn to accept and seek responsibility. His other assumption that should be of particular importance to total quality implementers is that in most organizations, the average employees' intellectual potentialities are under-utilized.

In today's increasingly competitive market organizations are continuously searching for new approaches that can cause them to be more flexible, adaptive and competitive. More and more organizations are rediscovering or led to rediscover that their employees are their biggest asset. More and more organizations are moving towards greater employee involvement in their decision making process. They realised that attaining greater employee involvement requires loosening of and removing well-established structures of control within the organization. The success of implementing a particular initiative depends on a number of factors such as technology, environment, and culture [115].

One thing is clear from the above discussion, that the bottom-line requires a fundamental change in the way management views employees in today's competitive environment. Results indicate that the greater the use of employee involvement, the greater is the company's performance, profitability, and competitiveness [58]. The existing conditions in some organizations that sometimes subscribe to Theory X, which are a negative set of values, beliefs and norms, are not employee-friendly and are not conducive to a total quality approach.

Cotton [115] defined total employee involvement as, "a participative process to use the entire capacity of workers, designed to encourage employee commitment to organizational success". It is a generic term used to include a variety of initiatives employed to achieve total quality. Some of the initiatives used in this study were identified by Cotton [115]. These are:

1.Employee suggestion.
2.Empowerment(self-directed teams).
3.Quality circles.
4.Quality improvement teams.
5.Reward system
6.Waste elimination program.

2.3.4.1 Employee Suggestion

Straub [116], stressed that the workers on the shopfloor know more about the problems on the floor than the supervisors and they have their ideas of dealing with workplace improvements. He added that it is up to management to solicit ideas from their workers and not to expect them volunteer opinions. No suggestion should be dismissed as being insignificant. It is to be expected that under the traditional bureaucratic structure, some employees may underestimate the value of their ideas or knowledge or may even believe that management may not be interested in whatever they think. According to Nelson [117], only 41 per cent of employees surveyed believed that they are listened to. According to Goetsch and Davis [74], suggestion system can be implemented in four broad stages

1.Create a supportive environment.
2.Identify and overcome barriers.
3.Put the enablers in place.
4.Evaluate.

The 1992 MBNQA winner, received two suggestions/per employee/year compared with only about one-third per employee per year the previous year. The 1989 award winner received about 19 suggestions per employee. The 1988 award winner reported that employee suggestion has tripled since 1988, and 80 per cent of these are accepted [59]. The average American worker contributes one or two suggestions per year while his or her Japanese counterpart submits hundreds annually [117]. Japanese organizations regard their employee suggestion system as important to business success. Theirs concentrate on social reinforcement rather than the tangible recognition. The small, but continuous, improvements resulting from suggestions are regarded as the key to success, as opposed to the individual big payoff suggestions. One of the strongest ways in which the message that suggestions are valued is recognition and acknowledgement of employee suggestions conveyed through an achievement reward system. This would normally mean operating a suggestion scheme tied to financial rewards.

There is a possibility that one good suggestion could trigger two or three new good suggestions. Once employees learned that their ideas are important and would be considered, participation would require little or no encouragement. On the other hand once they realised that management is not committed to deliver on the promised action on submitted ideas, the scheme would quickly run into a failure [118].

2.3.4.2 Empowerment (Self-Directed Teams)

The words empower and empowerment make only one appearance each in *employee involvement* [115]. Instead the term 'self-directed work teams' is used. The Oxford English dictionary gives the meaning of empower as, 'to invest legally or formally with power or authority', and empowerment as, 'the state of being empowered'. Both words bring with it legal connotations. Clearly, when reference is made to employee involvement, the term self-directed work team is most appropriate. The reason for increasing employee empowerment is to allow continuous improvement of work processes to take place. Empowerment must require getting involved, whereas getting involved without the power to influence changes is risky to future quality improvement programme. This happens to be the main reason why most employee involvement initiatives fail within the first year of introduction [23].

The 1989 MBNQA winner let its workers or 'associates' work primarily in self-directed work teams, establish their performance objectives, set their own training and work schedule and are free to stop a production process if they detect any safety violation or detects a quality problem.

2.3.4.3 Quality Circles

A quality circle (QC) is a voluntary group of between six to eight workers doing similar work. They meet regularly for the purpose of solving and recommending solutions to work related problems to management [23, 53, 119]. Quality circles normally meet during, before or after company time convened and facilitated by a leader. The leader is sometimes elected from a different group member at each meeting. Brainstorming sessions serve to identify or itemize problem areas. The problems are ranked, and data are collected for the top-rated problems. A fishbone diagram is used for displaying the elements of a problem, including interrelationships of operations. Solutions are then developed and proposed to management for their support of the plan and its implementation.

The quality circle concept first originated in Japan in the early 1960s and following Japan's phenomenal success, this concept has gained rapid popularity in the West. Many western organizations introduced quality circles and many were successful but many others failed. According to Dale [53] quality circles were implemented at the time when the meaning of total quality was not fully understood. It was adopted by many companies in search of a 'panacea' to solve many business problems arising from the Japanese competition. Hayes [120] reported that most of the Japanese companies already had a high reputation for quality by the time they embarked on QCs.

Juran believes that quality circles can only deal with the trivial problems on the shopfloor. While the major quality problems, usually associated with company policies, come under the domain of the top management. According to the Japanese Union of Scientists and Engineers only about 15 per cent of problems can be solved by the workers. It is important that management should not expect too much out of its implementation. In the words of Shingo, quality circles are like squeezing the last quality problems out of a production system that has already achieved outstanding quality. As reported in reference [103], MBNQA 1993 winner provided at least 24 hours of basic training in quality principles, techniques and tools for each team member.

2.3.4.4 Quality Improvement Teams

An essential element of effective employee involvement is teamwork. Small group improvement activities comprise the most fundamental layer of support and can greatly reduce waste-related costs [121, 122]. The 1992 MBNQA winner has 79 per cent of its workforce participating in improvement teams in 1991. Another winner has cross-functional teams comprised of between 10 and 15 hourly and salaried workers. Team members can also come from a single section or department and may include representatives from the customers or suppliers. Members can come from a mixture of different levels in the organization. There are many different types of teams that can be used and for a complete discussion please refer to books on quality.

2.3.4.5 Reward System

People are the key. When employees are focused on performance improvement and business objectives, management must reinforce behaviours that lead to the achievement of these objectives to help accelerate the process of change. Scott [61] reported that the implementation of total quality in a high-tech company in the US had resulted in a flatter organization and layoffs. These changes have a negative effect on the morale and compromising attitude of the workforce that made them more demanding in their dealing with the organization with respect to reward system [123].

Smolowitz [124] stressed that the reward system must not contradict the team concept advocated in TQM. Oakland et al [107] considered reward system one of the performance indicators in their study on linking TQM with bottom line results. They reported that the average remuneration in 93 per cent of the respondents is higher than the industry median. Kanji et al [125] reported the use of bonus, as one of the quality motivators besides quality circles and job rotation in Japan, Korea and Taiwan. The 1995 MBNQA winner practises a reward system that tied key performance indicators such as:

1.Customer returns.
2.Delivery performance.
3.Unit costs.
4.Sales.
5.Divisional profits.

2.3.4.6 Waste Elimination Program

Briefly, total quality is about elimination of waste. The Toyota production system is basically aimed at continuous effort to cut costs, which in turn, require commitment to eliminate waste. It has nothing to do with the waste of over production, JIT, or even the Kanban system which according to reference [121] is the means to achieving it. The bottom line is to be able to work easier, faster, cheaper, better, and safer. According to Hirano [64], Suzaki [109], Shingo [112], Ohno [126], Wilson [127] and Womack and Jones [128], total quality addresses the following wastes :

1.Work-in process.	6.In planning.
2.Defects	7.In human resources.
3.In equipment.	8.In operations
4.In expenses.	9.In start ups.
5.In indirect labour.	10.In design not meeting users' needs.

But according to Suzaki and Shingo the difficulty lies in finding wastes and eliminating it.

2.3.5 Technological Factors

Technology means many things to many people. It is the knowledge, tools, techniques, and actions to transform organizational inputs into outputs. Leading manufacturing industries in Japan are implementing modern technologies to produce still higher quality products to meet customer requirements. In their progression to world class manufacturers, they have done this at a much lower cost and much reduced lead time [129].

In this age of global competition, a manufacturer must export to succeed. To do so, it must be able to outclass foreign competitors in quality and productivity [23]. This can be achieved among other things through the implementation of competitive-enhancing technologies that include computer-assisted systems, automation, intelligent machines, and robots etc. These could help eliminate the causes of variation in the design or in the process [11]. According to Meredith and Hill [130], the decision to implement new technologies are influenced by such factors like long-term objectives, customer focused, co-operative working environment, positive management and employee attitude towards change and culture. They offer several reasons for embarking on automation:

1. Simple replacement of old machines.
2. Overcoming operational shortcomings.
3. Closing technological gap against competitors.
4. Achieving world-class manufacturing.

But if the meaning of automation as expounded by Shingo [112] is used then there must be only one reason that could justify the use of automation, that is achieving world-class manufacturing.

2.3.5.1 Automated Inspection

According to Shingo [112], an automated system must be able to detect and correct irregularities. Most systems do not have both. Most automated equipment is in fact mechanised equipment. Seen in this light, automated inspection is only a mechanised form of detection of irregularities since it cannot correct irregularities that have already occurred.

2.3.5.2 CNC Machines

CNC machines dramatically increased human productivity. But it must be emphasised that investments in these machines result only in operational improvements, not process improvements. CNC machines are just a complex piece of multi-functions mechanised equipment.

2.3.5.3 Computer Aided Design (CAD)

Traditional computer aided design systems optimise the design of individual part or components geometry. In total quality, computer aided design systems are linked to a group technology data base using information on part geometries and processes to design products which should conform to cell manufacturing. According to Drucker

[63] computer aided design will be found in factories of the future apart from integrated process and product development and the cellular approach.

A CAD system usually consists of software and a computer workstation. It allows designers to create a product design and view the part or assembly on the computer screen, print detailed drawings to a computer printer, and store the design for future use. It also facilitates downstream manufacturing processes such as analysis and preparation for manufacturing. It is often used in conjunction with finite element analysis.

2.3.6 Lean Production

Among the quality initiatives associated with lean production identified in reference [128] and used in this study are phase-reduction of inventory, reduce set-up time, cellular layout and total productive maintenance.

2.3.6.1 Phase Reduction of Inventory

It is acknowledge that inventory tends to hide various types of problems that will surface only when some of it is removed [121]. It means that reducing unnecessary inventory helps increase profit by reducing costs [131]. These are also the messages expounded by Shingo [112] and Womack and Jones [128]. Inventory is thus the source of waste. Reducing inventory level by producing in small lot size is one of the effective means in eliminating inventory. It must be emphasised that cell manufacturing, reducing set-up time, reducing lot size, and reducing inventory level may not result in favourable outcome and may not be effective when implemented on its own. They are not mutually exclusive but in fact complement and supplement each other.

2.3.6.2 Set-up Time Reduction

The Japanese industries are expert in this technique. It is now evident that reducing set-up time results in a chain of reductions in lot size, inventory level as well as production lead time. This improves flexibility of organization in general and production operation in particular to respond to changing market needs. For set-up time reduction to be executed careful planning is required. Engineering must recognise that there are internal and external set-up. This means there are separate tasks that must be identified and worked out. This requires teamwork through the involvement of many people on the shop floor. Generally a 70 per cent reduction of set-up time can be achieved without spending money on equipment [109].

2.3.6.3 Cellular Layout of Machines

Cellular layout of machines, or cellular manufacturing is the identification and grouping of machines according to the specific groups of parts or products to be manufactured [132]. Machines are located physically next to each other in such a way that significantly reduced set-ups, and materials physically move from one station to the next. Hirano [64], Shingo [112] and Ohno [126] are all champions of this flow manufacturing concept. It requires mutual co-operation between employees in a customer-supplier relationship where every employee's efforts is aligned with the aim of the organization as in TQM [133].

In essence, cellular layout enhances and complements efforts at achieving total quality in the organization [132]. Womack and Jones [128] stressed that cellular manufacturing is the foundation to lean production. From their wide experiences, they pointed out that flow principle when applied correctly, can cut down in half the amount of resources very quickly, and steady progress can be maintained which would cut inputs in half again within a few years. Cellular layout can be successfully implemented with little or no investment in equipment as proven by the Japanese. The advantages of a cell layout are, namely :

1. Reduce material movement.
2. Reduce work-in-process.
3. Reduce throughput time.
4. Reduce lot sizes.
5. Improve working environment.
6. Allows job enrichment.

The overall effect is to improve quality and reduce unnecessary waste. According to Marsh [134] cell layouts tend to have long useful lives except for the industries employing small lot production and running different models where layouts changes frequently.

2.3.6.4 Total Productive Maintenance (TPM)

According to Nakajima [135], TPM is productive maintenance carried out by all employees through small group activity. TPM is a very important element of the lean production concept [128]. Machines must be made 100 per cent available and accurate if this to happen. Poor maintenance can result in :

1.Stoppages from unexpected damage.

2.Longer set-up time.

3.Idle time.

4.More waste from defects.

5.Under-utilization of machine.

In a competitive environment maintaining all equipment and machines continuously and efficiently is a necessary prerequisite. This means that every employee must be concerned about achieving zero machine failure. One way would be to increase the skills of operators of machines. Thus the education and training of operators in eliminating the causes of failures if the objective of zero failures is to be realised are most important.

2.4 Quality Initiative Implementation

One of the main objectives of this study is to identify an implementation framework or a useable roadmap detailing the order in which various quality improvement initiatives should be implemented. These initiatives originate from such well-known paradigms like total quality control, total productive maintenance, and lean production. According to Dale [53], are all similar concepts with each essentially present in the other. But there cannot be a complete study of the quality management practises if it only focused on certain quality management tools and techniques in isolation without taking into consideration other quality activities that together contribute to the quality development and competitiveness of the organization. Davies [136] stressed the importance of knowing the quality position to plan for the next phase in the quality development.

With the availability of so many quality initiatives to choose, many are confused as to the effects of various initiatives and paradigms. Many would not be able to decide which and when to implement certain quality initiatives, in their struggle to remain competitive. According to Goodman et al [137] many organizations wasted their resources by embarking on the wrong quality improvement activities in their TQM efforts. Many others may have used tools simply because others are using it without understanding how to apply the tools [138]. There are numerous instances reported in the quality literature where these tools and techniques are an end by itself, its application a mere window dressing to please the customers [139]. Ideally each quality initiative implemented should strengthen the previous one and builds on the momentum in the continuous drive to delighting the customers. It is hypothesised that superior levels of performance can be achieved through effective management of quality initiatives.

According to Miyake et al [140], none of these initiatives are mutually exclusive and inconsistent. On the contrary they need complementary support and may reinforce mutually. In their study of some Japanese companies that outclass their competitors they found that these companies have been selective in their approach by adopting, cumulatively the different paradigms mentioned above.

There is a lack of a detailed information on the comprehensive plan of which particular quality initiatives to implement. Reference [119] suggested an implementation plan comprising of SPC, a quality management system and teamwork that should be introduced in the 'right' order. The guidance offered by quality gurus are mere generic statements lacking in technical directions and sometimes offer little immediate application to the organizations [141, 142]. Most of the literature centres on a particular paradigm and failed to take into consideration the presence of the other paradigms and their effects on the practice and performance of companies. The literature is wanting in this area perhaps due to the variety of starting points and motivations in which an organization can commence the total quality journey [143, 144].

For those that have, the journey was for most part more adhoc then systems approach. According to Rajagopal et al [145], contrary to the recommendations proposed by many quality experts, the TQM as practised by most companies is an 'added-on' rather than well conceived and integrated into management policies. Gyani [146] reported the implementation of TQM in an oil refinery that started off with quality circles involving all employees at the shop floor level.

To prevent accidental or by chance approach in the implementation of quality initiatives, Scholtes and Hacquebord [147] recommended that top management develops a blueprint for the transformation. The MBNQA winners are where they are today through a long and difficult process that have taken some anything between 10-17 years [105]. This is also the situation reported by Fletcher [148] in a study on the implementation of TQM in a steelmaking firm. In the words of Haas [149], western manufacturers have traditionally been preoccupied with operational improvement that may marginally enhance competitiveness over time rather than formulating a sound framework for improving it. Perhaps the ideas and work of Shingo [112] in identifying the flaws in the western manufacturers basic misconception of process and operations are not vigorously pursued.

There are many cases in the literature providing evidence that implementation of quality improvement initiatives as we have witnessed it evolved to date is a long, haphazard and difficult journey.

Central to this study is the premise that survival of companies in the future means that managers should not need to wait until the situation demands it or worst still when forced upon them to implement. As someone once commented, even if companies are on the right track, they may be run over if they just sit there. Change should occur as a result of strategic decisions. It implies a plan of action that is deliberate and focused, that is having direction and purpose. Certainly not to the extent of having to wait when survival is at stake to initiate meaningful changes in the operations of the company. Those companies that attempt to initiate changes only when survival is at stake continue to have their survival at stake [150]. Carpenter [151] believed that to avoid this from happening organizations must set their goals and monitor them.

Goh and Ridgway [18] in their study of TQM in SMEs asserted that a quality improvement initiatives' plan is required that will enable them to implement irrespective of present quality position. In his study of twenty-five TQM organizations, Ghobadian et al [152], found that a quality initiatives' implementation plan is required, without which company-wide improvement efforts can easily be misdirected. The advantage of such an implementation plan to the particular organization, if such an implementation framework can be possibly assembled from this study, is immeasurable.

This implementation plan should be sourced from a best practice-performance model. This is in line with the suggestion by Povey [153] to use the framework provided by a structured assessment based on a world-class model. It is understood that any approach would involve people, process and product. This would require a well-conceived plan to impart knowledge, increase awareness, and skills in the use of quality improvement initiatives.

Miyake et al [140], proposes an implementation order beginning with JIT followed by TPM and TQC. Evidence from their study seems to suggest that implementing TPM before TQC would enhance the successful application of the latter that require a much lengthier time to master. They observed that most of the companies had started on the TQC journey first by implementing the quality control basics like statistical methods, quality circles, etc., since TPM only surfaces in the 1970s.

2.5 Some Factors for Consideration in Developing Techniques Implementation Guidelines

2.5.1 Education and Training

The EC [1] identified education and training being an important element in competitiveness. Forfas [154] identified education and training of personnel as one of the key factors for achieving competitiveness. The task force set-up by the Irish government to formulate strategy into the 21st century recognised the need for constant improvement in skills, in both management and the workforce [3].

On education and training, the task force recommended:

1. that training be customised to the individual needs of the respective organization.
2. that wider use of the mentor type support at development stage.
3. that close working relationship be established between the industry and research organizations and colleges.

As with the concept of TQM, there is also a vast amount of literature on the subject of education and training relating to the quality transformation. Oakland and Waterworth [155] provided an overview of TQM training and recommended a TQM training model. Many quality practitioners stressed that total quality needs to be tailored to suit the organization. Atkinson [156], Dale [157] and Laszlo [158] are among those who acknowledged that each manufacturing system is unique and no two manufacturing systems are alike.

ISO 9000 requires the supplier to establish and maintain procedures for identifying the training needs, and to provide for the training of all personnel performing activities affecting quality [159]. It also requires that personnel performing specific assigned tasks be qualified on the basis of appropriate education, training and/or experience, as required and those appropriate records of training are kept. Successful organizations take efforts to monitor and evaluate their training activities. The standard also requires organization to keep and maintain records of training, and to use these records periodically to identify re-training. This is an important responsibility that must be carried out since training takes up a lot of company investment.

According to Scott [61], to achieve the total quality transformation, training is the single largest investment. Goh and Ridgway [18] reported that only 47 per cent of the SMEs train about 20 per cent of their workforce in quality related activities. The 1992 MBNQA winner provided each employee with at least 40 hours of training and education a year. Another winner provided their hourly employees with at least 84 hours of training excluding orientation programme. The 1990 award winner provided skilled workers a minimum of 80 hours of training in areas such as quality improvement and statistical methods among other things [103].

Experts agree that employees who used these quality improvement initiatives must know them well. Employees must also have the necessary skills of their jobs. Brown [160] identified the need for training in job skills as a necessary prerequisite before introducing total quality. Scholtes and Hacquebord [147] recommended the just-in-time training, where the relevant skills should be taught as they are needed while mass training of employees in the improvement skills is a waste of time and should be avoided. They identified some of the types of training and education required:

1. specific job skills plus new upper level and maintenance skills.
2. a systems perspective of how they fit into the organization.
3. quality concept and the organization's plan for transformation.
4. technical adviser training to individuals who would provide expert assistance.
5. basic improvement skills as and when it is needed such as team building, tools and techniques and so on.

According to Shaw et al [161], there is more to total quality than trying to put to work a few tools and techniques. Concentrating on the technical factors alone without due regard to human factors will lead to failure in its implementation. Some of these problems as reported by Chase [162] are :

1. Culture change.

2. Resistance from management, staff and workforce.

3. Finding time.

4. Poor communications.

5. Measuring results.

6. Lost momentum.

7. Obtaining tangible benefits.

Even with available expertise to develop training programmes, the decision to develop in-house or obtain externally rest upon other factors such as availability of equipment and facilities, financial resources and management policy [163]. With such a heavy commitment required, it is expected that only large and successful firms will have such a programme. Very few companies have the resources to determine the right training needs and fewer still with the capability and experience required to develop and conduct a training program for its employees. According to reference [164], employers have no training strategy. Many made bad decisions with regard to training because of the lack of a sound quality improvement plan [95]. Such a plan can only come, as far as this work is concerned, through translating the quality initiatives' implementation plan into short and long-term training needs.

According to Thomas [15], the total quality transformation requires strong and sustained management commitment and leadership over a long period of time. He recommended several steps, the first of which is a study into the strength, weaknesses, opportunities and threat (SWOT) of the entire organization. This would require a close examination of the present organizational culture necessitating the participation of a major section of the organization through many brainstorming sessions.

The second step involved providing top management with the necessary education and training to manage the resources of the organization. The essence of this crucial step is internalisation of the concept of total waste elimination in the management of business. Unless senior management is totally sold to this concept, there is no point in advancing to the next step. Borrowing from Kanter [94] the term ‘change masters’ or ‘prime movers’, senior management are the ultimate agents of change.

The third step involves the selection and pre-conditioning of capable facilitators, the change agents. In this study, they are referred to as ‘champion(s) of quality’. Since they are the agents of change, they also need to develop a strong understanding of the organizational behaviour and structure besides the total waste elimination concept. Training and education of facilitators are most effective when concentrated. This means there should be fewer interruptions in the training and education process. As a final note, it is worth mentioning that the transformation would have a small chance of success if the change comes from within.

2.5.2 Cultural Change

The total quality journey involved many changes in the organization's values, work process and so on [141, 142, 165-169]. Chase [162] reported that results from his survey on British firms indicated that the major problems encountered are culture change, management behaviour and making time. Cultural change in connection with TQM is like a chicken and egg situation. Many quality experts, like Deming, Juran, and Crosby, stressed the importance of building a quality culture as a prerequisite to major quality improvement efforts. Others argue that these must coincide with the introduction of tools and techniques. According to Crosby [170], transformation of the company's culture and attitudes requires the commitment of top officer in the company and his senior management team.

Still others believed that it is the TQM that transforms the organizational culture and not the other way around [171]. Eichelberger [113] advocates leading change through projects by the use of cross-functional teams. According to Heath [118] TQM is about cultural change more than anything else. While there are many definitions of culture, the most noted writer in the area of organizational culture is Edgar Schein [172] who defines culture as:

> 'A pattern of shared basic assumptions that the group learned as it solved its problems of external adaptation and internal integration, that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems'.

From the above definition of culture, quality culture can only mean that :

> 'Quality culture is a pattern of the shared collective learning of quality-related values as the organization continues to serve its customers'.

As the business environments change, organizations need to continually adapt to stay competitive [82]. This means that organizational culture needs to change with changing customer needs. But one of the main issue regarding culture transformation is that cultural aspects are well entrenched in the organization and not to expect permanent change to happen easily over a short period of time [150, 151]. Bettes [38] argues that cultural change comes from a succession of small changes in the work place. Kanter [94], and references [38, 150, 151] shared the same views.

Carpenter [156] believed that big change in productivity can happen if management is committed. According to Merron [173] many organizations were not adequately prepared for the change and frequently underestimate the time and effort required. The formation of a desirable quality culture is generally considered to require a well-developed organizational quality mission and supporting goals [173, 174]. Consequently, recognising this need for a quality culture or what is more important the need to change the existing culture rests with management [152].

2.5.3 Mechanisms of Change

Installing and implementing total quality initiatives demand changes in the organization. Kanter [94] described major changes in an organization as coming from the actions of people from the floor up to the top management level. This necessitates a slow and cautious built-up. Oakland [119] advocated the same approach. Most senior management seems to be preoccupied by short term impacts and are thus naturally impatient, losing sight of the long-term objectives [15]. Employees involved must also be told with this fact. Kanter described a combination of five major building blocks present in productive corporate changes.

1. Change occurring as a result of departures from tradition. - Generally at the floor level either random or by chance where the organization might permit some departure from the norm. This would permit resourceful employees to be innovative and provide solutions to the organization's problems. This means that an organization should provide an environment that is conducive to these people to experiment with new methods or procedures to solve new problems. This is precisely what total employee involvement is all about.

2. Change occurring as a result of crisis. - This is may not necessarily be from outside the organization. The literature is littered with this kind of change that is forced to take place as faced by Harley Davidson. Neither the first nor the second catalyst for change as described above can guarantee changes without two conditions in place.

These are the leadership for making strategic decisions and the presence of champions in this study.

3. Change occurring as a result of strategic decisions. - The term strategic according to the Oxford dictionary means long term plan or policy. It implies a plan of action that is deliberate and focused, that is having direction and purpose. Leaders must provide a vision of what lies ahead and encourages employees into the change process. They accept the previous two modes of change and learn from its experiences.

4. Champion(s) - The presence of a champion builds the pressure and keeps the momentum of change going especially through difficult times in the change process. Many organizations make a mistaken assumption that assigning responsibilities to individuals or teams automatically produce results. Many fail to realise that without a forceful figure to push and motivate the people, the change process usually stop. Heilmann [133] recognises the critical and pivotal role played by supervisors as role models for the work force in the organization.

5. Policies - This is the last critical element to implementing change in the organization. There is a need for multiple policies to support an idea because people's behaviour in organizations is influenced by their position and the responsibilities brought about by this position. This is also observed by Leitch et al [175] to be the strategy used by firms in their survey. Examples are policies on education and training, reward system, customers, working condition and so on. They believed that

these policies when implemented together would help reinforce the messages from the leaders and bring benefits to the people instituting the new practices. They also believed that employing a reward system that focuses on individual contributions to the collective efforts would be deemed to be hostile and clearly unsuitable in a total quality climate. According to Roth [176] employing a reward system that makes sense is a necessary prerequisite to a successful change.

2.5.4 SMEs

Most of the proposed guidelines, procedures and techniques found in the literature are applicable only to large firms. The difficulties of the SMEs especially in the mature traditional industries like metal and mechanical engineering and food remain. These are the industries where the manufacturing processes are well established.

SMEs find it hard to assess or even know their training needs [3, 177, 178]. Many are probably unaware that there are various bodies in the state that can provide assistance to their problems. Generally most lack the wide range of expertise necessary to run their businesses especially in finance, marketing, quality etc. In addition to this the location selected for training should provide an opportunity for all employees to attend training without having to completely close their operations.

Generally, SMEs lack the time and staff necessary to assess the quality programme offered by training institutions. If they send staff for training, the production process is disrupted because the person being trained is not replaced. If they organise training within the firm, there are problems of release time and logistics. This means the costs of training are a critical factor to the success of any quality programme.

2.5.5 Methods of Implementation

Case studies on the adoption and implementation of a teaching company scheme in the SMEs in UK demonstrated that the scheme proved to be a success in introducing innovation and appropriate technologies [179]. The project is funded by the department of trade and industry in corporation with the company and the university. In this project, a graduate engineer is involved in carrying out specific implementation programme in a company. The project recommended that the appropriate technology to be implemented should be part of the long-term commitment of continuous improvement by the company.

Also reported by Ridgway et al [179] is the initiation of 'Uncle' project in which the large companies in the locality assist the SMEs to create a total quality culture. This would fit into the findings of McCormick et al [181] who observed that foreign manufacturers open up the prospect of a transfer of best practice to indigenous firms.

According to Heath [118], management must first start off with establishing a mission and vision statement and use tools to identify key processes and set standards. The second stage involved training employees in the use of tools, introduce work teams and reinforce results through the use of meaningful rewards. The third stage expands employee involvement further by soliciting ideas and providing feedback.

Also in the case of Toyota, suppliers are seen as simply another production process of the Toyota plant [182]. The idea behind such initiatives must be to regard the SMEs as partners, or as an extension of the paternal company, where co-operation and teamwork exist in a symbiotic relationship. This would require the large companies to share its destiny with surrounding co-operative manufacturers as a single community.

The European round table of industrialist (ERT), proposed co-operation between large companies and SMEs by way of customer-supplier relationship and through sharing of destiny between large companies and SMEs [178]. They recommended sharing of training resources, having regular meetings and working with local educators.

In reference [169], the report observed the need for representatives from the industry, the education and training to co-operate to identify skill needs of the nation.

Another method that is similar to those described above is offered through Plato networks. This is solely dependent on large companies, known as parent companies, to help and support small companies in their area. Participant companies normally would have completed the start-up phase of development and are facing the challenges and issues associated with company growth and expansion. It is a two year business development programme targeted at SMEs by providing support and assistance through effective network linkages and by allowing owner-managers to develop their personal management skills. Executives from larger companies provide information and conduct training seminars periodically.

In essence, the education and training approaches with regard to implementation of quality improvement initiatives cannot be met by conventional training methods. The various approaches from the field confirm this view. The responsibility of trainers, educators and owners of any programme to educate and train employees in the use of quality improvement initiatives must no longer start and end in the classrooms, it must now start as far as is possible and end in the workplace. They must ensure that employees can effectively use the taught skills on the job.

This is in no way different to the purchase of new machines or equipment where the suppliers are required not only to see that the machines or equipment supplied are good and running, they must also ensure that the operators are trained to operate and run them.

2.6 Chapter Summary

The chapter starts with an overview of quality management followed by a brief description of the evolution of quality; it's accompanying definitions beginning from conformance to requirement to delighting the customers. This is followed by a discussion on the merits of ISO 9000; identifying the elements the make up total quality management; and the suggestion of a probable complementary effect of the former on the latter. The remainder of the chapter considers the evidences of correlationship between practice and performance; briefly discuses several tools and techniques used in the study; and examine the reasons, its implementation order or the lack of it in the industry. The chapter ends by identifying several factors to be considered when developing techniques' implementation guidelines among them education and training, cultural change, mechanisms of change and methods of implementation.

Chapter 3

DESIGNING THE SURVEY

3.1 Objectives of Survey

This survey is the heart of the research on quality management. It includes a wide spectrum of quality practices, as well as measures and indicators used in the industry. According to Juran [183], this would include among other things; technological, errors and failures, product and performance measures, management and quality related activities. Accordingly this study would proceed with utmost care to ensure that:

1. the quantitative as well as qualitative measures and indicators are put in place,
2. the procedures on questionnaire design and selection of sampling frame are established, and
3. other necessary steps taken to ensure a sound survey

follow well-established principles and guidelines. Where possible the study would make use of frequently used and tested measures and indicators as well as questions. These steps are necessary to address the issue of reliability and validity raised by Shepherd and Helms [184]. These measures and indicators are generally similar to the item's list contained in the 1997 MBNQA criteria.

Specifically, the objectives of the survey are:

1. to collect information on the quality practices.
2. to collect information on various performance indicators.
3. to collect information on the use of selected quality initiatives.
4. to collect information on implementation order of various quality initiatives.

3.2 Coverage of Survey

The target population, that is the population for which the results are required are all manufacturing companies within the industrial sectors as defined in Appendix A. This list of companies can be obtained from the KOMPASS database available on CD-ROM 1996 edition ver.1.0. The coverage of the survey excludes manufacturing companies outside the republic.

It is worth noting that many companies are involved in activities appropriate to two or more industrial sectors. According to customary practice, the company is classified according to the principal activity. Using the KOMPASS database and filtering for:

Area : S.Ireland (Republic of Ireland only)

Product and Service Group : Sectors as identified in Appendix A.

Nature of Business : Manufacturing

Nos. of Employees : 21 - 50 ; 51 - 100; 101 - 250; 251 - 500;

501 - 1000; above 1000.

a total of 3331 companies were identified. It was then decided that because of the low response rate in similar surveys as reported in the literature, a return of 15 per cent was estimated for this survey. This low estimate of 15 per cent plus the knowledge that at least 300 responses are needed for cross-tabulation exercises, a final survey population, was then calculated to be in the region of 2000 companies. Information on manufacturing companies from the KOMPASS CD-ROM database was downloaded to a diskette in the design below.

Each sector was further classified into number of employees and is given eight-digit code and identified as follows: XY215001. The coding system was developed to assist in the identification and classification of raw target population list and at the same time avoid duplication and repetition of firms in the final list, that is the sampling frame. The first two digits are taken from the sector code: XY. The digits that follow represent : 215 -nos. of employees between 21-50, the last three digits, 001 given for first company identified. Similarly 511 -nos. of employees between 51-100, the last three digits, 001 given for first company identified. For 101251 -nos. of employees between 101-251, the last two digits, 51 given for first company identified. For 2515 - nos. of employees between 251-500, the last two digits, 01 given for first company identified. For 501 -nos. of employees above 500, the last three digits, 001 given for first company identified.

