Total Quality Management and Drinking Water Quality: The Waikato Experience

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Abstract

Drinking water quality is a matter of concern in New Zealand. The quality of many New Zealand water supplies has been unsatisfactory as shown by the grading conducted since 1960 by the former Board of Health. In 1991, a quarter of the supplies surveyed failed to meet the Department of Health's microbiological standards. Since 1992, the Ministry of Health has undertaken a programme to improve water quality management. Hence, the achievement of high quality of drinking water requires the implementation of some form of quality management system (QMS) (e.g. Total Quality Management and its models i.e. ISO 9000 / ISO 14000 Standards, Quality Awards).

This thesis examines the managerial practices related to the supply of drinking water in water utilities within the Waikato Region and the role of Total Quality Management (TQM) and its models (i.e. ISO 9000 Series Standards, ISO 14000 Series Standards, and the different Quality Awards like The Deming Prize and the Malcolm Baldrige Award and its New Zealand equivalent the National Business Excellence Award) (Refer to Chapter One, Section 1.6 Definition of Terms Used in Research). The use of QMS is now an established part of management practice in most water utilities in New Zealand, having been introduced since 1995 as part of the reforms to public water supply management.

The thesis uses case studies to gain an in-depth understanding of quality management practices in the water utilities, the perceptions of water quality managers in relation to the adoption and adaptation of quality management systems. This is a descriptive and interpretive study of the existing quality systems in water supply organizations of the different Territorial Local Authorities of the Waikato Region. The aim is to unravel the managerial practices as a means of answering the research's four sub-research questions: 1) What perceptions do water utilities managers have about quality management in general and TQM in particular? 2) To what extent are TQM practices actually applied in the water utilities? 3) Is there a relationship between the use of specific TQM procedures/models and water quality? 4) What other quality factors do managers in water utilities identify as crucial for improvement of water quality?

This thesis uses methodological triangulation and data triangulation including face-to-face interviews, observations and document review. Multiple methods (qualitative analysis, quantitative analysis and cross case analysis) are used to study the problem in order to reveal the different aspects of empirical reality and at the same time validate the research findings (Denzin, 1978).

The research revealed that some managers working to achieve the minimal management quality that conforms with the New Zealand Drinking Water Standards, while others were aspiring to a high quality of service and seeking continual improvement in the water quality provided. Some managers were reluctant to change and were still practising old techniques, while others were motivated to adopt total quality management (TQM) teachings and apply for ISO certification. Moreover, the research revealed the input and the role played by the customers (i.e. community receiving the drinking water) requirements which is supported by the TQM literature about the importance of customer satisfaction.

In order to determine the extent of application of TQM practices by the Waikato Region TLAs and their adoption, the researcher utilized Lewin's Change Theory to analyse the data which was assembled. The results shows that 2 water utilities have already passed through the 3 phases of Lewin's Change Theory [i.e. they have adopted change towards the new managerial paradigm (unfreezing, changing, and refreezing)], 3 water utilities are at midway range (i.e. they require more work to fully integrate the new managerial paradigm) and 4 water utilities have not made any significant change to their management systems (i.e. these are the water utilities that have made no effort to change).

The results show correlation between the adoption of TQM and its models and the quality of drinking water provided to the community exemplified in their water grading. For example the water utilities who are adopting TQM and some of its models i.e. ISO 9000/14000 Standards and the quality awards, have both high score results in the quantitative analysis results and their water grading is higher showing minimal risk to the community.

The study identified other factors of importance in achieving higher drinking water quality as stated by the management teams of the water utilities. These factors are: 1) the size and nature of the community served by the council; 2) the community's willingness or unwillingness to add chemicals to drinking water; 3) TLA budget allocations and restrictions; 4) the Ministry of Health system of visiting water utilities every 5 years to revise their water grading; and 5) training budget constraints in relation to quality training

Finally, the thesis considers how important quality management practices could enhance the New Zealand water industry by discussing the relationship between the application of TQM and asset management planning within water utilities. Enhanced water quality will only result from TQM activity if TQM attitudes and methods are successfully incorporated into the complete set of water utility activities.

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Table of Contents

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF ABBREVIATIONS

AMPs	Asset Management Plans
APQC	American Productivity and Quality Centre
ASQC	American Society for Quality Control
BOD	Biochemical Oxygen Demand
CEO	Chief Executive Officer
DIN	Dissolved inorganic nitrogen
DO	Dissolved Oxygen
DRP	Dissolved reactive phosphorus
EMS	Environmental Management System
GEMS	Global Environmental Monitoring Survey
ISO	International Organization for Standardisation
ISO 9000 Series	International Standards for Quality Management
ISO 14000 Series	International Standards for Environmental Management
JUSE	Japanese Union of Scientists and Engineers
LATE	Local Authority Trading Enterprises
LRQA	Lloyd's Register of Quality Assurance
MoH	Ministry of Health
N5 (NUD*IST)	Non-numeric, Unstructured, Data Indexing, Searching and Theorising Computer Software
NZDWS	New Zealand Drinking Water Standards
NZQF	New Zealand Quality Foundation
OC	Observation Comments
OFI	Opportunity for Improvement Forms
PDCA cycle	Plan-Do-Check-Act Cycle
PSR	Pressure-State-Response
QA	Quality Assurance
QC	Quality Control
QMS	Quality Management Systems
RMA	Resource Management Act
SQC	Statistical Quality Control
SOP	Standard Operating Procedures

TLA	Territorial Local Authorities
TQM	Total Quality Management
WINZ	Water Information New Zealand (The database for those managing community drinking-water quality)
WHO	World Health Organisation
ZD day	Zero Defect Day

CHAPTER ONE:

OVERVIEW OF THE THESIS

1.1 Introduction

This chapter introduces the thesis by describing the basic features of the New Zealand water treatment and supply industry. It then describes a significant New Zealand water quality problem and discusses why the issue of water quality is worthy of research. It provides a brief introduction to New Zealand's fresh water environment and an outline of New Zealand's main concerns regarding water quality. It states the research aim and the anticipated contribution to knowledge. Definitions of terms used in the research are provided. Finally it presents the organisation of chapters for the thesis.

1.2 Basic Features of the New Zealand Water Treatment and Supply Industry

New Zealand has abundant water resources with rain falling predominantly in the colder months from May to August. New Zealand also has a significant number of lakes and rivers (around 1.1% of the country surface). Many of the rivers carry high sediment loads. The water in the upper parts of rivers and in upper catchment lakes is generally of the highest quality (OECD Environmental Performance Review, 1996). The streams and rivers of New Zealand have some of the highest self-cleaning rates but are subject to faecal, sediment and nutrient run-off from pastures in their middle and lower reaches, especially in the North Island (OECD Environmental Performance Review, 1996). Many streams in regions of high dairy industry concentration do not meet guidelines for contact recreation. Lowland lakes also have profuse aquatic growth, high turbidity and noticeable aquatic scum in some instances (OECD Environmental Performance Review, 1996).

Ground water is of very high quality when it comes from secure aquifers. However, there is evidence of slight nitrate contamination from dairy and maize farming in shallower aquifers (Russell, 1998). Aquifers in some market-gardening and horticulture areas show evidence of contamination with pesticide traces. Faecal coliforms are a particular problem for the water treatment and supply industry since the country's livestock generate as much faecal waste as a population of 180 million people (OECD Environmental Performance Review, 1996).

Drinking water supply is monitored by two levels of government. At the local level territorial local authorities (TLAs) take responsibility for the provision of safe drinking water to the different communities in New Zealand. The Ministry of Health provides national oversight of drinking water systems and their performance. Regional Councils are only indirectly involved in that their activities only influence the quality of source water available to water utilities (Ministry of Health, 2002a).

The territorial local authorities (TLAs) internally or externally have water utilities which extract the source water, run the treatment plant to remove risks or contaminants, and pipe the water to the community. The Ministry of Health (MoH) does not check on local authorities directly. The District Health Boards (DHBs) oversee the TLAs in their respective areas and ensure that they maintain appropriate water quality in accordance with the Drinking Water Standards for New Zealand 1995 and recently 2000 (DWSNZ) (Ministry of Health, 2002a). Moreover, those TLA water utilities usually provide sewage services and waste water treatment in addition to water supplies. Most water is paid for as part of rates (local authority taxes on property owners), with just over 25% of the population residing on metered properties (Scrimgeour, 1997).

In New Zealand in 2000, 82 percent of the total population was serviced by 114 drinking water supplies of medium to large size providing for more than 500 people. The remaining 18 percent of the population is serviced by over 1900 supplies that each provide for fewer than 500 people (Ministry of Health, 2002a). In 1998, 98.7 percent of the water supplies that failed to comply with the bacteriological requirements of the Drinking-Water Standards for New Zealand 1995 fell into this lower 18 percentile (Ministry of Health, 1995a). Most of these supplies are in dispersed rural communities that neither have access to laboratory facilities or funds for treatment and monitoring of their water supply (Ministry of Health, 2002b).

One estimate of expenditure by local authorities on water treatment and supply was around $250 million per annum with the intention to spend $3 billion to improve services over the medium term (OECD Environmental Performance Review, 1997). Eighty five percent of the money spent annually is on operating expenses (Scrimgeour, 1997).

1.3 The Water Quality Problem

1.3.1 The Problem of Water Quality World-wide

All countries face economic constraints. As a result, many countries have failed to adequately invest in the maintenance and expansion of irrigation, potable water and sanitation systems, as well as in environmental preservation, conservation and economic development programs. Arguably, this lack of investment in developing countries is due to the demands on public resources to service public debts and meet other competing demands. Accordingly, water, which is a vital element for ecosystems and human society, has progressively become a scarce resource (both in quantity and quality) for different social uses.

According to the World Health Organisation, 900 million people suffer from diarrhoea or diseases spread by contaminated water such as typhoid and cholera, and other diseases caused by intestinal worms every year. Accordingly, better water supplies and sanitation would cut the incidence of such diseases dramatically. In terms of the number of people killed by dirty water, it is probably the world's most serious pollution problem (Letvin, 1998).

Since 1980, there have been major improvements in some developing countries with investment of $25 to $30 billion per year. Two billion people have gained access to better water supplies and another 400 million have got better sanitation (Letvin, 1998). Nevertheless, these gains have been offset in large part by population growth. One billion people still do not have an adequate supply of water and 2 billion do not have access to adequate sanitation facilities. In order for governments of developing countries to improve matters for their people and keep up with future population growth, they need to invest huge sums of money in water and sanitation (Letvin, 1998).

Drinking water quality problems are not confined to developing nations. For a variety of reasons problems are experienced in Europe, North America, Japan and Australasia. Often these problems are discussed in engineering, political and scientific terms. However, the existence of these problems suggests that the study of the provision of high quality drinking water is important in developed countries as well as in developing countries.

1.3.2 The New Zealand Water Quality Problem

New Zealand, like other countries, has water quality problems even though it is a developed western democratic country. Although New Zealand has a strong rural base with a dispersed but relatively small population and it made a significant investment in water quality infrastructure not dissimilar to that in Western Europe and North America.

The most immediate water quality concern for New Zealanders is the quality of their drinking water (Ministry of Social Development, 2002). The safety of many of New Zealand water supplies has been in doubt, particularly since 1960 when the former Board of Health began grading them. In 1991, a quarter of the supplies surveyed failed to meet the Department of Health's microbiological standards (Walker, 1993). In 1992 and 1993, several small communities were advised to boil water because of microbiological contamination of their supplies (Public Health Commission, 1993-1994). In 1994, at least 8% of the population were served by unsafe water supply systems of unknown status because they were inadequately monitored (Ministry of Health, 1995a and 1995b). Moreover, while the Ministry of Health was developing a strategy to improve the management of community drinking-water supplies, it found the following issues related to drinking-water:

1. The legislation of drinking-water was spread over 36 Acts and Regulations. [Principal acts included: The Building Act 1991, The Food Act 1981, The

Health Act 1956, The Local Government Act 1974, The Resource Management Act 1991 and The Water Supplies Protection Regulations 1961 (Ministry of Health, 1995c)].

2. The drinking-water legislation is fragmented and incomplete, largely derived and relatively unchanged from the English legislation dating back to 1845.

All those above mentioned factors contributed to the Ministry of Health decision to review the legislation relating to drinking-water and publish a public discussion paper on the subject in May 1995 (Ministry of Health, 1995a and 1995b).

Since 1992, the Ministry of Health has undertaken a programme to improve water quality management. This programme involved the following:

1. A review of management procedures and of legislation relating to the public health aspects of drinking water through:
   a) Setting out the requirements for compliance with the Drinking-water Standards for New Zealand 1995;
   b) Facilitating consistency of application throughout New Zealand;
   c) Protecting public health while minimising unnecessary monitoring; and
   d) Making drinking-water appropriate for both large and small drinking-water supplies.

2. Revision of public health grading procedures for community drinking water supplies and the development of an accessible national drinking water database and the publication of:
   a) Guidelines for Drinking-Water Quality Management;
   b) Guidelines for Drinking Water Standards for New Zealand 1995; and
   c) Guidelines for the Register of Community Drinking-Water Supplies in New Zealand (Ministry of Health, 1995a).

The Ministry of Health currently grades water supplies by assessing the quality of the original water source and the ability of the treatment system and water pipes to prevent contamination. The 1997 survey[1] shows that New Zealand has 1,638 community drinking water supplies, serving 85% of the population. Of these supplies, 7% (serving 54% of the population) are considered safe and are graded A or B. A further 2% (serving 5% of the population) are of borderline safety and are graded C (Refer to Register Listings Table and its guide in Appendix 1 and Register for Community Water-Supplies in New Zealand in Appendix 2).

However, 19% of supplies (serving 18% of the population) provide an unsatisfactory level of protection against contamination and are graded D or E. The D and E grading do not mean the supplies are actually contaminated, merely that the risk is high. Most of these high risk water supplies serve small communities, though four serve cities over 20,000 people (Dunedin, Timaru, Nelson and Wanganui). The remaining 71% of community water supplies (serving 8% of the population) have not been graded because they are in communities of less than 500 people. Approximately 15% of the dwellings are not connected to community supplies (Ministry for the Environment, 1997).

The Ministry of Health gradings focus on the adequacy of the supply system rather than the actual quality of drinking water as it comes out of the tap. However, some data on drinking water quality does exist. Reviews of data gathered in the 1980s show that concentrations of some common chemicals exceeded the standard guidelines in a significant percentage of water supplies. One review found that 82% of samples failed to comply with at least one guideline value (Public Health Commission, 1993-1994). Common failings were excessive levels of aluminium (in 20% of supplies), copper (in 31%), turbidity (25%), and potentially carcinogenic trihalomethanes (26% of chlorinated supplies), and all were a result of poor water treatment. Two thirds were outside the recommended pH range of 7.4 to 8.5 (Public Health Commission, 1993-1994).

Cognisant of those results the Ministry of Health has been working for the past 10 years with the support of the Building Industry Authority and other central

[1] In 2002 (subsequent to the completion of the field research reported in this thesis) the Ministry of Health published a new report which provides further evidence of the water quality problem.)

government agencies on a strategy to bring improvements to the New Zealand drinking water (Ministry of Health, 2002c). The strategy is to:

1. Develop voluntary standards for drinking water safety and quality referred to as "The Drinking-Water Standards New Zealand 2000 (DWSNZ)". Those standards are revised periodically to take account of international scientific research and international industry best practice.

2. Promote voluntary compliance with the Standards. This compliance is measured by the grading of drinking water supplies and results published in the annual survey of microbiological drinking water safety and quality.

3. Review existing legislative framework for drinking water. As a result the Cabinet agreed in November 2000 for a new drinking-water Bill [i.e. the Health (Drinking Water) Amendment Bill] which is currently being drafted by the Parliamentary Counsel Office.

4. Establish a process for obtaining internationally acceptable accreditation for drinking water assessors with post graduate qualifications.

5. Develop guidelines for public health drinking water risk management plans with worked examples available from the Ministry of Health website.