Information on this diskette was then transferred to an Intel 100 Mhz pentium, ELONEX PC-5100/I Series 16 MB Ram and fed to a Microsoft Excel Version 5.0a with Math Co-Processor on board. The powerful Excel provided the researcher the ability to arrange the companies in ascending order within sectors and within number of employees categories, and to merge all sectors and arrange in ascending order (alphabetical order). This is to prevent any duplication or repetition that may occur given the large number of companies involved (17,038) in the KOMPASS database. As it turned out the raw target population list of 3331 number of companies contained numerous repetition and duplication in the manner as listed below:

Within sector:

1. Similar names of companies with similar addresses in same employees category.
2. Similar names of companies with similar addresses in different employees category.
3. Corporate office of group of companies already in the smaller employees category also found in the larger employees category.

Between sector:

1. Similar names of companies with similar addresses appearing in multiple industry sector.

Consequently, a closer investigation of the target population list was carried out aided over the telephone calls, telephone directories, fax directories, the National Standards Authority of Ireland's 1995 registered companies' guide, and the registrar of companies. This exercise culminated in the final target population list totalling 1806 number of companies that is shown in Table 3.1. As a comparison, statistics available on the number of enterprises with 20 or more persons engaged from the year 1982-1990 as compiled from the Census of Industrial Production 1990 by the Central Statistics Office is as shown below in Figure 3.1. It shows that the figure of 1806 companies is not too far off the average.

				TARGET	POPULATION				
			NUMBER OF EMPLOYEE						
SECTOR ID	IND GROUP		21-50	51-100	101-250	251-500	>501	TOTAL	PERCEN
31-32	CHEM		72	32	33	11	5	**153**	**8.47%**
29-30	PL&RB		73	30	24	7	2	**136**	**7.53%**
34-36,38-39,46-49	METAL		290	112	73	23	5	**503**	**27.85%**
37	ELECT.		53	32	43	15	17	**160**	**8.86%**
20-21	FOOD		148	95	86	31	15	**375**	**20.76%**
25-26	WOOD		63	27	5	3	0	**98**	**5.43%**
27-28	PA&PR		56	33	17	4	1	**111**	**6.15%**
22-24	TEXT.		92	53	33	8	4	**190**	**10.52%**
33	CLAY		38	28	5	7	2	**80**	**4.43%**
	TOTAL		**885**	**442**	**319**	**109**	**51**	**1806**	
	PERCENT		**49.00%**	**24.47%**	**17.66%**	**6.04%**	**2.82%**		

Table 3.1 Breakdown of target population by sector and size of employment

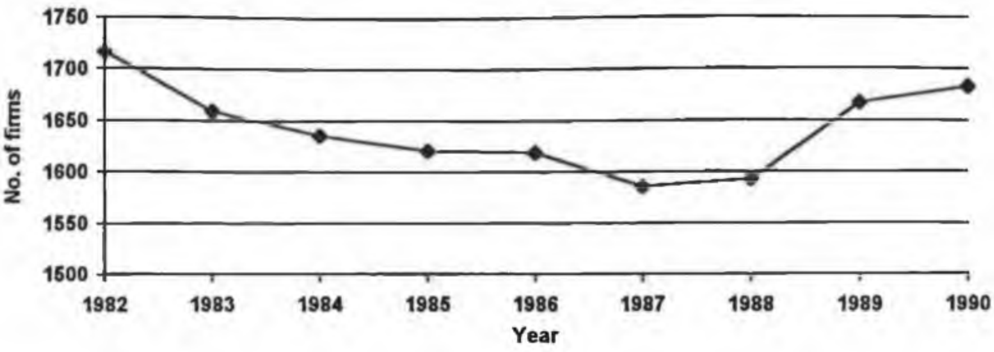

Figure 3.1 Population of manufacturing industries (following the central statistics' office classification of industry as used in the annual census of industrial production) with more than 20 employees from 1982-1990.

A breakdown for the various classification is shown in Figure 3.2 below. It was not possible to plot the graph for the industrial equipment sector as this was not available in the NACE classification. It is possible that this industry could have been left out or combined under the metal and engineering sector.

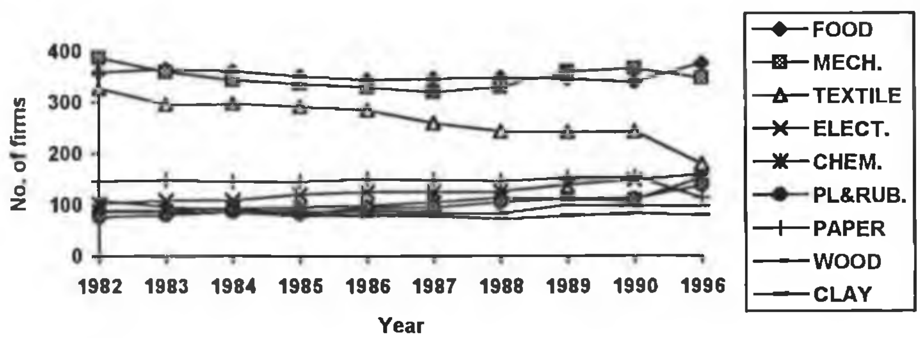

Figure 3.2 Enterprises with 20 or more persons (From Census of Industrial Production, 1990) according to industry sector.

Comparing Table 3.1 and Figure 3.2, except for the figure for the metal industry, there is almost duplicating accuracy between sectors from the census data and the sampling frame. It was decided that since the resultant number of the target population was only 1806, the initial survey population numbering 2000 companies was then changed to 1806 that is, to equal the target population. As such, for all practical purposes, the coverage of the survey is complete since virtually all the companies in the population are covered in the study. Thus there was no need to sample except for initiating the pilot survey, which will be dealt with in Section 3.10.

3.3 Collection of Information

Moser and Kalton [185] describe five methods of data collection as follows:

1. documentary sources
2. observation
3. postal survey
4. interviewing
5. combinations of the above

According to both Moser and Kalton [185] and Fowler [186], the choice of collection methods depends on the research topic, the sample frame (KOMPASS database), characteristics of the sample, and resources. It is clearly one of the most important decisions in this study as it has implications for the rate of response, the survey instrument, and the survey costs.

Methods 1 & 2 above are not suitable for this fact-finding enquiry into the subject that is of close interest to survival of respondents. Considering the nature and types of information required in this study, it is doubtful if there is any organization that collects and maintains a comprehensive information regarding the quality practices and performance of the entire manufacturing companies.

Of the three remaining methods, the deciding factor is without doubt the economics of the survey and the geographical dispersion of the companies. In the words of Selltiz et al [187] 'questionnaires can be sent through the mail; interviewers cannot.' It is clear that the cost of using the postal survey method is very much less than the interview method even if it is based on the selection of random sample. Thus the method of collecting information will be the postal survey method.

3.4 Limitations of the Mail Questionnaire Method

Moser and Kalton [185] identified seven main disadvantages to the mail questionnaire method. These will be described briefly in the following paragraphs.

1. non-response.
2. questions must be simple and straightforward.

3. no opportunity to check or clarify answers.

4. unsuitable where spontaneous answers are required.

5. questions cannot be made independent of each other as respondents can view all of them before answering.

6. someone else may answer the questions.

7. no opportunity to interact with the respondents.

Following these limitations, several guidelines would be observed in the designing of the questionnaires in section 3.7.

3.5 The Postal Survey

The research design employed in this study involved designing of a postal-survey questionnaire and mailing it to 1806 manufacturing firms in the Republic of Ireland. Another 19 questionnaires were mailed to the Malcolm Baldrige winners in the US. This is an attempt at providing benchmarking for what matters most is not only how well Irish firms are performing relative to its own, but rather how well it is performing in relation to world-class manufacturers.

Another 19 questionnaires were mailed to firms in Malaysia. Their names and addresses were randomly selected from the Malaysian Industrial Development Authority (MIDA) database by way of internet. It was anticipated that very few would respond. Nevertheless it would serve to test the reliability and validity of the test instrument in so far as to locate the position of each in the scatter diagram.

3.6 Questionnaire Design

First timer and inexperienced researcher would regard this as the easiest part of the survey design. Sudman [188] identified several important factors and procedures any questionnaire designer should take into careful consideration when designing questionnaires. Several factors identified as crucial are: 1) question wording, 2) order of questions and 3) formatting the questionnaire.

As a general rule, experts recommend asking continuously "*why am I asking this question*" for every question and to be able to tie-in with the objectives of the survey. Apart from the above, the guidelines proposed by Sudman [188] and Fink [189] as outlined below were observed:

1. draft questions that are related to survey's objectives.
2. avoid two-edged questions (the use of the word "and").
3. use tried-questions from similar surveys
4. ask specific and discriminating questions (requiring ordinal or numerical data).
5. order the questions in sequence.(refer to Appendix B)
6. format the questions.(refer to Appendix B)

7.precode and post-coding the responses.

8.draft questionnaires given to peers, supervisors, the NSAI and consultant group for comments and critical evaluation.

9.conduct pilot test

10.review, revise and eliminate problem questions.

Questions were designed to capture information about the quality management practices and business results from supplier to manufacturing system to customer. Care was taken to ensure that the design included several critical factors used to evaluate quality management in either manufacturing or service organizations developed by Saraph et al [167] and Tamimi [62]. It included key questions on organization and culture, quality management, education and training, and the use of including the seven quality control tools (control charts, trend/run charts, cause and effect diagram, etc.,) and techniques from the traditional statistical process control to the more complex and sophisticated design of experiment, and quality function deployment, etc. Some of the tools and techniques originated from just-in-time, total quality control, TPM, and lean production paradigms. On the whole, it covers all the seven stages of quality as described by Sullivan [30]. Operational performance measure includes productivity, lead time, market share, timeliness of delivery, employee turnover, etc., as used in Wilkinson et al [86] and the US General Accounts Office study reported in Zairi et al [75].

3.7 Scaling of Responses

The outcome of this fact finding survey is to be able to compare the quality management practises of each respondent. In other words, the whole story is more important than the individual snap shot. Complementary to this is the assumption that the quality management picture of each company can be ranged. This requires careful consideration in designing the question. Basically, the choices given to respondents for their answers take these forms:

1. Nominal or categorical scale: - these choices have no numerical or preferential values. It merely categorizes or classifies without quantifying the characteristics being measured. Example: Question no. 8: Is the firm a member of a quality association? YES/NO. This type of question has limited application and is used sparingly.

2. Ordinal scale: - ranking the choices but without quantifying the magnitude of the difference. Example: Question No. 32: Referring to question 31. Select four responses important to your firm's quality needs today. This type of question has limited application and is used sparingly.

3. Interval or Numerical scale: - this has equal units of measurement that makes it possible to interpret not only the order of the scales but the magnitude of the distances between them. Example: Question No. 6: Approximate percentage of products exported_________per cent.

4. Ratio scale: - this is the highest level of measurement that has the properties of an interval scale and a fixed origin or zero points. This makes it possible to compare both differences in scores and the relative magnitude of scores. Example: Question No. 36: Approximately how many times have your company been inspected for quality by any customer or on behalf of any customer in: 1. 1994___2. 1995___ 3. 1996___

As can be seen from the above measurement scales, all effort in designing questions must be directed to design specific and discriminating questions that can help in distinguishing clearly one respondent from the other.

3.8 Response Errors and Rates

This is a very important topic in any survey-based research that relates to reliability and validity that must be acknowledged, identified and discussed. There is abundant literature on this topic since it's early use as a method of collecting information by many quarters.

As far as the questionnaire used in this survey is concern, almost all the questions can be categorized as behavioural or fact-finding [188]. These are questions that ask about the characteristics of the companies, quality initiatives practised, etc., events, experiences or acts that are discrete, quantitative and quantifiable and can be verified by a third party.

The other type of questions that may cause errors in responses is categorized as psychological or attitudinal. These are questions that ask about attitudes and are thus qualitative, impossible to verify and unavailable to third party verification. Questions 43-46, falls into this category. In order to minimize the response errors it is important that the guidelines and principles described earlier are closely followed. According to Sudman [188] the different types of errors fall into four factors:

1. memory: material may be forgotten or may not be remembered clearly.
2. motivation: respondents may want to present their companies in a better light.
3. communication: inability to understand the questions asked.
4. knowledge: respondents may not know the answer.

Apart from the problem of response errors that has a bearing on the reliability and validity of the survey and consequently the research study, the problem of low response rates has always been a major cause of concern to any researcher. According to Moser and Kalton [185], it is not the loss in sample numbers that is serious, but the likelihood that the non-respondents differ significantly from the respondents. There are various types of non-response and some will be mentioned below:

1. companies outside the population
2. companies refusing to co-operate.
3. change of addresses or wrong addresses.

Various guidelines are followed to reduce the magnitude of low response rate. Some of these have been discussed in earlier sections, but a few will be mentioned here. Among those advocated are the provisions of gifts and/or cash incentives as practised by this survey and sending reminders and making repeated phone calls (see Appendix D). According to Sudman [188], questions requiring reference to files, manuals and other documents should be placed towards the end of the questionnaire. This is to avoid the respondent from being stuck in the answering process and increase the tendency to 'leave it aside' for later attention.

This has led to questions requiring references to documents and or files being placed towards the end of the questionnaire (Appendix B). In addition the section headings that grouped questions together in the questionnaire were later dropped out. This is to prevent respondents from feeling that the purpose behind the questionnaire survey is merely on evaluating on the adequacy or lack of management expertise in the running of the company.

There is a consensus among survey practitioners that every effort must be made to secure a high response rate. If where the response rate is still low the next course of action is to get as much information as possible from the non-response group. The method followed by this study as mentioned in earlier section described the use of eight-digit code for denoting industrial sector, and size of employment for each individual company, and the subsequent creation of databases. This will be used for further analysis on the non-response group in the survey in trying to understand the effects of non-response bias [185].

3.9 Pre-test, Pilot and Main Survey

Within the framework of the general principles and guidelines for administering a sound survey, pre-testing and pilot survey are a necessary prerequisite. In this study, pre-testing of survey questionnaire was conducted on a number of occasions. Sample questionnaires were given out to peers, academic staffs, consultant group and reviewed by staff of the NSAI. There are several reasons for conducting the pilot survey. According to Moser and Kalton [185], these are as follows:

1. test the adequacy of the KOMPASS 1996 database.
2. show some proof of the variability of the subject in question.
3. provide an estimate of the probable non-response rate.
4. test the suitability of the method of survey.
5. test the adequacy of the survey instrument.
6. review the questions.

The pilot survey, often dubbed as the dress rehearsal and a standard practice by many survey practitioners, was selected using a table of random numbers [190]. Based on conducted on the 26th. September 1996 and the 15th.October 1996 respectively. This time around the accompanying letter was signed by the Head of School using official letterhead. A total of 24 responses were received from this first reminder. Overall the pilot survey with two reminders complete with a copy of the questionnaire secured a response rate of 45 per cent. From the responses of the pilot survey, several questions were reworded, dropped, modified or merged. These are questions Nos.: 3, 7, 18, 20, 30, 31, 33 and 44. The final version of the questionnaire is thus ready for the main survey. The response rate for the pilot survey was considered favourable when compared with the average response rate of 21 per cent on similar surveys in the literature. It has often been shown that response is correlated with interest in the subject [185].

The main survey was conducted on the 25th. October 1996. Considering the large numbers involved, a selected reminder to a sub-sample of the initial non-respondents was sent without a copy of the questionnaire. The overall survey secured a total of 394 respondents excluding 11 closures and 26 outside the population; giving a response rate of 22 per cent. This is about the average response rate found in the literature.

3.10 The Questionnaire Content

In developing the questionnaire, some questions from the work of Mann [87], Roche survey [89], and Zaini [90] were combined, and redesigned. Always during the questionnaire design stage, the general framework outlined by Juran [183] and the MBNQA criteria were followed through. The majority of the questions were new but these were later accepted after going through continuous revision process.

Basically, the questionnaire is a set of questions used to capture the experiences and the practices of the organization with respect to quality and performance. Seen in this way, it is actually a measurement system. It is a snapshot of the organization's quality position.

Consequently the questionnaire, or the measurement system, for the purposes of this study has taken into consideration several areas that are common and are addressed by the other measurement systems. These areas extend from the external supplier to the organization to the external customer. Within the organization, it encompasses the horizontal (across shop floor) to vertical (senior management) level; from statistical data that measures operational performance (scrap, rework, percentage of incoming/outgoing goods rejected, etc.,) to those that measures business performance of the organization (market share, productivity, timeliness of delivery, etc.,).

Newell and Dale [81], stressed that quantitative data alone generated from the shopfloor operations are not sufficient to be considered as effective measures of the health of the organization. Thus the questionnaire was developed not only to capture various quantitative and qualitative data generated from the shopfloor but it was also designed to capture the experiences and the time frame when certain quality initiatives were implemented and its corresponding results.

3.10.1 Questionnaire Analysis

Question 1

The industrial sectors as classified in KOMPASS (see Appendix A) and as used by the Central Statistics Office in their Census on Industrial Production are similar except for the coding. In this question the grouping follows the practice of the Central Statistics Office. The numbers 1-11 are used for coding of the responses in this survey.

Question 2

Results from the 1980 survey showed that the responding firms were mainly in the traditional groups (food, textile & clothing, wood, paper, and metal), generally small (less than 100 employees), mainly export-oriented and largely Irish owned with the exception of the electrical and electronic and chemical & allied products group, which were largely foreign-owned. As can be observed the latter groups are in the fiercely competitive market and logically the quality development and the quality management systems are expected to be at a much higher level compared to the former group of companies.

Question 3

This question sought information as to how long the firm has been established. It is generally believed that the longer a firm has been in operation the more difficult it becomes to accept changes. Whereas for new ventures or fresh start firms, the chances of meeting resistances are minimal since there will be little or no established work culture that may hinder introduction of quality improvement initiatives.

Question 4

It is generally believed that the size of employment plays a crucial role in the development of quality. Large organizations with specialisation of functions will have a multi-team structure. Both the former and the latter assumptions are true in the case of the winners of the MBNQA. All the winners are large corporations employing more than 1000 employees.

Question 5

This is probably one of the most important question that attempts to gauge the performance of the organization. There were other 'hard' measures of financial performance designed in the earlier stages of questionnaire development namely: profit(loss) before taxation per employee; and total assets per employee, which were dropped. The question was also worded to include the word "approximate" as it was generally believed that this will culminate in a higher response.

Question 6

Since the home market is relatively small, most business enterprises are export-oriented. This opens the door to not only local but foreign competition. In a competitive market, factors such as price, on-time delivery, reliability, ease of maintenance, etc., are equally important. All these factors are within the meaning of the 'total quality' concept. As such, this question is very important since a higher percentage of products exported mean being more competitive.

Question 7

If the organization is part of or subsidiary of a larger organization, than the level of quality development and the quality management system is expected to be well developed.

Question 8

Result of the 1980 survey showed that only nine per cent of respondents were members of the Irish Quality Control Association. Being a member of a quality association can bring much benefit to the organizations as far as quality improvement activities are concerned. It is expected that the knowledge gained and the exposure to the practices of the industry as a whole will motivate the organization to implement some of the quality initiatives over time.

Question 9

BS 5750/ISO 9000 has been and is still severely criticized as a system that requires too much paperwork. Quite apart from this is the serious question of its real value to the organization. Since acquiring its registration is not synonymous with product quality. However, being registered to BS5750/ISO 9000 at the very least means that the organization has the basic quality system requirements in place in today's competitive market. The processes that a company goes through to meet the requirements of the ISO tend to enhance quality and productivity.

Question 10

This question seeks information on whether getting registered is an end in itself or rather as a starting point to introducing other quality initiatives.

Question 11

This question seeks information regarding the implementation of TQM and it's related quality initiatives in later questions in the questionnaire.

Question 12

This question seeks further information about the response to question 1; into the nature of the manufacturing system itself. Companies may have some of these in their location but it is possible that one method of manufacture will be more predominant.

Question 13

The manufacturing industries in Japan are using modern competitive-enhancing technologies to improve their quality of manufactured products, and reduce cost further. Improving and modernising the technology improves quality, thereby improving competitiveness. Deming emphasized the need for management to adopt a long-term approach towards improvement of product and service.

There is now too much emphasis on the 'softer' aspects of the organization to the point of neglecting the necessity of investing in new technology-driven improvement to quality and productivity. There is ample evidence in the literature of attempts by quality practitioners to link implementation of strategic quality management practises with technology in successful organizations without at the same time investigating on the contributory and complimentary effects of new technology on competitiveness. This question sought information on the level of automation or the lack of it in relation to the overall health of the organization.

Question 14

This question seeks to distinguish between large and small companies' commitment and recognition on the importance of quality. The formation of a separate quality department can be highly expected in a larger company than in a smaller company.

Question 15

This question sought further information on the commitment of top management on the importance of quality. A committed firm will have the person normally responsible for quality reporting to the highest ranking officer in the organization.

Question 16

This question is related to the two previous questions. There should be evidence of a number of personnel in the organization primarily responsible for quality apart from the other employees in the organization in general. It represents the backbone of the quality improvement and development drive in the company and through it educates and involves all the other employees.

Question 17

This question sought to discriminate between the quality committed organization and those that are not. Organizations that are totally committed to quality will have several personnel from different levels in the organization acting as the nuclei in the quality initiatives. The 1995 MBNQA winner overall responsibility rests with a 10-member quality leadership team composed of senior executives and headed by it's Chief Executive Officer. The winner of the 1990 MBNQA has union leaders play an active role in the quality improvement programmes.

Question 18

This question examines the extent of management's commitment to total quality. It is expected that successful companies would have an array of means of communicating its views on quality to its employees.

Question 19

The objective of customer focus should not only to meet customer needs, but to exceed those needs [51]. A strongly customer focused organization will have senior management involved in the process. While most companies may realise the importance of a customer focus in conducting their business, this question sought information as to how involved senior management is on the feedback from the market.

Question 20

The question of reward is not addressed by the quality Gurus. Deming is highly critical on the question of ranking and rating of individual performances. It is assumed that participation or involvement in quality activities has positive long term effect if it is voluntary; that producing defect free products is obligatory. Some companies do have bonuses or some other extrinsic rewards, financial and or non-financial, tied to performance. The 1995 MBNQA winner started a gainsharing plan that links among other things, performance aspects with each employee's compensation. Wilkinson et al [86] reported that 40 per cent of the respondents in the survey they carried out used quality indicators in their performance appraisal, a further 29 per cent linked this to performance related pay or bonuses, and that 64 per cent of the respondents themselves received some form of financial incentive. This question seeks to capture information on this issue.

Question 21

This question sought information on whether the manufacturing operations are carried out under appropriately controlled conditions by the provision of instructions for manufacturing, inspection, test, assembly, etc. These are requirements as explained in the standards.

Question 22

The international standard specifies that incoming, in-process and finished goods be inspected and verified. This question seeks to establish the amount of inspection carried out.

Question 23

This question sought information on the generic 'feedback' system that is a very important measure in the continuous quality improvement effort. The responses are ranged from the very rudimentary to the very sophisticated; from the quantitative to qualitative measure; from internal to external. The 1994 MBNQA winner, besides monitoring processes, conducts monthly reviews of internal customer satisfaction.

Question 24

This question sought information on the extent of the role of the ordinary workforce in the total quality picture in the organization. Dale [53] and Crosby dismissed the motivating effect of job enrichment in the workforce. The 1995 MBNQA paid its workers for mastering new skills and knowledge. Goetsch et al [23] stressed that the most valuable resources for improving competitiveness are personnel. The essence of total quality is in the involvement of employees at all levels in the organization [191].

Question 25

This question sought further information on the extent of employee involvement over decision-making at a much higher level than the shopfloor employees. This is an attempt to gauge the use of integrated process and product development in the manufacturing industry in Ireland. It indicates a serious commitment to total quality and a measure of the success of cultural change in the total quality organization. The 1990 MBNQA winner has suppliers involved in product development in 75 per cent of its product development and improvement teams.

Question 26

This question sought information on the quality management practises of organization in the procurement of materials and components. According to BS 4891, there should be a trend away from placing sole reliance on incoming inspection towards a more rigorous assessment of the supplier's ability to satisfy the customer's needs. In a total quality atmosphere, it is expected that many departments will be involved in this decision.

Question 27

This question sought information on the existence of a supplier management and development in the organization. An organization that subscribes to total quality will be expected to have a well-developed long-term partnership with suppliers [53, 192].

This sort of team approach means that both parties should be successful in their associated businesses and make a profit [193].

Question 28

As was stressed in the earlier section, measurement is at the heart of quality control. This question sought information on the statistical methods used on the shopfloor. Shingo [112] rejected the role of statistical methods in quality that uses historical data thereby tolerating the occurrence of defects. The overall effect is nothing much but diverts attention from the real goals of quality control. Nevertheless, the role of statistical methods is important in the quality improvement effort and its use is widespread in the industry and according to the 1980 survey, around 40 per cent of the respondents made use of it.

Question 29

This question sought further information on the effective use of the information generated from the statistical methods. Actually, it is an important source of information that could be used by various levels in the organization to facilitate improvement and be integrated into the way the business works [53]. McQuater et al [19] reported that many organizations fail to analyse and co-ordinate the data collected.

Question 30

The 1980 survey reported that over 60 per cent of respondents were satisfied with the services and activities that they considered capable of enhancing their company's quality needs provided by state owned agencies. This question sought additional information on whether external agencies other than state owned are involved in quality related activities. The respondents were also required to evaluate its usefulness on a five point interval scale.

Question 31

All the quality gurus stressed the importance of education and training in the quality improvement programme. The 1980 survey reported that about 50 per cent of respondents provided education and training for quality control and inspection personnel. Among the topics covered in their training programme were: quality management, quality costs, product liability and statistical techniques.

Question 32

This question sought information on the topics covered in the training provided for manufacturing as well as non-manufacturing staff.

Question 33

The development and subsequent running of in-house training programmes require substantial commitment of management and staff resources.

Question 34

This question sought information from the industry on the amount of training provided to each employee. The MBNQA winners invest heavily in training and education of their most valuable asset.

Question 35

This is a measure of how successful the total employee involvement effort has been. It is expected that the suggestion system will be very successful in those organizations that are seen to be employee-friendly. This question sought information as to the number of employee suggestions per year.

Question 36

In the continuous improvement drive, continuous assessment of the adequacy of the quality system of the supplier base is a major requirement. This is conducted at regular intervals. This question sought information on the frequency with which such assessments were carried out in the respondent organizations that would imply its quality standing in the industry.

Question 37

Teams should meet on a regular basis. This is to facilitate exchange of ideas, provide a means of reporting of activities, identifying and evaluating problems and creates opportunity to build a trustworthy relationship between members. It is expected that successful teams must meet regularly and often to be effective.

Question 38

In the 1980 survey, just under 40 per cent of the respondents measured quality costs. Although the elements that make up quality costs may differ from one to another, the main purpose of collecting such information must be to provide feedback on the performance of quality improvement programmes.

Question 39

From the responses to the 1980 survey, about 40 per cent of respondents keep failure costs. This question sought information on failure costs since about 60 per cent of respondents in the 1980 survey do not measure quality costs.

Question 40

This question sought information on the trend of the failure costs that can be used later to associate it with any major changes in the organization (such as implementing quality improvement programmes, adopting quality management strategies, etc).

Question 41

This question sought information that will be used later to evaluate the success or failure of a supplier development strategy. This information will later be used to evaluate the operating performances of the firms.

Question 42

This question sought information that will be used later to evaluate the operating performances of the firms.

Question 43

This question uses 13 quality initiatives to measure the variable 'improved quality' on a five-point scale.

Question 44

This question uses additional six quality initiatives to measure the variable 'employee involvement'.

Question 45

Wilkinson et al [86] used several variables, like productivity, scrap levels, and customer complaints among others in their survey. They reported that 60 per cent of respondents had some improvement in productivity, while about 30 per cent reported no change. Regarding customer complaints, 70 per cent of respondents reported some improvement, while 26 per cent reported no change.

Question 46

This question sought information that will later be used in formulating a quality management implementation strategy.

Question 47

This question is included in the survey questionnaire as it was assumed then that it will improve the response rate.

3.11 Processing of the Data

Once the responses start to trickle in, the process of editing and entering into the computer is initiated. Some amount of editing the responses was carried out at the time of entering the data. This task is made easy as most of the questions are precoded using as far as possible coding frames from other surveys. Only one open question required careful analysis before some kind of coding frame is employed. The computer software used in the data entry and processing was SPSS for Windows Release 6.0.

3.12 Scoring System

With regard to competitiveness, the literature is abundant with numerous works related to quality measurement, most often referred to as performance measurement. Zaini [90], Crawford et al [194], Dixon et al [195] and Pascale & Athios [196], to name a few published works on measuring of quality position. Essentially, this involves a combination of measurable indicators into an index, scale value or score.

Feigenbaum [55] stressed the need for a continuous, and timely reporting of performance indicators for the purposes of quality improvement efforts. Other quality Gurus like Crosby and Juran emphasized on the need for a good measurement system. Dale [53] stressed that measurement is indispensable in quality control and reported that, "If we cannot express what we know in numbers,

we do not know much about it."

It is also said that, "what one cannot measure, one cannot control." Without doubt, measurement is the pillar in quality management. Dale [53] described five stages where measurement is used:

1. define internal and external performance measures.
2. provide feedback to customers.
3. apply benchmarking technique.
4. rewarding efforts of individuals and teams.
5. getting ready for award-linked assessment (European Quality Award, MBNQA, Japanese Deming Prize etc.).

All the awards and the valuation leading to registration with specific quality systems standard are in essence some kind of measurement system. Each is unique and is designed to achieve different sets of goals. Each has its strengths and weaknesses. Nobody can claim that one is superior to the other. From the numerous works available in the literature one can safely conclude that there is no 'off-the-shelf' performance measurement system which could meet and satisfy the needs of many.

Instead of developing from scratch a new performance measurement system, this study embarked on assembling some of the elements used in previous studies. Since the objectives of this study cannot be met from the works of others mentioned above, additional measures and indicators of qualitative and quantitative performance were sought which would help in establishing the evidence of the supposedly strong links that existed between total quality and competitiveness. It would also help formulate the order of implementation of various quality initiatives identified.

These measurable indicators were then classified into seven items as used in reference [57] criteria and scored using the scoring system practised by the award (Appendix C). By employing the already established and highly acclaimed MBNQA criteria and it's accompanying scoring system, the question of its relative weights attached to each of the items that is central and crucial to the index is resolved. This excludes the need for having to use sophisticated multivariate statistical techniques or multiple regression or determinant analysis. In addition the question of its reliability and validity as discussed by Shepherd and Helms [184] is also resolved.

Respondents for the ordering analysis come from three scoring categories; 50 per cent total score, 50 per cent practice score, and 50-50 per cent practice-performance score resulting in a total of 68 cases. The reason the line is drawn at 50 per cent is not only because it is a line dividing the other half of the score and is thus a convenient norm used to assess high-low scores. But it is partly because of the need for a sufficient number of cases bounded by this scores.

3.13 Chapter Summary

The chapter describes the steps taken to ensure that the general principles and guidelines for administering a sound survey are followed. This starts by establishing a reliable sampling frame, deciding the method of data collection, outlining the procedures for questionnaire design and scaling of responses. This is followed by addressing the response errors and rate followed by the pre-testing of survey questionnaire and conducting the pilot survey. The chapter also describes the rationale behind each question used in the survey and ends by explaining the scoring system adopted for the study.

Chapter 4

RESULTS AND DISCUSSIONS

4.1 General

The respondents, with regard to site size and ISO 9000, are broadly representative with respect to the population. The chart in Figure 4.1 shows a normal P-P plot of the cumulative proportions of the variable TOTAL SCORE (a composite score of practice and performance) distribution against the cumulative proportions of the normal distribution. Since the plotted line almost approaches the diagonal line, it shows that the variable TOTAL SCORE is normally distributed. The practice and performance variables (both not shown here) which make up the total score are also normally distributed.

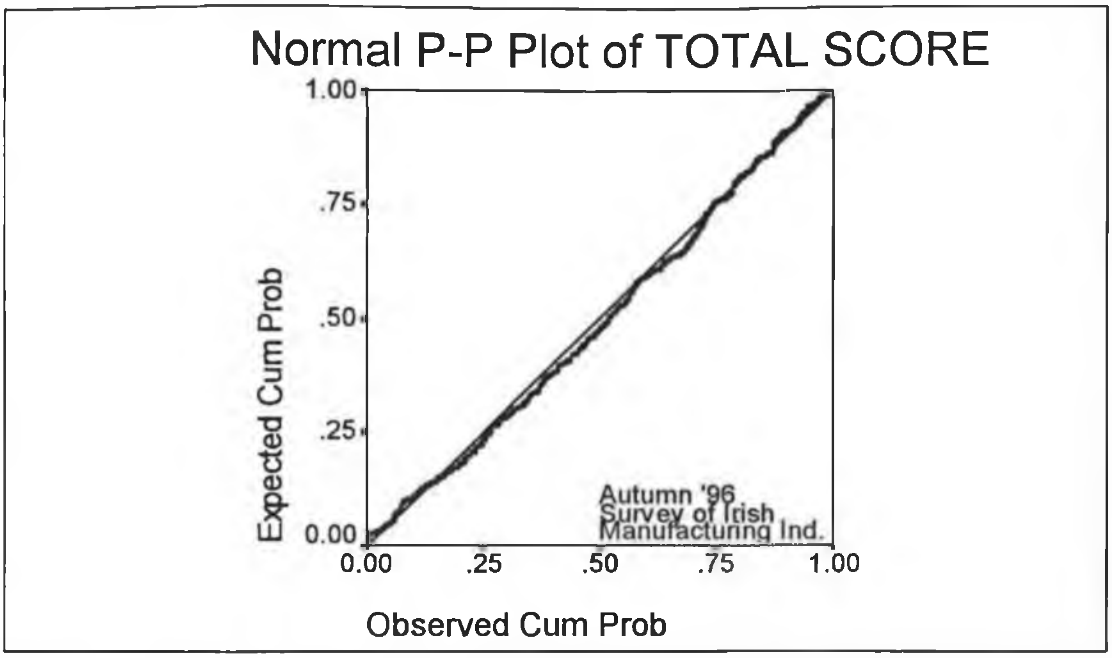

Figure 4.1 Normal P-P plot of total score (plots the cumulative proportions of a variable's distribution against the cumulative proportions of the normal distribution).