6. Work with the drinking water industry to help it set up a system of New Zealand Quality Assurance (NZQA) recognised training and qualifications. The aim of this system is to ensure that in the future people with appropriate competencies are able to install, maintain and repair water supply systems.

7. Investigate testing protocols using new low cost drinking water safety and quality tests. Those protocols are useful for small drinking water suppliers because they permit cheaper and more effective testing (Ministry of Health, 2002c).

Underpinning these initiatives is a paradigm shift from being solely focused on product quality standards to emphasis on process and improved management of risk to public health. The Office of the Parliamentary Counsel is currently working with the Ministry of Health on drafting the Bill with the intention of it sitting along side the Resource Management Act and Building Act. The Amendment Bill is expected to be introduced at some stage in 2003 (Ministry of Health, 2002c).

1.3.3 Micro-organisms in New Zealand Waters

There are a number of the problems apparent in some New Zealand drinking water. A monitoring study conducted in New Zealand in 1990 found Giardia cysts existing in 33 percent of water samples (i.e. 135 samples out of 412 total samples). The cyst concentration ranged from 1 cyst per 10 litres in some sources to 450 cysts per 10 litres in the worst infected water. It takes about 10 cysts to infect a person. Although the parasite has been identified in some high-use parts of national and forest parks, the highest infection rates seem to be in urban regions (van Duivenboden & Walker, 1993).

Giardia Lamblia is a single-celled protistan parasite that lives in the intestines of warm-blooded animals, including humans, and is passed on through water, hands or food that have been contaminated by faeces. Once expelled from the body, it survives by enclosing itself in a protective cyst until swallowed by another host (Ryan, August, 1991). Giardia is the most primitive living organism after the bacteria and can cause a nasty illness (giardiasis) which may last for months. Although up to 80% of infected people show no symptoms, a minority experience severe diarrhoea, stomach cramps, bloating, dehydration, nausea and weight loss. The illness is most common in children under five years and those in close contact with them (Day, 1994).

Cryptosporidium is another disease-causing micro-organism present in some New Zealand drinking water. It is a slightly more advanced protist than giardia and it may turn out to be a more significant health risk (Ryan, August, 1991). The extent of its distribution in New Zealand waters and water supplies is unknown because the cysts are small and difficult to detect. In 1993 there were 8,101 cases of campylobacteriosis (i.e. the disease caused by cryptosporidium). The infective dose of cryptosporidium is not known; however, it may be as low as one cyst. Accordingly, public water supplies are not permitted to contain even low concentrations of bacteria and infectious protists (Ministry of Health, 1995b).

"Giardia" and "cryptosporidium" organisms are becoming more common in the water supplies of New Zealand. They are considered dangerous because if they get into the water source, they can cause severe diarrhoea upon ingestion (Ministry of Health, 1995b). In a particularly notable case in February 1997, 29 cases of flu-like symptoms followed by stomach cramps and diarrhoea were reported in Ashburton after a period of heavy rain. Accordingly there was an alert from a health protection officer who noticed an unusual increase in Ashburton of reports of the water-borne disease campylobacteriosis. The Coustomer Magazine (Anonymous, June, 1997) reported that the reason for this water and health crisis was that the chlorinator at the water treatment plant had broken down a week earlier. There was no back-up system, so chlorination was not resumed until two days later. After the outbreak was detected, campylobacter was found in samples of the source water. Subsequently, the district council installed a chlorine monitor connected to an alarm system, and implemented more frequent inspections of the system. It is noted that in 1997 Ashburton had a D grade (i.e. unsatisfactory and high level of risk) for its water source and treatment.

New Zealand water catchment areas are under threat from both animals and recreational use which may lead to microbiological contamination of rivers and lakes. Logging and other activities impact run-off and sediment in the water.

1.3.4 Water Quality in the Waikato River

Water quality in the Waikato River is of immense significance in the Waikato Region as it is the primary source for many drinking water systems. The Waikato River is the largest fresh water source in the Waikato. It is the source of supply of much of the water surveyed in this thesis. The river originates at Lake Taupo. It is the longest and most used river in New Zealand. It is 425k long with a catchment area of 1,114,000 hectares. The catchment includes agricultural land, electric power station, planted exotic forests, mining and manufacturing industries, townships, and a major city (Hamilton) (Ministry for the Environment, 1997).

The Waikato River starts its journey to the sea from the central North Island volcanic plateau flowing north, passing through eight hydro dams, and through the lowlands from Cambridge to Mercer. The Waikato River finally flows into the Tasman Sea at Port Waikato (Environment Waikato, 2003).

The Waikato Maori consider the Waikato River is a tupuna (ancestor), a taonga (treasure), and the mauri (life force) of Tainui Waka and Ngati Tuwharetoa (Waikato Maori Tribes) (Environment Waikato, 2003).

A survey of the catchment's status between 1972 and 1978 showed that the river was under stress (Ministry of Works and Development, 1979). Large amount of fertiliser and around 30 billion litres of animal wastes, were deposited annually in the catchment. The river also received wastes from 12 dairy factories, two abattoirs, one wool scourer, one pulp and paper mill, several open cast coal mines, one sulphur mine, one ironsand mine and 13 urban sewage treatment plants. Further pressures came from 13 power stations, eight of which were hydro powered, two thermally powered and two geothermally powered. The stations drew off substantial amounts of cooling water and also discharged effluent into river. Discharges from one geothermal station were high in toxic elements such as arsenic, fluoride and borate (Glasby, 1991).

The Waikato Catchment Board and subsequently the Waikato Regional Council (i.e. Environment Waikato) have systematically monitored the river in the years that followed the 1972 – 1978 survey. Environment Waikato began measuring water quality every month at 10 sites along the Waikato River to assess suitability for recreation (such as swimming) and for the plants and animals that live there. Measurements helped Environment Waikato develop policy on how it should address the issues and activities affecting water quality in the Waikato River (Environment Waikato, 2003). By 1988, the river was considered to be of very high quality along most of its length. However, the improvements have not been evenly spread along the river. The lower reaches drain intensively used farmland, as well as swamps and peat lands, and are in far worse condition than are the upper reaches of the river (Ministry for the Environment, 1997).

The pressures on the Waikato River impact the water quality of almost all water sources in the Waikato.

1.4 The Need for Research into Water Quality Management

Water is critical for life on earth. It links the planet's diverse ecosystems as it moves between the sea, air and land, providing for human health and welfare, food security, and economic development.

Scarcity, misuse and pollution of fresh water resources pose increasingly serious threats to ecologically and socially sustainable development, human health, and ecosystem maintenance, all of which will be exacerbated by impacts of global climate change on the hydrologic cycle (NZ NGO/UNCED Liaison Committee, 1992). Human intervention in the environment has contributed to changes in hydrologic regimes and the contamination of water resource systems. Although fresh water resources are renewable, they are limited. Per capita water supplies are declining as the world population increases. The increased demand for water exceed supplies, which have been wasted and contaminated (NZ NGO/UNCED Liaison Committee, 1992). Accordingly there is a need to research the quality management strategies that are in place in New Zealand and the level of protection to the water resources and its effect on the economic and social development of the country. The New Zealand Ministry of Health quality management of drinking-water supplies structure and design is investigated in this research.

1.5 The Researcher's Interest in the Topic

The researcher developed a research interest in drinking water quality during the 1990s when she started working in the Schistosomiasis Research Project, a medical project funded by the USAID (United States AID) in Cairo, Egypt. The project dealt with Schistosomiaisis which is the medical term for Bilharzia, a water-borne parasite which infected farmers in rural areas in Egypt. The researcher developed a passion for this subject and conducted numerous studies in that field while completing her masters degree at the American University in Cairo.

At the outset of the study, the researcher was more interested in pursuing the research from a different angle dealing with the microbiological organisms in the New Zealand drinking water supplies i.e. faecal coliforms, Giardia, and Cryptosporidium. However, given the need to focus on improving water quality, the researcher concentrated on the management systems practiced by Water Utilities in New Zealand and their effect on the drinking water quality.

The researcher's main interest in this research is drinking water quality. Accordingly, the managerial practice explored in this research is Total Quality Management. This involves the consideration of applications (ISO 9000 Standards, ISO 14000 Standards, and the different Quality Awards like The Deming Award and the Malcolm Baldrige Award). ISO 9000 implementation in the Water Utilities in New Zealand is relatively recent, i.e. within approximately, the past seven years. ISO 9000 Standards have been used mainly in the manufacturing and industrial sector. Recently, the ISO Standardisation (Refer to Appendix 3: ISO 9000 Standards and Appendix 4: ISO 14000 Standards) has been implemented in nearly all different fields as a means of quality assurance.

1.6 Research Question

The major research question of this study is: "What managerial systems are used in New Zealand Water Utilities and how do these management systems affect the quality of drinking water delivered to the community?"

In order to respond to this research question further investigations are undertaken to answer the following sub-research questions:

1. What perceptions do water utilities managers have about quality management in general and TQM in particular?

2. To what extent are TQM practices actually applied in the water utilities?
3. Is there a relationship between the use of specific TQM procedures/models and water quality?
4. What other quality factors do managers in water utilities identify as crucial for improvement of water quality?

1.7 Contribution to Knowledge

This research explores how the concept of quality has relevance in the water industry. There are several dimensions to quality in this context:

1. Water quality in terms of its impact on human health and uses of water by humans – quality as a health or environmental issue;
2. Quality in terms of the delivery of service by the water treatment and supply industry – quality as a service or organisational performance issue;
3. Quality in terms of the management of the assets of the specific enterprise supplying water – quality in terms of efficiency of economic management.

Total Quality Management (TQM) has a contribution to make to all three areas although this is not necessarily obvious at first glance. Table 1.2 shows how a TQM approach may be useful in addressing these aspects of quality in the water industry.

Table 1.1: Quality Issues in Water Supply Management

Quality Issues in Water Supply Management	Who is interested in quality?	Potential Contribution of Total Quality Management Approach
Water quality in terms of its impact on human health and uses of water by humans	• Business Customers • Household Customers • Environmental groups • Maori (cultural beliefs about water) • Regulatory agencies • Health and Environment	• The principal contribution of TQM to this aspect of quality is offered by practices other than TQM (e.g. environmental engineering, public health, environmental science, economics etc.) • Contribution of TQM is to provide a framework of organisational efficiency in which the other technical practices can operate. • TQM as implemented through ISO 9000 and related approaches prepare the organisation for integration of environmental and risk management systems (e.g. ISO 14000). • TQM supports quick organisational response to public health crisis and emergencies as a well established TQM system would support the establishment and maintenance of a robust organisational approach to emergencies and would provide the basis for analysing the root cause of emergencies.
Quality in terms of the delivery of service by the water treatment and supply industry	• Business Customers • Household Customers • Lenders • Regulators	• TQM is the pre-eminent way of achieving the delivery of service to customers. • Customer charters covering pricing and quality issues are emerging in utility industries such as water, electricity and telecommunications. • Customer charters may sometimes provide legal rights to consumers or can be used in court cases. • TQM supports the organisation's ability to meet its promises to consumers as set out in Codes of Practice or customer charters between the organisation and the Consumer/customer.
Quality as a function of asset management and economic efficiency and long-term sustainability and profitability at industry or enterprise level	• Lenders • Regulators • Business Customers • Household Customers	• TQM supports asset management through its total review approach to the organisation and its emphasis on continuous improvement. • TQM emphasis on periodic reviews provides a framework for making asset management a central reviewable part of operations.

SOURCE: Author's table – information obtained through reading from TQM Guru teachings (e.g. W Edwards Deming, Joseph M. Juran, and Philip B. Crosby) and formal and informal interviews conducted with Water Utility Managers in the Regional and District Councils of the Waikato Region (El-Kafafi, 2000b).

1.8 Definition of Terms Used in this Research

Water Quality

The definition of acceptable water quality depends on the use of the water. Quality requirements for a healthy wildlife habitat may differ from those for a productive irrigated agriculture. The most stringent quality requirements may apply to water used for human consumption.

Municipal water agencies have been required by the New Zealand Ministry of Health to provide safe drinking water, with safety determined by the control of waterborne infectious diseases, often through the reduction of coliform bacteria (Ministry of Health, 1995a). Other constituents, such as alkalinity or dissolved solids, were thought to affect the aesthetic characteristics of the water but not human health (Frisvold & Caswell, 1995).

The term 'water quality' used in this thesis refers to the quality of drinking water supplied by the water utilities within the Waikato Region to their communities.

Water Grading

This term refers to a certain grading (i.e. a, b, c, d, e and u) that is given to the water standard that is provided to each community in New Zealand. This grading shows how safe or unsafe the drinking water is. In this thesis, it is used as one of the indicators in investigating the effect of using TQM and its models by the Waikato Region water utilities in the improvement of water quality provided to its communities. Water grading is determined by health officials working in the Ministry of Health in accordance to specific scientific requirements and levels of conformance set in the New Zealand Drinking Water Standards. To understand the exact significance of each letter, refer to Appendix 2 – Register of Community Drinking-Water Supplies in New Zealand.

TQM Gurus

The 'Gurus' of Total Quality Management are the people who initiated and contributed to the field of quality management by shaping it through their philosophies, principles and methods. The 'gurus' referred to in this thesis are W. Edward Deming (well known as the father of quality management), Joseph M. Juran and Philip B. Crosby.

TQM Models

This term is used in the thesis to refer to the 'Models' of Total Quality Management. Those models are ISO 9000 Series Standards, ISO 14000 Series Standards, and the different Quality Awards like The Deming Prize and the Malcolm Baldrige Award and its New Zealand equivalent the National Business Excellence Award. The research investigates the use of the TQM models in the water utilities in the Waikato Region and the effect on their managerial performance and organisational change.

Water Utilities

The water utilities referred to in this thesis are the water supply units of the city and district councils within the Waikato Region in New Zealand. For further details the Waikato Region, refer to Chapter 2, Sections 2.3 The Waikato Region, 2.3.1 The Establishment of the Waikato Region, and 2.3.2 Waikato Region Geography and Chapter 2, Map 2.3 Waikato Regional Council – Territorial Authority Boundaries.

Triangulation

This term is taken originally from land surveying. It involves locating two landmarks as means of helping the person taking the bearings in two directions and locating themselves at the intersection. In this thesis, triangulation is used to help give a better picture of the subject matter. In other words, it involves using mixed methods (a variety of data sources and a multiple methods to study a single problem) to assist in verifying and validating the final findings of the study. Chapter 4, Sections 4.4 Methodological Considerations and 4.4.1 Why Methodological Triangulation? gives a more detailed description of the term.

Participant Observations

This term is used frequently in the thesis as one of the data collection methods utilised in this study. This method has been used by the researcher by visiting the water treatment plants of three councils within the Waikato Region. The researcher gathered data by participating in the daily life of the technicians of the water treatment plants; sometimes watching them and how they dealt with situations they meet and sometimes by participating in their daily work to discover their interpretations of the events under observation.

Thematic Analysis

This term is used to refer to a technique used by the researcher to deduce the initial themes from the face-to-face interviews and observations conducted in this study. The themes were derived from the respondents' replies following the criteria of recurrence, repetition and forcefulness.

N5

N5 is the latest version in the NUD*IST computer software series which stands for Non-numeric, Unstructured, Data Indexing, Searching and Theorising (Qualitative Solutions and Research, 2000). As the data collected in this research was mostly a large amount of unstructured text, this computer software was utilised in this study for data management, sorting and exploring the data, creating and managing ideas and searching documents and ideas.

Lewin's Change Model

This model is used as a tool for analysing effective management of change within organisations. It was developed by Kurt Lewin (1947), a behavioural scientist. It comprises the following three steps: 1) unfreezing, 2) changing, and 3) refreezing. This model was used in the thesis to assess the organisational change in the nine case studies within the Waikato Region.

1.9 Organisation of Chapters

This thesis comprises seven chapters.

Chapter one is an introduction, providing a context for this study and foreshadowing what is to come in the following chapters. It presents the research question under investigation and discusses why it is worthy of research.