4.2 Effects of ISO 9000 and TQM Implementation

4.2.1 Quality Management Systems

Figure 4.2 shows a scatter diagram of performance against practice with markers for TQM only, ISO only, No TQM & ISO and TQM only. Pearson's correlation coefficient between the variables of practice and performance resulted in a value of 0.694. This indicates a moderately strong positive linear relationship. It means that poor performance may be the result of quality management practices at a lower level in the TQM ladder. The scatter diagram shows in very simple and plain language that higher performance scores are attainable as the practice scores increase. This finding means that good quality management practices correlates with higher performance that agrees with findings from the work of others [20, 66-68].

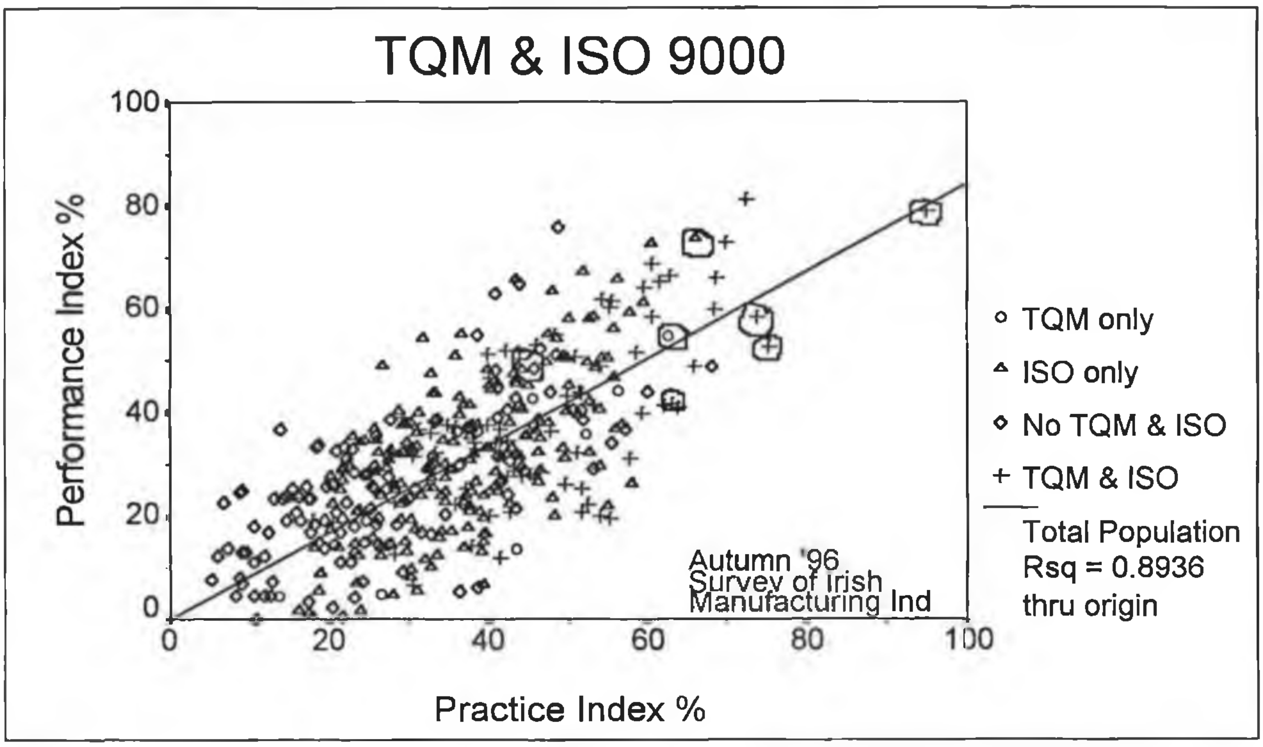

Figure 4.2 Practice vs. performance for TQM & ISO 9000 firms.

The survey instrument used to measure practice against performance for manufacturing firms in the Republic has also been used to measure several MBNQA winners. It is hypothesised that the MBNQA winners, firms regarded as world-class manufacturers, would occupy the top most right-hand corner of the practice versus performance scatter diagram. The circles in the diagram showing their positions confirm this hypothesis. This shows that the test instrument locates and fills the top portion of the quadrant where one might expect a world class firm would be. As the test instrument accurately reflected this, it is highly reliable.

The scatter diagram also indicates that different organizations are in different stages of TQM transformation. It also shows that as the best fit line approaches the top-most right hand corner of the the scatter diagram, the number of cases decreases. This means that very few firms can claim to be world-class manufacturers. But the most significant message is that the more quality initiatives practiced, the better is the chance of becoming more competitive. Closer scrutiny in the top right quadrant of the practice versus performance scatter diagram reveals that small firms (between 20-50 employees) are present and come from the traditional as well as the competitive sectors. These findings concur with the research works of others as reported in Hardill and Wynarczyk [197]. It is also important to observe that this study identified a number of Irish-owned firms who have been very successful and these are reflected in the top right segment of the scatter diagram. Forfas had acknowledged the presence of these local firms [154].

ISO 9000

Result of the survey into TQM and ISO 9000 implementation is shown in the pie chart in Figure 4.3 below. Firms employing less than 50 employees recorded higher new registration at 35 per cent compared to the other employment category. This is expected since they are parts' suppliers to the larger firms. Of those without both TQM and ISO, 66 per cent are local firms. Overall, just under 80 per cent of firms without both TQM and ISO are firms with less than 100 employees.

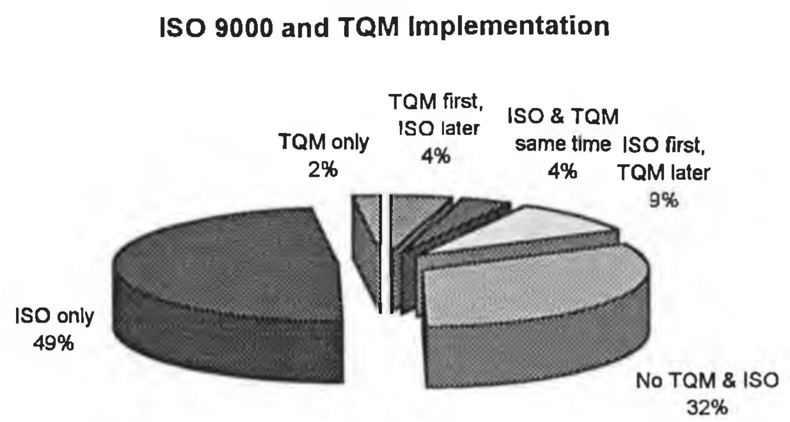

Figure 4.3 Pie chart showing ISO 9000 and TQM implementation

A sectoral analysis reveals that the chemical, electrical and electronics, plastics and rubber sectors have more new ISO registrations over the traditional sectors like food, wood, paper & printing, textiles, and clay. It is observed that there is a continuous decline in the number of new ISO registration in the manufacturing industry since reaching its peak less than five years ago. But data from The Mobil Survey of 1995 [31] shows a healthy increase of between 24-27 per cent of ISO 9000 certificates issued in Ireland since September 1993. This discrepancy could mean that ISO registration from the service industry has increased tremendously, whereas the manufacturing industry, for which the standard was originally intended, declined over the same period. It is possible that this happened because the service industry has recently seek accreditation in large numbers over its manufacturing counterpart who had done so much earlier.

Analysis of mean performance score of ISO 9000 only firms against their respective registration year shows that there are immediate short-term benefits followed by a declining trend. This happens after the fourth year although multiple comparisons' tests do not show any significant difference in mean performance score over the time ISO 9000 is in place. It is significant to note that the industry started to show strong interests in quality with just over 80 per cent of ISO 9000 registration less than six years ago.

Total Quality Management

Research into the implementation of ISO 9000 and TQM would have used the figures of 66 per cent and 19 per cent respectively shown in the pie chart in Figure 4.3 and would have failed to isolate the effects of each in such exercises. Result of the survey shows that only 19 per cent of respondents has installed TQM (with ISO). It means that over a decade of publicity failed to sell this TQM philosophy to the business community. This is in agreement with other surveys in the UK that recorded figures between 15-20 per cent. Out of the 19 per cent of respondents with TQM, just about 80 per cent have had their TQM installed less than five years ago. Idris et al. [198] reported the same situation in their study of TQM in Malaysia. Only a very small percentage (two per cent) has 'TQM only' installed. This leads to the probability that TQM by itself (without ISO 9000) is not a sound option.

It is observed that TQM is well received in the competitive foreign dominated sectors whereas traditional sectors except for metal and mechanical showed smaller percentages embracing TQM.

The mean performance index of firms with less than 50 employees is about 33 per cent. This is below the mean performance index for the entire survey population at 39 per cent. Those with more than 50 employees recorded a much higher mean performance index. This indicates that from the perspective of competitive advantage the results of TQM are relatively more effective and producing significant results with increasing site size.

4.2.2 Complementary Effects

Using the categories as shown in Figure 4.3, result shows that for ISO firms acknowledging implementation of TQM, there is a marginal increase in mean performance over the years. Multiple comparisons' tests conducted does not show any significant difference on the mean performance scores of firms over the time TQM is in place. This is in direct agreement with the reported payoff of TQM efforts amongst most of the MBNQA winners after only five to ten years of its implementation [59, 199, 200]. Figure 4.4 shows the line chart of the mean performance index of each category. It shows beyond reasonable doubt that firms with ISO 9000 and TQM installed have higher mean performance index than those firms without ISO and TQM.

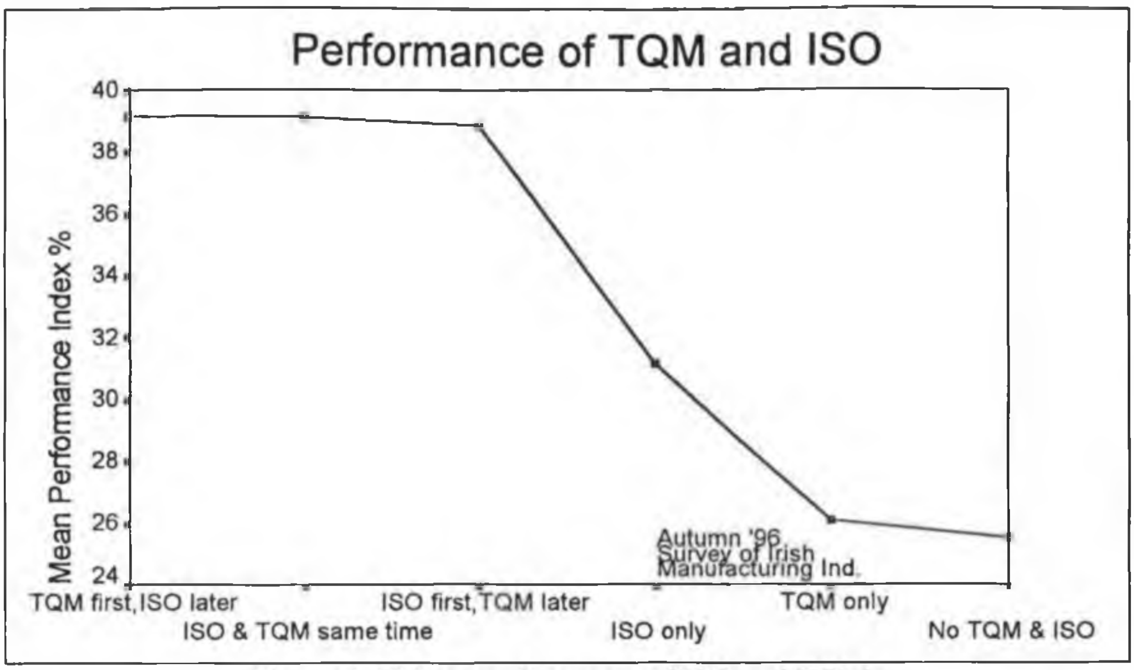

Figure 4.4 Mean performance of ISO and TQM

Statistically significant differences exist to support this relationship. Apparently the mean performance index of three categories: 1) ISO 9000 and TQM at the same time, 2) ISO 9000 first, TQM later, 3) TQM first, ISO 9000 later, are marginally different.

ANOVA procedures using PRACTICE SCORE as the dependent variable and using seven factors - site size, industry type, subsidiary or part of larger organization, membership to quality association, automation level, manufacturing methods, and ownership does not show the presence of significant interaction between any factors. Following the same procedures on the dependent variable PERFORMANCE SCORE and using the same factors give the same result. These may mean that no two or more factors jointly affect the dependent variables. Since there is no significant interaction, the factors can be tested individually. All the available multiple comparisons' tests in the SPSS resulted in following results:

1) Firms can choose to implement either TQM first followed by registration for ISO 9000 later or vice versa or implement both at about the same time. The figures show that firms implementing both at about the same time (within one year) have mean performance score marginally better than the others.

2) Firms with only ISO 9000 in place are better off than firms without ISO 9000. From the perspective of competitive advantage, it pays to have ISO 9000 registration.

3) ISO 9000 per se results in an increase in performance of 22 per cent whereas TQM per se results in an increase in performance of 21 per cent.

4) About 52 per cent favoured installing ISO 9000 first followed by TQM later. There is still a large majority of manufacturing organizations (32 per cent of respondents) without any form of quality management at all.

There are also statistically significant relationships between firms with neither TQM & ISO and those with TQM only or ISO only with mean number of technique used in each category at eight for the former, five and four for the latter. It is observed that the mean number of techniques employed in firms with both ISO 9000 and TQM are above the population mean.

4.3 Effects of Organizational Characteristics on Performance

4.3.1 Management Commitment

Weak Leadership and Lack of Commitment

Weak leadership and lack of commitment are the number one reason given by respondents in this survey for the poor performance and failure of quality improvement initiatives.

Champion(s) of Quality

The person-in-charge of quality carries the title of quality control (four per cent) and quality assurance/manager (56 per cent). This person reports to the managing director in about 44 per cent of respondents. Overall, a total of 69 per cent reports to the level of general manager and above. This is about the same figure as published in the 1980 survey [89].

From Table 4.1, the average company would have the managing director and the quality manager as champions in their organization. The mean number of quality champion for the entire population is two. If the concept of total quality is to be applied, then it requires the participation of everyone in every division of the company to study, practice, participate, implement, and promote quality [29]. Only three per cent (12 cases) of respondents belong to this category.

No	Champion(s)	1	2	3	4	5	6	Cases	%
1	Quality Manager	72	82	56	39	18	3	270	70
2	Managing Director	36	69	59	40	18	3	225	59
3	Factory Manager	20	31	44	33	18	3	149	39
4	Supervisor	7	24	32	31	18	3	115	30
5	Engineering Manager	1	4	4	24	17	3	53	14
6	Everyone	7	0	0	1	1	3	12	3
	Total	143	105	65	42	18	3		

Table 4.1 Cross-tabulation of quality champions

The table above means that it is highly unlikely for a supervisor or engineering manager, or everyone to be the champion if there is only one quality champion in the company. Likewise, if there are two champions, then they would most probably be quality manager and managing director.

Figure 4.5 is a line chart showing the number of quality champions on the X-axis and mean number in per cent on the Y-axis for both practice and performance score lines plotted on the same chart. A line parallel to the Y-axis is drawn from the X-axis at point two and cut the practice score line at slightly higher than 34 per cent (ISO only score) as shown by the line parallel to the X-axis and cuts the performance score line at just under 30 per cent. Firms with high practice scores have a correspondingly higher number of quality champions. This means that as more and more people becomes quality champions, the level of practice improves. Firms with ISO level of practice would have on the average two champions of quality only. Firms with performance scores higher than ISO have correspondingly higher number of champions. It is observed that the performance scores of firms with three, or four, or five champions are marginally different. Those firms with less than 100 employees have mean number of quality champions less than two.

Figure 4.5 Practice and performance with number of quality champions

Communicating Quality

The most widely used methods of communicating views on quality are shown in Table 4.2 below. *Quality manual* emerged as the main method of communicating quality views in this survey as compared to *verbal* method in the 1980 survey. This means that 74 per cent of respondents would be expected to have a formal written quality policy. This is a very encouraging situation compared to the disappointingly low figure of only 23 per cent in 1980. It is also most encouraging that just over 50 per cent of respondents would have used a combination of the first five methods to communicate views on quality. The *campaign* method is used in 20 per cent of respondents with SMEs accounting for 75 per cent of it. Further analysis of each method and site size, reveal that in firms with 20-50 employees, *verbal* and *quality manual* are the two top methods used at 43 per cent and 36 per cent respectively.

	Method	1	2	3	4	5	6	7	8	Cases	%
1	Quality manual	8	27	70	69	57	32	21	7	291	74
2	Verbally	22	22	51	67	47	30	21	7	267	67
3	New Employee Training	4	16	58	71	56	32	21	7	265	68
4	Printed statement	4	20	50	48	52	30	21	7	232	59
5	Regular Meeting	6	13	32	57	46	30	21	7	212	54
6	Campaign	0	2	8	15	13	16	16	7	77	20
7	Company rulebook	0	1	4	13	18	12	14	7	69	18
8	Newsletter	0	1	3	4	11	10	12	7	48	12
	Total	44	51	92	86	60	32	21	7		

Table 4.2 Cross-tabulation of communication methods

The table also indicates that it is highly unlikely for a company to use the campaign , company rule book or newsletter methods if it employs only one method to communicate quality views. In this case it would use the verbal method of communicating quality views to its employees. Likewise, if it employs two methods, then these two methods would most likely be verbal and quality manual and so on. The mean and median number of methods for the overall population are four. Firms with higher performance scores employed an increasing array of methods to communicate quality to its employees. Similarly it is observed that larger firms employed more methods to communicate quality to its employees than smaller firms.

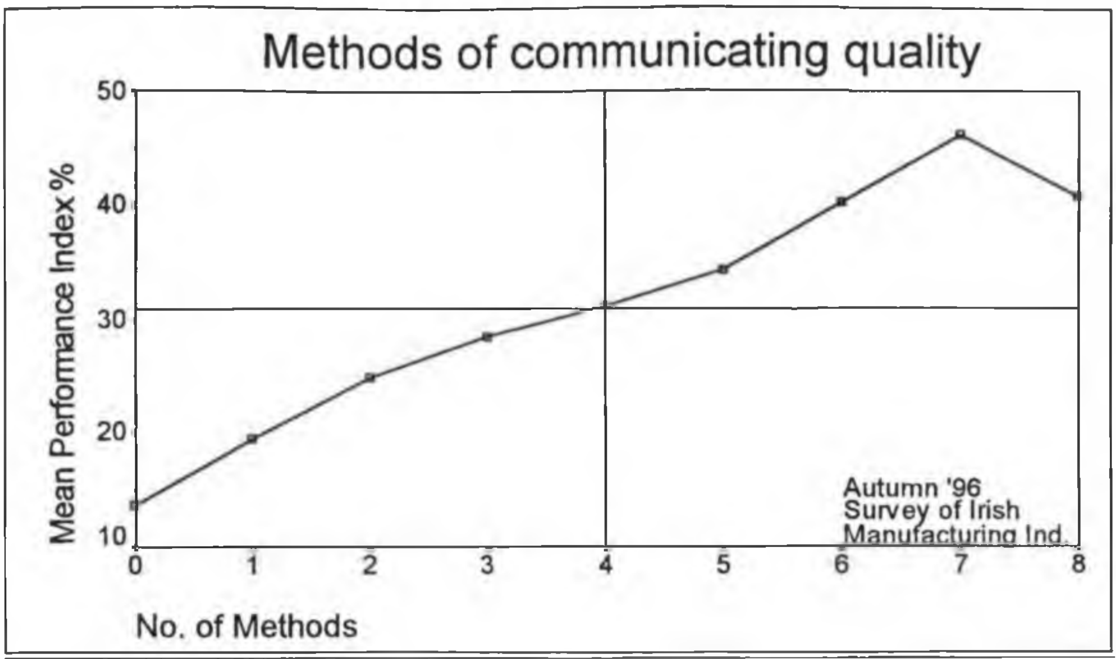

Figure 4.6 Mean performance with number of methods of communicating quality

Education and Training

Results of the survey show that quality training is provided for quality personnel in 85 per cent (334 cases) of respondents. To a question concerning the topics covered in the training carried out, respondents are requested to select from a number of listed options. A majority of respondents, 58 per cent, covered between 1-3 topics, 24 per cent covered between 4-6 topics and only three per cent covered more than seven topics. A sizeable number, 15 per cent had no training given to quality personnel. Table 4.3 summarises the popularity of the topics covered in the training given to quality personnel. Table 4.4 identifies the topics which firms consider as important to their quality needs.

	Training Given to Q. Personnel	No.	% of cases
1	**Quality audit**	286	86
2	**Quality mgmt**	250	75
3	**Statistical method**	141	42
4	**Interpersonal skills**	119	36
5	**QFD**	65	20
6	**TPM**	63	19
7	**FMEA**	55	17
8	**DOE**	37	11
9	**Customer**	2	1

Table 4.3 Training topics given to quality personnel

	Training Needs	manuf	non manuf	both
1	**Quality audit**	58	79	61
2	**Quality mgmt**	52	64	99
3	**Statistical method**	66	35	38
4	**Interpersonal skills**	50	70	82
5	**QFD**	30	40	18
6	**TPM**	123	19	17
7	**FMEA**	45	33	23
8	**DOE**	27	29	6
9	**Customer**	3	3	4

Table 4.4 Training topics important to quality needs today

The first four topics considered important to their quality needs with the exception of TPM for manufacturing staff, actually coincide with the training topics already given to quality personnel. From the popularity of the topics covered in the training given it would be safe to conclude that the majority of the respondents are in the very early stages of the total quality transformation.

Using cross-tabulation to look at the relationship between site size and in-house training over a three year period 1994-96 reveals that on the average 53 per cent conducted less than three in-house training in a year regardless of site size. Only about six per cent of respondents have ongoing in-house training and just under 50 per cent of these are in firms with more than 500 employees. This could mean two things; either there is a general lack of importance attached to training or that most of the training is not conducted in-house. The first is not true since 85 per cent of respondents do provide training to quality personnel. Which means that most of the training would be done elsewhere and not conducted by the company concern. This kind of training would not be suitable for imparting skills to employees. The number with on-going in-house training is very small and they are mainly in large companies that actually confirms the fact that large amount of resources is required to run a training programme.

4.3.2 Size of Employment

In examining the effects of site size on practice, performance and the number of techniques installed, comparison is made on the overall population and between indigenous and foreign firms. Site size is divided into five categories as shown below:

Group I ----20-50 employees
Group II ----51-100 employees
Group III ----101-250 employees
Group IV ----251-500 employees
Group V ----more than 500 employees

The survey shows that 87 per cent of the respondents are firms with less than 250 employees. Small firms with 20-50 employees account for 42 per cent (166 cases) of the respondents. Of this, just under four per cent were founded less than five years* ago. This means that a large majority of small firms remain small.

It is shown in Figure 4.6 below that the practice and performance of the overall respondents increase with size of employment. It is also observed that installation of quality techniques is also dependent on size of employment. The larger the size the higher the number of techniques employed. About 55 per cent of those employing less than three techniques are firms with less than 50 employees. There are statistically significant relationships between usage of techniques and site size. This concurs with the findings of others like Lascelles and Dale [143]. It is observed that the small firms have a mean number of techniques employed which is below the population mean. Thus smaller firms are less likely to have a well-developed quality improvement programme and this finding agrees with the findings of Wilkinson et al [86]. Consequently most small firms are not expected to have a high level of quality practice.

Statistically significant relationships exist between groups II, III, IV, V and I on practice, performance, total techniques and selected techniques installed. Statistically, it shows beyond reasonable doubt that 'bigger is better'. This is in agreement with the findings of Voss et al [67]. The mean performance score of smaller companies employing between 20-50 employees is way below industry average. Clearly this finding indicates that smaller sized companies are at a disadvantage to stay competitive because of their lack of critical mass to employ and adapt best practices.

* References to the number of years is to mean up to and including 1996.

This is in agreement with the report by Forfas that acknowledged that lack of scale is the substantial barrier to growth [154]. Reference [1] concludes that it is difficult for the SMEs than for large firms to stay competitive and to gain from the advancement in technology and sophisticated management techniques and business services.

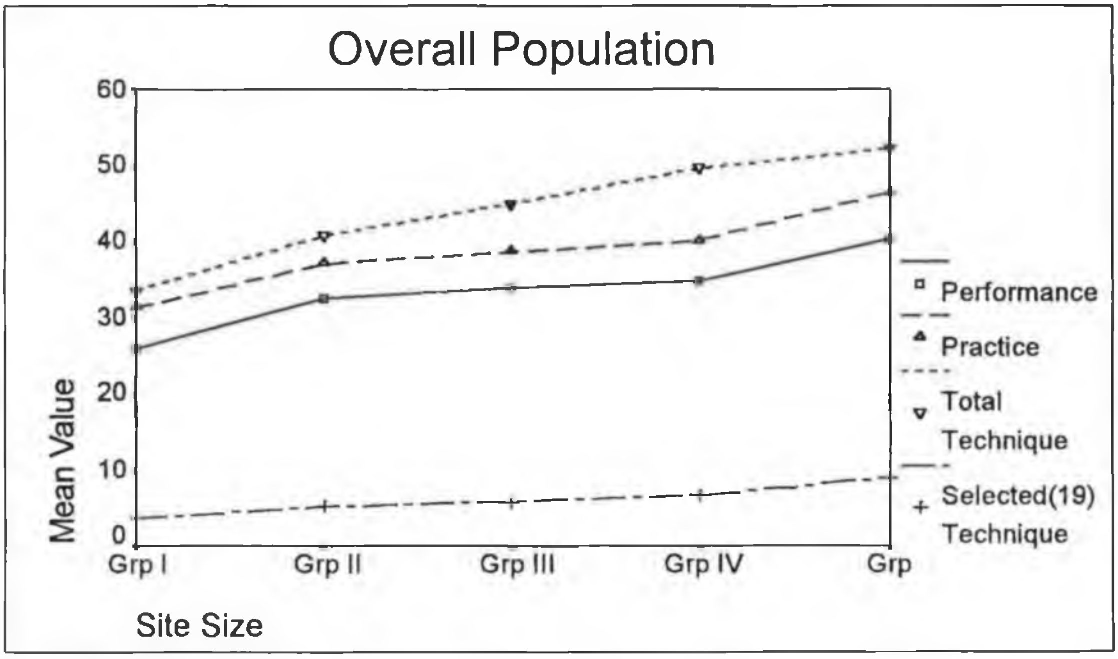

Figure 4.6 Practice, performance and number of quality initiatives with site size

In the cases of practice, total technique and selected technique, best results indicate significant relationship between groups II, III, IV, V and I; between groups V and II; and between groups V and III respectively while least result shows significant difference between groups III, IV, V and group I for all factors analysed.

Results indicate that in general, practice, performance, and the number of techniques installed improves with increasing size of employment in foreign firms and also in indigenous firms. But results also indicate that indigenous firms are low in quality practices and in performance in all five employment groups compared to foreign firms. This implies that the introduction and subsequent adoption of a particular technique require a potential firm to have the necessary resources, expertise and trained employees for the purpose.

4.3.3 Ownership and Subsidiary

About 31 per cent of respondents with 20-50 employees are local firms. Although this study does not have the number of foreign firms operating in the country, almost 43 per cent of respondents are 100 per cent foreign firms indicating a high interest in the subject. Results from a 1980 survey indicated that foreign-dominated competitive sectors like chemical, electrical and electronics recorded higher response rate than the others. In examining the effect of ownership on the performance of firms, there is statistical difference in relationship between the mean performance score index of foreign and local firms at 43 per cent and 33 per cent respectively.

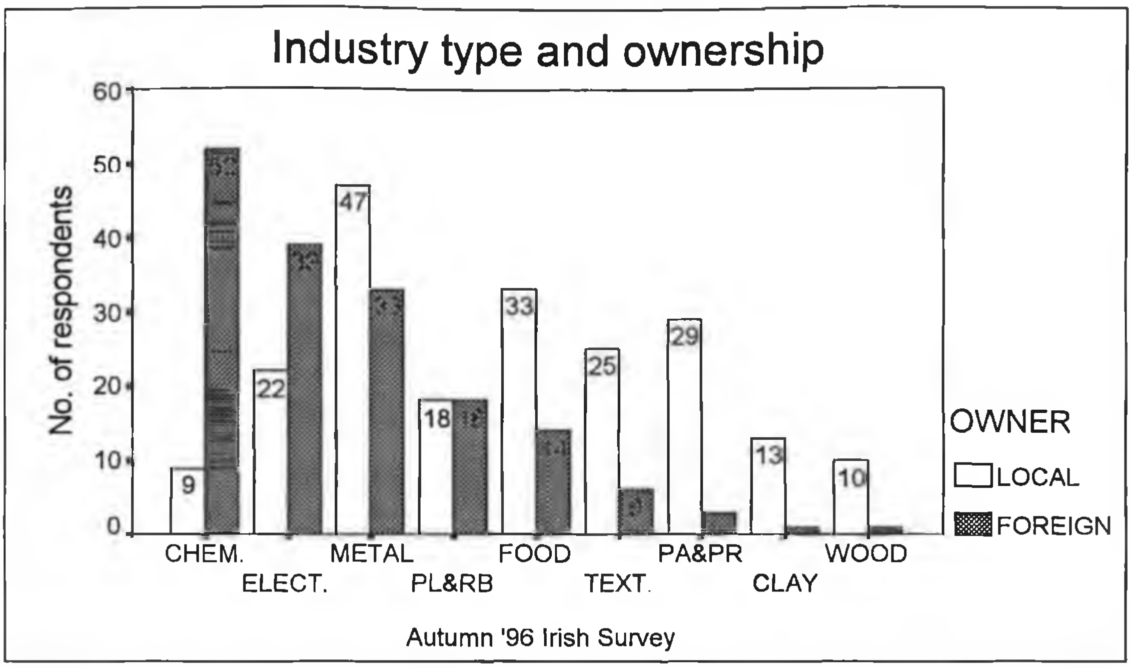

Figure 4.7 Industry sector showing local and foreign concentration

Figure 4.7 shows that indigenous firms are dominant in the traditional and relatively non-competitive sectors like metal, food, textile, paper and printing and wood. This is also highlighted by Forfas in their summary report [154]. Foreign firms are dominant in the competitive sectors like chemical, electrical and electronics and plastics and rubber. This is one reason why the mean performance scores of these sectors are much higher than the traditional sectors.

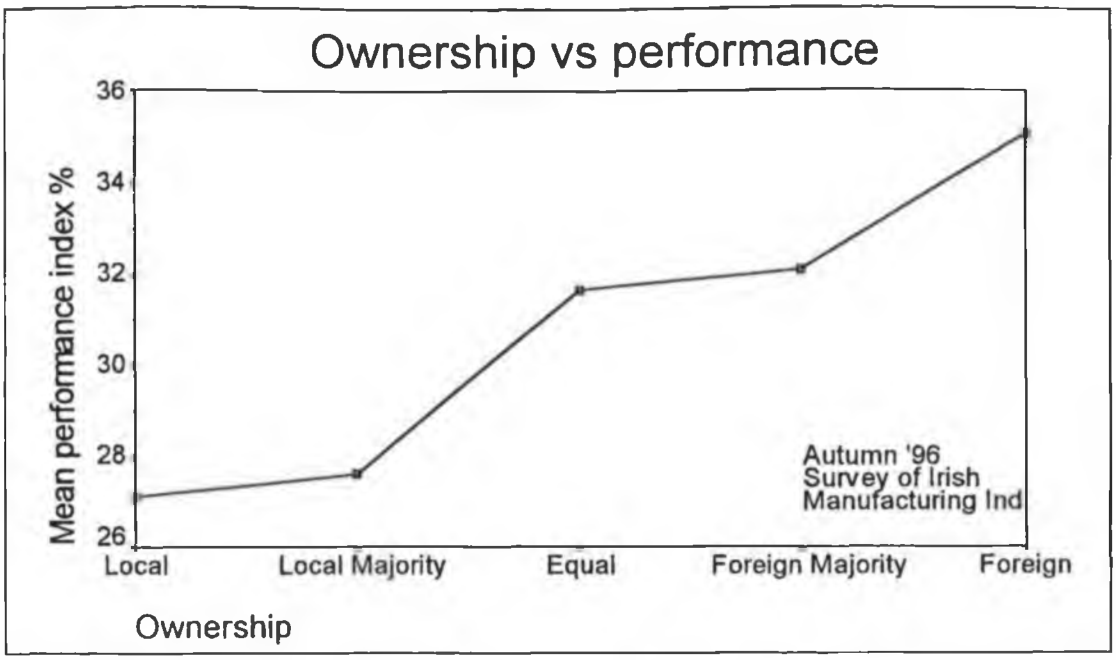

Figure 4.8 Performance with ownership

Figure 4.8 shows a line chart of ownership versus mean performance score. It shows that as foreign ownership in the business increases, its performance also increases. Foreign firms are much better off in practice and performance than local firms. But statistically significant difference in relationship is observed between practice and performance of local and foreign firms only. This could possibly be due to the small number of firms of local majority(L/Maj), Equal partnership, and foreign majority(F/Maj.) among the respondents. The mean practice and performance scores of foreign-owned firms are 21 per cent and 29 per cent higher than those of local firms respectively. This is in agreement with the findings of Voss et al [67]. What this means is that foreign-owned firms are generally at a much higher quality position than their local counterparts. They would have employed a wide range of quality practices covering every aspect of their business from supplier at one end to customer at the other end.

However examining the effect of ownership in firms with less than 100 employees between indigenous and foreign firms reveals that there is no significant difference in performance between the two groups. This means that foreign firms are not significantly higher in performance than indigenous firms in firms with less than 100 employees. This appears to contradict the finding that the performances of foreign firms are significantly higher than indigenous firms.

Therefore it can be concluded that irrespective of who owns the firm, implementation of quality improvement initiatives would be a big problem to firms with less than 100 employees.

About 58 per cent (229 cases) of respondents are subsidiaries or are part of larger organizations. Of these 70 per cent are foreign firms. On closer scrutiny, it is observed that only six per cent of foreign firms are not subsidiaries or part of larger organizations whereas the figure for local firms stood at 71 per cent. Taken as a whole, there is significant difference in relationship between the performance of firms who are subsidiaries or part of larger organizations and those who are operating on their own. Firms in the former have higher performance than those in the latter.

When examining the effects of being a subsidiary in local firms, it is observed that there are no significant differences in relationship between the performance of firms that are subsidiaries and those operating alone. However it is observed that the mean performance score of the former is marginally higher than the latter. Local firms are at a competitive disadvantage unless jointly owned by foreign partners. Foreign owned firms have better quality management practice and better performance with a mean total score (practice score + performance score) of 25 per cent higher than local firms.

The mean number of techniques used is also dependent upon the ownership. It increases with increase in ownership. Foreign owned companies have a relatively higher number of techniques used compared to indigenous firms. It is observed that the mean number of techniques employed in firms with less foreign ownership are below population mean.

4.3.4 Outside Help

Results of this study also show that 46 per cent of respondents do not seek outside help to improve quality. The remainder who did are as follows: seven per cent from stateown; 31 per cent from private; and 16 per cent from both. Just above 80 per cent are satisfied with stateown while 94 per cent who seek private help are satisfied. From the perspective of competitive advantage, seeking outside help from stateown agencies is better-off than from the private sector. It is also observed that the mean number of technique employed increases when respondents seek outside help from private sector, state and both, in that order. Firms that do not seek outside help to improve quality have mean number of techniques below population mean.

A large majority of organizations cannot afford the services of consultants and have to rely on their sound judgement and internal resources in developing their quality goals.

Of the 182 cases who do not seek outside help, it is observed that there are 91 cases (50 per cent) local and 81 cases (45 per cent) foreign firms. On closer scrutiny it is discovered that out of the 81 foreign firms who do not seek 'outside help', only six are not a subsidiary and part of larger organization whereas the figure for local firms is 60 out of 91. This may indicate that the former do not seek outside help because they are part of an extended family. The figure from the survey shows that a majority of local firms, 70 per cent, operate alone and are not blessed with the kind of 'parental guidance' often associated in a parent-subsidiary relationship. Thus short of a joint-venture with suitable foreign partners, the only other alternative would be to be part of a supplier-development programme or to seek assistance and be in a continuous linkup with some agencies specially set-up for the purpose.

4.3.5 Membership to Quality Association

Results show that membership to a quality association contributes to better practice and performance. Thus employees in general and the firms in particular stand to gain by being a member to a quality association. Results from this survey showed that 65 per cent of respondents are members of quality association while the 1980 survey of Irish manufacturing firms recorded only nine per cent. Among locals, only 56 per cent are members while the figure for foreign firms is much higher at 76 per cent. Of those who are not members, locals makeup 66 per cent comprising mainly of small firms employing less than 100 employees.

4.3.6 Industry Sector

The response from traditional sectors like clay, textile, wood, food, and metal sectors are low compared to the more competitive sectors. Indigenous groups are dominant in the traditional sectors.

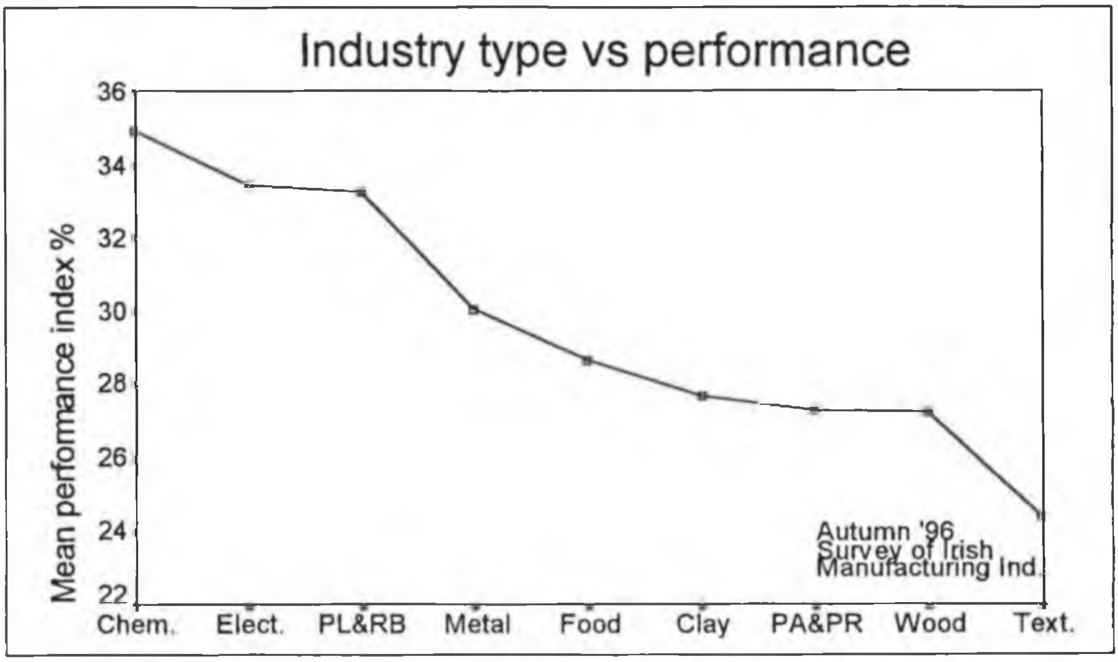

Figure 4.9 Performance of each industrial group

Figure 4.9 shows that the competitive sectors like chemical, electrical and electronics, and plastics and rubber, have higher scores on performance than the rest. Industry types that are predominantly associated and monopolised by locals have mean performance scores that are way below industry average.

Multiple comparisons' tests show that performance score from the sectors; chemical, electrical and electronics and plastics and rubber are significantly different from the textile sector. Thus, except for the textile industry, it is safe to conclude that there are no marked differences in performance in the other groups. The low performance scores in the textile and clothing industry seem to suggest that this industry is further away from the mainstream of the quality revolution in the country. These findings concur with the findings of Hardill and Wynarczyk [197] who noted that the textile and clothing industry are not fully participating in and benefiting from the current structural and technological revolution.

The competitive sectors have a mean number of techniques' usage higher than the traditional sectors. It is observed that the mean number of techniques employed in the five sectors namely; clay, paper and printing, food, wood, and textile sectors, are below the population mean.

4.3.7 Proportion of Output Exported

In examining the relationship between performance and proportion of output exported, the respondents are grouped into four categories. The four groups are:

Non-exporters	: 0 per cent Exported
Home market oriented	: 1-49 per cent
Export market oriented	: 50-99 per cent
Wholly exporters	: 100 per cent

The Figure 4.10 below shows a relationship between performance and proportion of output exported. It shows that firms with higher performance have higher proportion of output exported.

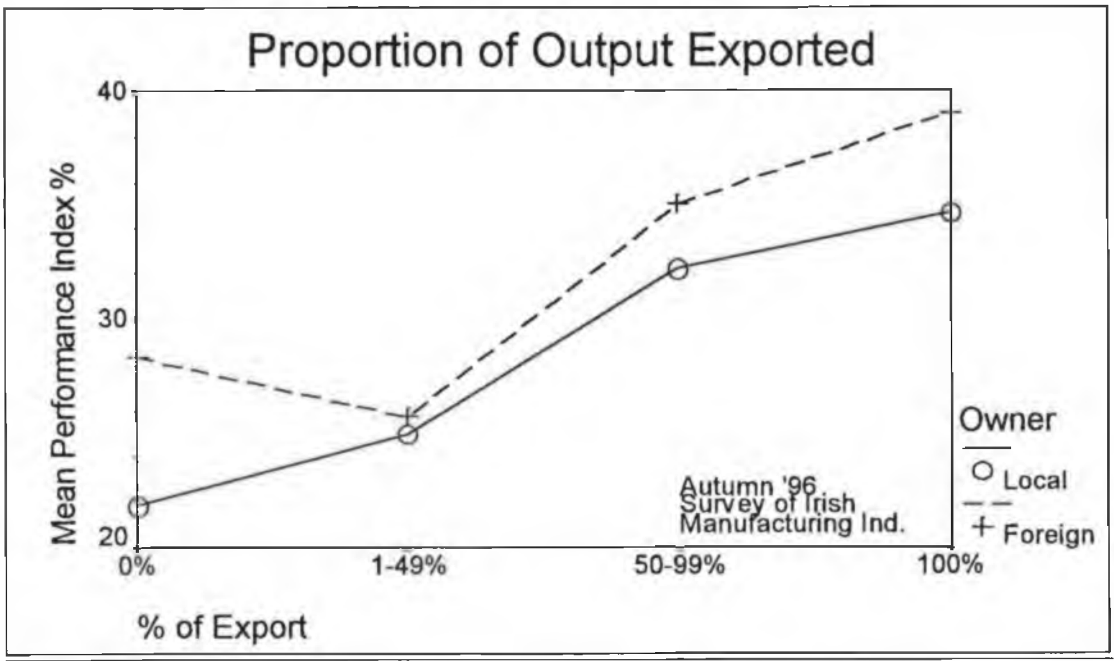

Figure 4.10 Proportion of output exported in local and foreign firms

Further examination reveals that there are statistically significant relationships in performance between the four groups. About 98 per cent of foreign firms who are wholly exporters are subsidiaries of overseas companies. Just under three per cent of local firms are wholly exporters. This indicates that there are large number of foreign subsidiaries in this country whose markets are overseas.

4.3.8 Year Founded

In examining the relationship between performance and company age, results do not show significant difference in performance between firms established earlier than those established later. Thus company age is not an important contributing factor to performance in firms. Nevertheless the study recorded a decline in the number of new manufacturing firms established over the years as shown in the Figure 4.11 below. Although it cannot be said for sure that a drop in the number of manufacturing firms would result in a corresponding drop in the number of employment, Forfas [154] acknowledged that there has been a fall in employment over the past 20 years.

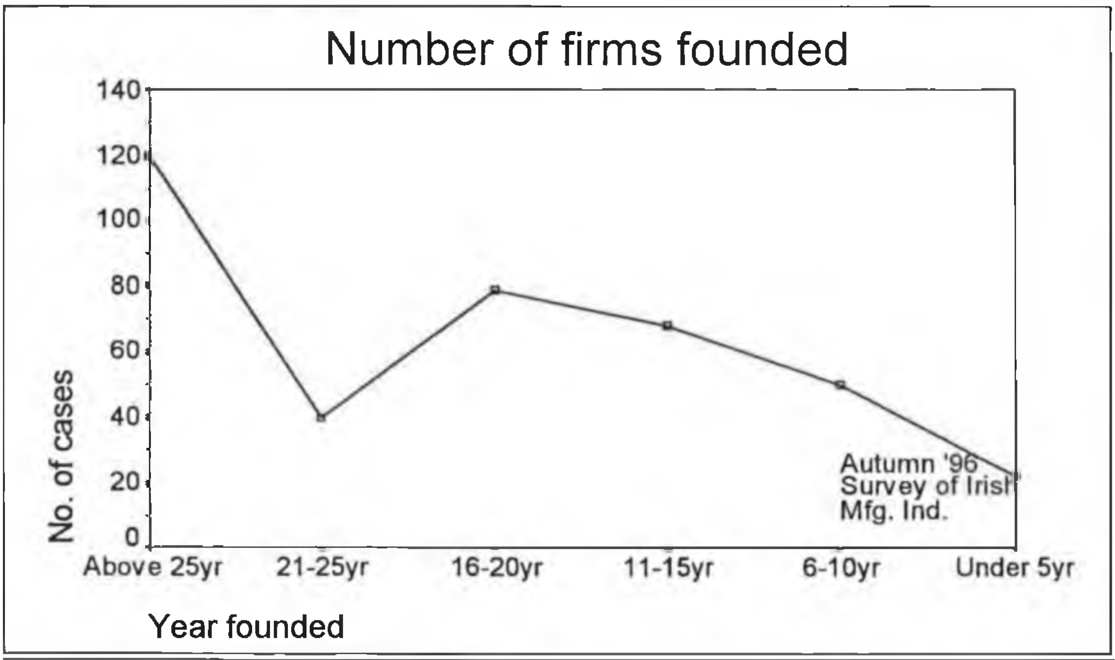

Figure 4.11 Number of new firms founded over the years.

4.3.9 Automation Level

In examining the effect of automation level on performance comparison is made on the overall population, within and between indigenous and foreign firms. Firms with higher performance scores have higher levels of automation. The differences are marginal and multiple comparison tests shows that no two groups are significantly different. In examining the effects of automation level on performance comparison is also made between foreign and indigenous firms. Multiple comparisons' tests show that for firms without automation and those with automated machines linked with material and tool handling systems, significant differences in performance exist between foreign and indigenous firms in three of seven tests.

For firms with stand-alone automated machines significant differences exist between foreign and indigenous firms. It is important to observe that empirical result of the overall population does not show automation level as a significant factor in enhancing the quality position of firms. This means that the differences in performance are brought about not because of automation but because of foreign expertise and experiences in quality practices.

It is observed that the mean number of techniques employed in firms with automated production lines at seven is higher than in firms with only automated machines linked to material and tool handling system at six which is in turn higher than those firms with only stand-alone automated machines at five which is below population mean. This is so since on a percentage basis, firms with automated production lines are larger firms, while those with only stand-alone are generally smaller firms. The survey recorded about a quarter (26 per cent) of respondents without any form of automation and that 34 per cent (116 cases) of respondents have stand-alone automated machines. Out of this, 80 per cent are firms with less than 100 employees. Of those without automation, just under 80 per cent are firms with less than 100 employees.

4.3.10 Manufacturing Method

Just over 50 per cent of respondents have batch as their main manufacturing method. Jobbing and batch manufacturing are by far the two largest category of manufacturing methods with stand-alone automated machines at 75 per cent between them. The mean number of techniques employed in firms with flow, process, batch and mass manufacturing methods is five whereas in firms using jobbing it is at four that is below population mean.

In examining the effect of manufacturing methods on performance comparison is made on the overall population and between indigenous and foreign firms. Multiple comparisons' tests on the overall population show there is significant differences in relationship between batch and jobbing and between process and jobbing. Among the five manufacturing methods, process secures the highest mean performance score followed by batch. The least score is secured by jobbing. This means that from the perspective of competitive advantage, jobbing firms would be less likely to succeed.

Multiple comparisons' tests among indigenous firms indicate significant relationship between batch, flow, process with both jobbing and mass. This supports the conclusion as stated above.

The same is not observed in foreign firms. This does not mean that there are no significant differences in relationship but because the numbers are just too small for statistical analysis.

Comparing the five manufacturing methods with regard to ownership, it is observed that the mean performance scores of foreign firms are much higher than indigenous firms. Thus unlike automation, the type of manufacturing methods does have a significant influence on the performance of firms irrespective of ownership.

4.4 Techniques Implementation Order

4.4.1 Respondents for Ordering Study

The composition of the 68 cases (selected according to section 3.12) that forms the background of this analysis with respect to site size; group I, II, III, and IV, V combined are about equal. All the nine industrial sectors are represented but 80 per cent are from the sectors; chemical, plastics and rubber, metal and mechanical, and electrical and electronics. This means that the backbone of this ordering study comes from the practices of the competitive sector.

Just under six per cent are firms founded less than five years ago, 16 per cent founded 6-10 years ago, 22 per cent founded 11-15 years ago, and 37 per cent founded more than twenty years ago. About 75 per cent are firms with export market larger than 50 per cent. Only nine per cent employ jobbing as the main manufacturing method while the main bulk, batch at 55 per cent. It is observed that the level of automation is not particularly important since all modes of automation are significantly present. They are predominantly foreign firms at 68 per cent while local stood at only 28 per cent. Compare these figures to those of the overall survey where 42 per cent are foreign firms and 52 per cent local firms. They are all ISO 9000 registered firms. More than 80 per cent are subsidiaries or part of a larger organization and 80 per cent are registered member to a quality association.

The mean number of quality control tools is four with the top four; control chart, sampling plan, pareto, and histogram. The mean number of methods in communicating quality policy is five with the top five; quality manual, new employee training, printed statement, meetings, and verbally. The mean number of elements in a reward system is two with the top five: bonus, merit pay, health, team incentives, and achievement award. The mean number of regular quality feedback is four with the top five: inspection, audit, returned goods, customer survey and quality costing. The mean number of elements in the integrated process and product development(IPPD) is three with the top four; production, quality, supplier, and purchasing. The mean number of selected techniques used is ten. This is summarised and compared to those from the entire population as shown below in Table 4.5.

	Description	Population(394) mean number	68 best performing firms mean number
1	Rewards	2	2
2	Quality champions	2	3
3	IPPD	2	3
4	QC tools	2	4
5	Quality feedback	3	4
6	Communicating policy	4	5
7	Selected techniques	5	10

Table 4.5 Comparison of population and model means

4.4.2 Implementation Order

It is important to acknowledge at this juncture that using practice-performance score to select best practice firms and using these firms to study implementation order may not result in a proper order. These firms may have gone through a long and winding process and the techniques may have been installed or added-on without well-conceived policies. The resulting implementation order may or may not offer a sound logical order for others to follow.

The methods used to search for a probable sequence of installation is described below. First, the year of installation would be studied for its chronological sequence and rank into 1, 2, 3, 4, and a tally kept for each as shown in Table 4.6. Second, nonparametric correlation coefficient, r, shown in Table 4.7, would be used to determine the components of each phase. Since r is a quantitative expression of the commonly observed similarity among techniques of the same phase - the tendency of the techniques to be close to each other. Additionally, nonparametric test was conducted on each of the nineteen quality initiatives to test the hypotheses that firms are equally likely to install techniques in five different implementation phases.

	68 Cases					Order							Total	Chi	Sig.
No	Description	1	2	3	4	5	6	7	8	9	10	11	Cases	Square	Level
1	Statistical Method	18	17	13	5	2	2	0	0	0	0	0	57	18.727	0.0009
2	Customer Survey	14	20	11	5	4	2	0	0	0	0	0	56	16.185	0.0028
3	Quality Improvement Team	9	14	7	6	7	1	2	0	0	0	0	46	4.7907	0.3095
4	Quality Costing	14	12	10	4	2	1	1	0	0	0	0	44	12.762	0.0125
5	Waste Elimination	8	6	9	11	8	1	0	1	0	0	0	44	1.5714	0.8139
6	Employee Suggestion	22	8	3	6	3	0	0	0	0	0	0	42	29.667	0
7	CAD	10	8	8	2	5	2	1	0	0	0	0	36	5.9394	0.2037
8	TPM	7	13	4	4	4	0	0	1	1	0	1	35	9.5625	0.0485
9	Empowerment	6	7	5	7	4	4	1	0	0	1	0	35	1.1724	0.8826
10	Benchmarking	8	3	9	3	2	4	0	2	0	0	0	31	8.4	0.078
11	Reduce Inventory	4	7	7	4	7	0	1	0	0	0	0	30	1.8621	0.7611
12	Reduce Set-up Time	7	7	3	7	1	1	2	0	0	0	0	28	6.4	0.1712
13	Cellular Layout	4	2	8	7	3	0	1	0	1	0	0	26	5.5833	0.2325
14	QFD	7	4	3	2	4	1	0	1	0	0	0	22	3.5	0.4779
15	Design of Experiment	4	7	2	3	2	3	1	0	0	0	0	22	4.7777	0.3109
16	Auto Inspection	4	6	2	1	2	0	2	0	0	0	0	17	5.3333	0.2548
17	CNC Machine	6	6	1	2	1	0	0	0	0	0	0	16	8.375	0.0788
18	Team-based Reward	0	7	1	1	1	3	1	0	0	1	0	15	16	0.003
19	Quality Cirlce	2	4	5	2	1	0	0	0	0	0	0	14	3.8571	0.4257

Table 4.6 Ordering of quality initiatives

Description		Spearman
Reward	Empower	0.8559
Empower	Q.Circle	0.8726
Cellular	Benchmark	0.7645
QFD	Employ	0.7667
Empower	QFD	0.7285
Empower	QITeam	0.7029
TPM	SetUpTime	0.6842
CAD	Benchmark	0.6832
Inventory	Benchmark	0.6128
CNC	QCosting	-0.8251
AutoInsp	Cusurvey	0.5773
DOE	TPM	0.6075
Waste	Benchmark	0.5606

Table 4.7 Correlation coefficients of quality initiatives

As an example, in the case of *employee suggestion*, the level of significance is 0. This means the hypothesis that firms are indifferent to its implementation phase and are evenly distributed is rejected. In other words, the implementation of employee suggestion occurs in a specified phase only and in the first phase for this initiative. In the case of *empowerment*, the level of significance is 0.8826. This means that the number of implementation in each phase is about evenly distributed and the hypothesis must be accepted.

Empirical results show the existence of these two categories; initiatives that are phase specific that must be implemented in a particular period, and those that are flexible that are equally likely to be implemented in each time/phase. Selecting the highest figure in the former and using nonparametric correlation the components in each phase arranged in descending order are as shown in Table 4.8. It is observed that in almost all the initiatives, 50 per cent of cases would have their implementation by the second phase with the exception of techniques in the third phase; waste elimination, reduce inventory, cellular layout, CAD, and benchmarking.

1st Phase
1. Statistical method
2. Quality costing
3. Employee suggestion

2nd Phase
1. Customer survey
2. Quality improvement team
3. Total productive maintenance
4. Empowerment
5. Reduce set-up time
6. QFD
7. DOE
8. Automated inspection
9. CNC
10. Team-based reward
11. Quality circle

3rd Phase
1. Waste elimination
2. Reduce inventory
3. Cellular layout
4. CAD
5. Benchmarking

Table 4.8 Installation order from empirical analysis

First Phase

Techniques included in the first phase involved the core business of measuring physical variation, transforming this into dollars and cents, and soliciting employee participation to reduce or control this variation. This is and should be the logical order of implementation in the first phase. The essence of this phase is to establish process control. This phase should be able to reduce the major variations leaving the trivial few to be picked up by the second phase.

Second Phase

The second phase is essentially aimed at team-building and empowering them to act autonomously to further reduce variation in a strategy towards delighting the customer. Customer input should be the logical start-up in this second phase as a continuation of the efforts to reduce variation through input from within started in the first phase. Only after the customer's voice has been introduced into the process can there be such techniques like quality function deployment and design of experiment using small group activities be introduced. Small group activities in the form of quality improvement teams or by any other names and quality circles should also be introduced around this time. It must be emphasised that the Japanese introduced quality circles when their quality was already running very high. As a consequence of introducing groups or teams the reward system needs to be overhauled to also include team based incentives.

The next technique should be TPM that requires everybodys participation through small groups necessitating autonomy to achieve 100 per cent machine readiness. There should be a minimum of interference from management, and empowerment of the workers should be encouraged. Thus empowering the employees is the next logical step. Once machines and equipment are effectively and reliably maintained and ceased to be the cause of delays, the last technique in the second phase would be logically reducing set-up time. Mastering this technique takes a lot of planning, practice and teamwork. All these take a lot of time. Reducing set-up time will result in a chain of events becoming increasingly possible like smaller lot size, reduce inventory level, etc.

Third Phase

The third phase is essentially towards further reduction of waste. It is about lean production. This phase may involve transformation of the entire manufacturing scenario involving values, work process, organization and so on. Logically before such a critical change takes place the first step would be to reactivate and reenergise efforts at total elimination of waste. The whole organization, including non-manufacturing, must be prepared towards this and should anticipate any problems that might arise in its implementation. It is hoped that this would reduce the probability of unnecessary disfunctional consequences usually associated with installation of reduce inventory and cellular layout.

The next step would be to introduce three techniques reducing inventory, cellular layout, and computer aided design. Inventory reduction must be recognized as a consequence of efficient and effective operations. It should have been the by-product of the preceding variation reduction techniques in phases one and two, on the system or through process improvement. They could be in various forms; elimination of all unnecessary lead-times, optimised material flow throughout the plant, minimise scrap, rework and resultant delays in production, reduce set-up costs to achieve the smallest economical lot size, etc. Reduction of inventory and cellular layout are two techniques complementing and supplementing each other.

Another technique that must be employed to make it more effective is computer aided design. Firms that have plans to invest in new machines and equipment should do so only after three techniques have been implemented. This is because they require little no investment in new machines. The need for investment in automated machines and equipment; automated inspection and CNC machines could be assessed at this time. The last step in this phase would be to employ benchmarking technique. This is rightly so since it would be pointless to actively engage in benchmarking unless there is something worthwhile to benchmark against. There is no point in benchmarking when perfection is not pursued vigorously and waste is part of doing business.

A tabular summary of the recommended implementation order is as shown in Table 4.9.

1st Phase	2nd Phase
1. Statistical method 2. Quality costing 3. Employee suggestion	1. Customer survey 2. QFD DOE QIT Q. circle Team-based reward 3. TPM Empowerment 4. Reduce set-up time

3rd Phase
1. Waste elimination 2. Reduce inventory Cellular layout CAD 3 Automated inspection CNC 4. Benchmarking

Table 4.9 Recommended implementation order

4.4.3 Identifying Potential Organizations

The quality initiatives' implementation plan above could be used by generally any organization irrespective of size. For the purposes of this study, potential organizations would be identified more specifically. One of the most important criteria used is the mean practice score line of the population that is about 34 per cent. The practice score is a composite score of all the quality practices used in the survey. It is observed that the mean practice and performance score remain about the same in the following situation in Figure 4.12.

Description	No. Cases	Practice Mean	Std. Dev.	Performance Mean	Std. Dev.
Population	394	35.7	13.65	30.63	15.3
Excl. Outliers	384	35.6	12.85	30.45	14.3
Excl. Grp V Below 500 employee)	381	35.3	13.36	30.3	14.9

Figure 4.12 Comparing mean and standard deviation of practice and performance

The other criteria used is the mean practice score of ISO 9000 only firms that stood at 34 per cent. This would indicate the minimum level of internationally recognised quality system attained by the firms. Since the mean practice score of ISO 9000 only firms is just about the mean practice score of the population at 34 per cent, for the purpose of this study the mean practice score of the former would be used to identify potential firms. It would not be wrong to conclude that the quality position of the average firm would be at par to the ISO level of practice in the industry.

Figure 4.13 below shows the line chart of practice and performance scores with each successive technique installed. It indicates the number of techniques installed for firms with ISO 9000 level of practice. As the number of firms employing higher number of techniques decreases, the average score becomes more irregular and cannot be used as a reliable indicator as can be seen from the figure.

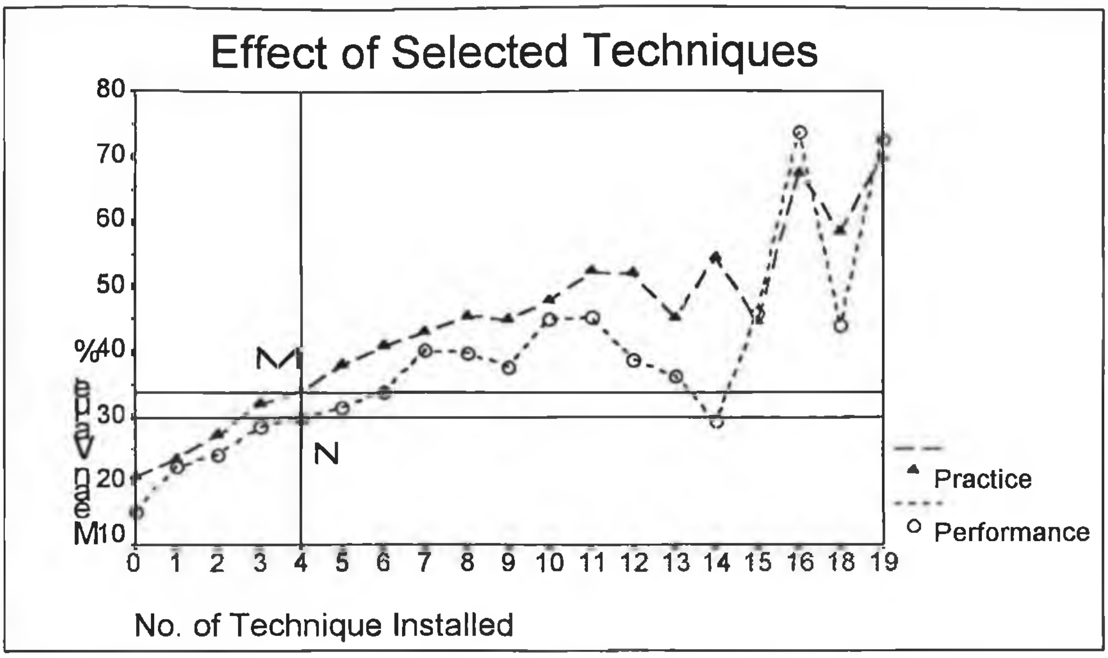

Figure 4.13 Number of techniques installed against practice and performance

A reference line equivalent to an ISO only practice score of 34 per cent drawn parallel to the X-axis intersects the practice line at point M. All the practice scores that fall below this line would then belong to firms with a level of practice below that of ISO 9000. Similarly all practice scores above this line belong to firms with ISO and are in various stages of TQM transformation. A line drawn from this intersection and parallel to the Y-axis cuts the X-axis at point number 4. It also cuts the performance line at point N. A line drawn parallel to the X-axis and which passes point N intersects the Y-axis at a performance score of slightly above 30 per cent. This is equivalent to the mean performance score of ISO 9000 only firms at 31 per cent.

The group of firms with practice scores less than 34 per cent would have installed three techniques namely: 1)statistical method, 2)employee suggestion, and 3)customer survey. This is shown in Table 4.10 in the next section. About one third of the respondents (127 cases) has practice scores below 34 per cent. About 80 per cent are firms with less than 100 employees. Just 64 per cent are indigenous firms. About 70 per cent are firms established more than 16 years ago. Firms with practice scores of about 34 per cent are ISO only firms. They would have installed at the most, four techniques. There are only 28 cases under this group. About 85 per cent are firms with less than 100 employees. About 60 per cent are indigenous firms. Just under four per cent are firms established less than five years ago.

4.4.4 Implementation Time Frame

For the implementation model shown, the minimum implementation time would be three years and the maximum could be five years. In actual fact there are evidence to indicate that some firms have implemented most techniques within the first phase. While others have stretched it up to the fifth phase. Some literature put the length of time at implementation between four and five years. According to Mann [87], unless there was a problem with the very survival of the particular organization, a gradual implementation approach is preferred with the average time of implementation at around three and half years.

4.5 Use of Selected Techniques

4.5.1 Overall Response

Table 4.10 is a picture of the current state of the quality position of the respondents in a cross tabulation of the selected quality initiatives with the number of initiatives employed ranging from 1 to 19.

									Number of Techniques Used												
No	Quality Mgmt. Initiatives	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOT	%
1	Statistical Method	2	12	10	12	21	23	13	18	18	15	7	14	4	2	5	2	0	3	1	182	46
2	Employee Suggestion	6	11	10	12	19	21	11	14	17	14	6	11	3	2	5	0	0	3	1	166	42
3	Customer Survey	6	3	8	11	19	26	16	17	11	14	6	11	3	2	3	2	0	3	1	162	41
4	Waste Elimination	3	11	8	11	12	19	13	14	14	8	4	10	4	1	5	2	0	3	1	143	36
5	Quality Improvement Team	1	1	6	8	15	21	12	12	15	11	7	12	5	2	5	2	0	3	1	139	35
6	Quality Costing	2	6	4	13	13	17	12	13	13	9	5	12	4	2	4	2	0	3	1	135	34
7	Phased Reduction-Inventory	1	3	8	4	13	14	9	15	13	10	4	9	3	2	5	2	0	3	1	119	30
8	TPM	0	5	6	6	13	13	11	9	11	9	5	11	4	1	5	2	0	3	1	115	29
9	Set-up Time Reduction	0	1	3	6	16	9	11	8	12	10	5	11	5	2	5	2	0	3	1	110	28
10	Empowerment	0	1	8	3	8	10	12	11	12	10	7	11	4	2	5	1	0	3	1	109	28
11	Computer Aided Design	6	5	6	6	11	12	11	7	8	12	4	7	3	1	3	2	0	3	1	108	27
12	Cellular Layout of Machines	0	2	3	2	6	7	6	9	8	9	5	11	4	2	4	2	0	2	1	83	21
13	Q. Function Depl. (QFD)	0	5	3	5	10	9	2	10	7	8	3	7	2	1	5	1	0	3	1	82	21
14	Benchmarking	0	0	4	2	9	6	4	6	8	5	4	11	3	1	4	2	0	3	1	73	19
15	Automated Inspection	2	1	2	4	4	5	4	4	8	3	4	4	1	1	3	2	0	2	1	55	14
16	Comp. Numerical Ctrl. M/cs	0	5	3	4	6	5	4	2	4	7	4	3	2	1	0	2	0	2	1	55	14
17	Reward System	0	1	1	2	3	8	4	4	8	4	2	3	5	1	3	2	0	3	1	55	14
18	Design of Experiment (DOE)	0	1	0	0	4	5	2	6	6	9	3	5	3	2	2	2	0	3	1	54	14
19	Quality Control Circles (QCs)	0	2	3	1	3	4	4	5	5	3	3	5	3	0	4	0	0	3	1	49	12

Table 4.10 Cross-tabulation of quality initiatives

The numbers in the cells are the number of firms. It shows the 19 initiatives arranged in descending order of popularity. Respondents were asked which particular initiatives had been implemented in their company and to state the corresponding year of implementation of each where applicable.