Chapter two sets the scene by giving an overall view of the environmental management and water quality issues in the Waikato Region of New Zealand. It gives a detailed description of the region, its history, its plans, its achievements and problems in the area in relation to the major determinants of drinking water quality.

Chapter three gives background about the evolution of quality management. It explains the meaning of the term "Total Quality Management" through the perception of the quality gurus, and their roles in its evolution. Moreover, the chapter describes the different models of total quality management (i.e. ISO 9000 Series Standards, ISO 14000 Series Standards, the Deming Award, the Malcolm Baldridge National Quality Award and its New Zealand equivalent "Business Excellence Quality Award".) It also presents some international studies conducted in the field before presenting the New Zealand water utilities management context.

Chapter four defines the research question and the methodological framework used. Furthermore, it details the mixed methodological methods used for data collection and analysis utilized in this research.

Chapter five explains the methods used in analysing each case and the general framework of themes employed. It details the analysis of all the nine case studies of the water utilities within the Waikato Region.

Chapter six discusses the cross case analysis and rationale, Lewin's Change Model that was used in analysing the level of organizational change in the water utilities, and finally reports on the cross case analysis of the nine case studies.

Chapter seven is the final chapter in this thesis. It reports on the research findings for the whole thesis, and concludes with a discussion of opportunities for water utilities to enhance the delivery of high quality of drinking water to the community. This involves the integration of improved management into all aspects of organisational practice and strategy.

CHAPTER TWO:
SETTING THE SCENE

EVIRONMENTAL MANAGEMENT AND WATER QUALITY IN THE WAIKATO REGION OF NEW ZEALAND

2.1 Introduction

The Waikato Region in the North Island of New Zealand is predominantly rural and includes just one city and several towns. The major land uses are pastoral farming and forestry. The Waikato River is the major river system which dominates the region. This chapter examines two sets of documents to gain an understanding of the management of water quality in the Waikato Region of New Zealand. One set is the environmental management documents of the Waikato Regional Council (the local Environmental Protection Agency) and the other is the Ministry of Health water quality analyses of all water supplies for human consumption. The chapter identifies the environmental goals anticipated from the current management regime and examines the extent to which the current management is impacting on water quality. The ameliorating actions and management practices of water supply agencies are also reviewed. Finally, the chapter provides an assessment of the potential for current practices to improve the quality of water for human consumption.

This chapter examines the Ministry of Health publications (e.g. Drinking Water Standards for New Zealand, Register of Community Drinking-Water Supplies in New Zealand, Drinking-Water Public Health Issues), Local Government Commission publications (i.e. Reform of Local Government in New Zealand), Waikato Regional Council publications (e.g. Strategic Plans, Policy Statements, Annual Reports), and other reports commissioned by the Waikato Regional Council reporting on the Waikato River water quality and reporting on discharges to the Waikato River to give guidelines for consent assessment.

2.2 The Waikato Region

This section describes the establishment of the Waikato Region and its geography.

2.2.1 The Establishment of the Waikato Region

The provisional scheme for the establishment of a regional government for the Waikato region was prepared by the Local Government Commission according to the Local Government Act 1974 [Section 19 (2)] and amended by the Local Government Amendment Act 1976 (Local Government Commission, 1989). After the Commission considered objections to the provisional scheme in terms of section 21 of the Local Government Act 1974 (i.e. strong opposition of the majority of the local authorities in the Thames area to the inclusion of their district in the proposed Waikato region), it decided that the Waikato region comprise the following cities and districts: Hamilton City, Huntly, Ngaruawahia, Cambridge, Te Awamutu, Matamata, Putaruru and Tokoroa Boroughs, Raglan, Waikato, Waipa and Matamata Counties, and Otorohanga and Waitomo Districts (Local Government Commission, 1989).

Pursuant to section 15B of the Local Government Act 1974, the Local Government Commission stated that the commencement of the scheme shall come into force on the 1st of November 1989. Hence, Environment Waikato (Waikato Regional Council) local authority was as a result of the local government reform programme (Local Government Commission, June 1989 and Waikato Regional Council, 1998).

Environment Waikato undertakes its responsibilities under the following Acts of Parliament:

1. **Local Government Act 1974 and Amendments:**

   Apart from the establishment of the region's cities and districts, the amendments to this legislation have introduced the following:

   a) community consultation and accountability;

   b) more business-like approach to local government;

   c) annual reporting;

d) strategic planning and 10 year financial strategy;

e) preparation of asset management plans; and

f) review of funding policies.

2. Civil Defence Act 1983:

Regional councils are required to participate in civil defence planning and co-ordination.

3. Transit New Zealand Act 1989:

The Land Transport Act gave new responsibilities to regional councils in passenger transport planning and delivery, total mobility services, land transport strategies, and road safety.

4. Resource Management Act 1991:

The Resource Management Act (RMA) not only replaced the Water and Soil Act and Town and Country Planning Acts, but also introduced a totally new approach to resource management. It assigned the following additional responsibilities to regional councils:

a) The responsibility for air, coastal and geothermal resources.

b) A new planning framework which included regional policy statements, coastal plan and regional plans.

5. Biosecurity Act 1993:

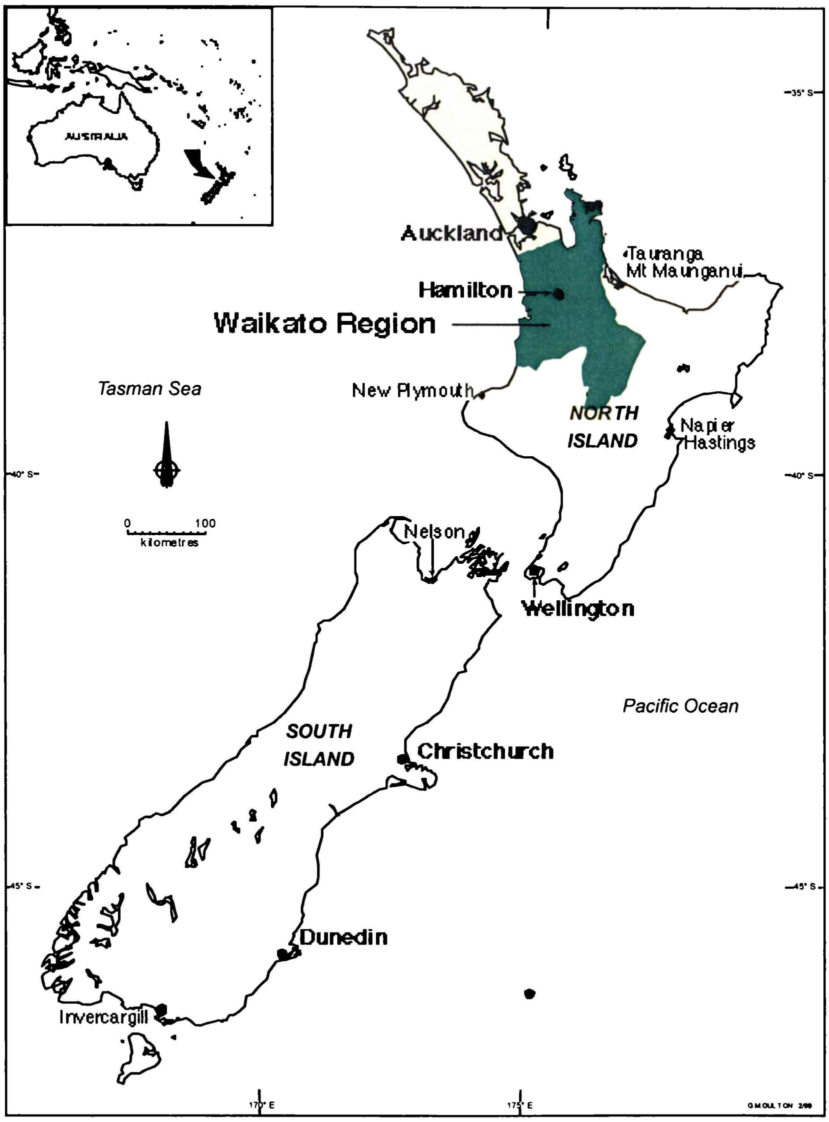
The Biosecurity Act not only replaced the Noxious Plants and the Agricultural Pest Destruction Acts, but also provided additional powers and responsibilities to regional councils. This resulted in the development of the pest management strategies.

2.2.2 Waikato Region Geography

The Waikato Region covers 25,000 square kilometres in the central North Island of New Zealand (Refer to Map 2.1). It contains a rich diversity of natural resources including snow-capped mountains, extensive river and lake systems, forests, geothermal fields and productive farm land. A human population of 363,354 (Statistics New Zealand, 2001) live in the Waikato Region mostly within and around urban areas. Within the Waikato Region are the rohe, or tribal areas, of a number of iwi including Tainui, Tuwharetoa and Ngati Tahu (Waikato Regional Council, 1994 and 1998). Water known as 'wai' in Maori is regarded as a cleansing and sacred cover. In times of need, in times of trouble Maori (normally performed by a Tohunga *Specialist* will perform a ritual known as a karakia *prayer* followed by the sprinkling of water to cleanse and filter any unwanted presences i.e. hindering spirits.

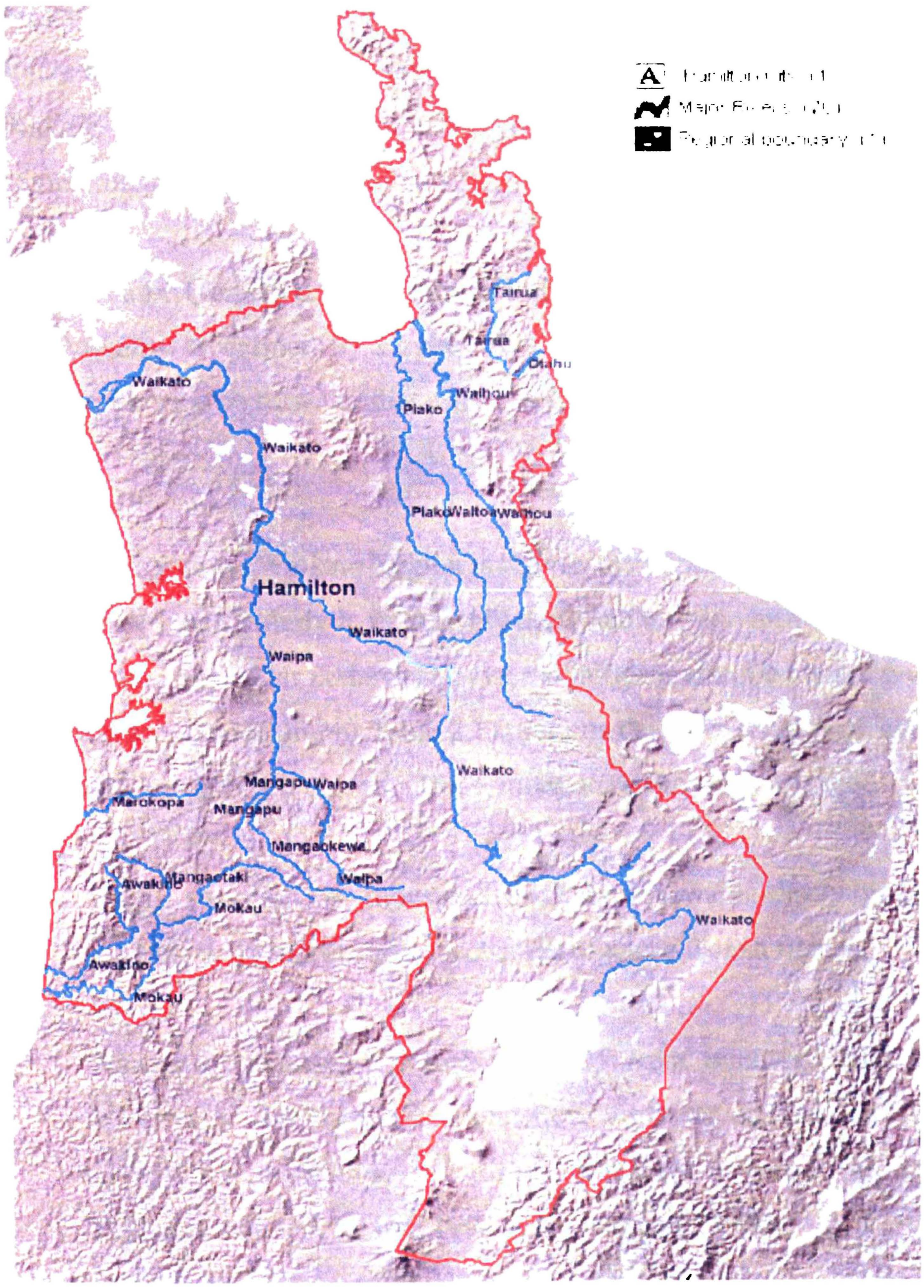
Rivers and lakes are important to the region (Refer to Map 2.2). The Waikato River is the longest river in New Zealand and is considered an important natural resource for the Region and nationally for hydroelectric generation. It joins the Waipa River at Ngaruawahia. In the region there are also the Waipa, Piako and Waihou Rivers which form extensive flood plains in the north. Lake Taupo, the largest lake in New Zealand is also in this Region.

Map 2.1: The Waikato Region



SOURCE: Waikato Region Council, 1994 in El-Kafafi and Scrimgeour, 1999

Map 2.2: Waikato Region Major Waterways



SOURCE: Waikato Regional Council, March 1996

2.3 Water Quality

This section consists of two parts. The first part reports on the water quality in the Waikato Region through the presentation of the policy statement of Environment Waikato and the second part presents empirical evidence concerning Waikato Region drinking water supplies that was derived from the Ministry of Health Register of Community drinking water supplies.

2.3.1 Water Quality in the Waikato Region:

Water quality is defined by Environment Waikato as: "the physical, chemical and biological attributes of water that affect its ability to sustain environmental values and uses."

Water quality in the Waikato Region is high in the upper catchments, but downstream it is degraded, particularly in intensively used catchments. Introduction of contaminants into water bodies can have a significant effect on water quality. The following schedule (Refer to Table 2.1) presents the main sources of surface water contamination and their effects. The sources are grouped as follows:

1. **Point sources** i.e. industrial discharge, sewage discharges, storm water systems and farm effluent discharges of waste from a pipe.

2. **Non-point sources** i.e. surface runoff from intensive land uses, stock in waterways, agrichemical application, fertiliser application, leaching from agricultural land uses, and diffuse discharge in urbanised areas (Waikato Regional Council, March, 1996 and September, 1998).

Table 2.1: Principal Sources of Surface Water Contamination

SOURCE	EFFECT Aesthetics Siltation	Nutrients	Faecal Bacteria	Toxicity	Temperature
Point Sources					
Sewage Discharges	+			+	
Dairy Sheds/Piggeries	+				+
Agricultural Industry	+		+		+
Other Industries	+	+			+
Quarries/Mines		+		+	
Non-point Sources					
Agricultural Run-off			+	+	+
Urban Run-off/ Stormwater		+	+		+
Earthworks/ Construction		+		+	
Septic Tanks	+		+		
Forestry/Land Disturbances		+			+
Landfills/Contaminated Sites	+	+			
Dams/Reservoirs	+				
Transport	+				
Atmospheric Deposition		+		+	+

N.B.: = Dominant Effect
+ = Sub-Dominant Effect

Source: Waikato Regional Council, March, 1996

The following are the principal concerns regarding New Zealand's water quality:

1. Suspended solids
2. Excessive nutrients
3. Micro-organisms
4. Chemical contamination

1. Suspended Solids:

These are inorganic sediments from rocks and soil as well as organic matter. Their negative effects include ruining fish habitat by reducing light, reducing the quality of drinking water and recreational use of water. The following are the parameters used to measure suspended solids in water:

a) Water clarity:

When suspended solids increase, water quality decreases. Water clarity is best measured by the sighting distance (in meters) by lowering a black disk on a rope into a stream or river.

b) Water turbidity:

Turbidity means muddiness. It is very difficult to measure turbidity in absolute units because the same water sample can give different results in different analytical machines. Therefore, water clarity measurements are considered to be more reliable in assessing water quality.