4.5.2 Total Employee Involvement (TEI)

Table 4.11 is a crosstabulation of the total employee involvement techniques with the number of techniques employed arranged in descending order of application in the industry. It comes from the overall picture shown in Table 4.10 above.

Total Employee Involvement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	TOT
Employee Suggestion	6	11	10	12	19	21	11	14	17	14	6	11	3	2	5	0	0	3	1	166
Waste Elimination	3	11	8	11	12	19	13	14	14	8	4	10	4	1	5	2	0	3	1	143
Quality Improvement Team	1	1	6	8	15	21	12	12	15	11	7	12	5	2	5	2	0	3	1	139
Empowerment	0	1	8	3	8	10	12	11	12	10	7	11	4	2	5	1	0	3	1	109
Team-Based Reward System	0	1	1	2	3	8	4	4	8	4	2	3	5	1	3	2	0	3	1	55
Quality Control Circles (QCs)	0	2	3	1	3	4	4	5	5	3	3	5	3	0	4	0	0	3	1	49

Table 4.11 Cross-tabulation of total employee involvement initiatives

Analysis of responding firms employing TEI techniques reveals that a large majority, 87 per cent, employ between zero and three techniques. On the whole, it is observed that there are 77 per cent of responding firms of less than 250 employees employing between 0-3 techniques. It is also observed that the percentage of firms without any employee involvement techniques is 31 per cent with the main bulk, at just over half, comprising of small firms with 20-50 employees. Due to insufficient number of respondents employing 5-6 TEI techniques, one-way ANOVA of the dependent variable performance was carried out with the variable TEI at 0-4 techniques. Results indicate that firms with higher performance have higher number of techniques employed. The results of this study are in total agreement with the results of the study conducted by Mohrman et al [58]. On further analysis of employee involvement techniques in firms with both TQM and ISO 9000 in place, the quality improvement team, empowerment and waste elimination techniques rank first, second and third.

Team-Based Reward

Just above 80 per cent had installed within the last four years. The percentages of respondents employing this technique is higher in larger companies with more than 250 employees and in companies with both TQM and ISO in place. It is also observed that it is practiced more in foreign than locally owned companies and in the chemical, electrical and electronics and plastics and rubber than the other industry sectors. This is not a very popular quality initiative to implement yet and is new even in large companies. The fact that this particular technique is not implemented widely may open to question the effectiveness of certain techniques that need to be implemented in the total quality approach.

Since not many would employ team-based reward, question number 20 was designed to probe the kind of reward system practiced by the company. Respondents were required to choose from a list of responses provided the elements of a reward system practiced by their company. The survey recorded 23 per cent of the respondents who do not respond to this question. Table 4.12 shows the elements of the reward system cross tabulated with the total number of elements of the reward system employed by each company.

	Reward system	1	2	3	4	5	6	7	8	9	Cases	%
1	Bonus	80	53	21	8	7	4	3	0	0	176	58
2	Merit pay	19	26	18	12	7	3	2	0	0	87	29
3	Health care	7	22	18	9	10	4	3	0	0	73	24
4	Team incentives	17	20	9	4	2	2	2	0	0	56	19
5	Achievement award	8	9	13	7	6	3	2	0	0	48	16
6	Retirement	5	12	11	6	7	3	2	0	0	46	15
7	Profit sharing	9	14	8	4	3	0	2	0	0	40	13
8	Stock ownership	2	11	7	5	5	2	3	0	0	35	12
9	Vacation	1	5	6	5	3	3	2	0	0	25	8
	Total	148	86	37	15	10	4	3	0	0		

Table 4.12 Cross-tabulation of elements of reward system

The table shows that it is highly likely that bonus is part of the reward system (excluding pay) if the company practiced only one reward system. That is if a company employs only one reward system it is highly unlikely that it would be vacation, or stock ownership, or profit sharing, etc. Likewise if it employs two elements of a reward system, then these would most likely be bonus and merit pay. Firms with higher performance employed higher number of reward system. The mean number of reward system for the population is two. It remains two even when outliers and firms employing more than 500 employees are taken out of the analysis. Similarly larger firms practiced a bigger number of reward system compared to smaller firms.

Employee Suggestion

Employee suggestion system is one of the oldest methods of communication. About 80 per cent of those had installed within the last seven years and is frequently the first technique to be employed in the scramble to enlarge the scope of employee involvement in the total quality concept. Of those who installed employee suggestion system, 63 per cent have less than three numbers of employee suggestions per employee per year; 23 per cent have between 3-7; eight per cent between 8-12; and only six per cent have more than twelve numbers of employee suggestions per employee per year. About 19 per cent reported no change in employee involvement; a large majority, 62 per cent, reported minor improvement; and only 18 per cent reported major improvement in employee involvement. It is also observed that employee suggestion scheme is not related to site size, industry sector, ownership, or quality position (with or without TQM/ISO or both).

The figures above are considerably much lower than those observed in high performance companies like MBNQA winners. If the quantities of suggestions are seen as a measure of the management's ability to create a conducive environment where employee involvement could prosper, then at least 60 per cent would have failed miserably. It is hypothesized that the number of elements of a reward system would play a dominant role in the number of employee suggestions and overall performance.

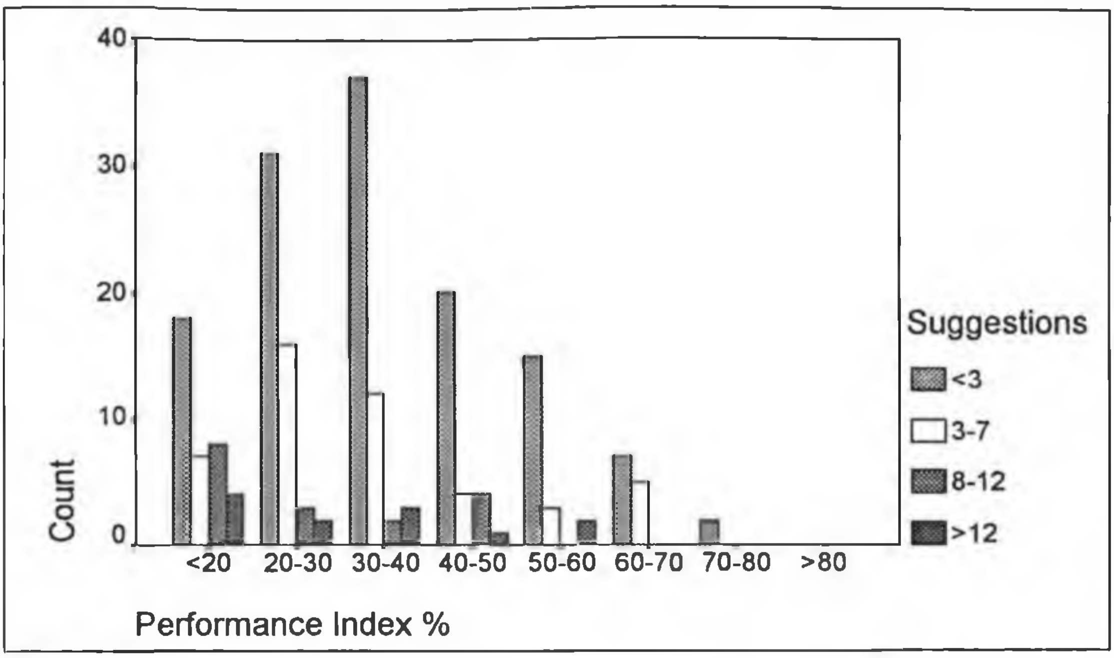

Figure 4.14 Bar chart of performance and number of employee suggestions

The information as shown in Figure 4.14 indicates that the hypothesis is not true. There is no indication of a link between number of suggestions and performance at least as far as this population is concerned. This is a population where the average level of quality practiced is at the ISO 9000 level and the first employee involvement technique is frequently employee suggestion. There is also no indication of a link between number of employee suggestions and the number of elements in a reward system. This is shown in Figure 4.15 below.

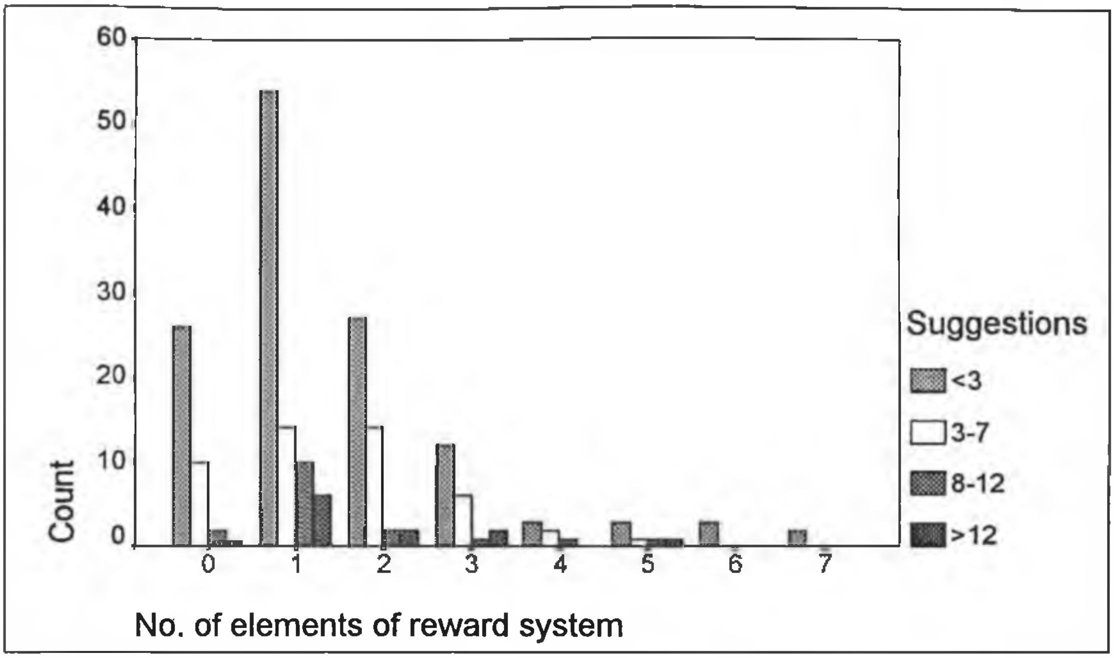

Figure 4.15 Bar chart of elements of reward system and suggestions

One thing is clear from this information, installing it is much easier than making it work effectively. There is no evidence to suggest that its installation, on its own, would result in immediate benefits.

Waste Elimination

Just above 80 per cent had installed within the last five years. It is practiced less in the 20-50 employee than in the other site size category. It is not so well received in the wood and textile industry than in the other sectors. The percentage of usage is higher in foreign than in locally owned companies. Its implementation requires the user to identify, assuming it already has the knowledge and expertise to do so, and eliminate wastes. This would mean having the people and training them to carry it out. It is expected that small firms will not be in a position to effectively install this initiative. It is expected that a majority would be foreign firms who would have the necessary expertise to do so and must do so to compete with locals and firms abroad. Just under 60 per cent reported minor improvement, 31 per cent reported major improvement while the balance reported no change.

Quality Improvement Team

A total of 139 respondents have installed quality improvement teams. Of this figure, 80 per cent had installed within the last five years. It is observed that the use of quality improvement team is highest in the chemical, electrical and electronics, and plastics and rubber than the other industry sectors. These are the competitive sectors where foreign firms are more dominant than indigenous firms. The percentage of users is twice as high in foreign-owned than in locally owned companies. It is also observed that the percentage of users increases with increase in site size. This is so since it needs the resources to operate effectively. It is also observed that the use of quality improvement team is more prominent in companies with both TQM & ISO in place at 72 per cent; at 44 per cent in companies with only TQM and at 33 per cent in companies with only ISO in place.

To an earlier question on the frequency of meetings per week, if quality improvement teams are operating on the shop floor, 146 responded. This shows that the returned questionnaires were in responsible hands at the time of survey and the information supplied are reliable. Just under 90 per cent reported to have one meeting per week.

Empowerment (self-directed teams)

Just under 80 per cent had installed within the last four years. It is observed that the percentage of users increases with increase in site size. It is also observed that it is practiced more in foreign than locally owned companies. It is practiced more in firms with both TQM & ISO in place. The percentage using this technique is much higher in the chemical, electrical and electronics, and plastics and rubber companies than the other industry sectors.

Quality Circles

About 80 per cent had installed within the last six years. It is observed that the percentage of users increases with increase in site size. It is also observed that this technique is practiced in companies regardless of whether TQM/ISO or both are in place or not. The results of the survey show that only three out of five Malcolm Baldrige award winners who responded have it in place while in the top 68 cases in the practice-performance scatter diagram, only five respondents have it installed less than four years ago. The fact that very few respondents have quality circles in place could possibly be due to strong trade and labour unions' movement. Or it could be the result of a fundamental misunderstanding between the nature and characteristics of quality circles and various other small group activities existing in the organization.

Quality circles are recognised as one of the platforms where employees could get involved in the continuous improvement in the organization. If the number of firms employing quality circles can be used as a measure of management's commitment towards creating a greater employee involvement, then many would have failed to live up to it.

4.5.3 Lean Production

Phased Reduction of Inventory

Just under 80 per cent had installed within the last five years and is twice as high in companies employing more than 500 employees than the rest. It is well received in the electrical and electronics, foreign rather than locally owned companies and in firms with both TQM and ISO installed. Just under 40 per cent of firms employing the batch and flow production implemented this technique compared to only about 20 per cent for firms using jobbing, process, and mass production methods and only 76 per cent reported to have made some improvement to quality. One of the possibilities why it is not so widely practiced in the smaller companies is because of pressure from large customers practising JIT system forcing these smaller companies to be their hidden buffer according to Brown and Inman [201].

Reduce Set-Up Time

About 80 per cent had installed within the last five years and is least in firms employing less than 50 employees and highest in firms with more than 500 employees. It is highest in the plastics and rubber industry; and in companies with both TQM and ISO installed than the others. About 90 per cent of user reported to have some improvement to quality. Further analysis reveals that only about 30 per cent of firms under each manufacturing methods of jobbing, batch, flow, process, and mass production have implemented this technique

Cellular Layout

About 80 per cent had installed within the last six years. It is observed that implementation of this technique improves with increase in site size; is poor across all industry sectors; is almost twice as high in foreign than in locally owned companies; and is much higher in companies with both TQM and ISO installed. It is installed in more companies with stand-alone automatic machines than in other level of automation, automatic machines linked with material and tool handling and automatic production lines; and is predominantly in batch manufacturing.

Total Productive Maintenance (TPM)

Just under 80 per cent had installed within the last four years. It is observed that its use is not related to site size except in companies with more than 250 employees where it is about 50 per cent higher and higher still in companies with more than 500 employees. Its use is highest in companies founded between 11-15 years ago; not particularly influenced by industry sectors or ownership; is almost twice higher in companies with both TQM and ISO installed than in ISO only companies; is least in stand-alone automatic machines; and is highest in process followed by batch manufacturing. Operators are also responsible for maintenance of machines in 33 per cent of respondents. This response compares favourably to those who had TPM at 29 per cent. This means that the responses are reliable.

4.5.4 Feedback Measurement

Benchmarking

It is said that to be the best, one must learn from the best. This is generally associated with benchmarking. It is a relatively new concept that has stormed the business community. About 80 per cent had installed within the last seven years and is very well received in companies with more than 500 employees with percentage at more than twice that of the other site size category. It is least practiced in companies with less than 50 employees; more in foreign than in locally owned companies. It is also observed that 41 per cent of those firms with both ISO 9000 and TQM practiced benchmarking compared to only about 14 per cent of those which have not implemented TQM. This finding agrees with those observed by Zairi [102] and Davenport [202].

Customer Surveys

About 80 per cent had installed within the last six years. This technique is practiced more in larger companies by at least 50 per cent higher than those in less than 50 employees. It is observed that this technique is highly practice in the clay industry followed by the food and electrical and electronics sectors; and in companies with both TQM and ISO installed; and is highest in those industries employing flow as the main manufacturing method.

Quality Costing

Just above 80 per cent had installed within the last seven years. It is less likely to be implemented in those companies with less than 50 employees; is practice across all industry sectors; is more likely to be employed as foreign ownership increases; practiced at 50 per cent more in automatic production lines than in other levels of automation; is least in jobbing and highest in flow manufacturing. When asked to estimate failure costs compared to 3-5 years ago, 72 per cent of respondents from the overall survey responded. It is observed that out of this figure, 57 per cent reported costs to have gone down, 38 per cent reported no change, and only five per cent reported costs actually went up.

Cost Source	% Response	Most Response
Rejected Product	61%	0.75-1.5%
Rework	55%	greater than 5.0%
Scrap	53%	greater than 5.0%
Faulty Material	53%	less than 0.25%
Complaints	47%	less than 0.25%
External Repair	33%	less than 0.25%
Warranty Repair	33%	less than 0.25%

Table 4.13 Failure losses as percentage of production costs

The top failure losses, rework and scrap, as shown in Table 4.13 have failure costs in excess of five per cent of production costs. Those who reported to have no change in the failure costs have low practice and performance scores than those who reported costs to have gone down. Interestingly the mean practice score of those who reported no change in costs is 33.8 per cent and those who reported cost to have gone up have mean practice score of 32 per cent.

Only 35 per cent of the respondents measured the cost of maintaining current quality levels. The 1980 survey reported a figure of 39 per cent. Out of this, 85 per cent reported a figure of less than five per cent relative to turnover. The results of a survey by Rayner and Porter [203] reveal the same story. This figure is relatively much lower than that reported by Porter and Rayner [204] who puts the median quality costs from an extensive review of the literature as 18 per cent of turnover. They also reported that only about 35 per cent monitor quality costs in their survey on small firms in the UK.

Quality Feedback

Quality feedback is practiced by almost 100 per cent of the respondents in one form or another. This is shown in Table 4.14 below. It is observed that on the average a company would have in place three forms of regular quality feedback, namely: inspection, quality audit and returned goods. All the figures in the table below are for regular quality feedback. Further analysis reveals that the use of quality costing, returned goods, quality audits, customer surveys and benchmarking for regular quality feedback are very much higher in companies with more than 50 employees by a margin of at least 50 per cent compared to those companies with less than 50 employees. The use of the last two, customer surveys and benchmarking appears to increase with increase in site size. The use of benchmarking and quality audit are almost 50 per cent higher in foreign-owned companies while quality costing is almost twice higher than in locally owned companies. In companies with both TQM and ISO installed the use of quality costing, benchmarking, and delivery time are 50 per cent higher than in companies with only ISO but use of returned goods as a regular source of quality feedback is instead higher in the latter. As the level of automation increases from stand-alone to automated production lines so too the use of delivery time, benchmarking, and customer surveys as a regular source of quality feedback. While the use of quality costing is highest in flow manufacturing and least in jobbing; use of quality audits is highest in mass manufacturing and least in flow manufacturing; and the use of inspection as a source of regular quality feedback is highest in mass manufacturing and least in jobbing.

No	Method	1	2	3	4	5	6	7	8	9	Cases	%
1	Inspection	25	77	100	78	26	29	7	2	0	344	88
2	Quality audit	4	38	70	74	22	24	7	2	0	241	62
3	Returned goods	6	24	72	64	22	28	7	2	0	225	57
4	Delivery time	1	13	27	31	18	23	7	2	0	122	31
5	Customer survey	3	7	22	34	18	18	5	2	0	120	31
6	Quality cost	0	9	24	38	16	23	7	2	0	119	30
7	Machine breakdown	0	3	7	6	6	18	2	2	0	44	11
8	Benchmarking	0	1	7	11	6	11	6	1	0	43	11
9	Customer complaint	2	0	5	4	1	0	1	1	0	14	4
	Total	41	86	115	85	27	29	7	2	0		

Table 4.14 Cross-tabulation of feedback methods

It shows that it is highly likely that in firms with only one mode of quality feedback, inspection would be its only source. If a firm is to employ two modes of feedback, then the other would most likely be quality audit. It is highly unlikely for a firm to employ benchmarking for example, if it is the only mode of feedback employed. The average number of regular quality feedback employed for the entire population is three. Firms with higher performance scores employed various methods of quality feedback. Similarly larger firms employed much more feedback method than smaller firms.

Supplier Evaluation

Supplier evaluation is practiced by almost 100 per cent of respondents in one form or another as shown in Table 4.15 below. It is observed that on the average a company would have used a combination of at least three modes of supplier evaluation namely: incoming inspection, using past records, and visits to and examination of suppliers' quality arrangement. On further analysis, it is observed that the use of visits to and examination of suppliers quality arrangement and supplier's test records are practiced more in larger companies with the latter at 50 per cent higher than in companies with less than 50 employees; is almost 50 per cent higher in foreign than in locally owned companies. While the use of evaluation by parent company is highest in the electrical and electronics industry followed by the chemical sector; is predominantly a practice of foreign-owned companies. Visits to and examination of supplier's quality arrangement is least in companies with jobbing as the main manufacturing method and the use of incoming inspection is highest in companies with stand-alone automatic machines. In companies with both TQM and ISO installed, it is observed that with the exception of visits to and examination of supplier's quality arrangement that is highest; incoming inspection, and the uses of past records are lowest compared to companies with only ISO in place.

Supplier evaluation		% of
Name	Count	Cases
1.Incoming inspection	290	76
2.Past records	290	76
3.Visit supplier	228	60
4.Supplier's test records	142	37
5.Parent company	45	12
6.Other (accreditation)	4	1

Table 4.15 Practice of supplier evaluation

4.5.5 Quantitative and Qualitative Techniques

Statistical Methods

About 80 per cent had installed within the last seven years. The percentage of users is at least twice as more in companies with more than 50 employees and highest in companies with more than 500 employees. Except in the wood and textile industry, this technique is well received in all the other industry sectors. Its usage is higher in foreign than in locally owned companies; and in companies with both TQM and ISO installed. To a question on the statistical tools used, respondents were asked to choose preselected lists provided. The most significant observation is that the analytical tools that can provide greater insight into the variability of the process are yet to be used by many in the industry. This situation may indicate that the use of statistical tools in the manufacturing industry in general may still be at its basic inspection level and little benefits if any could be generated from this data collection exercise. Table 4.16 shows a cross tabulation between the types of tools in the column and the number of tools employed in the row cells ranging from 1 to 8.

No.	Method	1	2	3	4	5	6	7	8	Cases	%
1	Sampling	35	44	39	39	21	18	2	3	201	65
2	Control charts	22	40	32	35	22	17	2	3	173	56
3	Histogram	9	16	24	21	19	13	2	3	107	35
4	Pareto	4	11	20	30	19	17	2	3	106	34
5	Trend charts	9	25	21	28	6	10	2	3	104	34
6	Process capability anal.	4	11	15	23	16	17	2	3	91	30
7	Cause & effect	1	3	7	16	8	14	2	3	54	18
8	Scatterdiagram	0	2	1	4	4	2	0	3	16	5
	Total	84	76	53	49	23	18	2	3		

Table 4.16 Cross-tabulation of quality control tools

It shows that if a firm employs only one tool, then it is highly likely that this would be sampling inspection. If a firm employs two tools, it is highly likely that these would be sampling and control chart. Likewise, it is highly unlikely that a firm would employ the tools that would offer process capability analysis or cause and effect if it only employs one tool.

The survey recorded 22 per cent of respondents who have zero use of statistical tools. The average number of quality control tools used for the population is two. Figure 4.16 shows a line chart of the mean performance index against the number of QC tools. The line drawn parallel to the Y-axis from 2 cuts the performance score line at point P. The line drawn parallel to the X-axis and cuts this point cuts the Y-axis at a performance score index of about 31 per cent that is the performance score of ISO 9000 only firms. Firms with higher performance scores have higher mean number of quality control tools. Similarly larger firms have more number of tools than smaller firms.

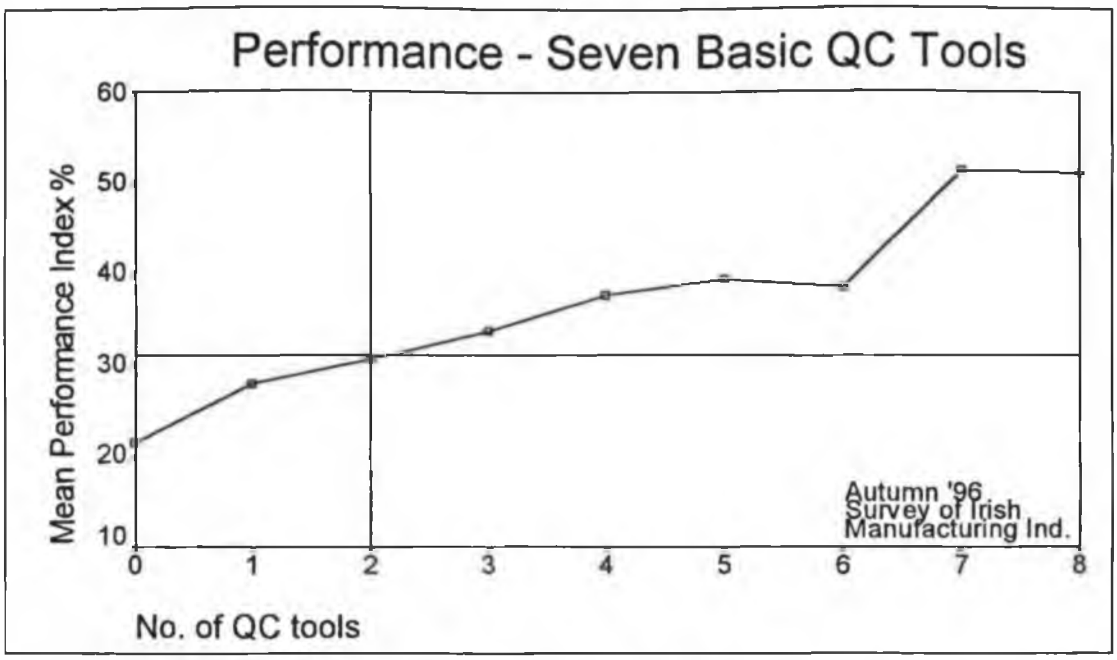

Figure 4.16 Performance with number of quality control tools used

Design of Experiment (DOE)

About 80 per cent had installed within the last seven years. Of this, 50 per cent had implemented it less than four years ago. The percentage of users increases with increase in site size and is poor across all industry sectors; slightly higher in foreign than locally owned; and slightly higher in companies with both TQM and ISO installed than those without.

Integrated Process and Product Development (IPPD)

IPPD is a system approach of bringing out a product from its inception to final marketing, such that all subprocess required to bring forth the product are integrated harmoniously. Table 4.17 summarises the responses to a question concerning IPPD.

Respondents are requested to select from a number of listed responses the personnel or department involved in this multidisciplinary process and product development activities. The table shows that the production, quality and technical staff of a majority of the respondents are involved in both process improvement and product development activities. The average figure works out to about 26 per cent assuming, although it is not necessarily so, all the groups are included in such a process. To further assess the use of this multidisciplinary approach in the transformation of product features and customers' needs from inception to final marketing, the study has included the closest resemblance of this process to date, the quality function deployment technique, in a separate question together with the rest of the 19 techniques for an overview of the overall quality picture.

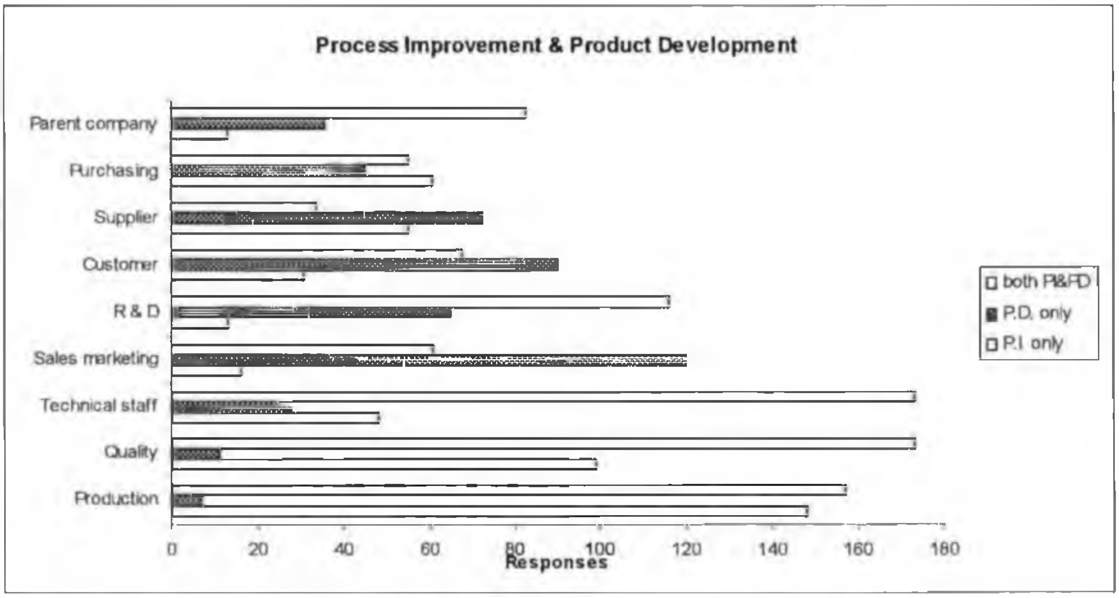

Table 4.17 Participation in integrated process and product development (IPPD)

No.	Elements	1	2	3	4	5	6	7	8	9	Cases	%
1	Quality	9	19	42	52	26	9	8	3	5	173	60
2	Technical Staff	13	30	35	46	23	10	8	3	5	173	60
3	Production	14	17	37	43	22	9	7	3	5	157	55
4	R & D	4	14	24	34	18	7	8	2	5	116	40
5	Parent Company	12	8	8	18	16	6	7	3	5	83	29
6	Customer	2	3	16	16	9	9	5	3	5	68	24
7	Sales & Marketing	1	10	9	13	8	7	6	2	5	61	21
8	Purchasing	3	2	6	13	9	10	4	3	5	55	19
9	Supplier	1	1	3	5	9	5	3	2	5	34	12
	Total	59	52	60	60	28	12	8	3	5		

Table 4.18 Cross-tabulation of IPPD

Table 4.18 is a cross tabulation of the various personnel involved in the process with the number of personnel as shown in the top row ranging from 1 to 9. It shows that if a firm has only one department responsible for process improvement and product development then this would most likely be production. Likewise with two departments these would most likely be left to technical staff and quality people. Similarly it would be highly unlikely for the supplier, purchasing, sales and marketing and customer to be involved in the process in a majority of cases. The mean number of participants in IPPD for the entire population is two. This means that in the average firm the most likely people to be involved in the process would be the technical staff and the quality people. Firms with higher performance scores have correspondingly higher mean number of participants involved in the process. Similarly larger firms have higher number of participants involved than smaller firms.

Quality Function Deployment (QFD)

About 80 per cent had installed within the last six years. It is used most in companies with more than 100 employees but surprisingly the least used in the electrical and electronics industry. One possible reason being that this intensely competitive discrete product industry, often with new and sometimes frequent and rapid changes in product features and customer's needs is consolidated in that direction in the parent company, overseas. Its use is twice higher in companies with both TQM and ISO installed than in companies with only ISO and is not influenced by level of automation or in manufacturing methods employed by companies.

4.5.6 Technological Factors

Automated Inspection

About 80 per cent had installed within the last eight years. It is observed that the use of this technique is the least in companies with less than 50 employees and increases with increase in site size. It is highest in the food followed by the plastics and rubber and the electrical and electronics industry; slightly higher in foreign-owned companies; about three times higher in companies with both TQM and ISO; increases by almost 50 per cent from stand-alone to automatic machines with material and tool handling system and again by about 50 per cent to automatic production lines; more in batch and process industry and by about twice higher in mass manufacturing. It must be emphasized that this technique is wasteful since it adds cost but not value to the product.

CNC Machines

About 80 per cent had installed within the last twelve years. It is observed that the use of computer numerically controlled machines are widespread in all the site size category except for those with greater than 500 employees where it is three times higher than the others. Its use is highest in the woods followed by the metal industry; not influenced by ownership or whether by both TQM and ISO or ISO only companies; highest percentage of users in companies founded between 11-15 years ago and decreases by about 30 per cent that amount in companies founded recently; is predominantly used as stand-alone but marginally lower when linked with material and tool handling system; and is highest in jobbing followed by the flow manufacturing method.

Computer Aided Design (CAD)

Just above 80 per cent had installed within the last seven years. As with CNC machines, its use is widespread in all site size category except for those with greater than 500 employees where it is almost twice higher than the others. Like CNC machines, its use is highest in companies founded 11-15 years ago and decreases by about 60 per cent in companies founded recently; its highest user is in the metal followed by the wood and clay industry; not particularly influenced by ownership or whether in both TQM and or ISO installed companies or the level of automation but is highest in the jobbing industry. On further analysis, the use of CAD in conjunction with CNC machines is predominantly in the less than 50 employees category at 51 per cent, between 50-100 employees at 14 per cent and between 100-250 employees at 21 per cent; is mainly in the metal industry at 63 per cent; is most popularly employed in companies founded between 11-20 years ago; is highest in ISO only companies at 54 per cent; is highest in companies with stand-alone automatic machines at 49 per cent followed by automatic machines linked with material and tools handling system at 28 per cent; highest in batch at 47 per cent followed by jobbing at only 28 per cent.

4.5.7 Overall Implementation in Industry

There are fewer respondents implementing techniques closely associated with lean production like QFD, reduction of inventory, TPM and reduce set-up time. Techniques enclosed within the first three layers in Table 4.10 appear to suggest that these are the very foundation in total quality that enhances and accelerates the implementation of other quality initiatives.

The table shows that it is highly unlikely for a firm to employ techniques like set-up time reduction, cellular layout, empowerment, DOE, QFD, quality circles, etc., if it employs only one, two or even three techniques. If it employs two techniques, then they are most likely to be statistical method and employee suggestion or may be waste elimination. It is observed that foreign firms and those with higher performance have a higher number of techniques installed. The number of firms employing more and more techniques decrease as the number of techniques employed increases. Just under 60 per cent of respondents employing up to six techniques are firms with less than 100 employees when the mean number of techniques employed for the entire population is five.

From the tabular summary of the findings of this study shown in Table 4.19, it would appear that the respondents initially tried to adopt some form of TQC followed by JIT/lean production and TPM and again the former. Generally respondents would have no set order to follow in implementing lean production techniques. Among the 23 firms with cellular layout, reduction of inventory, reduce set-up time and total productive maintenance, there are about an equal number implementing either reduction of inventory or reduce set-up time followed by cellular layout with total productive maintenance the last four. This would be in agreement with the work of Womack and Jones [128].

Techniques closely associated with TEI which have the most wear and exhaustion on management like team-based reward system, empowerment, quality improvement team etc., with the exception of employee suggestion and quality circle which exert the least wear, are also relatively new with about 80 per cent of all installation within the last four to five years. Additionally, it is not known what effects the implementation of team-based rewards would have when installed later rather than earlier. According to Leitch et al [175] employing a reward system that focuses on individual contributions to the collective efforts would be hostile and clearly unsuitable in a total quality climate. Lastly among the techniques, those associated with operational-based improvement, especially with sophisticated machines like CNCs, automated inspection or CAD or combination, appeared to be least aggressively pursued as compared to more process-based improvement techniques of recent years. This finding seems to agree with the findings of Kim [205] who reported that US industries are lacking in investments in capital equipment.

80% Installation Including 1996 For Each Quality Initiative From Each Year Inclusive
(Number of cases In brackets)

1985	1989	1990	1991	1992	1993	Autumn **1996** Survey
CNC(55)	Auto Inspection(55)	Statistical Method(182)	Customer Survey(162)	Waste Elimination(143)	TPM(115)	
		Employee Suggestion(166)	Cellular Layout(83)	Q.Improvement Team(139)	Empowerment(109)	
		Quality Costing(135)	QFD(82)	Reduce Inventory(119)	Team-based Reward(55)	
		CAD(108)	Quality Circle(49)	Reduce Set-up Time(110)		
		Benchmarking(73)				
		DOE(54)				

Table 4.19 Installation of quality initiatives in the industry 1985-1996

4.6 Correlationship Between Performance and Seven Categories

There are seven categories under the 1997 Malcolm Baldrige Award Criteria. These are:

1. Leadership
2. Strategic Planning
3. Customer and Market Focus
4. Information and Analysis
5. Human Resource Development and Management
6. Process Management
7. Business (Performance) Results

The first six categories total up to form the composite score of practice. Conducting correlation analysis between the composite score and the seven categories result in the table below.

	Correlationship between performance and categories	
No	Categories	Performance
1	Practice	0.6737
2	Information and analysis	0.5963
3	Customer and market focus	0.4917
4	Strategy development	0.4797
5	Process management	0.4513
6	Human Resource Dev. Mgmt	0.4216
7	Leadership system	0.3874

Table 4.20 Correlation coefficients between performance and categories

Table 4.20 shows that information and analysis is strongly correlated to performance than the others. This category examines the management and effectiveness of the use of financial and non-financial information and data to support processes and improve performance. It means that those who select, manage, and use financial and non-financial data would have a much higher performance than those who do not. The weakest link appears to be between leadership and performance. This may indicate that generally the leadership system among the survey respondents is weak. Multiple regression analysis conducted result in a model excluding leadership system in the equation. There are only two reasons contributing to a weak correlationship and in the case of leadership and performance may be due to a sizeable number of respondents with:

1. High leadership score but low performance score.
2. Low leadership score but high performance score.

A strong correlationship means that the slope of the fit line would be steeper than the slope of the fit line from a weak correlationship. This would mean that a much smaller increase in the information and analysis score is all that is needed to appreciably increase the performance score compared to the increase in the leadership score required to increase performance by the same amount.

The strength of the correlationships between the performance variable and the others is just a snapshot figure of the quality position in the industry at the time of study. Since the average quality position of the population is at the ISO level, much change in the leadership system is required if the industry is to proceed further in the total quality transformation using ISO 9000 as a launching pad.

It is important to acknowledge that studying the effects of changes in the scores of the variables on the performance score and determining its relative importance is not as simplistic as using the correlation coefficients. It is not a straightforward approach since the variables are not totally independent of each other and they are correlated as seen in Table 4.21. While it may be easy to impose a change in one variable to study its effects on performance, it may not be possible to control the consequences of this change on the other variables. Thus the real effect of a change in the particular variable in question on performance may be totally different from the theoretical effect. In addition since the variables are correlated, the contribution of a variable on performance depends on the order in which the variables are introduced in the regression procedure [206].

Correlationship between award categories		
Information and analysis	Process management	0.5667
Information and analysis	Leadership system	0.4985
Information and analysis	Strategy development	0.459
Information and analysis	HRDM	0.4511
Information and analysis	Customer and market focus	0.4341
Process management	HRDM	0.4284
Process management	Leadership system	0.4186
Strategy development	Customer and market focus	0.3751
Strategy development	HRDM	0.3334
Leadership system	HRDM	0.3316
Process management	Customer and market focus	0.3136
Process management	Strategy development	0.3063
Customer and market focus	HRDM	0.2773
Customer and market focus	Leadership system	0.2545
Strategy development	Leadership system	0.2347

Table 4.21 Correlation coefficients between award categories

4.7 Chapter Summary

This chapter starts by establishing that the distributions of the practice, performance and total score variables are normally distributed. The practice and performance correlationship are also examined. This important correlationship forms the basis for further analysis into ISO 9000 and TQM installation and its complementary effects. The effects of organizational characteristics like management commitment, site size, ownership, etc., on performance are also examined. Next the order of implementation of selected techniques and its use are studied. The chapter ends by examining the correlationships among the seven Malcolm Baldrige categories used in the study.

Chapter 5

IMPLEMENTATION AND RESOURCE IMPLICATIONS

5.1 Introduction

SMEs should think hard at the benefits of installing a quality management system in the long run. Efforts to improve the quality position should not stop at just installing ISO 9000 or its equivalent. It is established that ISO 9000 or its equivalent level of practise, is the launching pad for a majority of TQM implementation regardless of the size of the company. It is acknowledged that costs and bureaucracy associated with assessment, registration, operation and maintenance had long been the key issues with the standard. The alternative would be to install a quality management system that starts off at the level of practice that is at par to the level of practice found in ISO 9000 without seeking registration. This would require some sort of co-operation and link-up with recognised organizations. Nevertheless this study shows that in the long run the benefits far outweigh the initial difficulties.

One of the primary aim of this study is to help firms decide which quality initiatives to employ and its corresponding order of implementation in the total quality journey. But it should be realised that introducing certain quality initiatives just because others are doing so should be avoided. The results of this study are intended to supplement and complement any existing organizational structure used to implement total quality. This is usually done through quality councils, or steering groups, or steering teams set-up to steer, supervise and manage its implementation. Usually a quality activity and training plan of implementation are available. Such a plan can only come, as far as this study is concerned, through translating the quality initiatives' identification and implementation plan into short and long-term training needs.

This chapter describes the implementation of quality initiatives in three phases derived in chapter 4 and the method of implementation combined with training needs as identified in chapter 2.

5.2 Implementation

Managing change of this nature must not be left to chance. There is a need for several policies to support this important total quality transformation. Such policies on education and training, reward system, communicating quality etc, should be well conceived and implemented to help reinforce the messages from top management and to bring benefits to the people engaged in the new practices.

5.2.1 The Potential Firm

Size of Employment

In general, the potential organization or target user of this implementation is a firm with less than 100 employees. They need to increase in size since it is acknowledged that the lack of scale is the substantial barrier to growth. Otherwise the other alternatives available are through joint-venture with suitable foreign partners, mergers, partnerships, or alliances. If all the above appears unattractive especially to the owner managed firm, the other alternatives would be to be part of a supplier-development programme or to seek assistance and be in a continuous linkup with some agencies specially set-up for the purpose.

Number of Techniques Employed

Generally a firm would qualify if it only employs three techniques out of the nineteen selected for this study. This may include firms with ISO 9000 registration.

Never Been ISO 9000 Registered

For those without ISO 9000, there is about a 60 per cent chance to qualify if the firm is a manufacturing industry with size of employment of between 20-50 employees; just under 50 per cent if size of employment is between 51-100; about 50 per cent if size of employment is between 101-250. Local firms have just under 70 per cent chance to qualify. Those employing less than 100 employees have a 62 per cent chance to qualify. Generally, firms from the clothing and textile industry would qualify automatically. If the main manufacturing method is either jobbing or batch the probability is 62 per cent and 50 per cent respectively.

5.2.2 Getting Ready

Conduct SWOT Analysis

Many quality practitioners acknowledged that each manufacturing system is unique with its history, culture, people, processes, and product and thus no two manufacturing systems are alike. One of the most important prerequisite to total quality implementation programme then is to conduct a critical diagnosis of the present strengths, weaknesses, opportunities and threats of each potential organization. It should involve collecting and documenting information on current performance indicators before the start of the project that would be used to evaluate the effectiveness of each phase in particular and the whole project in general. This is an important step and one which many organizations have to depend on external expertise. Once this has been taken care of, the next step involved preconditioning the mind of top management.

Getting Management Committed

Senior management is the ultimate agents of change. They have the responsibility to manage the resources of the organization and manage them well. This step requires management to internalise the concepts of total quality in their organization to stay competitive. This will make its commitment rock solid and help in establishing clear objectives, decide which techniques to implement, and stay focus all the way. The importance of education at this upper level is not only to internalise the underlying concepts of total waste elimination but also to develop a strong understanding of the organizational behaviour and structure involved in the transformation. These education sessions should include all the selected quality initiatives identified for implementation.

Appointing Champions

The next step involves selecting and appointing champion(s) of quality in the organization. These are persons responsible for implementing total quality and or persons who assist others in the implementation. Preferably to start from the top and move down the organizational hierarchy. There should be more champions through volunteers than as the result of positions in the organization. The first two quality champions should be the top officer in the organization, or the managing director and another person, the quality manager or quality assurance manager or quality control manager who is in charge of quality. Results from the study show that generally firms with a third person appointed as quality champion would have higher performance scores than the average firms.

Getting QA Membership

Through registration as member of quality association, management would have opened up a window to the outside world. Information such as names of organizations, contact persons, and articles from practising quality practitioners to research etc, would be readily available.

Communicating Quality

There is a need for management to increase its use of methods to communicate quality to at least equal to five. This is the mean number used in the best 68 cases in the industry. The five should include new employees training, quality manual, verbal, printed statement, and regular meeting. The use of the last three should not pose any major problems. While the opportunity to use new employee training to communicate quality policy may be few and far between. Thus the only method that may cause some problem is in developing a quality manual. This should be done by the organization with outside assistance.

Regular Quality Feedback

There is a need for management to further increase its use of regular quality feedback from three to equal four used in the best 68 cases. They are inspection, quality audit, returned goods, and delivery time. The fifth and sixth are customer survey and quality costing respectively.

Education and Training of Employees

At this stage management should decide the education and training needs of its employees. Once management has decided the techniques to implement, the short and long term training needs are automatically determined. While it is acknowledged that each organization is unique, some of the major content of the training programme can be planned in advance.

An important factor that should be considered is the immediate losses to the organization as a result of releasing employees to attend training. It is thus preferable if training be customised to the individual needs of the respective organization. That is with regard to the contents, duration, timing, location and so on. It is also important to realise that education and training of personnel in statistical techniques and in difficult and advanced quality techniques like design of experiment and quality function deployment is not a one time affair. It requires hours of close and active coaching from the instructor.

Familiarise With Quality Management System

Each organization should first refer to ISO 8402 for an understanding of the terminologies used. This can then be followed by consulting ISO 9000-1 and ISO 9004-1 for direction on how to set up an effective quality management system as a basis for continuous improvement. The organization could then install if and when required, any one of the three external quality assurance models of the ISO 9000 series: ISO 9001, ISO 9002 or ISO 9003 later on if the situation demands it.

Commit Resources

In the context of this study, resources are taken to mean money allocated for improving quality through people and technology. Figures from surveys in the US and in the UK revealed that costs of quality are approximately 20 per cent of annual sales turnover. The 1980 survey of Irish manufacturing industries reported that about 38 per cent of firms have costs of quality below 10 per cent. Most of those surveyed reported having quality costs less than five per cent relative to turnover. In addition having more employees does not help indigenous firms in implementing quality management practices. In contrast foreign firms have much more practice and are producing better performance that increased with increase in site size. This implies that the introduction and subsequent adoption of a particular technique require a potential firm to have the knowledge, experience, and expertise for the purpose. This situation cannot be met by indigenous SMEs and acquiring it would stretch their small resources. Ultimately third party or outside help would be needed to supplement and complement the total quality journey of SMEs.

5.2.3 Outside Assistance

This study found that seeking outside assistance is the most important factor to SMEs in the competitiveness equation. The difficulties they faced require close supervision and assistance from external organizations. But a large majority may not be able to afford the services of consultants and may have to rely on their internal resources and sound judgement in developing their quality goals.

Outside assistance can come from profit making or non-profit making organizations. They can be private, or state bodies or non governmental organizations. There may be hundreds of private sector consultants big and small with varying levels of knowledge and expertise in many different fields. Since total quality transformation is a long-term process that cannot be achieved in a couple of months, employing a consultant firm over a long period of time may not be financially wise. They should be regarded as a partner in learning and not an expert since if real change is to happen the particular firm and its people must own the change process. Furthermore it must be clearly understood that the use of outside assistance does not relieve the responsibilities of top management for implementation of quality improvement initiatives.

At the time of completing this study there is not one state organization that has developed and conducted training programme on a regular basis in many of the quality techniques often associated with total quality management. Some have quality training available on some techniques but it stops at that. The training does not go that additional step to provide direct assistance in its implementation in the participating organization. One non-government organization that provides the support structure that comes close to the requirements is Plato. But this is through a once-a-month meeting where 10-12 owner-managers of participant companies come together to discuss a wide range of management issues and compare notes.

State bodies can come from research and training organizations and institutions of higher learning. There are many state bodies involved in the training of employees. Training of employees who will be using the techniques may require close and active working relationship with the instructor(s). This may only be available through linkages between the firm and a user organization where such techniques are in use, linkup with supplier, research organizations and institutions of higher learning.

User Firms

The user companies may or may not be the potential firm's business partner. The essence of this linkup is for the user companies to demonstrate their commitment to the wider economic development of the area in which they are located by assisting the SMEs to create a total quality culture. One of the objectives of this linkup is to provide direct workplace learning as against the classroom approach. A comprehensive training package, interactive and customised, should be developed in conjunction with the parties involved. It is envisaged that employees from several potential firms may benefit from this. Staffs from several user companies should be invited to share their experiences. They should come not only from quality but also from production, engineering, purchasing, R&D and so on. This linkup require the state agencies to support, participate and co-ordinate their activities. Each of the SMEs can be seen as simply another production process of the user organization.

In the case where the user company is a customer, the idea behind is to regard the SMEs as partners, or as an extension of the parent company, where co-operation and teamwork exist in a symbiotic relationship. This will require the customer to realise that its future competitiveness may lie with the surrounding SMEs as a single community. The customer should be sending their expert staffs to improve the process capabilities of their SMEs and to eliminate the wastes that are typically accumulated between them.

University

This linkup should be funded by the state in corporation with the potential firms, user firms and the university and colleges. It requires university staff and graduate engineers to be involved in conducting limited education and training sessions when required and help implement quality tools and techniques in the firm. Its main objectives are:

1.To introduce and improve the SMEs quality practises by the effective use of academic resources.

2.To conduct limited education and training sessions when required especially in intermediate and advanced statistical methods like: sampling inspection, estimates, design of experiments, multivariate analysis, operations research etc.

3.To assist in the development of young engineers.

4.To set-up a university-industry co-operation in a long-term relationship beneficial to both parties.

5.2.4 First Phase

There are three fundamentally basic techniques in this phase. They are essentially techniques that ensure process control and lay the strong foundation for later introduction of fine tuning techniques. The first technique is essentially measuring physical variations and the second technique transforms this information into a language that is easy to understand, that is monetary cost. The third technique is essentially concerned with reducing these costs by soliciting help from owners of the problems, the workers on the shopfloor. Seen in this way, each of the successive techniques installed actually builds on the previous one.

Statistical Methods

The first thing to remember is that firms become more competitive as they install an increasing number of quality control tools. According to Ishikawa [29], ninety-five per cent of the problems in a company can be solved by the seven tools of quality control. This means that increasing the number of quality control tools (not necessarily limited to the seven QC tools) used would result in the gradual elimination of wastes.

One of the most important steps in the implementation would be to learn to use the seven basic quality control tools. The first thing to do is to introduce two other tools from the present average of two, making it a total of four. This will bring the number of tools to at least equal to the mean of the best 68 firms. The first two would be sampling inspection (or checklists), and control charts. The next two; histogram and pareto would make use of the process data generated from the first two. It can be seen that introducing these additional two tools would increase the analytical capability further thereby providing greater understanding of the variables in the process.

The other four tools; trend charts, process capability analysis, cause and effect and scatter diagram should also be introduced. The last two are important tools often used in small group activities like quality circles, quality improvement teams, etc. Except for cause and effect that must reside in the heart of the personnel, all the other tools mentioned above can reside in a computer. Which means that they do not require much brainpower to generate than it takes to analyse them. Computer software is available that can put these tools through from the shopfloor direct to the users of such information in the offices. If firms do not have this, then they need to spend money to install such systems and train personnel to operate them. Supervisors, department managers, and senior management would then be able to make better decisions to improve quality in their respective organizations since they examine statistical information in more than half of the respondents in the survey.

Quality Costing

Of all the techniques this particular one could prove to be the most difficult to implement. This is so because it has a direct bearing on the way firms measure profit and loss. Employees should be educated on the concepts of quality costing. Until such time when traditional financial accounting can come to terms with the need for change and transform itself readily to complement the total quality concept, firms should keep and maintain failure costs as a percentage of production costs. That is they need to maintain:

1.Rejected product	5.External repair
2.Rework	6.Warranty repair
3.Faulty material	7.Scrap
4.Complaints	

Employee Suggestion

This is the last technique in the first phase. Management must accept the fact that workers know more about the problems on the floor than the supervisors. If solicited they may have their own ideas of dealing with workplace improvements. This is also the oldest, simplest and the first technique used to secure employee involvement in a total quality culture. Companies already employing this technique realise that employees will know whether management is genuine and sincere in its effort to solicit and implement ideas. The immediate acceptance and speed of implementing improvements are some of the criteria used. Also some form of a reward system whether monetary or otherwise in conjunction with the amount of savings involved and so on must be used.

5.2.5 Second Phase

This phase essentially involved fine tuning of process variations through greater employee involvement using small group activities. Initial success in establishing teamwork culture would provide the foundation for later introduction of advanced techniques.

Customer Survey

Management should immediately adopt customer surveys as standard operating procedure. There is a need to know about the quality of products and services. Is the firm providing the right products and services? Are there other products and services it should be providing? How well is the staff performing? Every part of the operation needs to be reviewed. There are software packages available to guide the firm in getting started. They could also be used equally effectively to design, administer, and analyse any type of survey that can include: training needs analysis, employee attitudes, managerial skills, etc.

QFD, DOE, using QIT, QCs and Team-Based Reward

Quality function deployment and design of experiment require small group activities in the form of teams. This is usually made up of a group of 5-8 people with expertise in their fields. In the case of QFD, there is a need to involve more than two different functions to at least equal to three, the mean number used in the 68 cases. A cross-functional team provides input to product realisation from all areas of business. These participants are quality, technical staff/engineering, production and the fourth being R&D. Basically small group activities are aimed at further fine tuning the process variations. Management should not hastily set-up small group activities. It is not just a matter of putting members together. A lot of preparatory work in the form of education and training in the use of statistical methods, team building, inter personal relationship, guiding, coaching, etc., are needed before any team can be expected to show results. Start with a single team working on a simple project before moving on to major projects where its use would result in greater benefits. For effective use of design of experiment members need sufficient training in intermediate and advanced statistics.

Demonstrate commitment by showing active support in its activities. Team incentives communicate management's goals, reinforce the behaviours that lead to the achievement of these goals, and accelerate the process of change. Increase the number of ways in rewarding the employees since firms with higher performance employed higher number of reward systems. They used bonus, merit pay, health care, and team incentives. Do not expect miracles to happen. Once management can detect some kind of success in its small group activity, it is ready to proceed to the next two techniques; total productive maintenance and empowerment.

TPM through Empowerment

Total productive maintenance must be carried out by all employees through small group activity. Everyone must co-operate to maintain equipment the company depends on for survival and ultimately for profitability. To eliminate the waste and losses hidden in plant, management must acknowledge the central role of workers in managing the production process.

Management should create a feeling of ownership for workers, giving them a personal stake in the success or failure of the TPM programme, as well as the authority to create change. Management should also define the benefits that TPM can have for all workers, particularly maintenance personnel. Everyone should know how their job affects the business. Basically the machine operator must be made responsible for the maintenance of the machine, as well as its operation. Both operations and maintenance departments should accept responsibility of keeping equipment in good conditions. TPM should produce immediate result in considerable cost savings through increased productivity of the machinery.

Reduce Set-up Time

This technique requires careful planning as there are internal and external set-up which must be identified and worked out. In addition it involves many people operators, engineers, maintenance crews, and quality people. Start by appointing a team of may be, 5 to 8 people and give them responsibility for reducing set-up time on a specific machine. Have the team make a video tape of the set-up as it is being done now. The team needs training in fast changeover concepts and techniques and a lot of practice. Set-up time reduction of between 40-60 per cent is readily achievable.

5.2.6 Third Phase

This phase starts-off with waste elimination programmes as a necessary prerequisite to the introduction of reducing inventory and cellular layout techniques. It is an important step which aims to further eliminate wasteful activities.

Waste Elimination Programme

Management should actively pursue and initiate waste elimination programmes through techniques already installed in the first and second phase. It would be helpful if the campaign method is used to communicate the objectives of such a programme. With the awareness of the need to reduce waste heightened, management can proceed to the next techniques; reducing inventory and cellular layout.

Reduce Inventory, Cellular Layout of Machines and CAD

The end result of these techniques (not necessarily limited to these techniques) is a reduction in lot size approaching a single workpiece. The technical design of cells may involve the use of interactive computer based decision support tools which enable the user to be in control of the design process. Apart from the practical coding systems involved and the need to generate part families and identify machine groups for cell formation, others include worker training, scheduling and space allocation during cell implementation. It also involves analysing process flow to identify current process group relationships. This would lead to cell building to form practical groups of processes and loading of parts to cells. Before implementing, a simulation study must be conducted to understand and optimize the behaviour of the system and to predict the performance of cells.

Removing inventory from the process to uncover waste is a useful tool but it must be done systematically and progressively. It must be part of a long-term goal to eliminate waste throughout the system. Once the inventory buffer has been removed, the reason behind its existence can be revealed and resolved, resulting in reduced inventory.

The plant layout must be organised to produce the greatest throughput. Minimise the distance that a product has to travel from the first operation to the last operation. A good plant layout consumes less space. Having too much space available can be a problem because it promotes waste. Essentially this involves building U-shaped cells. A cell built incorrectly will hinder the flow of workpieces. This contributes to standby waste and reduces production output. Continuous checks are needed to ensure that it operates at the designed rate. Start by setting up U-shaped cells in assembly lines.

CNC Machines and Automated Inspection

These two initiatives require high investment. These involve equipment and devices, usually large, and intended for batch production. They may not be suitable and difficult to co-ordinate in a cellular layout or cell manufacturing. The level of automation is not a significant factor in contributing to high levels of practice and performance. Having sophisticated equipment do not necessarily lead to a high level of practice resulting in a high level of performance. But this is the average picture. Obviously there are also high performance firms that have sophisticated and complex equipment. Those firms that have done everything possible to reduce variations through existing technology and require that extra mile to outclass its competitors should do so with long-term objectives in mind.

Benchmarking

The first thing to realise is that many companies would have little or no prior knowledge of how they compare. The second is that many are unsure in which areas they should focus their benchmarking efforts. The best step would be to join a benchmarking club. Participants complete a questionnaire, and receive a report comparing them to similar plants on many different measures like: productivity, sales growth, delivery, scrap and rejects, many others. Finally it must be accepted that there is no such thing as the best practice firm. Nobody is good at everything.

5.3 Evaluation of Implementation

Evaluation should be conducted at each phase and throughout the whole project on a continuous basis. It is an important part of the total quality transformation that gives important feedback not only to instructors, trainers, co-ordinators but to owner-managers and employees of target firms. Instructors and trainers would be interested to know the reactions and the amount of learning of the trainees. This information would be very useful in deciding future training methods. Owner-managers and employees would be interested to know the level of performance improvement resulting from their involvement in the project. Both kinds of evaluation are important and would provide the necessary catalyst and helps strengthen commitment in the total quality transformation. Without which any organization cannot sustain the effort and continuing support it requires to make the programme a success.

5.4 Resource Implication

5.4.1 Estimated Training Time

Forbairt's industrial education programme on statistical process control (SPC) offers a one day (six-hour) course with practical exercises for quality engineers, supervisors and process operators. The course content includes; introduction to SPC, variables control charts, attributes control charts and process capability. Its introductory course to ISO 9000 and ISO 9000 in manufacturing last one-day and two-days respectively. In reference [207], employees are trained between 70-100 hours annually on awareness, tools and techniques.

Oakland [119], an authority on TQM, recommended between 8-20 hours seminar(s) for senior management, 20-30 hours seminar(s) for middle management, 30-40 hours seminar(s) with follow-up workshops for first level supervision and quality team leaders, and half day per week for six weeks for all other employees. He added that quality training must be continuous in order to meet changes in a dynamic business environment. Thomas [15], from their wide experience with implementing total quality initiatives recommended about 20 days for pre-conditioning of senior management, and a minimum of ten days for training facilitators depending on the circumstances.

Oakland's recommended four-level hierarchy is meant for large corporations with well-educated and capable people at senior management level with qualified specialists at middle management level. This recommendation may not be suitable for organizations with less than 100 employees. These are organizations that are generally owner-managed and would have at best, three-level hierarchy in the organization.

For the purpose of this study, the three-level hierarchy is adopted in estimating training time and costs. That is there would be a management level comprising of owner and managers, the middle level comprising of foremen, supervisors or technicians and the third level comprising of all other employees. The training time would follow that recommended by Oakland, that is 20-30 hours seminar(s) for management, 30-40 hours seminar(s) with follow-up workshops for middle level, and half day (about three-hour) per week for six weeks for all other employees that would be carried out annually.

Actually, there is no hard and fast rules on the length of time required to effectively transfer knowledge especially so in the interactive aspects of TQM. Ultimately the length of time to conduct training would depend on the level of education of each employee. Since there would be employees from several target organizations with different levels of educational background, it could probably take longer time. For this reason, the higher-end figures are used for estimating training time in this study.

5.4.2 Class Size

There is no consensus among experts as to the normal class size. Some like Plato groups between 10-12, others advocate between 20 and 30 participants. Oakland recommended not more than 20 people but not less than six. Eventually the optimum class size would take into consideration the availability of target organizations in a particular area and on financial consideration.

5.4.3 Estimated Project Completion Time

Implementing total quality is a long and difficult journey but there is no other options if a company is to survive in today's competitive market. Some literature put the length of time at implementation as four to five years. The method used to calculate the quality initiative implementation order in this study as described in chapter 2 has a minimum chronological time of one year. This would suggest that the minimum implementation time is three years and the maximum could be up to five years.

5.4.4 Training Budget

As an indication of the fees that would be incurred in a training session, Forbairt's one-day (about six-hour) training on SPC costs £185. Its one-day training on introduction to ISO 9000 costs £185 and a two-day training on ISO 9000 in manufacturing costs £350 per person. All fees include documentation, lunch and refreshments.

The total training time is 88(30+40+18) hours annually for the three categories. This is equivalent to 15 days (on the basis of a six hour-day). Using the fees charged for a six-hour training as £185, and, the estimated training budget for one year amounts to £16,280. This sum excludes costs of training in job skills, and travelling and accommodation expenses. This is the estimated annual training budget that should be provided for by the state or through established state bodies.

5.4.5 Instructors and Experts

They should be members of a consultancy unit in the university and should as a far as is possible, be the authority in the area of training specified. Instructors can also come from the management team of participating firms. In fact this should be most encouraged as it demonstrates the level of management commitment. Each task has been estimated to last 6 hr work day so that only one instructor or expert is present.

Experts for the hands-on training may or may not be the instructors. They can come from the user organization where such techniques are currently used or they can come from the consultants provided they have the experience of using or have used the techniques before.

Instructors and experts would be expected to evaluate on a continuous basis as the project developed. They must also realise that it is important for the project to produce immediate short term tangible benefits that are aimed at building momentum and confidence early on in the programme. This will require them to identify a waste elimination problem using selected tools and techniques.

5.4.6 Location of Meetings

Locations of meetings play an important part in providing the climate for effective learning. They should be well equipped with the necessary audio-visual, good heating and ventilation, and other facilities normally expected of a decent training location. Selecting the locations is also influenced by financial considerations as well. It is expected that the co-ordinator identifies training locations preferably where 80 per cent of the participants would be least inconvenienced. If these are available in organizations involved in the project funds must be made available to pay for their use.

5.5 Chapter Summary

The chapter provides some guidelines to the installation of quality tools and techniques and its recommended implementation order. These include identifying the potential firms, in general those with less than 100 employees, and the need to carry out several essential steps before the actual installation of quality tools and techniques. This chapter also identified several organizations and their role in the implementation of quality tools and techniques. This is followed by a discussion on the general implementation that is conducted in three phases, the need for evaluation of implementation and finally a brief discussion on the resources required.

Chapter 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Correlationship Between Performance and Seven Categories

The strongest correlationship among the seven categories used in the Malcolm Baldrige award criteria is between information and analysis and performance while it is weakest between leadership system and performance. The information and analysis category examine the management and the effectiveness of the use of data and information to support key company processes and the company's performance management system [57]. Among other things these would involve the measurement, collection, analysis and feedback of data and information of company processes.

In this study these came as readily available quantitative data and information generated from statistical quality control tools, to quality costing, to much less readily available or quantifiable data and information such as customer complaints, market share, productivity, and timeliness of delivery, etc. It is essentially a measure of the organization's operating and strategic business performance. Thus those organizations that not only have these data and information but make use of it would outperform others without such data and information.

A sizeable number of respondents have good leadership score but low performance score while others have just the opposite, poor leadership score but high performance score. This means a much smaller increase in the information and analysis score is all that is needed to appreciably increase the performance score compared to the increase in the leadership score required to increase the performance by the same amount. These are the respondents where the average level of quality practice is at about the level of the ISO 9000 quality system.

There is a moderately strong positive linear relationship between the variables of practice and performance with Pearson's correlation coefficient value of 0.694. Firms with higher performance scores have correspondingly higher practice scores. This in turn establishes the importance of ISO and TQM practises. The mean practice score index for the industry stands at about 36 per cent while installing only ISO 9000 results in a practice score of 34 per cent.

The SMEs are the backbone of the manufacturing industry. It was initially believed that a lot of information regarding the implementation order of quality improvement initiatives could be discovered from 'green venture' firms, but this is not so since only one case fits into this category upon examining the 'best practice-performance' model. Most of the TQM installation had taken place less than five years ago. It is expected that its contribution on performance would still be statistically insignificant and at the very least marginal.

This study concludes that the level of quality as practised by the Irish manufacturing industry is on average at the ISO level. The best group of firms in the industry are on average in the good part of humanism stage. The results of this study also indicate that a few leading Irish companies are very competitive.

There is a need for wider and more effective roles by certain organizations in this country in a concerted effort to improve the quality practises of small and medium sized firms in particular indigenous firms. This is so because a large section of the manufacturing industry in Ireland has still a long way to go in developing a company-wide approach to quality management. The whole leadership system that may have been sufficient up to the ISO level of practice must first be transformed before the total quality journey can be undertaken. Those who select, manage, and use financial and non-financial data would have a much higher performance than those who do not.

6.2 Effects of ISO 9000 and TQM Implementation

There is a decline in the number of new manufacturing firms registering for ISO 9000 since the early 1990s. Statistically significant relationships exist between the performance of firms with ISO and those without ISO registration.

A large majority of the firms have ISO 9000 registration before successfully embracing and implementing TQM. About 66 per cent are local firms without neither TQM and ISO. Just under 80 per cent of these firms have less than 100 employees.

There is a marginal increase in performance over a four-year period upon installing ISO 9000 followed by a downward trend. Upon implementing TQM programmes there is a marginal increase in mean performance score over a six year period. From the perspective of competitive advantage, firms with both ISO 9000 and TQM in place are 52 per cent better-off in performance than those firms without and are 24 per cent better-off over those with only ISO 9000. The latter is 22 per cent better-off than those without neither TQM and ISO 9000. The order of installation does not matter much at all as there are marginal differences between them.