2. Excessive Nutrients:

Nutrients are the combination of nitrogen (N) and phosphorus (P) and often referred to as nutrient enrichment which is very vital for plant and animal health. Nevertheless, their abundance results in excessive plant and algal growth in rivers and estuaries. This case is referred to by the term "eutrophication" which degrades surface water by depleting the water's oxygen. As a result it changes the quantity and type of food available for fish and birds; consequently it alters the habitat for fish and invertebrates.

Dissolved reactive phosphorus (DRP) and dissolved inorganic nitrogen (DIN) which includes nitrate-nitrogen and ammonical nitrogen, cause algal growth in waterways.

Moreover, while ammonia can be toxic to fish, nitrate can be toxic to people and animals who drink the water.

3. Micro-organisms:

These are also referred to as microbes which are minute organisms consisting of a single cell. They include simple bacteria and complex one-celled organisms. Simple bacteria include faecal coliforms, enterococci and campylobacteria. Complex one-celled organisms include giardia, cryprosporedium, amoebea and micro-algae. Micro-organisms cause illness in humans who are exposed to contaminated water either through eating shellfish or swallowing water while swimming, boating or fishing.

The following are indicators of microbial contamination:

a) Faecal Coliforms:

The risk of high harmful organisms is assumed when the concentration of faecal coliform are high.

b) Biochemical Oxygen Demand (BOD):

BOD increases with the amount of dead organic material in water. It is measured by the amount of oxygen in a water sample consumed over a five-day test period.

c) Dissolved Oxygen (DO):

DO is very important to ensure the survival of aquatic animals. It is measured by how many grams of oxygen per cubic metre of water. DO sampling should be taken with care because it varies and is usually lowest around day-break.

4. Chemical Contaminants:

Chemical contaminants in water include:

a) Metals:

Under this category falls arsenic, mercury, lead, zinc and copper. They enter waterways from industrial sites, rubbish tips, motor vehicles and geothermal area and then accumulate to reach a toxic level in shellfish, fish, marine mammals and water itself. They are measured by grams, milligrams or micrograms per cubic metre in a volume of water.

b) Toxic Organic Substances:

They include oil, petroleum products, pesticides, some plastic compounds and industrial chemicals. They enter water through spills, failures in pipes and storage facilities and by inappropriate pesticide applications. Some of those toxic organic substances are considered carcinogenic. On the other hand they are suspected of being environmental oestrogens (i.e. interfering with the human body's hormonal balance) (Trebilco, et al, July, 1998 and Ministry for the Environment, 1997).

The following Table 2.2 sheds light on the condition of the Region's rivers that are affected by both point source and non-point source discharges in different ways as an illustration to the PSR model:

Table 2.2: General Water Quality Status of the Main Rivers in Waikato Region

River Area	Aquatic Ecosystem Health	Recreational Status
Upper Waikato River	Good	Good
Lower Waikato River	Moderate	Moderate
Upland Waikato	Moderate	Moderate
Lowland Waikato	Moderate	Poor
Hauraki	Moderate	Poor
Waipa	Moderate	Poor
Coromandel	Good	Moderate
West Coast	Good	Poor
Taupo Tributaries	Good	Good

SOURCE: Waikato Regional Council, September, 1998

2.3.2 Empirical Evidence concerning Drinking Water Supplies

This section is built on information presented in Appendices 5a, 5b, 5c, and 5d, which were derived from the Ministry of Health Register of Community Drinking Water Supplies of May 1998. The information was divided into the following groups according to the population number of each community in the area:

1. Population less than 500 (Appendix 5a)
2. Population between 501 – 2000 (Appendix 5b)
3. Population between 2001 – 5000 (Appendix 5c)
4. Population over 5000 (Appendix 5d)

Each of the above groups has been sorted to three different tables. First, each group according to the community name i.e. alphabetically. Second, each group was sorted according to the population number. Third, each group was sorted according to the water grading given by the Ministry of Health to that zone.

1. Population Less than 500:

There are 79 communities in the Waikato Region that fall under this category (Refer to Appendix 5a). Out of the 79 communities, only 29 communities water supplies are being graded. Nevertheless, the Ministry of Health is planning in the future to grade the rest of the communities with as few as 25 users.

The following is an analysis of each of the gradings:

- Tahuna community has the best grading because it has an 'A' for the source and treatment grading which is satisfactory and with very low level of risk. The small 'a' represents the distribution zone grading which is also completely satisfactory and demonstrates high quality of drinking water.
- Although Matangi and Tamahere communities have an 'A" grade for the source and treatment , they have a 'd' grade for distribution zone which is unsatisfactory and have a high level of risk. The Register shows only the grading and does not say exactly why it is low, or what would make it higher. In such cases we could assume several reasons for the grading of water. The following are some of the possible reasons:
  a) Non-compliance for faecal coliform bacteria
  b) Non-compliance for heath-significant chemicals
  c) Inadequate supply management

d) Inadequate pressure, storage, backflow prevention

e) Inadequate piping, maintenance.

- Eureka, Gordonton and Rototuna communities have an 'A' grade for the source and treatment and a 'u' grade for distribution zone which means they are not graded. In such cases we cannot really be sure how safe the water that reaches the consumer and if it is satisfactory or not.
- Te Poi community has a 'B' grade for its source and treatment which is satisfactory. On the other hand it has an 'a' for the distribution which is completely satisfactory. The reason could be because it is a small community of 100 people.
- Piopio, Waipa and Waitoa communities have marginal water quality i.e. moderate level of risk. Nevertheless, some people perceive it acceptable in such small communities.
- The rest of the communities under 500 in this schedule have grading between 'D' and 'E' which is either unsatisfactory or completely unsatisfactory.

Table 2.3 summarises the relevant information.

Table 2.3: Graded Drinking-Water in Waikato Region – Population Less than 500

Status	Satisfactory	Marginal	Unsatisfactory
No. of sites	9	3	17
% of sites	31	10.34%	58.62%
% of population in centres less than 500	33.56%	12.56%	53.86%
% of Waikato Region Population*	0.96%	0.36%	1.54%

SOURCE: El-Kafafi and Scrimgeour, July 1999

*** Number of population referred to here is 242,852 (i.e. the total of 114 communities as mentioned in the 1998 MOH Register of Community Drinking-Water Supplies in New Zealand and not according to the actual number of New Zealand 2001 Census (i.e. population of 363,354).**

2. Population Between 501 – 2000:

This category consists of 13 communities that are graded for the source and treatment and the distribution zone (Refer to Appendix 5b). There is only one exception which is Pauanui community that has no grading for the source and treatment. Nevertheless, the distribution zone is 'b' which is satisfactory and demonstrates high quality.

- Kihikihi community has the best water quality in this category with a grading of 'Aa'.
- Newstead and Te Kauwhata communities, although they have an 'A' grade for the source and treatment, they have a 'd' for the distribution zone which is unsatisfactory with high level of risk. The reasons for such discrepancy could be for one of the above reasons mentioned in the first category of populations.
- Templeview and Tokanui Hospital communities have a satisfactory 'A' grade for the source and treatment. On the other hand, their distribution zone is not graded i.e. 'u' which implies that the drinking water quality could either be satisfactory or not satisfactory.
- Taupiri – Hopu Hopu and Waharoa communities have a satisfactory 'B' grade for the source and treatment, while they have a completely satisfactory and high quality 'a' grade for their distribution zone. The reason could be to the small size of community that ranges between 600 and 660.
- Waikeria community is considered marginal with moderate level of risk.
- Tairua community is a similar case to Newstead and Te Kauwhata communities which have a satisfactory source and treatment grade but when the water reaches the consumer, its grade is unsatisfactory with high level of risk.
- Tirau community is exactly the opposite of Tairua community. The water source and treatment is an unsatisfactory grade 'D' but the water reaching the consumer has a satisfactory grade 'b'.

- The water quality in both Ohinemuri and Coromandel communities is completely unsatisfactory with very high levels of risk.

Table 2.4 summarises the relevant information.

Table 2.4: Graded Drinking-Water in Waikato Region – Population 501 - 2000

Status	Satisfactory	Marginal	Unsatisfactory
No. of sites	10	0	3
% of sites	76.92%	0%	23%
% of population in centres 501-2000	77.68%	0%	22.31%
% of Waikato Region Population*	4.43%	0%	1.27%

SOURCE: El-Kafafi and Scrimgeour, July 1999

*** Number of population referred to here is 242,852 (i.e. the total of 114 communities as mentioned in the 1998 MOH Register of Community Drinking-Water Supplies in New Zealand and not according to the actual number of New Zealand 2001 Census (i.e. population of 3563,354).**

3. Population Between 2001 – 5000:

This category constitutes of 12 communities that are all graded (Refer to Appendix 5c).

- Raglan scores the highest completely satisfactory grade of 'Aa' in both source and treatment and distribution zone.
- Although Mataouna/Manunui community scores a grade of 'A' for the source and treatment, it scores an unsatisfactory 'd' grade for consumers water.
- Pukerimu Rural community source and treatment is completely satisfactory while the 'u' grade for its distribution zone makes it difficult for us to tell what quality of water is received by the consumer.
- Te Aroha, Te Kuiti, Waihi and Whangamata all share the same grade and satisfactory water quality.
- Although Whitianga and Paeroa communities have the same grade marginal grade 'C' for their course and treatment, the water reaches the

consumer as either completely satisfactory (i.e. grade 'a') or satisfactory (i.e. grade 'b').

- Otorohanga community has a marginal and moderate water quality of grade 'Cc'.
- Taumarunui community is the only case in this category that has got unsatisfactory water quality grade of 'Ed'.

Table 2.5 summarises the relevant information.

Table 2.5: Graded Drinking-Water in Waikato Region – Population 2001 - 5000

Status	Satisfactory	Marginal	Unsatisfactory
No. of sites	8	3	1
% of sites	66.66%	25%	8.33%
% of population in centres 2001-5000	67.76%	24.16%	8%
% of Waikato Region Population*	12.09%	4.31%	1.44%

SOURCE: El-Kafafi and Scrimgeour, July 1999

*** Number of population referred to here is 242,852 (i.e. the total of 114 communities as mentioned in the 1998 MOH Register of Community Drinking-Water Supplies in New Zealand and not according to the actual number of New Zealand 2001 Census (i.e. population of 363,354).**

4. Population Over 5000:

This category comprises of 10 communities that are all graded (Refer to Appendix 5d).

- Hamilton and Thames communities score the highest grade of 'Aa' which is completely satisfactory high water quality.
- Cambridge and Te Awakutu and Pirongia communities comes next in scale by scoring 'Ab' which is also satisfactory.
- Huntly, Matamata, Morrinsville and Ngaruawahia communities score a grade of 'Ba' which is also satisfactory.
- Although the source and treatment at Tokoroa is a marginal 'C', it reaches the consumer as completely satisfactory grade 'a'.

- Hauraki Plains is the only case where the source and treatment is unsatisfactory grade 'D'. Nevertheless, it reaches the consumer as a marginal grade 'c'.

Table 2.6 summarises the relevant information.

Table 2.6: Graded Drinking-Water in Waikato Region – Population over 5000

Status	Satisfactory	Marginal	Unsatisfactory
No. of sites	8	1	1
% of sites	80%	10%	10%
% of population in centres over 5000	86.97%	10%	2.97%
% of Waikato Region Population*	62%	7.16%	2.12%

SOURCE: El-Kafafi and Scrimgeour, July 1999.

*** Number of population referred to here is 242,852 (i.e. the total of 114 communities as mentioned in the 1998 MOH Register of Community Drinking-Water Supplies in New Zealand and not according to the actual number of New Zealand 2001 Census (i.e. population of 363,354).**

The highest drinking water quality grading lies within the fourth category i.e. the population over 5000. There is a slight difference between the last three categories. The highest percentage of ungraded water quality lies in the category of population less than 500.

Table 2.7 summarises the relevant information.

Table 2.7: Graded Drinking-Water in Waikato Region – Total Population of Waikato*

Population Category	Satisfactory %	Marginal %	Unsatisfactory %	Total %
< 500	0.96	0.36	1.54	2.86%
501 - 2000	4.43	0.00	1.27	5.70%
2001 - 5000	12.09	4.31	1.44	17.84%
> 5000	62	7.16	2.12	71.28%
Total	**79.48**	**11.83**	**6.37**	**97.68%**
		Ungraded		**2.32%**

SOURCE: El-Kafafi and Scrimgeour, July 1999.

*** Number of population referred to here is 242,852 (i.e. the total of 114 communities as mentioned in the 1998 MOH Register of Community Drinking-Water Supplies in New Zealand and not according to the actual number of New Zealand 2001 Census (i.e. population of 363,354).**

2.4 Waikato Regional Council (Environment Waikato) Organisational Focus on Water Quality

This section explains the role played by Environment Waikato through describing its general functions and its specific functions related to water quality.

2.4.1 General Description of Environment Waikato Functions

Waikato Regional Council (Environment Waikato) was established in 1989 as a result of Government's local government reform programme. Environment Waikato is responsible for the management of the natural and physical resources in the central North Island. The following are the key work areas of Environment Waikato:

1. Management of land, air, water and geothermal resources through regulation, planning, education, information and co-ordination.
2. Management of water quality issues and coastal activities over an extensive open coastline.
3. River control and flood management, soil conservation and drainage schemes.
4. Controlling animal and plant pests which damage the natural environment and economy of the Waikato Region.
5. Co-ordinating and preparing contingency plans for civil defence emergencies.
6. Identifying and minimising the impact of hazards (i.e. earthquakes, floods, & volcanic eruptions) in the Waikato Region.
7. Planning and co-ordinating the Region's land transport needs. This activity also includes road safety, passenger transport and transport services for the disabled (Harris, 1997).

The following are the goals of the Environment Waikato as stated in various of its publications i.e. Annual Reports and Strategic Plans:

1. To be a good corporate citizen and fulfil the requirements of legislation under which Council operates.
2. To see the Region's resources managed in a sustainable and efficient way.

3. To protect and improve the natural heritage of the Region.
4. To encourage economic development to be in harmony with the environment.
5. To increase public knowledge of environmental issues and promote participation in environmental activities.
6. To consult with the people in the Region.
7. To take account of the principles of the Treaty of Watangi.
8. To be a cost effective and efficient organisation operating in an open and accountable manner.

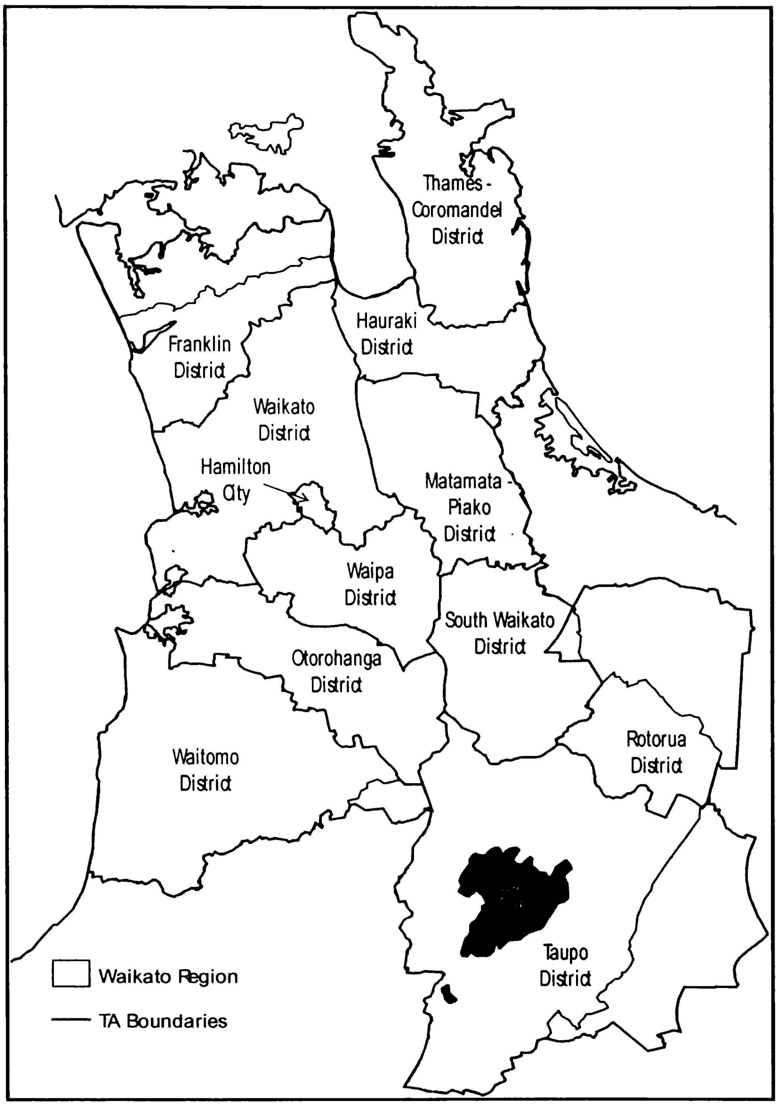
Environment Waikato believes that it should ensure the protection of the significant characteristics of the quality of those outstanding water bodies through the implementation of the following methods:

1. Regional plans, district plans and resource consents that identify and provide for the protection of significant characteristics of outstanding water bodies.

2. Liaison with territorial authorities (Refer to Map 2.3 – Waikato Region Council – Territorial Authority Boundaries) and interested parties to ensure the integrated management of land and water resources.

3. Regional plans, district plans, and resource consent applications that require the assessment of effects of land use development and subdivision on the significant characteristics of water quality.

Map 2.3: Waikato Regional Council – Territorial Authority Boundaries



SOURCE: Waikato Regional Council, September 1998

Moreover, Environment Waikato recognizes that water is a finite resource. Accordingly it is calling for efficient and effective allocation and use of the water resource. It is one of the main issues in Environment Waikato's resource management policies to ensure that the available water is apportioned properly and used efficiently especially in the time of need (Waikato Regional Council, March, 1996).

The following are key documents that Environment Waikato issues:

1. Regional Policy Statement
2. Waikato Regional Plan
3. Environmental Information Strategy
4. Annual Plan
5. Strategic Plans
6. Technical and Environmental Monitoring Reports
7. Organisational Changes, Gains and Achievements

1. Regional Policy Statement:

The Regional Policy Statement is prepared in accordance with the requirements of the Resource Management Act 1991 (RMA) to promote the sustainable management of natural and physical resources in the region. The Regional Policy Statement relevant to the study period was issued in March 1996. An amendment was issued in September 1998 after the appeals and Environment Court consent orders.

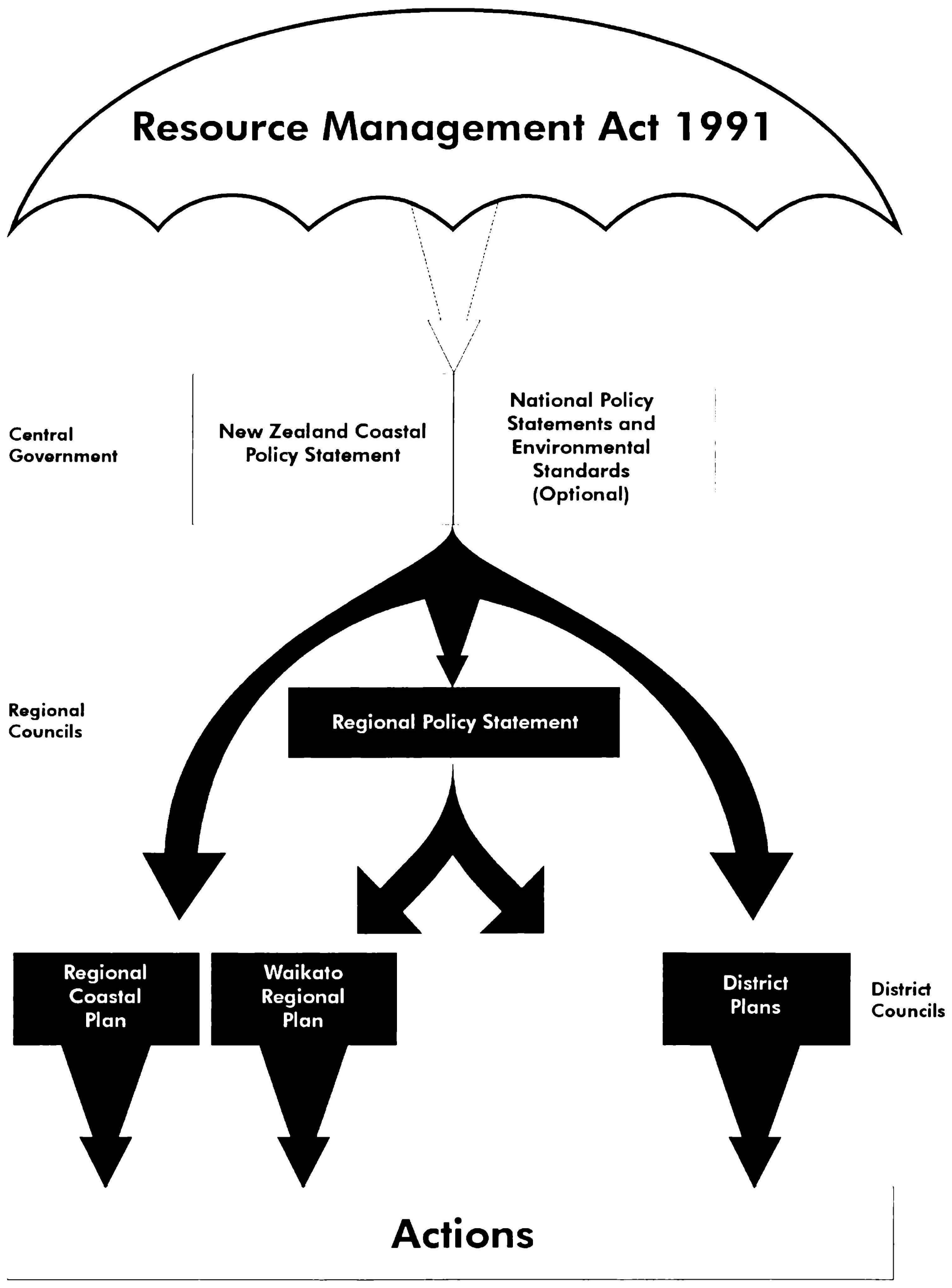
The policy has a whole section about water in which it identifies, lists and describes all the fresh water resources in the Region i.e. surface water resources (rivers and lakes in the region) and the ground water resources. It also sets out the significant resource management issues arising from the use development and protection of those resources (Waikato Regional Council, March, 1996).

2. Waikato Regional Plan:

The proposed Waikato Regional Plan of September 1998 is formulated to assist people in the Waikato Region to achieve environmental outcomes that the Region as a whole aspires to. This document progresses from the Regional Policy Statement to a focus on Environment Waikato's direct functions and addresses areas where the Council can add clarity and efficiency. Moreover, the Plan seeks to assist the Waikato Regional Council to carry out the purpose and principles of the Resource Management Act 1991. In order to promote the

Resource Management Act 1991, the following framework (Refer to Figure 2.1) was established for resource management at national, regional and local levels. Consequently, policies or plans developed within this framework must promote sustainable management of natural and physical resources.

Figure 2.1: Planning Framework



SOURCE: Waikato Regional Council, September 1998

The Water Module is discussed in the document according to the following points:

a) Water Resources
b) Water Management Classes, Flows and Levels
c) Water Takes
d) Efficient Use of Water
e) Discharges
f) Damming and Diverting
g) Wetlands
h) Drilling
i) Non-Point Source Discharges

Moreover, the Regional Plan discusses river and lake beds management, structures and disturbances as a separate module.

3. **Environmental Information Strategy:**

The purpose of this document is to develop and implement Environment Waikato's approach to gathering and making available the information that the Regional Council needs to meet the overall directions in accordance with its Corporate Strategic Plan. "A responsible environmental management requires Environment Waikato to have clear links between:

a) the resources information it gathers;
b) the use of information to develop policy; and
c) how the council implements its policy (i.e. the monitoring of the effectiveness of these programmes will feed back into information gathering)." (Waikato Regional Council, March, 1996).

4. **Annual Plan:**

The Annual Plan usually outlines the Regional Council's programme of work for each financial year beginning on 1 July. The work proposed in the annual plan is identified through the Environment Waikato's Strategic Planning and public consultation. Environment Waikato's programmes include improved activities in biosecurity, resource management, collecting information on the region's environment, land transport, natural hazard management and environmental education (Waikato Regional Council, 1997 – 1998).

5. **Strategic Plans:**

Environment Waikato has prepared two strategic plans, the first in 1995 and the second in 1998 as a review of the first one. The 1998 Strategic Plan states what will be done to manage the environment and methods used to do so. In other words it is a means of implementing the directions stated in the various policy documents of the Environment Waikato through the following steps:

a) Providing the Council with a long term framework (i.e. July 1998 – June 2008) for conducting its activities;
b) Enabling the Council to anticipate and prepare for expected changes;
c) Providing the Council with a firm basis for planning financial and resource requirements; and
d) Putting in place systems for improving efficiency and quality of service.

6. **Technical & Environmental Monitoring Reports:**

The Environmental Information Strategy is considered one of the Council's technical reports. Moreover, the Council's other reports "Water Resources of the Port Waikato Area and Lower Waikato River" and the Waikato River Water Quality Monitoring Programme Report are issued annually as a means of reporting on the status of the water quality in this region. There are also technical reports on the trends in River Water Quality in the Waikato Region since 1980 (Maggs, 1992; Huser & Wilson, October, 1995; Huser & Wilson, June, 1997; Wilson, Vant &, June, 1998 and Vant & Wilson, September, 1998).

7. **Organisational Changes, Gains and Achievements:**

This document is a report issued by Environment Waikato presenting its achievements since its establishment in 1989 until 1997. It illustrates and quantifies the outputs from Environment Waikato as a means of conveying a message to the community of the regional council's efforts to contribute to a healthy economy and a sustainable environment.

2.4.2 Focus on Water Quality

Environment Waikato gives great importance to the following issues:

- maintaining and improving the water quality,
- maintaining and enhancing flow regimes,
- efficient use of water, and
- enhancing public access (Environment Waikato Strategic Plan, 1994 & 1998).

Apart from its general planning role, Environment Waikato is involved in the following activities or programmes related to water quality in the region:

1. Environmental Monitoring Programme
2. Resource Use Programme
3. Environmental Education Programme

1. Environmental Monitoring Programme:

Under Section 32 of the Resource Management Act 1991, Environment Waikato is required to collect environmental data. The following Table 2.8 serves as a sample to illustrate the permanent and temporary recording done by Environment Waikato in the region.

Table 2.8: Summary of 1997 Automatic Records

		PERMANENT RECORDERS	
Sites	**Type**	**Parameters**	**Data Sets**
19	Rainfall	Rain (17), Flood Warning (2)	19
53*	Surface water	Level (53, Flow (42), Temperature (11)	106
1	Coastal	Sea Level, Wave Amplitude, Wind Speed, Wind Direction, Barometric Pressure	5
2	Groundwater	Level	2
1	Water Quality	Turbidity, pH	2
1	Air Quality	Wind Speed, Wind Direction, Temperature, Carbon Monoxide, Oxides of Nitrogen, Particular Matter<10 microns	6
77		**Totals**	**140**
		TEMPORARY/PORTABLE RECORDERS	
Sites	**Type**	**Parameters**	**Data Sets**
6	Water Quality	Temperature, pH, dissolved Oxygen, Turbidity, Conductivity	30
1	Water Quality	Suspended Solids	1
7		**Totals**	**31**

SOURCE: Wilson; Vant & Huser, June, 1998

***including two sites operated by other agencies, but which have some Environment Waikato equipment to provide level and flow information for flood warning purposes only.**

The field procedures governing the monitoring are carried out according to the standards set out in the Environmental Monitoring Quality Manuals written in late 1994 in compliance with ISO 9002. Telarc New Zealand offered registration to this standard in early May 1995. Water quality and biological data collection have been added to the system since that date. Environmental Monitoring's registration (i.e. ISO 9002) passed Telarc's review procedure in 1997 (Wilson; Vant & Huser, 1998).

Until September 1997, Qualtarc (a laboratory database) was used by Environment Waikato to file all water quality results. Afterwards all historical data with a geographic location was converted to Hydrol (another database system). Over 4790 samples were analysed during 1997 of which 70% were related to a geographic location. Moreover, samples are taken at selected sites for specific projects. Intensive water quality measurements are taken using Datasonde logger/sensor instruments and are typically operated for three-day periods. The following Table 2.9 illustrates how the sample collection data is presented.

Table 2.9: Water Quality Sets with Site and Sample Totals

Project ID	Data Set	Name	No. Sites	No. Samples
WCBBS	4114	Coastal Water Quality: Bacteriological- West Coast Beach	10	70
HYDROSS	5123	Surface Water: Suspended Sediment/Temperature Monitoring	33	792
CLASWAIK	5342	Water Quality: Bacteriological – Waikato River	13	64
TRLAKES	5401	Lake Water Quality: Regional	15	116
TAUPO	5402	Lake Water Quality: Taupo	18	143
URBAN	5501	Water Quality: Urban Stream	7	15
TRRERIMP	5505	Water Quality: Waikato River Monitoring Programme	95	1122
TRWAIK	5700	Water Quality: Waikato River Monitoring Programme	9	120
WRINV	6150	Groundwater: Consents Monitoring	8	40
GWNITRATE	6220	Groundwater: Nitrate	88	176
GWPESTICIDE	6300	Groundwater: Pesticide	19	76
CMGOLD	8300	Compliance Monitoring: Gold Mines	17	32
		Total	332	2766

SOURCE: Wilson; Vant & Huser, June, 1998

2. Resource Use Programme:

The Environment Waikato Resource Use Programme is responsible for ensuring that the use and development of natural and physical resources is in compliance with the Council's Regional Policy Statement and Regional Plans. Moreover, sustainable management should also be achieved in the process. The following actions are the means by which Environment Waikato achieves the above mentioned goals as stated in its Strategic Plan of 1998 – 2008:

1. Evaluating and processing resource consent applications for decision by a Hearing Committee;

2. Ensuring that the consent conditions and requirements of plans and legislation are in compliance with the monitoring and auditing procedures;
3. Responding to public concerns such as complaints and reports of pollution incidents and providing people with information on resource use issues and consent applications; and
4. Measuring pressures on resources arising from their rate of use or development.

3. Environment Education Programme:

The main aim of this programme is to raise community awareness of environmental issues and transform this awareness into informed action. An Environmental Education Strategy was developed by Environment Waikato in 1996 to guide Environment Waikato's activities for a period of ten years. These activities and the associated planning and co-ordination are carried out through the Environmental Education Programme which targets, the care groups and other community groups, the formal education sector, industry, business and other resource users, and the regional community (Waikato Regional Council, 1998).

The Waikato Regional Council has actively recognised environmental practice and achievements through general environmental awards and farm environment awards (Harris, 1997).

2.5 Customers and Water Quality

This section discusses the role played by the customers in shaping quality. Any organisation has to go through the following stages:

1. Identify who the customers are so that they can clarify what servicing the customer means. (In this research the customer we are targeting is mainly the community receiving the drinking water through the Territorial Local Authorities provision).
2. Identify and understand the customers' needs (i.e. the acceptability of drinking water e.g. colour, taste and continuity).

3. Translate these customer needs into technical requirements i.e. usually customers express their needs in a way that reflects their perceptions in relation to the product manufacturer or service provider (in this case it would be the customers' expectations from the Territorial Local Authorities and their provision of quality drinking water).