Conclusions and Recommendations

Regardless of what critics had said in the past, whether subjective or objective, or whatever the reasons for obtaining it, the empirical results of this study point to one direction, that it pays to have ISO 9000 registration since it resulted in a 22 per cent increase in performance. In general, there could be a much higher increase in performance if the seven quality control tools are used more extensively.

Since ISO 9000 is the launching pad for a majority of firms implementing TQM, the decrease in the number of new ISO registration would mean that on the average, the level of competitiveness in the coming years would drop to the level where the manufacturing industry in general would be subjected to fierce competition from abroad. There should be a drive towards getting ISO registration and to start implementing TQM. Implementation of TQM should start not later than four years after ISO 9000 registration. Since there would be a marginal increase in mean performance score over a six year period, firms must maintain and sustain the TQM drives continuously to avoid a decline in competitiveness..

6.3 Effects of Organizational Characteristics

Competitive sectors like plastics and rubber, chemical, electrical and electronics have higher mean performance scores than the rest and are above industry average.

Firms that have larger export markets have better quality management practices.

Membership to a quality association contributes to better practice and performance. About 65 per cent of respondents are members of quality association in this study while the 1980 survey of Irish manufacturing firms recorded only nine per cent.

The mean number of techniques used increases with increase in ownership. The mean number of techniques employed in firms with less foreign ownership are below the population mean of five. Taken as a whole, there is significant difference in relationship between performance of firms who are subsidiaries or part of larger organizations and those who are operating on their own. Significant differences in practice and performance scores also occur between firms employing less than 100 employees and those with more than 100 employees. Foreign owned firms have a mean total score of 25 per cent higher than local firms. Performance of local firms improves considerably with increase in foreign content or foreign input.

The mean number of techniques employed increases when respondents seek outside help from private sector, state and both, in that order. Firms that do not seek outside help to improve quality has mean number of techniques employed below the population mean. The mean number of techniques employed increases with increase in site size. Small firms have a mean number of techniques employed which is below the population mean. Larger firms employ higher number of techniques than smaller firms.

The top three topics identified as important to their quality needs are quality auditing, quality management, and statistical methods. On average, 53 per cent conduct less than three in-house training a year. Only about six per cent of respondents have ongoing in-house training and interestingly just under 50 per cent are in firms with more than 500 employees.

Firms with higher practice and performance scores have a correspondingly higher number of quality champions. The performance scores of firms with three, or four, or five champions are marginally different. In addition, firms with higher practice and performance scores employed an increasing array of methods to communicate quality to its employees, and employ higher number of reward system.

Conclusions and Recommendations

Small firms, green ventures, jobbing industry and local firms faced a tough and uphill struggle to stay competitive and to gain from the advancement in technology and sophisticated management techniques. From the perspective of improving practice and performance, the results from the above analysis show that generally local and foreign firms should not employ less than 100 employees. Apart from site size, and being part of a larger organization, membership to a quality association apparently has a bearing on the adoption and implementation of good quality management practises and contributes to better performance than those without. There should be more and more people becoming quality champions as this would definitely improve the level of practice.

Small firms need to increase in size either through normal organic expansion or through partnerships, joint-ventures, mergers etc. Increasing foreign involvement would bring immediate benefits in the form of new and better practices, new equipment and technology. They should also seek assistance from state or private sector or both and from their customer-manufacturers in a supplier development programme. From the perspective of competitive advantage, seeking outside help from state owned agencies are better-off than from the private sector. The manufacturers on the other hand should regard its suppliers as members of their team. They should support and develop their suppliers by sending teams of experts to assist with problem-solving, training, and continuous improvement activities. This would bring benefits in terms of gain from the improvement in technology and management techniques. It would create a long-term relationship in an environment of mutual trust and respect. Firms should also become members of quality association as this would open up the window to good quality practises in the industry.

Investment in new machines and equipment for the purposes of improving productivity should be made when process based improvement techniques have been installed and practised effectively.

From the popularity of the topics covered in the training given it would be safe to conclude that the majority of the respondents are in the very early stages of the total quality transformation. There should be greater investment in employee education and training and this would be reflected in higher costs relative to turnover

6.4 Use of Selected Techniques

About 55 per cent of those employing less than three techniques are firms with less than 50 employees. The mean number of techniques employed in firms with ISO 9000 is four that is below the population mean.

Firms with higher performance scores have higher mean number of quality control tools. Larger firms employ more quality control tools than smaller firms. About 22 per cent of respondents do not employ statistical methods.

Statistically significant differences in relationship exist between practice and performance of firms and failure costs. Those with no change in the failure costs have low practice and performance scores and are below the reference score of 34 per cent.

Firms with higher practice and performance scores employed various methods of quality feedback. Larger firms employed much more feedback method than smaller firms.

The more automated the firm, the higher the mean number of techniques employed. Firms with stand-alone automated machines have mean number of techniques employed which is below the population mean. The survey recorded that about a quarter (26 per cent) of the respondents are without any form of automation and that 34 per cent of the respondents have stand-alone automated machines. Automation level is not a significant factor in improving the practice and performance of firms.

In the average firm the most likely people to be involved in integrated process and product development would be the technical staff and the quality people. Firms with higher performance scores have correspondingly more participants involved in the process. Larger firms have higher number of participants involved than smaller firms.

Total employee involvement techniques with the exception of employee suggestion and quality circle are relatively new with about 80 per cent of all installation within the last four to five years.

The respondents initially tried to adopt some form of TQC followed by just-in-time and total productive maintenance and again the former. Generally respondents have no set order to follow in implementing quality management tools and techniques. Among the 23 firms with lean production techniques, there are about an equal number implementing either reduction of inventory or reduce set-up time first followed by cellular layout with total productive maintenance last. Operational-based improvement, especially with sophisticated machines like CNCs, automated inspection or CAD or combination, appeared to be least aggressively pursued as compared to more process-based improvement techniques of recent years.

Conclusions and Recommendations

The use of analytical techniques especially those that can reduce variability are still at its basic inspection level. Little benefit if any could be generated from this 'data collection' exercise. In general the use of quality management tools and techniques selected in this study is still very low. In firms with higher number of the selected techniques installed, there is no fixed order to follow. It is realised that statistically significant results will only be observable when a series of techniques has been installed. It is recommended that firms proceed with installation of techniques only with a well-conceived long term plan. Firms should avoid unnecessary investment in automated machines and equipment to increase productivity until company-wide efforts has been made to reduce and eliminate waste. It is recommended that the installation of team-based rewards should have been made in tandem with the use of small group activities by the firm.

6.5 Techniques Implementation Order

Empirical results show the existence of two categories; techniques that are phase specific that must be implemented in a particular period, and those that are flexible that are equally likely to be implemented in each phase. In almost all the techniques, 50 per cent of cases would have their implementation by the second phase except for techniques in the third phase; waste elimination, inventory reduction, cellular layout, CAD, and benchmarking. Result of the empirical study on the implementation order is as shown in Figure 6.1 below:

1st Phase
1. Statistical method
2. Quality costing
3. Employee suggestion

3rd Phase
1. Waste elimination
2. Reduce inventory
3. Cellular layout
4. CAD
5. Benchmarking

2nd Phase
1. Customer survey
2. Quality improvement team
3. Total productive maintenance
4. Empowerment
5. Reduce set-up time
6. QFD
7. DOE
8. Automated inspection
9. CNC
10. Team-based reward
11. Quality circle

Figure 6.1 Empirical result of implementation order

Techniques in the first phase involved the core business of measuring physical variation, quantifying into monetary value, and soliciting employee participation to reduce or control this variation. The second phase uses autonomous teams to further reduce variation. The third phase may involve transformation of the entire manufacturing scenario involving values, work process, organization and so on.

One third of the potential organizations (127 cases) has practice scores below 34 per cent (equivalent to ISO level). About 80 per cent of these are firms with less than 100 employees. Just 64 per cent are indigenous firms. About 70 per cent are firms established more than 16 years ago. These groups of firms would have installed three techniques; statistical method, employee suggestion, and customer survey. Generally a firm would qualify if it only employs three techniques out of the nineteen selected for this study. This may include firms with ISO 9000 registration. There is about 60 per cent chance to qualify if the firm is a manufacturing industry with size of employment of between 20-50 employees; just under 50 per cent if the size of employment is between 51-100 and about 50 per cent if the size of employment is between 101-250. Local firms have just under 70 per cent chance to qualify. Those employing less than 100 employees have 62 per cent chance to qualify. Generally, firms from the clothing and textile industry would qualify automatically. If the main manufacturing method is either jobbing or batch the probability is 62 per cent and 50 per cent respectively.

The minimum implementation time would be three years and the maximum could be five years. In actual fact there are evidence to indicate that some firms have implemented most techniques within the first phase. While others have stretched it up to the fifth phase.

Conclusions and Recommendations

Firms intending to install TQM should first proceed to establish process control. There is solid empirical evidence established from the study to support this recommendation. Once process control is firmly established, the order of installation seemed to indicate existence of some degree of latitude in its implementation. Very simply, there is no set order that a company could follow. There are organizations that have installed many TQM techniques all in one year. While at the other extreme there are organizations that have 'added-ons' and have taken a long journey between 10-17 years. The circumstances contributing to this situation come from the confusion and uncertainty as to what, when and how to install various quality management tools and techniques. Another is the chicken and egg dilemma facing organizations in deciding which comes first transforming the organization's culture or TQM. Last but not the least leaving it up to chance to install TQM. All of these factors could have in one way or another contributed to the implementation order in Figure 6.1.

The recommended implementation order is as shown in Figure 6.2 and it occurs in three phases.

1	Statistical method	**1st Phase**
2	Quality costing	
3	Employee suggestion	
1	Customer survey	**2nd Phase**
2	QFD, DOE, QIT, QCC, Team-based reward	
3	TPM, Empowerment	
4	Reduce set-up time	
1	Waste elimination programme	**3rd Phase**
2	Reduce inventory, Cellular layout, CAD	
3	Automated inspection, CNC	
4	Benchmarking	

Figure 6.2 Recommended implementation order

The only difference between Figure 6.1 and Figure 6.2 apart from the presence of steps, is that the automated inspection and CNC are now moved to phase three. Investment in new machines and equipment should only happen after reduced inventory, cellular layout and CAD in phase three have been implemented. This is because implementation of these techniques requires little or no investment in new machines. If sophisticated and expensive machines and equipment have been acquired, they would have posed a very difficult problem for the organization to install lean production techniques. This is because installation of these lean techniques would almost invariably result in down-sizing of operations. Thus the need for investment in automated machines and equipment, automated inspection and CNC machines should only be considered in phase three after the installation of lean production techniques.

In general, if the potential organization or target user of this implementation is a firm with less than 100 employees, then it needs to increase in size since it is acknowledged that the lack of scale is the substantial barrier to growth. Otherwise the other alternatives available are through joint-venture with suitable foreign partners, mergers, partnerships, or alliances. If all the above appears unattractive especially to the owner managed firm, the other alternatives would be to be part of a supplier-development programme or to seek assistance and be in a continuous linkup with some agencies specially set-up for the purpose.

6.6 Thesis Contribution

The results of this study would contribute greatly to the understanding of quality management in the manufacturing industry. In particular to those firms intending to implement quality management tools and techniques in their total quality journey. It would also be of great benefit to those people involved in the nurturing of the competitiveness of the company and in the introduction and implementation of quality management in particular. In general, the results in this study contributed to the following:

1. The survey questionnaire and coding system could be used in future study.
2. There is a moderately strong, positive linear relationship between practice and performance. The more quality initiatives practised, the better is the chance of becoming more competitive.

3. In high performance firms, the emphasis is on teamwork and co-operation between employers and employees.
4. ISO 9000 is the launching pad for implementing TQM.
5. From the perspective of competitive advantage, the performance of firms with both ISO 9000 and TQM are 52% better off over those without; 24% over those with only ISO 9000. Those with only ISO 9000 in place are 22% better off over those without.
6. Performance of local firms improves considerably with increase in foreign ownership.
7. Firms with higher practice and performance scores employed an increasing array of methods to communicate quality to its employees, and employ higher number of elements in their reward system.
8. Membership to a quality association contributes to better practice and performance.
9. Increasing foreign involvement would bring immediate benefits in the form of new and better practices, new equipment and technology.
10. From the perspective of improving practice and performance, the results show that generally local and foreign firms should not employ less than 100 employees.
11. Firms with higher practice and performance scores employed various methods of quality feedback. Larger firms employed much more feedback method than smaller firms.
12. Investment in new machines and equipment for the purposes of improving productivity should be made when process based improvement techniques have been installed and practised effectively.

13. The number of techniques employed increases when respondents seek outside help.
14. Firms become more competitive as they install an increasing number of quality control tools.
15. Implementation of the selected quality techniques could take a minimum of three years and the maximum could be five years.
16. Firms intending to install TQM should first proceed to establish process control.
17. Implementation order of selected quality techniques developed in three phases.
18. The organizations required for the implementation of quality tools and techniques are identified and their role described.

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APPENDIX A
INDUSTRIAL SECTOR CODE CLASSIFICATION

Sector Code	Manufacturing Description
20	Food and Tobacco.
21	Beverages.
22	Leathers, Furs, Footwear.
23	Textile Industry.
24	Wearing Apparel and Made-up Textile Goods.
25	Wood and Cork Products.
26	Furniture.
27	Cellulose, Paper and Board Industries.
28	Printing and Publishing.
29	Rubber Products.
30	Plastics Products.
31-32	Chemical and Pharmaceutical Industries.
33	Non-Metallic Mineral Products.
34	Basic Metal Industry.
35-36	Metal Products.
37	Electrical, Electronic and Data Processing Equipment.
38	Precision Equipment; Instrumentation.
39	Transport Equipment.
40	Hydraulic and Pneumatic Equipment.
41	Agriculture, Horticulture, Food Industry Equipment.
42	Chemical and Plastics Plant and Equipment; Process Equipment.
43	Textile, Clothing, Leather Industry and Shoemaking Equipment.
44	Pulp and Paper Industry; Printing Machinery.
45	Mechanical Handling Equipment.
46	Heavy Industry and Metal Working Plant and Machinery.
47	Machine Tools and Accessories.
48	General Mechanical Engineering Sub-Contractors.
49	Watches, Jewellery, Toys, Office Equipment etc.

APPENDIX B
SURVEY QUESTIONNAIRE AND RESULTS

DUBLIN CITY UNIVERSITY STUDY ON QUALITY MANAGEMENT MODEL

Code #:____________
Study # 95970967Ver.2

The School Of Mechanical and Manufacturing Engineering of Dublin City University is studying Quality Management practices in the Manufacturing Industry. As part of this study, would you please fill out this questionnaire. ***Please circle or fill in the blanks provided.*** **Thank you.**

1. Industrial Group: (Please circle major group --- ONE only)

1.Chemicals & Allied Products	6.Wood & Furniture	11.Other(specify)
2.Plastics & Rubber	7.Paper & Printing	____________
3.Metal & Mech. Engineering	8.Industrial Equipment	
4.Electrical & Electronics	9.Textiles, Clothing & Footwear	
5.Food, Tobacco & Beverages	10.Clay & Building Ind. Products	

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
CHEM.	1	63	16.0	16.0	16.0
PL&RB	2	41	10.4	10.4	26.4
METAL	3	84	21.3	21.3	47.7
ELECT.	4	62	15.7	15.7	63.5
FOOD	5	49	12.4	12.4	75.9
WOOD	6	11	2.8	2.8	78.7
PA&PR	7	36	9.1	9.1	87.8
TEXT.	8	33	8.4	8.4	96.2
CLAY	9	15	3.8	3.8	100.0
	Total	394	100.0	100.0	

Valid cases 394 Missing cases 0

2. Ownership: 1. Local____% 2. Foreign____%

Value Label	Value	Frequency	Percent	Percent	Percent
LOCAL	1	206	52.3	52.7	52.7
FOREIGN	2	167	42.4	42.7	95.4
L/MAJ.	3	7	1.8	1.8	97.2
F/MAJ.	4	6	1.5	1.5	98.7
EQUAL	5	5	1.3	1.3	100.0
	9	3	.8	Missing	
	Total	394	100.0	100.0	

Valid cases 391 Missing cases 3

3.Year Founded_____

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<=5YRS	1	22	5.6	5.8	5.8
6-10YRS	2	50	12.7	13.2	19.0
11-15YRS	3	68	17.3	17.9	36.9
16-20YRS	4	79	20.1	20.8	57.8
21-25YRS	5	40	10.2	10.6	68.3
>25YRS	6	120	30.5	31.7	100.0
	9	15	3.8	Missing	
	Total	394	100.0	100.0	

Valid cases 379 Missing cases 15

4.Number of Employees on site_______

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
20-50	1	166	42.1	42.1	42.1
51-100	2	97	24.6	24.6	66.8
101-250	3	81	20.6	20.6	87.3
251-500	4	37	9.4	9.4	96.7
>501	5	13	3.3	3.3	100.0
	Total	394	100.0	100.0	

Valid cases 394 Missing cases 0

5. Approximate Turnover________$M

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<1M	1	86	21.8	26.6	26.6
1-5M	2	110	27.9	34.1	60.7
6-10M	3	83	21.1	25.7	86.4
11-20M	4	30	7.6	9.3	95.7
21-50M	5	11	2.8	3.4	99.1
51-100M	6	3	.8	.9	100.0
	9	71	18.0	Missing	
	Total	394	100.0	100.0	

Valid cases 323 Missing cases 71

6. Approximate percentage of products exported________%

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
0%	1	43	10.9	11.4	11.4
<10%	2	40	10.2	10.6	22.0
10-24%	3	36	9.1	9.5	31.5
25-49%	4	38	9.6	10.1	41.5
50-74%	5	36	9.1	9.5	51.1
75-89%	6	32	8.1	8.5	59.5
90-99%	7	82	20.8	21.7	81.2
100%	8	71	18.0	18.8	100.0
	9	16	4.1	Missing	
	Total	394	100.0	100.0	

Valid cases 378 Missing cases 16

7. Is the firm a subsidiary/part of some larger organization ? 1.YES 2.NO

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
YES	1	229	58.1	58.3	58.3
NO	2	164	41.6	41.7	100.0
	9	1	.3	Missing	
	Total	394	100.0	100.0	

Valid cases 393 Missing cases 1

8. Is the firm a member of a quality association? 1.YES 2.NO

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
YES	1	253	64.2	65.2	65.2
NO	2	135	34.3	34.8	100.0
	9	6	1.5	Missing	
	Total	394	100.0	100.0	

Valid cases 388 Missing cases 6

9. Quality registration awarded__________

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
ISO9000 SERIES	1	260	66.0	90.0	90.0
OTHER	2	26	6.6	9.0	99.0
PREPARING	3	3	.8	1.0	100.0
	9	105	26.6	Missing	
	Total	394	100.0	100.0	

Valid cases 289 Missing cases 105

10. Year awarded__________

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<1yr	0	25	6.3	9.1	9.1
1-2yr	1	33	8.4	12.0	21.0
2-3yr	2	34	8.6	12.3	33.3
3-4yr	3	40	10.2	14.5	47.8
4-5yr	4	49	12.4	17.8	65.6
5-6yr	5	34	8.6	12.3	77.9
6-7yr	6	21	5.3	7.6	85.5
7-8yr	7	14	3.6	5.1	90.6
>=8yr	8	26	6.6	9.4	100.0
	9	118	29.9	Missing	
	Total	394	100.0	100.0	

Valid cases 276 Missing cases 118

11. If the firm has introduced TQM(**YES/NO**) and/or WCM(**YES/NO**), year introduced 19____

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<2yr	1	29	7.4	35.8	35.8
2-4yr	2	24	6.1	29.6	65.4
4-6yr	3	14	3.6	17.3	82.7
>6yr	4	12	3.0	14.8	97.5
WCM<=2yr	10	2	.5	2.5	100.0
	9	313	79.4	Missing	
	Total	394	100.0	100.0	

Valid cases 81 Missing cases 313

12. The main method of manufacture: 1.Jobbing 2.Batch 3.Flow 4.Process 5.Mass

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
JOBBING	1	58	14.7	15.4	15.4
BATCH	2	200	50.8	53.1	68.4
FLOW	3	28	7.1	7.4	75.9
PROCESS	4	70	17.8	18.6	94.4
MASS	5	21	5.3	5.6	100.0
	9	17	4.3	Missing	
	Total	394	100.0	100.0	

Valid cases 377 Missing cases 17

13. How would you describe the level of automation used in production. (Circle as apply)
1.Stand-alone automated machines
2.Automated machines linked with material/tool handling system
3.Automated production lines. 4.None of these.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
STAND-ALONE AUTO M/C	1	116	29.4	34.3	34.3
AUTO M/C L/W MATL/TO	2	74	18.8	21.9	56.2
AUTO PROD LINES	3	61	15.5	18.0	74.3
NONE	4	87	22.1	25.7	100.0
	9	56	14.2	Missing	
	Total	394	100.0	100.0	

Valid cases 338 Missing cases 56

14. What is the title of the person in charge of the Quality Department?_________________

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
Q.C. MANAGER	1	17	4.3	4.4	4.4
Q.A. MANAGER	2	91	23.1	23.6	28.1
Q. MANAGER	3	124	31.5	32.2	60.3
DIR. QA	4	7	1.8	1.8	62.1
Q.CNTRLLER/COORD./S'	5	49	12.4	12.7	74.8
OTHER	6	97	24.6	25.2	100.0
	9	9	2.3	Missing	
	Total	394	100.0	100.0	

Valid cases 385 Missing cases 9

15. To whom does this person responsible for Quality normally report?__________________

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
C.E.O/PRES./OWNER	1	26	6.6	6.8	6.8
MAN. DIR./V.PRES.	2	174	44.2	45.3	52.1
GEN. MANAGER	3	65	16.5	16.9	69.0
OPER./P. MANAGER	4	61	15.5	15.9	84.9
OTHER	5	58	14.7	15.1	100.0
	9	10	2.5	Missing	
	Total	394	100.0	100.0	

Valid cases 384 Missing cases 10

16. Please state numbers of Quality personnel in the following categories:
1. Management____ 3. Supervisory____ 5. Technician_____
2. Engineer/Scientist____ 4. Inspector____ 6. Clerical_______

Dichotomy label	Name	Count	Pct of Responses	Pct of Cases
MANAGEMENT	MGMTPERS	303	35.7	83.0
ENGINEERING	ENGRPERS	93	11.0	25.5
SUPERVISORY	SPVISORY	157	18.5	43.0
INSPECTORS	INSPETOR	104	12.2	28.5
TECHNICIAN	TECNCIAN	97	11.4	26.6
CLERICAL	CLERICAL	95	11.2	26.0
	Total responses	849	100.0	232.6

29 missing cases; 365 valid cases

17. Who is your company's Champion(s) of Quality? (Circle as many as apply):
1.Managing Director 3.Quality Manager 5.Supervisor 7.None
2.Factory Manager 4.Engineering Manager 6.Everyone

Champions of Quality	count	% of responses	% of cases
Quality Manager	270	32.5	70.3
Managing Director	225	27	58.6
Factory Manager	149	17.9	38.8
Supervisor	115	13.8	30
Engineering Manager	53	6.4	13.8
Everyone	12	1.4	3.1
None	8	1	2.1
Total responses	832	100	216.7

Missing cases	10	2.50%
Valid cases	384	97.50%
Total cases	394	100%

18. The firm's views on quality are made known to employees (Circle as many as apply)

1.By Printed Statement	4.By Quality Manual	7.Verbally
2.By Company Rule Book	5.By Regular Meeting	8.Newsletter
3.By New Employee Training	6.By Quality Campaign	

Views on quality	Count	% of cases	% of responses
1 Quality manual	291	74	20
2 Employee training	267	67	18
3 Verbally	265	68	18
4 Printed statement	232	59	16
5 Meeting	212	54	15
6 Campaign	77	20	5
7 Company rulebook	69	18	5
8 Newsletter	48	12	3
Total responses	1461	372	100
Missing cases	1		
Valid cases	393		
Total cases	394		

19. Who deals with customer complaints? (Circle as many as apply)

1.Senior Management	3.Quality Assurance	5.Sales/Marketing
2.Production	4.Engineering	6.Tech./Customer Services

Dealing with complaints		Count	% of responses	% of cases
Assurance	30%	278	30%	70.90%
Snr. mgmt.	24%	224	24.20%	57.10%
Sales/marktng	21%	192	20.80%	49.00%
Production	15%	139	15.00%	35.50%
Engineering	8%	74	8.00%	18.90%
Tech/service	2%	18	1.90%	4.60%
Total responses		925	100	236.00%
Missing cases		2		
Valid cases		392		
Total cases		394		

20. Which of the following reward system is practised by your company:
(Circle as many as apply)

1.Merit Pay	4.Team Incentives	7.Retirement
2.Profit Sharing	5.Stock Ownership	8.Health Care
3.Achievement Award	6.Vacation	9.Bonus

Reward system		count	% of responses	% of cases
Bonus	30%	176	30%	58.10%
Merit pay	15%	87	15%	28.70%
Health care	13%	73	12.50%	24.10%
Team incentives	10%	56	9.60%	18.50%
Achievement award	8%	48	8.20%	15.80%
Retirement	8%	46	7.80%	15%
Profit sharing	7%	40	6.80%	13%
Stock ownership	6%	35	6%	11.60%
Vacation	4%	25	4.30%	8%
Total responses	586		100	193.4
Missing cases	91			
Valid cases	303			
Total cases	394			

21. If written instruction sheets are used in production, do these instructions specify:
(Circle as many as apply)

1.Methods?	3.Allowed Time?	5.Machines?
2.Materials?	4.Quality Requirements?	6.Inspection Procedures?

	Count	Pct of Responses	Pct of Cases
Methods	295	20.5	80.4
Materials	300	20.8	81.7
Allowed time	99	6.9	27
Quality reqd	279	19.4	76
Machines used	206	14.3	56.1
Inspection procedure	261	18.1	71.1
Total responses	1440	100	392.4
missing cases	27		
valid cases	367		
Total cases	394		

22. What amount of inspection does your company practices for: (Circle where apply)

	100% (all items)	Sampling Inspection	Spot Checks	No Fixed Rules
1.Incoming goods	1	2	3	4
2.In-process goods?	1	2	3	4
3.Finished goods?	1	2	3	4

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
100%	1	72	18.3	18.5	18.5
SAMPLING INSPECTION	2	185	47.0	47.6	66.1
SPOT CHECKS	3	84	21.3	21.6	87.7
NO FIXED RULES	4	32	8.1	8.2	95.9
SAMPLING & SPOT CHEC	5	6	1.5	1.5	97.4
100% & SAMPLING INSP	6	10	2.5	2.6	100.0
	9	5	1.3	Missing	
	Total	394	100.0	100.0	

Valid cases 389 Missing cases 5

INPROSES INPROCESS GOODS

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
100%	1	102	25.9	26.3	26.3
SAMPLING INSPECTION	2	176	44.7	45.4	71.6
SPOT CHECKS	3	63	16.0	16.2	87.9
NO FIXED RULES	4	15	3.8	3.9	91.8
SAMPLING & SPOT CHEC	5	14	3.6	3.6	95.4
100% & SAMPLING INSP	6	18	4.6	4.6	100.0
	9	6	1.5	Missing	
	Total	394	100.0	100.0	

Valid cases 388 Missing cases 6

FINISHED FINISHED GOODS

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
100%	1	151	38.3	39.0	39.0
SAMPLING INSPECTION	2	163	41.4	42.1	81.1
SPOT CHECKS	3	39	9.9	10.1	91.2
NO FIXED RULES	4	10	2.5	2.6	93.8
SAMPLING & SPOT CHEC	5	4	1.0	1.0	94.8
100% & SAMPLING INSP	6	20	5.1	5.2	100.0
	9	7	1.8	Missing	
	Total	394	100.0	100.0	

Valid cases 387 Missing cases 7

23. Which of the following has been your company's <u>regular</u> source of feedback regarding quality? (Circle as many as apply)

1.Inspection?	4.Returned Goods?	7.Quality audits?
2.Delivery Time?	5.Machine Breakdown?	8.Costs of Quality?
3.Benchmarking Competitor	6.Customer Survey?	9.Customer Complaint

Quality feedback Name	Pct of Responses	Pct of Cases	Count
Inspection	27	88	344
Quality audit	18.9	62	241
Returned goods	17.7	57	225
Delivery time	9.6	31	122
Customer survey	9.4	31	120
Quality cost	9.4	30	119
Machine breakdown	3.5	11	44
Benchmarking	3.4	11	43
Customer complaint	1.1	4	14
Total responses	100	325	1272

missing cases	2
valid cases	392
Total cases	394

24. Apart from running their own machine, operators in your company are also responsible for:(Circle as many as apply)

1.Machine set-ups	3.Job Scheduling	5.Preventive Maintenance
2.Material handling	4.Running Other Machines	6.Operating Control Charts

Responsibility	Count	Pct of Responses	Pct of Cases
Material handling.	250	25.7	70
Machine setup	243	25	68.1
Run other machine	163	16.8	45.7
Operate chart	146	15	40.9
Maintenance	131	13.5	36.7
Job scheduling	39	4	10.9
Total responses	972	100	272.3

missing cases	37
valid cases	357
Total cases	394

25. Which of these participate in **Process-Improvement(P.I.)** and ***Product Development(P.D.)*** (Circle as many as apply)

	P.I.	***P.D.***		**P.I.**	***P.D.***		**P.I.**	***P.D.***
1.Production	1	2	4.R&D	1	2	7.Marketing/Sales	1	2
2.Supplier	1	2	5.Quality	1	2	8.Technical Staff	1	2
3.Purchasing	1	2	6.Customer	1	2	9.Parent Company	1	2

	Process improvement Count			Product development Count			Both P.I & P.D. Count		
	P.I. only	Pct of Responses	Pct of Cases	P.D. only	Pct of Responses	Pct of Cases	both PI&P	Pct of Response	Pct of Cases
Production	148	30.6	67	7	1.5	3.1	157	17.1	54.7
Quality	99	20.5	44.8	11	2.3	4.9	173	18.8	60.3
Technical staff	48	9.9	21.7	28	5.9	12.6	173	18.8	60.3
Sales marketing	16	3.3	7.2	120	25.3	53.8	61	6.6	21.3
R & D	13	2.7	5.9	65	13.7	29.1	116	12.6	40.4
Customer	31	6.4	14	90	18.9	40.4	68	7.4	23.7
Supplier	55	11.4	24.9	73	15.4	32.7	34	3.7	11.8
Purchasing	61	12.6	27.6	45	9.5	20.2	55	6	19.2
Parent company	13	2.7	5.9	36	7.6	16.1	83	9	28.9
Total responses	484	100	219	475	100	213	920	100	320.6

26. Who specifies materials/components used? (Circle as many as apply)

1.R&D Dept.	4.Quality Dept.	7.Engineering Dept.
2.Purchasing Dept.	5.Customer	8.Sales & Marketing
3.Production Dept.	6.Parent Company	

Name	Count	Pct of Responses	Pct of Cases
Quality	178	17.6	46.2
Production	166	16.4	43.1
Customer	148	14.7	38.4
Purchasing	147	14.6	38.2
R&D	146	14.5	37.9
Engineering	137	13.6	35.6
Parent company	82	8.1	21.3
Sales marketing	6	0.6	1.6
Total responses	1010	100	262.3
missing cases	9		
valid cases	385		
Total cases	394		

27. If your company evaluate suppliers, is this based on: (Circle as many as apply)

1.Goods Inwards Inspection
2.Past Records?
3.Test Records provided by Supplier
4.Visit(s) to and examination of suppliers quality arrangements
5.Evaluation by Parent Company?
6.Accreditation to ISO 9000

Supplier evaluation Name	Count	% of Cases	Pct of Responses
1.Incoming inspection	290	76	29
2.Past records	290	76	29
3.Visit supplier	228	60	22.8
4.Supplier's test records	142	37	14.2
5.Parent company	45	12	4.5
6.Other (accreditation)	4	1	0.4
Total responses	999	261.5	100
missing cases	12		
valid cases	382	97%	
Total cases	394		

28. Which of the following statistical methods are used? (Circle as many as apply)

1.Control charts
2.Trend/Run Charts
3.Process Capability Analysis
4.Sampling Plan
5.Scatter Diagrams
6.Pareto Analysis
7.Histograms
8.Cause & Effect Diagram
9.None

Statistical Methods	count	% of responses	% of cases
Sampling	201	23.6	65.3
Control charts	173	20.3	56.2
Histogram	107	12.6	34.7
Pareto analysis	106	12.4	34.4
Trend/Run charts	104	12.2	33.8
Process capability analysis	91	10.7	29.5
Cause & effect	54	6.3	17.5
Scatterdiagram	16	1.9	5.2
Total responses	852	100	276.6
Missing cases	86	21.80%	
Valid cases	308	78.20%	
Total cases	394	100.00%	

29. Who examines these statistical informations? (Circle as many as apply)

1.Production Workers	4.Inspectors	7.Senior Management
2.Supervisors	5.Department Manager	8.Other(specify)
3.Foremen	6.Technical Staff	______________

Statistical informatio	Count	Pct of Responses	Pct of Cases
Snr. mgmt.	224	26.7	72.3
Dept. managers	190	22.6	61.3
Supervisors	163	19.4	52.6
Technical staff	129	15.4	41.6
Production workers	100	11.9	32.3
Foremen	33	3.9	10.6
Total responses	839	100	270.6
missing cases	84		
valid cases	310		
Total cases	394		

30. If your company had engaged external help to improve quality during the past three(3) years, please rate its usefulness in meeting the company's quality needs.(Circle as apply).