The ultimate test of the quality of any product or service is whether it provides satisfaction of the customer's needs. There are there types of satisfaction that can be provided to the customer:

1. **Assumed Features of the Product/Service:**
   These are the features of the product or service that are inherent in its nature. The customer expects a quality of drinking water that is not hazardous i.e. healthy and safe and up to the minimum requirement of the New Zealand Drinking Water Grading System.
2. **Advertised Features of the Product/Service:**
   These are the critical features which determine the customer's choice. The product or service is selected precisely because it offers these features which may differ between competing products or services. This feature does not apply to publicly provided water services. Water utilities care about their reputation and gaining the trust of their customers.
3. **Unexpected Features of the Product/Service:**
   These are extra features that the customer did not expect to receive. In this research we can relate it when the water grading would be of excellent grading while the source and origin of the water is of extremely low quality. In such cases the TLA did not meet the minimum standards but aimed at providing a high level of quality (i.e. colour, taste and continuity besides meeting the standards of New Zealand Drinking Water Grading System).

Accordingly establishing quality goals for drinking water requires dialogue between the TLAs and their customers (i.e. community served). This could be achieved through regular customer feedback to incorporate their perceptions in the continual improvement process.

2.6 Conclusion

This section summarises the information presented in the chapter as a means of identifying the major water quality problems in the Waikato Region, the measures taken in order to improve the situation and their likely impact on drinking water quality.

The major causes of degradation are:

1. Point source discharges (i.e. industrial discharge, sewage discharges, storm water systems and farm effluent discharges of waste from a pipe) into water bodies;

2. Cumulative effects of non-point source discharges (i.e. surface runoff from intensive land uses, stock in waterways, agricultural application, fertiliser application, leaching from agricultural land uses, and diffuse discharge in urbanised areas); and

3. Inappropriate taking and impounding regimes.

Waikato Regional Council is attempting to attain the following objectives:

1. Net improvement of water quality across the region.

2. Avoidance of significant adverse effects on aquatic ecosystems

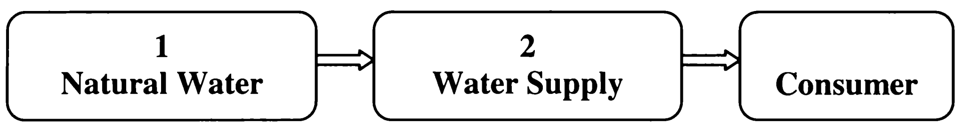
3. Ensuring water use is consistent with maintaining the desired flow regimes.

4. Maximise the opportunities for efficient utilisation of the available water.

5. Increasing the quality and quantity of the Region's wetlands.

Water quality can be assessed from the perspective of the aquatic biosphere, in-situ use by people e.g. recreation, and by drinking water quality. The actions of Environment Waikato primarily impact the first two amenities. There are two primary determinants of drinking water quality as illustrated in the figure below:

Figure 2.2: Water Quality Determinants



SOURCE: El-Kafafi and Scrimgeour, July, 1999.

The major determinant of drinking-water quality is number 2 (i.e. water supply systems) while number 1 (i.e. natural water flows) in itself does not directly affect many people.

The actions of Environment Waikato have minimal effect on drinking water quality. Hence, if drinking water quality for the people of the Waikato Region is to be improved, more attention needs to be focused on the water supply systems. These systems are controlled by territorial authorities and private owners. Accordingly, the research underpinning this dissertation investigates the water utilities located within the territorial authorities (i.e. the water service departments of the TLAs within the Waikato Region and their contractors) and their managerial systems.

The following Table 2.10 illustrates the surface water resources available in the Waikato Region, their water quality, reasons behind that, the actions taken by Environment Waikato in respect to the situation and its effect on drinking water quality.

Table 2.10: Surface Water Resources in the Waikato Region

Water Catchment	Water Quality	Reasons	Environment Waikato's action	Potential Impact on Catchment	Potential Impact on Drinking Water
Upper Waikato River	Good	No discharges no contamination			
Middle and Lower Waikato River	Moderate	Waste discharges (i.e. community sewage and agricultural resources) erosion (i.e. flooding)			
Upper Waipa River	Good				
Down stream Waipa	Moderate to Poor	Community sewage, non-point discharges, farm effluent discharges			
Waihou River System	Good water quality BUT degradation to wild life habitat	Presence of aquatic weeds associated with drainage channels and river banking which causes blockages and reduce water quality	Education Farm dairy regimes. Resource consents.	Improved aquatic ecosystem health. Improved recreational opportunities.	Minimal
Piako and Waitakaruru Catchment	Poor	Discharges of dairy farm effluent, nutrient enriched run-off, soil erosion and subsequent sedimentation			
Coromandel Peninsula	Good In some areas moderate Water demand exceeds supply in summer months	Soil erosion and the subsequent silting of streams			

SOURCE: El-Kafafi and Scrimgeour, July, 1999.

CHAPTER THREE:
QUALITY MANAGEMENT MODELS AND THEIR RELEVANCE FOR WATER UTILITIES' MANAGEMENT IN NEW ZEALAND

3.1 Introduction

This chapter consists of six parts. It gives background about the evolution of quality management and its different definitions. It explains the meaning of the term 'Total Quality Management' through the perceptions of the quality gurus and examines their role in its evolution. The chapter then describes the different models of total quality management i.e. ISO 9000 Series Standards, the Deming Award, the Malcolm Baldrige National Quality Award and its New Zealand equivalent "Business Excellence Quality Award." Finally the chapter concludes by introducing the application of Total Quality Management (TQM) in New Zealand water utilities.

3.2 Background

3.2.1 Historical Evolution of Quality Management

Quality has emerged and remained as a dominant theme in management literature since the 1940s (Beckford, 1998). The quality idea has been around for hundreds of years. People have always been concerned with the quality of food they eat, the quality of water they drink, the quality of shelter they have, the quality of their relationships with one another and the overall quality of life.

A study conducted by Gitlow, Oppenheim & Openheim (1995) traced the history of quality as far as 2000 BC examining how society demanded that providers of goods or services should meet their obligations. As long ago as 1700 BC, King Hammurabi of Babylon introduced the concept of product quality and liability into the building industry of the time by declaring (item 229 in Code of Hammurabi):

> *... if a building falls into pieces and the owner is killed then the builder shall also be put to death. If the owners' children are killed then the builders' children shall also be put to death* (Kehoe, 1996; Madu, 1998).

This sense of responsibility for the performance of the work forces the builder to inspect every part used in the building construction and assure the quality of the work, otherwise the consequences will be grave.

This prehistoric concept of quality is still unchanged. The principle difference that has occurred is the contemporary focus on a structured quality approach. In other words, a quality plan that is well articulated, included in operational strategies and integrated in a decision making framework to attain some predefined goals (Madu, 1998).

Centuries ago, the discerning customer in shops and market places applied quality techniques by prodding and turning fruits and vegetables testing for firmness, freshness and fitness for the purpose of consumption. If the product was not adequate, the purchase would not take place (Flood, 1993). Building quality into product was traditionally the aim of skilled crafts people. Trades people gained a reputation for quality products through skilled craftsmanship that was maintained over time by enforcing lengthy apprenticeship of newcomers to masters of the trade. Monopolistic guilds were organised to ensure achievements of a high level of skill and quality throughout its membership and the trade (Kehoe, 1996).

The Industrial Revolution revolutionised the manufacturing of products. Mass production set in large factories employing lots of people gave rise to new management ways (Flood, 1993). Fredrick Taylor's work in the late 1800s and early 1900s established his famous scientific management with the following key attributes:

1. work sub-divided into small components with individual workers assigned to each specialised role;
2. responsibility associated with each job limited to a minimum to provide better managerial control;
3. pay based upon individual performance;
4. scientific selection, training and development of workers by supervisors; and
5. quality control as a separate function (McGregor, 1967; Flood, 1993).

The craftsmanship concept disappeared with Taylorism and so to an extent did quality achieved through skilled craftsmanship. Inspection thus remained the guarantor of quality. Hence, quality was no longer built into the product (Flood, 1993).

During the First World War, quality became a pressing issue with forces requiring reliable products to arrive in time. This led to the formation of associations and institutions. For example, in Britain, the Technical Inspection Association was formed in 1919 which later on in 1922 was incorporated as the Institution of Engineering Inspection. In 1932 the first standard on quality control was published by the British Standards Institute (BSI) (Flood, 1993). The Second World War had a greater effect on North America. Thousands of quality specialists trained mostly by the War Production Board, formed the American Society for Quality Control (ASQC) (Flood, 1993).

Although the initial approaches to quality emerged from American theorists and practitioners, early commercial applications were predominantly amongst Japanese companies (Beckford, 1998). The Japanese faced a major challenge in overcoming a reputation for shoddy products. A major thrust in Japanese manufacturing was to tackle these difficulties by employing and developing quality approaches. Flood (1993) notes that W. Edward Deming and J.M. Juran are two of the most famous "gurus" who played a major role in this process of improvement in Japan. Deming was called the "Father of TQM" while J.M. Juran was considered one of the experts on quality control. Juran was invited to Japan in 1954 to deal with the different forms of waste. Since then identification and reduction of waste became one of the core activities of quality management (Dahlgaard & Dahlgaard, 2001). By the 1970s, the Japanese became masters at achieving quality in their manufacturing sector (Beckford, 1998 & Flood, 1993).

Ishikawa (in Japan) made a substantial contribution to achieving quality in production. Ishikawa's Statistical Quality Control (SQC), is a system of production methods to produce economically quality goods or services while meeting consumers' requirements. The Japanese went rapidly beyond quality in production by recognising the importance of quality in management. They devised the following strategies that formed the basis of today's international efforts:

1. Senior managers must personally take charge of quality management implementation.
2. Personnel from all levels and functions of an organisation must undergo training in quality management.
3. Quality improvement must be continuous.
4. The workforce must participate in quality improvement (Pratt, 1994 & Flood, 1993).

The Japanese were exceptional in the speed of adaptation to a focus on competitiveness based on quality. In winning the quality challenge, the Japanese were able to achieve a massive increase in their export levels (Flood, 1993). Porter and Hamel (2001) believe that Japanese companies imitate and emulate one another and that what distinguishes one organisation from another is its operational effectiveness i.e. performing similar activities better than rivals.

Since the earlier days of the quality revolution (started by the Japanese as illustrated above) of the 1970s and 1980s, many organisations have realised that quality development represents an enormous management challenge. This challenge for continuous improvement requires the continuous development of systems, techniques and people. On the other hand, competitive improvement through quality development can only be achieved if the organisation understands not only what the various quality options are but also when a particular technique or approach is applicable. Hence, quality development has no single blueprint, but requires a learning organisation which understands the key concepts and methods of implementation (Kehoe, 1996).

More recently (i.e. late 1980s and early 1990s) organisations throughout the world have begun to embrace the theories and practices of quality. It has been an era of competitive challenge with increasing numbers of companies adopting quality management systems. Many consultancy companies have latched on to quality training and intervention as services they can offer. This adds significantly to the general awareness of quality management. The 1990s saw quality management become an international management philosophy, tipped to continue into the new millennium (Beckford, 1998 & Flood, 1993).

Taking a closer look at the global competitors and the significant changes in their strategic plans over the past decade, we can find a difference between the European and American manufacturers versus the Japanese manufacturers in relation to their quality improvement programs. Hunt (1993) illustrates in the following table (Table 3.1), in rank order of importance, programmes that companies in Japan, Europe and the United States stress as their priorities. He further explains that the European and American manufacturers have improved their manufacturing capabilities in order to hold or attempt to regain a viable market-share position depending on the type of products. Their strategy has been based on a return to the fundamentals of effective product and process development integration, with a special focus on quality improvement and organisational restructuring. On the other hand, the Japanese manufacturers, feeling confident with the quality of their products, emphasised flexibility through the use of automation (CAD, robots, CIM) and price reduction of their products.

Table 3.1: Quality Improvement Programs Priorities in Japan, Europe and the United States

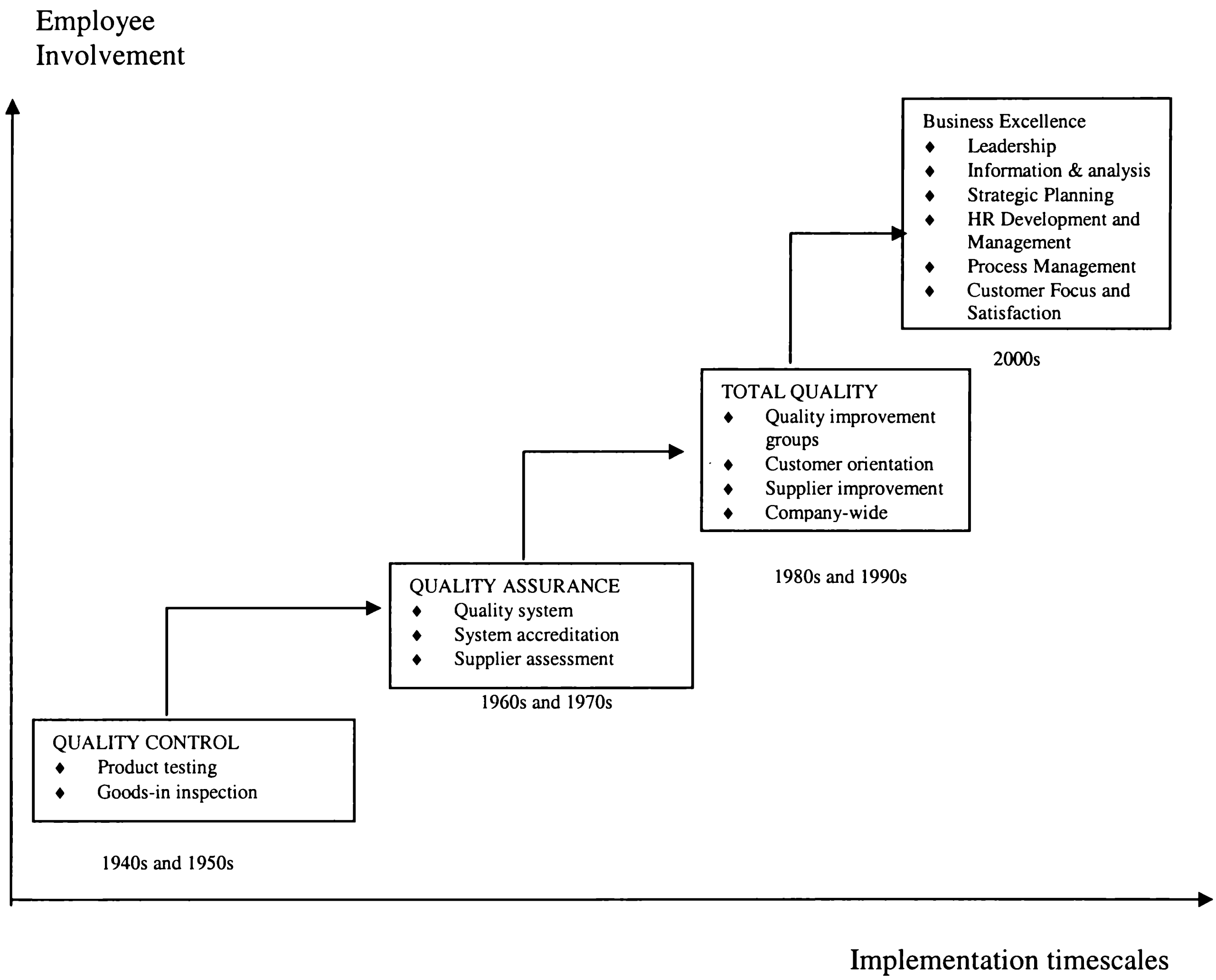
Japan	Europe	United States
Lead time reduction	Zero defects	Supplier quality
Computer-aided design	New product information	Statistical process control
Value analysis	Supplier quality	Systems integration
New process/product development	Systems integration	Lead time reduction
Systems Integration	Team motivation	Worker safety
New product introduction	Lead time reduction	Zero defects
Job enlargement	Supervisor training	Defining strategy
Supplier lead time reductions	Just-in-time	Supervisor training
FMS/CIM/EIS	Statistical quality control*	New product introduction

***Flexible Manufacturing Systems, Computer Integrated Manufacturing, Enterprise Integration Systems**

SOURCE: Reproduced with permission of Manufacturing Roundtable, Boston University, In Hunt, 1993, p.9.

The following figure (Figure 3.1) illustrates the development of quality management approaches through the years:

Figure 3.1: The Development of Quality Management Approaches



SOURCE: Partially adapted from Kehoe, 1996, p.3.

The above summary of the evolution in quality management thinking ends up with Business Excellence (discussed further later in the chapter) which evolves from Total Quality Management (TQM). Total Quality Management is the main subject of this chapter in which the literature is reviewed to draw attention to what is relevant for water utilities management in New Zealand.

3.2.2 Definition of Quality Management:

To most people and in general speech, the word quality is used to describe excellence, value, reliability or goodness. The Oxford English Dictionary and the Webster's New World Dictionary define quality as *"the degree of excellence or superiority which a thing possesses."*

Ishikawa, one of the Japanese pioneers of Quality movement, distinguished between the broad and narrow definition of quality as follows:

> *Narrowly interpreted, quality means quality of product. Broadly interpreted, quality means quality of work, quality of information, quality of process, quality of division, quality of people, including workers, engineers, managers, and executives, quality of system, quality of company, quality of objectives, etc* (Ishikawa, 1985, p.45).

In the business context, quality is understood as meeting the customer's expectations. In order to manage quality, organisations need to have mechanisms in place in order to establish what the customer expects or requires and at the same time confirms that these expectations have been met (Kehoe, 1996; Oakland & Sohal, 1996; & Dahlgaard & Dahlgaard, 2001).

One of the internationally agreed upon basic definitions of "quality" is contained in ISO 8402 (i.e. International Standards for Quality) stating:

> *Quality: The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs. [per note 6 under the definition, quality is referred to as "fitness for use" or "fitness for purpose" or "customer satisfaction" or "conformance to the requirements."]* (ISO 8402, 1993).

Zink (1998) defined quality as: *"Quality is the fulfilment of agreed requirements for long-term customer satisfaction."* According to this definition, two aspects must be dealt with:

1. The differentiation between product and service quality because many studies have shown that shortcomings in service are the main reason for customers turning to competitors; and
2. The question of whether or not fulfilling agreed requirements contributes to long term customer satisfaction or not.

He goes further by describing three different levels of quality:

1. "Take-it-for-Granted-Quality": Quality is only perceived when it is insufficient.
2. "One-Dimensional-Quality": Quality of product or service as specified contributes to customer satisfaction.
3. Attractive Quality": This dimension of quality delights the customer because it is unexpected. Moreover, this understanding of quality can barely be evaluated by traditional customer surveys.

Kehoe (1996) gave the following definitions to the term "quality":

1. "the features and characteristics of a product or service which bear upon its ability to satisfy a stated or implied need";
2. "conformance to specification";
3. "fitness for purpose";
4. "meeting customers' requirements, and exceeding their expectations";
5. "doing things right first time".

Hunt (1993), in his book "Managing for Quality" showed how broadly the term "Quality" is being defined within the business community by presenting the following table (Table 3.2) in which he presents the definition of the term "Quality" by different people.

Table 3.2: Definitions of Quality

1. **Customer-based**
"Quality is fitness for use."
J.M. Juran
"Total Quality is performance leadership in meeting customer requirements by doing the right things right the first time."
Westinghouse
"Quality is meeting customer expectations. The Quality Improvement Process is a set of principles, policies, support structures, and practices designed to continually improve the efficiency and effectiveness of our way of life."
AT&T
2. **Manufacturing-based**
"Quality [means] conformance to requirements."
Philip B. Crosby
"Quality is the degree to which a specific product conforms to a design or specification."
Harold L. Gilmore
3. **Product-based**
"Difference in quality amount to difference in the quantity of some desired ingredient or attribute."
Lawrence Abbott
"Quality refers to the amount of the unpriced attribute contained in each unit of the priced attribute."
Keith B. Leffler
4. **Value-based**
"Quality is the degree of excellence at an acceptable price and the control of variability at an acceptable cost."
Robert A. Broh
"Quality means best for certain customer conditions. These conditions are (a) the actual use and (b) the selling price of the product."
Armand V. Feigenbaum
5. **Transcendent**
"Quality is neither mind nor matter, but a third entity independent of the other two ... even though Quality cannot be defined, you know what it is."
Robert Pirsig
"... a condition of excellence implying fine quality as distinct from poor quality ... Quality is achieving or reaching the highest standard as against being satisfied with the sloppy or fraudulent."
Barbara W. Tuchman

SOURCE: Hunt, 1993, p.32

According to the previous range of quality definitions, the argument is that for most enterprises the key to survival is high quality products and service associated with customer satisfaction. Logothetis (1992) stated that current worldwide competition generally demands from any corporation the following four types of ability characteristics:

1. To understand what the customer wants and to provide it, immediately on demand, at the lowest cost.

2. To consistently provide products and services of high quality and reliability.
3. To keep up with the pace of change, technological as well as political and social.
4. To be one step ahead of the customer's needs; that is, to predict what the customer will want one year or ten years from now.

On the other hand, Porter (1980, 1985 and 1998) stated that for a business to succeed in general, it requires not only achieving its business's aims and objectives, but also maintaining itself in a balanced equilibrium in the face of all the forces impinging upon it in its environment. Porter argued that businesses must respond to the following five competitive forces:

1. the threat of new entrants,
2. the bargaining power of suppliers,
3. threats from substitute products or services,
4. the bargaining power of buyers, and
5. rivalry amongst existing firms.

Accordingly, Porter recommended three generic strategies (i.e. cost leadership, differentiation and focus) to out-perform competitors or maintain a market position against competition (Porter & Hamel, 2001; Porter, 1996; and McDermid, Guether, & Hansen, n.d.).

Moreover, Miller (January/February, 1992) stated that a single generic strategy is not always the best choice because customers may demand a mix of satisfactions (e.g. quality, reliability, style, novelty, convenience, service, and price); hence, a mixed strategy is required to satisfy them. From this perspective, quality strategies should not be pursued as stand alone paths to success.

3.2.3 Total Quality Management (TQM)

There is no consensus on a single definition for TQM (Gehani, 1993). The following are a few of the definitions that have emerged and proved useful in understanding the central notions of TQM. This section presents the various definitions of TQM by authoritative organizations and experts in the field of quality management. It ends by summarizing the similarities and differences among those definitions. This approach was chosen as it is of importance to this research as one aspect of the research was investigating the water utilities' management's perception of TQM.

In 1989, the British Quality Association provided the following official definition of TQM:

> *Total Quality Management (TQM) is a corporate business management philosophy which recognises that customer needs and business goals are inseparable. It is applicable within both industry and commerce.*
>
> *It ensures maximum effectiveness and efficiency within a business and secures commercial leadership by putting in place processes and systems which will promote excellence, prevent errors and ensure that every aspect of the business is aligned to customer needs and the advancement of business goals without duplication or waste of effort.*
>
> *It involves every department, function and process in a business and the active commitment of all employees to meeting customer needs. In this regard the customers of each employee are separately and individually identified* (British Quality Association, 1989).

In 1991, Ted Marchese explained TQM as an approach to management, a set of tools, and a blend of new and old ideas. Those ideas are from systems thinking and statistical process control, theories of human behaviour, leadership and planning, and lessons from successful attempts at quality improvement such as quality circles. He further explained that all those ideas were brought together in a new orthodoxy (Vardeman, 2001).

On the other hand, he said that if we looked at TQM as a phenomenon, it is a call to leadership for the reform and change in management practice of the organisation. This organisation's culture should be quality-driven, customer-oriented, marked by teamwork and avid about improvement.

Prof. John Oakland in a Department of Trade and Industry booklet entitled "Total Quality Management" defined TQM as follows: *"TQM is a way of managing to improve the effectiveness, flexibility and competitiveness of a business as a whole. It applies just as much to service industries as it does to manufacturing"* (Pike, and Barnes, 1996).

The International Standards Organisation (ISO 8402) defined TQM as:

> *A management approach of an organisation, centred on quality, based on the participation of all of its members and aiming at long-term success through customer satisfaction and benefits to the members of the organisation and to society* (Kirchenstein, and Blake, 1999).

The Royal Mail defines TQM as:

> *A comprehensive way of working throughout the organisation which allows all employees as individuals and as teams to add and satisfy the needs of the customer* (Pike, and Barnes, 1996).

The UK government's Department of Trade and Industry (1986) defines TQM as:

> *Modern Quality Management means adopting a total approach to quality. A vital ingredient is a commitment at the highest level to improving quality. .....ensures that a product or service is designed, built and delivered to meet the final customer's needs and expectations. A vital part of this making every member of the organisation aware of the importance of their role in achieving it* (Logothetis, 1992).

The United States Department of Defence (1988) defines TQM as:

> *...both a philosophy and a set of guiding principles that represent the foundation of a continuously improving organisation. TQM is the application of quantitative methods and human resources to improve the materials and services supplies to an organisation, all the processes within an organisation, and the degree to which the needs of the customer are met, now and in the future* (Pike, and Barnes, 1996).

In 1990, SEMATECH (Semiconductor Manufacturing Technology), a consortium dedicated to keeping the U.S. semiconductor industry viable and competitive in the global marketplace, published this definition:

> *Total Quality Management is a [holistic] business management methodology that aligns the activities of all employees in an organisation with the common focus on customer satisfaction [to be achieved] through continuous improvement in the quality of all activities [processes], goods and services* (Burrill and Ledolter, 1999).

Logothetis in his book "Managing for Total Quality" (1992) defines TQM as:

> *Total quality management is a culture; inherent in this culture is a total commitment to quality and an attitude expressed by everybody's involvement in the process of continuous improvement of products and services, through the use of innovative scientific methods.*

He explains that his definition is built upon the need for the establishment of the following three fundamental characteristics in which he connects in a triangle and calls them the TQM axioms (Figure 3.2):

1. **Commitment (to never-ending quality improvement and innovation).**

   This axiom is concerned with structural aspects.

   The commitment referred to is the management commitment to continually improving the quality for products and services. He stated that management participation and demonstration by example are the best ways of convincing the workforce that the managers are serious about quality and that the same should be expected of everybody. On the other hand, management should apply a system with the following components to motivate their employees towards a real commitment to quality and innovation: proper working conditions, adequate education and training, good communication and co-operation, modern leadership rather than strict supervision, good incoming materials and equipment, appropriate quality tools and job satisfaction.

2. **Scientific knowledge (of the proper tools and techniques for the technical change).**

   This axiom is concerned with technological aspects.

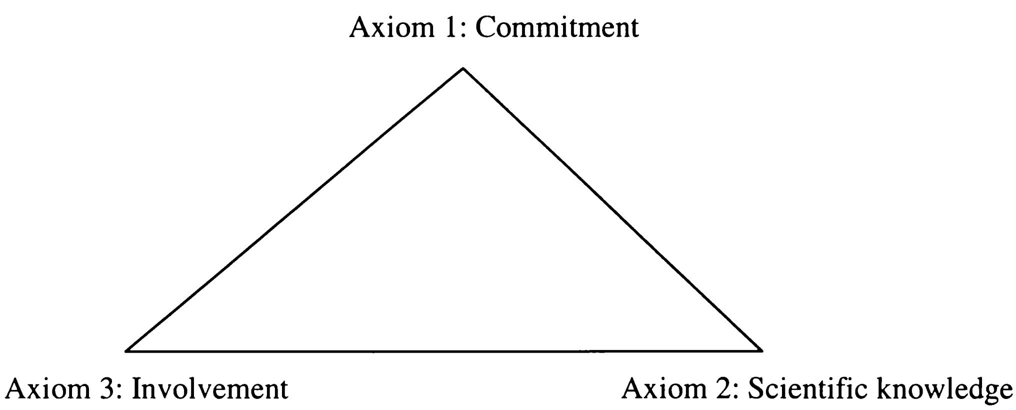
   The majority of the scientific methods are applicable to both manufacturing and service industry. It could be also used by a manager and an engineer. Apart from providing a common language throughout the organisation, the scientific methods help in assignment of responsibilities. They provide exact boundaries which fairly separate everybody's duties and obligations concerning quality, so that the vicious circle of blame, unjust recrimination and apathy is eliminated.

3. **Involvement (all in one team, for the social change).**

This axiom is concerned with the social aspect.

The social factor is of great importance to bringing about a TQM culture in an organisation because total quality is not about a particular process or department, or about the responsibilities of a particular quality manager. It concerns everybody in the company; hence, it requires a new social attitude and a new network of relationships to make it work successfully.

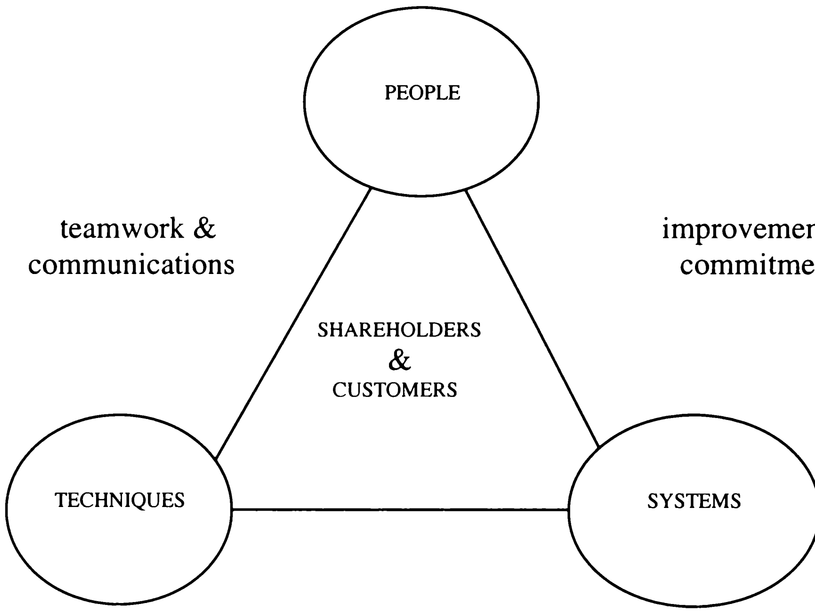
Figure 3.2: The TQM Triangle (axioms)



SOURCE: Logothetis, 1992, p.4

In 1996, Dennis F. Kehoe stated that for most organisations the challenge of quality development requires progress in three basic dimensions of quality management: people, systems, and techniques. He gave the following figure (Figure 3.3) as an illustration.

Figure 3.3: The Dimensions of Quality Management



SOURCE: Kehoe, 1996, p. 5

It is through the systematic integration of all the above mentioned three dimensions that organisations can achieve the breakthrough in operational performance and customer service associated with total quality (Kehoe, 1996; Oppenheim & Przasnyski, 1999; and Vardeman, 2001). However, progress requires among other things understanding of the fundamental principles of quality management and an appreciation of the implementation approaches necessary for practical success (Kehoe, 1996).

As illustrated in Figure 3.2, quality management has a significant impact upon all three elements of business (i.e. customers, shareholders and employees). Improved customer service enhances customer loyalty and generates increased revenues. More effective internal operations reduce quality costs and hence improve business performance. Accordingly, a quality culture in which people are empowered creates increased job satisfaction and therefore a more motivated workforce (Sankar et al, 1995 and Kehoe, 1996).

The common theme is the comprehensive nature of the TQM approach upon which all the definitions agree. The other noticeable thing is that all definitions emphasised that TQM is a philosophy and culture that needs to be adopted by top management. Moreover it stressed that in order for this business management methodology to be successful and reach its goal (i.e. customer satisfaction and the organization's prosperity) all levels of the organization should collaborate and work together as one team. The common words among all definitions were: customer needs, leadership, continuous improvement, customer satisfaction, teamwork, commitment, everybody's involvement and innovative scientific methods. A common deficiency was the lack of detail about how this applies to organisational structures, strategies and processes. It appears that the practical application of the concept is assumed to be straightforward.