	Not at all Useful	Not very Useful	Somewhat Useful	Very Useful
1.Govt owned	1	2	3	4
2.Private	1	2	3	4
3.None				

Outside help	count	% of cases	satisfied
State	28	7	81%
Both	61	16	
Private	123	31	94%
None	182	46	
Valid cases	212	54%	
Missing cases	182	46%	
Total cases	394	100%	

31. If your company had provided Quality training for Quality personnel, which of the following topics were covered?(Circle as many as apply).

1.Quality Management	4.Interpersonal Skills	7.Total Productive Maintenance
2.Statistical Methods	5.Quality Auditing	8.Quality Function Deployment
3.Design of Experiment	6.Failure Mode Effect Analysis	9.Customer Satisfaction

Dichotomy label	Count	Pct of Responses	Pct of Cases
Quality management	250	24.6	74.9
Statistical methods	141	13.9	42.2
DOE	37	3.6	11.1
Interpersonal skills	119	11.7	35.6
Quality audit	286	28.1	85.6
FMEA	55	5.4	16.5
TPM	63	6.2	18.9
QFD	65	6.4	19.5
Customer satisfaction	2	0.2	0.6
Total responses	1018	100	304.8
missing cases	59		
valid cases	335		

32. Refering to codes 1-8 in Question 31, select three(3) topics (not in any particular order) important to your firm's quality needs today:(Please print on the spaces provided).

1.For Manufacturing Staff — 2.For Non-Manufacturing Staff

1. ___ — 1. ___
2. ___ — 2. ___
3. ___ — 3. ___

	Training Needs	manuf	non manuf	both
1	Quality audit	58	79	61
2	Quality mgmt	52	64	99
3	Statistical method	66	35	38
4	Interpersonal skills	50	70	82
5	QFD	30	40	18
6	TPM	123	19	17
7	FMEA	45	33	23
8	DOE	27	29	6
9	Customer	3	3	4
	missing cases	145		
	valid cases	249		

33. Approximately how many times does your company conduct in-house quality training in:
1.1994______ 2.1995______ 3.1996______

INHOUS94 inhouse 1994 training

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	139	35.3	56.7	56.7
3-7	2	65	16.5	26.5	83.3
8-12	3	16	4.1	6.5	89.8
>12	4	12	3.0	4.9	94.7
ONGOING	5	13	3.3	5.3	100.0
	9	149	37.8	Missing	
	Total	394	100.0	100.0	

Valid cases 245 Missing cases 149

INHOUS95 INHOUSE 1995 TRAINING

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	152	38.6	55.9	55.9
3-7	2	72	18.3	26.5	82.4
8-12	3	20	5.1	7.4	89.7
>12	4	15	3.8	5.5	95.2
ONGOING	5	13	3.3	4.8	100.0
	9	122	31.0	Missing	
	Total	394	100.0	100.0	

Valid cases 272 Missing cases 122

INHOUS96 INHOUSE 1996 TRAINING

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	139	35.3	47.0	47.0
3-7	2	86	21.8	29.1	76.0
8-12	3	25	6.3	8.4	84.5
>12	4	19	4.8	6.4	90.9
ONGOING	5	27	6.9	9.1	100.0
	9	98	24.9	Missing	
	Total	394	100.0	100.0	

Valid cases 296 Missing cases 98

34. In 1995, on the average, how many days of quality training each employee received?

	1.Off-the-job	2.On-the-job
1. For Manufacturing Staff	____	____
2. For Non-Manufacturing Staff	____	____

MANUFON Manufacturing ON-THE-JOB

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	121	30.7	45.1	45.1
3-7	2	84	21.3	31.3	76.5
8-12	3	28	7.1	10.4	86.9
>12	4	19	4.8	7.1	94.0
ONGOING	5	16	4.1	6.0	100.0
	9	126	32.0	Missing	
	Total	394	100.0	100.0	

Valid cases 268 Missing cases 126

MANUFOFF Manufacturing OFF-THE-JOB

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	122	31.0	67.4	67.4
3-7	2	39	9.9	21.5	89.0
8-12	3	8	2.0	4.4	93.4
>12	4	3	.8	1.7	95.0
ONGOING	5	9	2.3	5.0	100.0
	9	213	54.1	Missing	
	Total	394	100.0	100.0	

Valid cases 181 Missing cases 213

NOMANUON Non manufacturing ON-THE-JOB

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	113	28.7	53.1	53.1
3-7	2	62	15.7	29.1	82.2
8-12	3	12	3.0	5.6	87.8
>12	4	14	3.6	6.6	94.4
ONGOING	5	12	3.0	5.6	100.0
	9	181	45.9	Missing	
	Total	394	100.0	100.0	

Valid cases 213 Missing cases 181

NOMANOFF Non manufacturing OFF-THE-JOB

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	118	29.9	64.1	64.1
3-7	2	42	10.7	22.8	87.0
8-12	3	8	2.0	4.3	91.3
>12	4	7	1.8	3.8	95.1
ONGOING	5	9	2.3	4.9	100.0
	9	210	53.3	Missing	
	Total	394	100.0	100.0	

Valid cases 184 Missing cases 210

35. On the average, what is the number of employee suggestions per employee per year?
__________nos./employee/year

SUGGEST EMPLOYEE SUGG.

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	130	33.0	63.1	63.1
3-7	2	47	11.9	22.8	85.9
8-12	3	17	4.3	8.3	94.2
>12	4	12	3.0	5.8	100.0
	9	188	47.7	Missing	
	Total	394	100.0	100.0	

Valid cases 206 Missing cases 188

36. Approximately how many times has your company been inspected for quality by any customer or on behalf of any customer in: 1.1994____ 2.1995____ 3.1996____

AUDIT94 QUALITY AUDIT 94

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	106	26.9	40.9	40.9
3-7	2	112	28.4	43.2	84.2
8-12	3	24	6.1	9.3	93.4
>12	4	17	4.3	6.6	100.0
	9	135	34.3	Missing	
	Total	394	100.0	100.0	

Valid cases 259 Missing cases 135

AUDIT95 QUALITY AUDIT 95

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	102	25.9	36.7	36.7
3-7	2	122	31.0	43.9	80.6
8-12	3	31	7.9	11.2	91.7
>12	4	23	5.8	8.3	100.0
	9	116	29.4	Missing	
	Total	394	100.0	100.0	

Valid cases 278 Missing cases 116

AUDIT96 QUALITY AUDIT 96

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<3	1	99	25.1	35.2	35.2
3-7	2	129	32.7	45.9	81.1
8-12	3	26	6.6	9.3	90.4
>12	4	27	6.9	9.6	100.0
	9	113	28.7	Missing	
	Total	394	100.0	100.0	

Valid cases 281 Missing cases 113

37. If your company has quality improvement teams at shop floor level, on the average, how often do they meet in a week?________times/week.

IMPRTEAM TEAM MEETINGS

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<2PER WEEK	1	130	33.0	89.0	89.0
2-4PER WEEK	2	7	1.8	4.8	93.8
>4PER WEEK	3	9	2.3	6.2	100.0
	9	248	62.9	Missing	
	Total	394	100.0	100.0	

Valid cases 146 Missing cases 248

38. If your company measure the cost of maintaining current quality levels, in what range (relative to turnover) do these costs lie? ______________%

COSRANGE COSTS OF QUALITY

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<=5%	1	116	29.4	84.7	84.7
6-10%	2	14	3.6	10.2	94.9
11-15%	3	5	1.3	3.6	98.5
16-20%	4	1	.3	.7	99.3
>26%	6	1	.3	.7	100.0
	9	257	65.2	Missing	
	Total	394	100.0	100.0	

Valid cases 137 Missing cases 257

39. Estimate your company's failure losses in % of production costs arising from:

1.Faulty Material?____% 4.Rejected Products?____%
2.External Repair?____% 5.Rework?____%
3.Warranty/Repair?____% 6.Scrap?____% 7.Complaints?____%

		count	%	valid %	cum
Faulty Material	<0.25%	55	14	26.6	26.6
	0.25-0.75%	24	6.1	11.6	38.2
	0.75-1.5%	40	10.2	19.3	57.5
	1.5-3%	35	8.9	16.9	74.4
	3-5%	14	3.6	6.8	81.2
	>5%	39	9.9	18.8	100
External Repair	<0.25%	63	16	48.5	48.5
	0.25-0.75%	10	2.5	7.7	56.2
	0.75-1.5%	16	4.1	12.3	68.5
	1.5-3%	20	5.1	15.4	83.8
	3-5%	5	1.3	3.8	87.7
	>5%	16	4.1	12.3	100
Warranty Repair	<0.25%	57	14.5	44.2	44.2
	0.25-0.75%	8	2	6.2	50.4
	0.75-1.5%	23	5.9	17.8	68.2
	1.5-3%	16	4.1	12.4	80.6
	3-5%	8	2	6.2	86.8
	>5%	17	4.3	13.2	100
Rejected Products	<0.25%	42	10.7	17.6	17.6
	0.25-0.75%	27	6.9	11.3	28.9
	0.75-1.5%	55	14	23	51.9
	1.5-3%	41	10.4	17.2	69
	3-5%	30	7.6	12.6	81.6
	>5%	44	11.2	18.4	100

Rework	<0.25%	28	7.1	13	13
	0.25-0.75%	24	6.1	11.1	24.1
	0.75-1.5%	37	9.4	17.1	41.2
	1.5-3%	51	13	23.6	64.8
	3-5%	24	6.1	11.1	75.9
	>5%	52	13.2	24.1	100
Scrap	<0.25%	32	8.1	15.4	15.4
	0.25-0.75%	26	6.6	12.5	27.9
	0.75-1.5%	40	10.2	19.2	47.1
	1.5-3%	39	9.9	18.8	65.9
	3-5%	30	7.6	14.4	80.3
	>5%	41	10.4	19.7	100
Complaints	<0.25%	54	13.7	29	29
	0.25-0.75%	25	6.4	13.4	42.5
	0.75-1.5%	45	11.5	24.2	66.7
	1.5-3%	24	6.1	12.9	79.6
	3-5%	11	2.8	5.9	85.5
	>5%	27	6.9	14.5	100

40. Failure costs, compared to 3-5 years ago:
1.Increases by ____% 2.Decreases by ____% 3.No Change

Costs 3-5yrs	Down by<10%	56	14.2	19.8	19.8
	Down by 10-20%	27	6.9	9.5	29.3
	Down by 20-30%	24	6.1	8.5	37.8
	Down by >30%	55	14	19.4	57.2
	Unchange	107	27.2	37.8	95.1
	Up by<10%	10	2.5	3.5	98.6
	Up by 11-20%	3	0.8	1.1	99.6
	Missing	110	28	Missing	
	Total	393	100	100	

41. On average, what percentage of incoming goods are rejected in a week?
____%/week

INGOODS % GOODS REJECTED

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<0.005%	1	112	28.4	32.7	32.7
0.005-0.009%	2	2	.5	.6	33.2
0.010-0.019%	3	6	1.5	1.7	35.0
0.020-0.099%	4	15	3.8	4.4	39.4
0.10-0.49%	5	32	8.1	9.3	48.7
0.5-1.0%	6	53	13.5	15.5	64.1
1-5%	7	92	23.4	26.8	91.0
>5%	8	31	7.9	9.0	100.0
	9	51	12.9	Missing	
	Total	394	100.0	100.0	

Valid cases 343 Missing cases 51

42. On <u>average</u>, what percentage of <u>outgoing</u> goods are returned in a week? ____%/week

OUTGOING % GOODS RETURN

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
<0.005%	1	112	28.4	32.8	32.8
0.005-0.009%	2	1	.3	.3	33.1
0.010-0.019%	3	11	2.8	3.2	36.4
0.020-0.099%	4	26	6.6	7.6	44.0
0.10-0.49%	5	45	11.4	13.2	57.2
0.5-1%	6	57	14.5	16.7	73.9
1-5%	7	75	19.0	22.0	95.9
>5%	8	14	3.6	4.1	100.0
	9	53	13.5	Missing	
	Total	394	100.0	100.0	

Valid cases 341 Missing cases 53

43. If the following has been implemented, please circle its contribution to **improving quality** on the lines provided. (For **None** circle 1)

QUALITY INITIATIVES	None	YEAR IMPLEMENTED Year	IMPROVED QUALITY Major Deterioration	Minor Deterioration	No Change	Minor Improvement	Major Improvement
1.Automated Inspection	1	19___	1	2	3	4	5
2.Benchmarking	1	19___	1	2	3	4	5
3.CNC Machines	1	19___	1	2	3	4	5
4.Cellular Layout of Machines	1	19___	1	2	3	4	5
5.Computer Aided Design	1	19___	1	2	3	4	5
6.Customer Surveys	1	19___	1	2	3	4	5
7.Design of Experiment	1	19___	1	2	3	4	5
8.Phase Reduction of Inventory	1	19___	1	2	3	4	5
9.Quality Costing System	1	19___	1	2	3	4	5
10.Quality Function Deployment	1	19___	1	2	3	4	5
11.Set-up-time Reduction	1	19___	1	2	3	4	5
12.Statistical Methods	1	19___	1	2	3	4	5
13.Total Productive Maintenance	1	19___	1	2	3	4	5

	Quality Mgmt. Initiatives	No. of Cases (N=394)	Percentage (N=394)
1	Statistical Method	182	46.20
2	Customer Survey	162	41.10
3	Quality Costing	135	34.30
4	Phased Reduction-Inventory	119	30.20
5	Total Productive Maintenance	115	29.20
6	Set-up Time Reduction	110	28.00
7	Computer Aided Design	108	27.40
8	Cellular Layout of Machines	83	21.10
9	Q. Function Depl. (QFD)	82	20.80
10	Benchmarking	73	18.50
11	Automated Inspection	55	14.00
12	Comp. Numerical Ctrl. M/cs	55	14.00
13	Design of Experiment (DOE)	54	13.70

Group of 13 quality initiatives

Category label	Code	Count	Pct of Responses	Pct of Cases
MAJ.DETERIORATION	1	2	.2	.7
MIN.DETERIORATION	2	4	.4	1.5
NO CHANGE	3	170	15.3	63.0
MIN.IMPROVEMENT	4	514	46.2	190.4
MAJ.IMPROVEMENT	5	422	37.9	156.3
		-------	-----	-----
	Total responses	1112	100.0	411.9

124 missing cases; 270 valid cases

44. If the following has been implemented, please circle its contribution to **improving employee involvement** on the lines provided. (For None circle 1)

QUALITY INITIATIVES	**None**	YEAR IMPLEMENTED **Year**	**EMPLOYEE INVOLVEMENT** **Major Deterioration**	**Minor Deterioration**	**No Change**	**Minor Improvement**	**Major Improvement**
1.Employee Suggestion	1	19___	1	2	3	4	5
2.Empowerment(self-directed work teams)	1	19___	1	2	3	4	5
3.Quality Circles	1	19___	1	2	3	4	5
4.Quality Improvement Teams	1	19___	1	2	3	4	5
5.Team-Based Rewards	1	19___	1	2	3	4	5
6.Waste Elimination Program	1	19___	1	2	3	4	5

Quality Mgmt. Initiatives	**No. of Cases (N=394)**	**Percentage (N=394)**
1 Employee Suggestion	166	42.13
2 Waste Elimination	143	36.30
3 Quality Improvement Team	139	35.30
4 Empowerment	109	27.70
5 Reward System	55	14.00
6 Quality Control Circles (QCs)	49	12.40

Group of 6 quality initiatives

Category label	Code	Count	Pct of Responses	Pct of Cases
MAJOR DETERIORATION	1	2	.4	.8
MINOR DETERIORATION	2	2	.4	.8
NO CHANGE	3	79	14.3	33.5
MINOR IMPROVEMENT	4	289	52.3	122.5
MAJOR IMPROVEMENT	5	181	32.7	76.7
	Total responses	553	100.0	234.3

158 missing cases; 236 valid cases

45. Implementation of these Quality Initiatives has resulted in the following:(Please circle your response)

	Major Deterioration	**Minor Deterioration**	**No Change**	**Minor Improvement**	**Major Improvement**
1. Attendance	1	2	3	4	5
2. Customer Complaints	1	2	3	4	5
3. Employee Turnover	1	2	3	4	5
4. Lead Times	1	2	3	4	5
5. Market Share	1	2	3	4	5
6. Productivity	1	2	3	4	5
7. Timeliness of Delivery	1	2	3	4	5

Category label	Code	Count	Pct of Responses	Pct of Cases
MAJOR DETERIORATION	1	5	.3	1.8
MINOR DETERIORATION	2	45	2.9	16.5
NO CHANGE	3	493	31.8	181.3
MINOR IMPROVEMENT	4	599	38.7	220.2
MAJOR IMPROVEMENT	5	406	26.2	149.3
		-------	-----	-----
	Total responses	1548	100.0	569.1

122 missing cases; 272 valid cases

46. If the result of the implementation **falls** short of expectation, please suggest **three(3) major** reasons for this.

Dichotomy label	Count	Pct of Responses	Pct of Cases
WEAK LEADERSHIP & COMMITMENT	38	21.6	51.4
LACK OF AWARENESS	35	19.9	47.3
LACK OF QUALIFIED PERSONNEL	18	10.2	24.3
LACK KNOWLEDGE ON QUALITY INITIATIVES	12	6.8	16.2
POOR COMMUNICATION & FEEDBACK	22	12.5	29.7
OBJECTIVES NOT CLEAR	16	9.1	21.6
LACK EMPHASIS ON HUMAN FACTORS	17	9.7	23.0
LACK OF COOPERATION & SUPPORT	18	10.2	24.3
	-------	-----	-----
Total responses	176	100.0	264.9

THANK YOU FOR YOUR CO-OPERATION

APPENDIX C
SCORING SYSTEM

1 Leadership(110)

1.1	Leadership System(80)	Questions: 8,9,11,17,18,30
1.2	Company Responsibility and Citizenship(30)	nil

Ranking in decreasing order of importance to overall company's quality position.

	Weights	Points
Question 17	100%	(100/400)*80=20
Question 18	100%	(100/400)*80=20
Question 11	80%	(080/400)*80=16
Question 9	80%	(080/400)*80=16
Question 30	20%	(020/400)*80=4
Question 8	20%	(020/400)*80=4
Total	400%	

Question 8(4pt.)
Member of Quality Association

Yes	4
No	0

Question 9(16pt.)
Quality Registration

ISO 9000 Series	16
Other	4
Preparing	4

Question 11(16pt.)

Introduced TQM/WCM	16

Question 17(20pts.)

Managing Director Champion	8
Factory Manager Champion	3
Quality Manager Champion	3
Engineering Manager Champion	3
Supervisor Champion	3
Everyone Champion	20
No Champion	0

Question 18(20pts.)

By Printed Statement	2
By Company Rulebook	2
By New Employee Training	2
By Quality Manual	3
By Regular Meeting	3

By Quality Campaign	4
Verbally	2
Newsletter	2

Question 30(4pts.)

State-Owned	2
Private	2
None	0

2 Strategic Planning(80)

2.1 Strategy Development Process(40) 13,43(3-5,8-9,11)
2.2 Company Strategy(40) nil

Questions: 13,43(3-5,8-9,11)

Level of Automation	5.7
CNC Machines	5.7
Cellular Layout of Machines	5.7
Computer Aided Design	5.7
Phase-Reduction of Inventory	5.7
Quality Costing System	5.7
Set-up Time Reduction	5.7

3 Customer and Market Focus(80)

3.1 Customer and Market Knowledge(40) 43(6)
3.2 Customer Satisfaction and Relationship Enhancement(40) 19

Question: 43(6)(40pts.)

Customer Surveys	40

Question: 19(40pts.)

Senior Management	7
Production	7
Quality Assurance	7
Engineering	7
Sales/Marketing	6
Tech./Customer Services	6

4 Information and Analysis(80)

4.1 Selection and Use of Information and Data(25) 29
4.2 Selection and use of Comparative Information and Data(15) 43(2)

4.3 Analysis and Review of Company Performance(40) 23,28,38,39,40,45(1-7)

Question: 29(25pts.)	
Production Workers	3
Supervisors	3
Foremen	3
Inspectors	3
Department Managers	4
Technical Staff	4
Senior Management	5

Question: 43(2)(15pts.)	
Benchmarking	15

Questions: 23,28,38-40,45(1-7)(40pts.)

Question 23	
Inspection	1
Delivery Time	1
Benchmarking Competitor	3
Returned Goods	1
Machine Breakdown	1
Customer Survey	3
Quality Audits	2
Costs of Quality	2
Customer Complaint	1

Question 28	
Control Charts	1
Trend/Run Charts	1
Process Capability Analysis	1
Sampling Plan	1
Scatterdiagram	1
Pareto Analysis	1
Histogram	1
Cause & Effect Diagram	1

Question 38	
Costs of Maintaining Current Quality Levels	1

Question 39	
Faulty Material	1
External Repair	1
Warranty Repair	1
Rejected Products	1
Rework	1

Scrap	1
Complaints	1

Question 40	
Increased	1
Decreased	1
No Change	0

Question 45	
Attendance	1
Customer Complaints	1
Employee Turnover	1
Lead Times	1
Market Share	1
Productivity	1
Timeliness of Delivery	1

5 Human Resource Development and Management(100)

5.1 Work Systems(40) 20,21,24,37,43(7,10),44(2-6)

5.2 Employee Education, Training, and Development(30) 31,32,33,34

5.3 Employee Well-Being and Satisfaction(30) 35

Questions: 20,21,24,37,43(7,10),44(2-6)(40pts.)

Question 20	
Merit Pay	1
Profit Sharing	1
Achievement Award	1
Team Incentives	1
Stock Ownership	1
Vacation	1
Retirement	1
Health care	1
Bonus	1

Question 21	
Methods	1
Materials	1
Allowed Time	1
Quality Requirements	1
Machines	1
Inspection Procedures	1

Question 24	
Machine Set-Ups	1
Material Handling	1

Job Scheduling	1
Running Other Machines	1
Preventive Maintenance	1
Operating Control Charts	1

Question 37

Quality Improvement Teams	3

Question 43

Design of Experiment	4
Quality Function Deployment	4

Question 44

Empowerment	2
Quality Circles	2
Team-Based Rewards	2
Waste Elimination Program	2

Questions: 31-34(30pts.)

Question 31

Quality Management	1
Statistical Methods	1
Design of Experiment	2
Interpersonal Skills	1
Quality Auditing	1
Failure Mode and Effect Analysis	2
Total Productive Maintenance	2
Quality Function Deployment	2
Customer Satisfaction	2

Question 32

One Point For Each Response	1
One Point For Each Response	1
One Point For Each Response	1
One Point For Each Response	1
One Point For Each Response	1
One Point For Each Response	1

Question 33

In-House Training '94	2
In-House Training '95	2
In-House Training '96	2

Question 34

One Point For Each Response	1
One Point For Each Response	1
One Point For Each Response	1

One Point For Each Response	1

Questions: 35(30pts.)

Question 35	
Employee Suggestion	30

6 Process Management(100)

6.1	Management of Product and Service Processes(60)	22,25,26,42,43(1,12)	
6.2	Management of Support Processes(20)	43(13)	
6.3	Management of Supplier and Partnering Processes(20)		27,41

Questions: 22,25,26,42,43(1,12)(60pts.)

Question 22	
100%	1
Sampling Inspection	1
Spot Checks	1
No Fixed Rules	0
Sampling & Spot Checks	1
100% & Sampling Inspection	1

Question 25 (P.I=1;P.D=1;Both=2)	
Production	4(1,1,2)
Supplier	4(1,1,2)
Purchasing	4(1,1,2)
R&D	4(1,1,2)
Quality	4(1,1,2)
Customer	4(1,1,2)
Marketing/Sales	4(1,1,2)
Technical Staff	4(1,1,2)
Parent Company	4(1,1,2)

Question 26	
R&D Dept.	1
Purchasing Dept.	1
Production Dept.	1
Quality Dept.	1
Customer	1
Parent Company	1
Engineering Dept.	1
Sales/Marketing	1

Question 42	
% of Outgoing Goods Returned	1

Question 43	
Automated Inspection	4
Statistical Methods	4

Question 43(13)	
Total Productive Maintenance	20

Questions: 27,41(20pts.)

Question 27	
Goods Inwards Inspection	2
Past Records	2
Test Records	3
Supplier Quality Arrangements	4
Parent Company	2
Accreditation to ISO	4

Question 41	
% of Incoming Goods Rejected	3

7 Business Results(450)

7.1	Customer Satisfaction Results(130)	42,43(6),45(2)
7.2	Financial and Market Results(130)	6,45(5)
7.3	Human Resource Results(35)	33-35,37,44(1-6),45(1,3)
7.4	Supplier and Partner Results(25)	36,41
7.5	Company-Specific Results(130)	38-40,43(1-5,7-13),45(4,6-7)

Questions: 42,43(6),45(2)(130pts.)

Question 42(40pt.)	
Less Than 0.005%	40
0.005%-0.009%	30
0.010%-0.019%	20
0.020%-0.099%	10
0.10%-0.49%	8
0.50%-1.0%	6
1.0%-5.0%	4
Greater Than 5.0%	2

Question 43(6)	
Major Deterioration	45
Minor Deterioration	35
No Change	0
Minor Improvement	35
Major Improvement	45

Question 45(2) (45pt.)

Major Deterioration	45
Minor Deterioration	35
No Change	0
Minor Improvement	35
Major Improvement	45

Question 6(65pt.)

Less Than 10%	15
10%-24%	25
25%-49%	35
50%-74%	45
75%-89%	55
90%-100%	65

Question 45(5)(65pt.)

Major Deterioration	65
Minor Deterioration	35
No Change	0
Minor Improvement	35
Major Improvement	65

Questions: 33-35,37,44(1-6),45(1,3)

Question 33(2pt.)

Less Than 3	0.5
3-7	1.0
8-12	1.5
Greater Than 12	2
Ongoing	2

Question 34(8pt.)

Less Than 3	0.5
3-7	1.0
8-12	1.5
Greater Than 12	2
Ongoing	2

Question 35(2pt.)

Less Than 3	0.5
3-7	1.0
8-12	1.5
Greater Than 12	2

Question 37(2pt.)

Less Than 2 Per Week	0.5
2-4 Per Week	1
Greater Than 4 Per Week	2

Question 44(1-6)

Major Deterioration	2
Minor Deterioration	1
No Change	0
Minor Improvement	1
Major Improvement	2

Question 45(1,3)

Major Deterioration	2
Minor Deterioration	1
No Change	0
Minor Improvement	1
Major Improvement	2

Questions: 36,41

Question 36(3+3+3pts.)

Less Than 3	0.5
3-7	1.0
8-12	2.0
Greater Than 12	3.0

Question 41(16pts.)

Less Than 0.005%	16
0.005%-0.009%	12
0.010%-0.019%	8
0.020%-0.099%	4
0.10%-0.49%	3
0.50%-1.0%	2
1.0%-5.0%	1
Greater Than 5.0%	0

Questions: 38-40,43(1-5,7-13),45(4,6-7),10,11(130pts.)

Question 38

Less Than 5%	5
6-10%	4
11-15%	3
16-20%	2
21-25%	1
Greater Than 26%	0

Question 39

Less Than 0.25%	5
0.25-0.75%	4
0.75-1.5%	3
1.5-3%	2
3-5%	1
Greater Than 5%	0

Question 40

Decrease by 10%	2
Decrease by 10-20%	3
Decrease by 20-30%	4
Decrease by 30-40%	5
No Change	0
Increase by 10%	2
Increase by 10-20%	3
Increase Greater Than 20%	4

Question 43

Major Deterioration	5
Minor Deterioration	3
No Change	0
Minor Improvement	3
Major Improvement	5

Question 45

Major Deterioration	5
Minor Deterioration	3
No Change	0
Minor Improvement	3
Major Improvement	5

Question 10

Less Than 1yr	1
1-2yr	1
2-3yr	1
3-4yr	3
4-5yr	3
5-6yr	3
6-7yr	5
7-8yr	5
Greater Than 8yr	5

Question 11

Less Than 1yr	1
1-2yr	1
2-3yr	1
3-4yr	3
4-5yr	3
5-6yr	3
6-7yr	5
7-8yr	5
Greater Than 8yr	5
WCM Less Than 2yr.	5

APPENDIX D (Document 1)
QUALITY MANAGEMENT IN IRELAND'S
MANUFACTURING INDUSTRY SURVEY

4th Sept. 1996

Dear Sir/Madam,

A study into the Quality Management in the Manufacturing Industry in Ireland is being conducted by the School of Mechanical and Manufacturing Engineering at Dublin City University(DCU), with the cooperation of the National Standards Authority. Among its aim is to develop the framework for implementing quality programmes in companies with respect to its quality position.

It has long been an accepted fact that quality holds the key to competitiveness in the global market irrespective of the size of the company. And competitiveness for a firm is the ability to produce the right goods and services of the right quality, at the right price, and at the right time. In this respect, the competitiveness of firms in Ireland or for that matter, the competitiveness of Ireland as a nation, is not determined by the standards set by a few leading companies, but by the average.

It is for this reason that the survey is directed to the manufacturing industry in Ireland. The last national survey of quality control was conducted in 1980. Your experience in quality management practices can contribute greatly to this research effort. We acknowledge that it is going to take some effort on your part to complete the whole questionnaire.

Please complete the enclosed questionnaire and return it before 22nd Sept.1996 and automatically qualify for a:

	Lucky Draw
1st Prize	£200 cash
2nd Prize	Dinner for two in a restaurant of your choice
3rd Prize	A crate of wine

Please enclose a self addressed envelope which will be used to notify you should you become one of the lucky winners. Your response will be held in strict confidence. The eight digit code is computer generated and is used to ease our enormous administrative task.

Thank you for your time and cooperation.

Yours faithfully

......................................(Research Student)

APPENDIX D (Document 2)
QUALITY MANAGEMENT SURVEY
(FINAL REMINDER)

15th. Oct. 1996

Dear Sir/Madam,

We would like to remind you that two survey questionnaires were sent to you on the 4th. and 26th. Sept. 1996 respectively. If you have already completed the questionnaire and returned it to us we would like to thank you and please ignore this letter.

But if you have not done so yet owing to any reason, we would like to request to kindly complete the questionnaire and return it by **24th. October 1996.**

I would like to emphasize that this is a very important project we have undertaken and its success will depend on getting a good response from the 1809 firms we have identified in the manufacturing industry.

We realize that we have nothing to offer you in return for your co-operation other than free participation in a a lucky draw and our thanks.

If you have faced some problems in completing or if you have mislaid the questionnaire please do not hesitate to call us.

Your time and co-operation is highly appreciated.

Yours sincerely,

Prof. M. S. J. Hashmi

APPENDIX D (Document 3)
QUALITY MANAGEMENT SYSTEM IMPLEMENTATION
IN MANUFACTURING INDUSTRY

25th. Oct. 1996

Dear Sir/Madam,

A study into the Quality Management System implementation in the Manufacturing Industry in Ireland is being conducted by the School of Mechanical and Manufacturing Engineering at Dublin City University(DCU), with the cooperation of the National Standards Authority. Among its aim is to develop the framework for implementing quality programmes in companies with respect to its quality position.

It has long been an accepted fact that quality holds the key to competitiveness in the global market irrespective of the size of the company. In this respect, the competitiveness of firms in Ireland, is not determined by the standards set by a few leading companies, but by the average.

The last national survey of quality control was conducted in 1980. Your experience in quality management practices can contribute greatly to this research effort. I would like to emphasize that this is a very important project we have undertaken and its success will depend on getting a good response.

Please complete the enclosed questionnaire and return it before **15th Nov.1996** and automatically qualify for a:

	Lucky Draw
1st Prize	£200 cash
2nd Prize	Dinner for two in a restaurant of your choice
3rd Prize	A crate of wine

Please enclose a self addressed envelope which will be used to notify you should you become one of the lucky winners. Your response will be held in strict confidence. The eight digit code is computer generated and is used to ease our enormous administrative task in processing all the responses.

Thank you for your time and cooperation.

Yours faithfully,

Prof. M.S.J. Hashmi

APPENDIX D (Document 4)
QUALITY MANAGEMENT SYSTEM IMPLEMENTATION
IN MANUFACTURING INDUSTRY
(REMINDER)

22nd Nov. 1996

Dear Sir/Madam,

This is just to remind you that a survey questionnaire sent to your company on the 25th. October 1996 may not have been addressed directly to you. If you have already completed the questionnaire and returned it to us we would like to thank you and please ignore this letter.

But if you have not done so yet owing to any reason, we would like to request you to kindly complete the questionnaire and return it by the **6th. December 1996**.

I would like to emphasize that this is a very important project we have undertaken and its success will depend on getting a good response from the industry.

We realize that we have nothing to offer you in return for your co-operation other than our appreciation and free participation in a lucky draw which will be conducted by the middle of December 1996.

Your time and co-operation is highly appreciated.

Yours sincerely,

Prof. M.S.J. Hashmi

Lists of Publications

1. Ismail, M.Y., M. El-Baradie and M.S.J. Hashmi, Dec. 1997. 'Quality management in the manufacturing industry: Practice vs. Performance'. Proceedings of 22nd International Conference on Computers and Industrial Engineering, 20-22nd December 1997, Cairo, Egypt, pp. 355-358.
2. Ismail, M.Y. and M.S.J. Hashmi, Jul. 1998. 'Empirical study into quality initiatives implementation order'. Proceedings of the Third World Congress for Total Quality Management: Business Excellence Through Quality Culture, Vol. 9, No. 4&5, pp. S128-129.
3. Ismail, M.Y. and M.S.J. Hashmi, Aug. 1998. 'Effects of ISO 9000 and TQM implementation'. Proceedings of the Pacific Conference on Manufacturing, 18-21st. August 1988, Brisbane, Australia, pp. 208-213.