3.3 Quality "Gurus", their philosophies, principles and methods:

In the historical background to quality ideas, the names of key people who contributed to the field of quality management were mentioned. The main aim of this section is to provide insight from a closer look at the work and contributions of the "gurus" of quality management. The main ideas of W. Edward Deming, Joseph M. Juran, and Philip B.Crosby are reviewed and analysed by presenting their philosophies, principles and methods towards quality management.

3.3.1 W. Edwards Deming (1900 - 1993)

You do not have to do this; Survival is not compulsory! **(W. Edwards Deming)**

W. Edwards Deming was born in 1900 and received his Ph.D. in mathematics and physics from Yale University. In the late 1920s, Deming was first introduced to the basic beliefs of traditional management at Western Electric's famous Hawthorne plant in Chicago where he was a summer employee. At that time the revolutionary human relations studies of Harvard Professor Elton Mayo began to raise the question: How can firms best motivate workers? Deming found that the traditional motivation system in use at that time to be degrading and economically unproductive. Under that system, workers incentives were linked to piecework to maximise worker output. A final inspection process identified defective items to be subtracted from the worker's piecework credits (Hunt, 1993).

In the 1930s, Deming's collaboration with Walter A. Shewhart, a statistician working at Bell Telephone Laboratories, led to his conviction that traditional management methods should be replaced with statistical control techniques (Shewhart & Deming, 1939; and Blankenship & Petersen, 1999). Deming recognised that a statistically controlled management process gave the manager a new found capacity to systematically determine when to intervene and when to leave an industrial process alone (Flood,1993 & Hunt, 1993).

Deming's main source of concern in the drive to achieve quality in production was variability in manufacturing output. He believed that eradication of the causes would mean less variability and greater consistency in output which would enhance the product's reputation. Statistical Process Control (SPC) was the main technique put forward by Deming to perform the separation between special and common causes in variability and aid in diagnosis (Hyde, 1992 & Flood, 1993). The use of SPC was the core of Deming's quality management approach to continuously improve a firm's management process (Xu, 2000). According to Deming, only through statistical verification can the manager know that there is a problem, and find its cause (Deming, 1951 & Hunt, 1993). An example of SPC success in 1940 was the US Population Census introducing sample proofing of card punching instead of carrying out a 100% inspection process. This led to an increase in work flow by 600% (Pike & Barnes, 1996).

After World War II, Deming set up a private consulting practice. In 1947 he was sent to Japan by one of his clients to prepare a national census. There, his evolving quality control methods received a warm reception (Hunt, 1993). The Japanese acknowledgement of Deming's contribution to the field of quality was first reflected in the initiation in Japan in 1951 of the "Deming Application Prize" and then later in 1960 when he was decorated by Emperor Hirohito with Japan's Second Order Medal of the Sacred Treasure (Pike & Barnes, 1996; Hunt, 1993; & Vinzant & Vinzant, 1999).

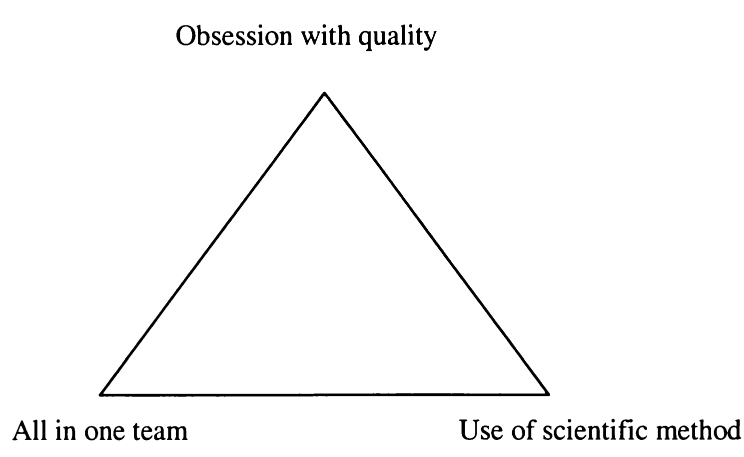
Joiner (Logothetis, 1992) stated that Deming's essential elements for his quality approach can be presented by three main principles at the corners of an equilateral triangle. The "Joiner triangle" is shown in Figure 3.4 and conveys the following three points:

1. Obsession with quality: The key to improved quality is focusing on efforts for continuous improvement of all processes.

2. Use of scientific method: The use of the scientific approach (not opinion or emotion) is the best way forward for improving processes.

3. All in one team: This describes the achievement among employees that they feel they are all part of one team working towards a common goal, towards self improvement and towards a long term company success (Logothetis, 1992).

Figure 3.4: The Joiner Triangle



SOURCE: Logothetis, 1992, p.14 and Graham, 1994, p.12

3.3.1.1 Deming's Seven Deadly Diseases:

Deming states in his book "Out of the Crisis" (1986) that American managers are responsible for causing a society-wide quality crisis. Deming believed that there are "Seven Deadly Diseases" associated with the traditional management practices. They are as follows:

1. **Lack of constancy of purpose.** A company that is without constancy of purpose has no long-range plans for staying in business. Management is insecure, and so are employees.

2. **Emphasis on short-term profits.** Looking to increase the quarterly dividend undermines quality and productivity.

3. **Evaluation by performance, merit rating, or annual review of performance.** The effect of these are devastating - teamwork is destroyed, rivalry is nurtured. Performance ratings build fear and leave people bitter, despondent, beaten. They also encourage defections in the ranks of management.

4. **Mobility of management.** Job-hopping managers never understand the companies they work for and are never there long enough to follow through on long-term changes that are necessary for quality productivity.

5. **Managing a company on visible figures alone.** The most important figures are unknown and unknowable - for example the "multiplier" effect of a happy customer (Deming, 1986; Logothetis, 1992; Hunt, 1993; Flood, 1993; & Pike & Barnes, 1996.

6. **Excessive medical costs for employee health care**, which increase the final costs of goods and services.

7. **Excessive costs of warranty**, fuelled by lawyers who work on the basis of contingency fees (Deming, 1986; Hunt, 1993; & Costin, 1994).

3.3.1.2 Deming's Obstacles to Progress:

In addition to the deadly diseases, Deming stated that there are other obstacles which inhibit progress but are easier to overcome. The following are the main obstacles:

1. **Hope of instant pudding.** The supposition that improvement of quality and productivity is accomplished suddenly by affirmation of faith is an important obstacle. In other words, quick results cannot be expected without consistent effort and sufficient education.

2. **The quantification of improvement.** The supposition that every improvement result must be quantified is another obstacle. Management must accept that the most improvements might remain invisible and unquantifiable. For example, how can one quantify the improvement in employees' morale, their pride in their work, or the customer's satisfaction with quality product?

3. **Search for examples.** It is a hazard to search for examples and copy them because if you just copy you will always lag behind. The principles and techniques of quality and productivity improvement are common and applicable to any company. The important factor is to understand the theory and be committed to applying it.

4. **Our problems are different/Our culture is different.** The impression that "our problems are different" is common among management and government administration. It is true that they are different, but the principles that will help to improve quality of product and service are universal in nature.

5. **Poor teaching of statistical methods in industry.** Adequate and proper teaching in statistical techniques and methods for improving quality in products, processes and services is of great importance.

6. **"We installed quality control."** This is the excuse of management so as not to get involved in quality improvement. Actually the activities of a quality control department are the provision of simple information on current defect rates, costs of inspection and warranty issues. The existence of a quality control department does not help in the solution of quality problems. Innovation and improvement of quality and productivity must be an ongoing process involving everybody, with the top management taking the lead.

7. **Specifications and the fallacy of zero defects.** It is claimed that whatever conforms to the specifications can guarantee zero defects. This is considered a dangerous fallacy because it does not take into consideration the effect of uncontrollable factors. Some of those factors are the user environment, the increasing loss associated with every departure from the target value, and the fact that satisfying the customer with conformance to the required specifications cannot guarantee the customer's return.

8. **Inadequate testing of prototypes.** If adequate testing takes place at the design stage of the product, problems could be avoided. Thus quality is built into the product and processed as early as at the prototype or the design stage (Deming, 1986 & Logothetis, 1992).

3.3.1.3 Deming's Fourteen Points for Managing Quality:

The following are Deming's (1982) fourteen points for managing quality. He believed these essential points of action are required to tackle the diseases plaguing industry:

1. **Create constancy of purpose for improvement of product and service.** Deming suggests a radical new definition of a company's role: Rather than to make money, it is to stay in business and provide jobs through innovation, research, constant improvement, and maintenance.

2. **Adopt the new philosophy.** A new economic age means Western management must awaken to the challenge, must learn their responsibilities, and take on leadership for change.

3. **Cease dependence on mass inspection and achieve quality by building it into the product in the first place**. Quality comes not from inspection but from improvement of the process. With instruction, workers can be enlisted in this improvement.

4. **End the practice of awarding business on the price tag alone.** Purchasing departments customarily operate on orders to seek the lowest price vendor. Frequently, this leads to supplies of low quality. Instead, buyers should seek the best quality in a long-term relationship with a single supplier for any one item.

5. **Improve constantly and forever the system of production and service.** Improvement is not a one-time effort. Management is obliged to continually look for ways to reduce waste and improve quality.

6. **Institute training on the job.** Too often workers have learned their job from another worker who was never trained properly. They are forced to follow

unintelligible instructions. They can not do their jobs well because no one tells them how to do so.

7. **Institute leadership.** The job of a supervisor is not to tell people what to do, nor to punish them, but to lead. Leading consists of helping people do a better job and of learning by objective methods who is in need of individual help.

8. **Drive out fear.** Many employees are afraid to ask questions or to take a position, even when they do not understand what their job is or what is right or wrong. They will continue to do things the wrong way, or not do them at all. The economic losses from fear are appalling. To ensure better quality and productivity, make sure workers feel secure.

9. **Break down barriers between staff areas.** Often a company's departments or units are competing with each other, or have goals that conflict. They do not work as a team so they cannot solve or foresee problems. Worse, one department's goals may cause trouble for another.

10. **Eliminate slogans, exhortations, and targets for the work force**. These never helped anybody do a good job. Let workers formulate their own slogans.

11. **Eliminate numerical quotas.** Quotas take into account only numbers, not quality or methods. They are usually a guarantee of inefficiency and high cost. A person, to hold a job, meets a quota at any cost, without regard to damage to the company.

12. **Remove barriers to pride of workmanship.** People are eager to do a good job and distressed when they cannot. To often, misguided supervisors, faulty

equipment, and defective materials stand in the way of good performance. These barriers must be removed.

13. **Institute a vigorous program of education and retaining.** Both management and the work force will have to be educated in the new methods, including teamwork and statistical techniques.

14. **Take action to accomplish the transformation.** It will require a special top management team with a plan of action to carry out the quality mission. Workers cannot do it on their own, nor can managers.

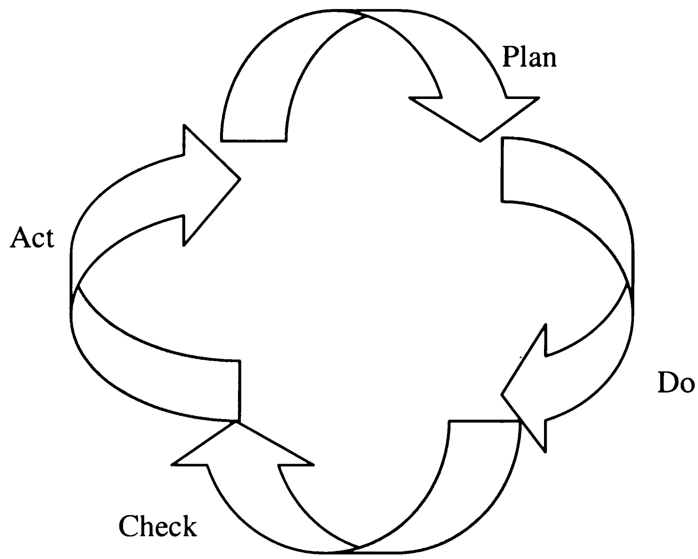
It is generally agreed that a critical mass of people in the company must understand the Fourteen Points, and the Seven Deadly Diseases to be able to manage quality in the organisation (Deming, 1986; Gabor, 1990; Logothetis, 1992; Hunt, 1993; Flood, 1993; Costin, 1994; Pike & Barnes, 1996; van Matre, 1995; & Ross, 1995).

It could be difficult to direct a critical mass to understand, commit and run the organization while bearing in mind Deming's Fourteen Points and at the same time refrain from getting infected by any of the Seven Deadly Diseases. In other words this equation can only exist in a perfect world where all employees in an organization are committed.

3.3.1.4 Deming's Quality Cycle:

Deming suggested a never-ending, circular management process which links the seven diseases, the fourteen points, and the statistical techniques into a continuous process. The Plan-Do-Check-Act (PDCA) Cycle is called the "Deming Cycle (or as Deming prefers, the Shewhart cycle) consists of four main stages, one following another in a specific order which is repeated continuously. Only through the ongoing application of the four stages cycle shown in Figure 3.5 below, an organisation can attain and retain a superior quality management process. The PDCA cycle reflects the basis of a self sustaining quality programme. It is also considered a classic problem-solving loop-learning model (Logothetis, 1992; Hunt, 1993; & Flood, 1993).

Figure 3.5: The Deming Cycle



SOURCE: Researcher's figure based on Demings, 1986

Hence, Deming's cycle of continuous improvement can be summed up in the following 4 steps:

1. **PLAN:** establish performance objectives and standards.

2. **DO:** measure actual performance.

3. **CHECK:** compare actual performance with the objectives and standards - determine the gap.

4. **ACT:** take the necessary actions to close the gap and make the necessary improvements (Oakland, & Sohal, 1996; & Deming, 1993).

Vinzant & Vinzant (1999) stated that although Deming never used the term "total quality management", his work formed the foundation for the quality management movement that has been shaped latter on by others (e.g. Juran, 1989; Crosby, 1979; & Ishikawa, 1982).

Vinzant & Vinzant (1999) further explained that contemporary TQM approaches include statistical quality control, benchmarking, supplier partnerships, performance management, cross-training and broadened rewards and recognition. Hence, the role of TQM is to provide a framework in which an integration and reinforcement of those elements is undertaken in order to improve quality in the eyes of the customer.

Although the US companies ignored Deming and TQM at first, a 1992 GAO (General Accounting Office) survey showed that 70 percent of federal governmental organizations had some kind of TQM initiative (Vinzant & Vinzant, 1999). Moreover, it has been suggested by Harrison and Stupak (1993) that TQM may serve as the "new paradigm for public administration" because TQM approaches have become so widespread in the public sector and they effectively integrate contemporary public administration theory.

On the other hand, Schonberger (1992) stated that not all quality improvement efforts are successful. Nevertheless, he advised that one of the most critical factors identified in successful applications is the exercise of strategic leadership. Furthermore, McCormack, Lewis, & Batten (June, 1992) emphasised that organizations need a strategic framework for implementing TQM which addresses specific organizational problems. It is also worth mentioning that organizational readiness should be carefully evaluated and that TQM programs should be tailored to meet the needs of different organizations in order to be implemented successfully and the organization gains its full benefit (Larkin, October, 1992; Schmidt & Finnigan, 1992; & Vinzant & Vinzant, 1996).

Xu (2000) raised a critical issue relating to Deming's philosophy which states that people are operating within a system, with which problems arise and not with people.

Accordingly the system and people are separate. On the other hand, Xu quotes that Deming suggested that people be treated as part of the system. If this is followed then the implication would be that people become sources of problems. In other words, Xu says that Deming is treading on a delicate line by envisaging a technically independent system that follows its own logic that is external to operators. People become part of that system which implies that any problem with the system could be a problem generated by operators.

3.3.2 Joseph M. Juran (1904 -----)

Quality does not happen by accident;It has to be planned. **(Joseph M. Juran)**

Joseph M. Juran is the other major figure in the development of quality management (Butman, 1997). He was born in 1904 in Romania then migrated with his family to the USA in 1912. In 1924 he earned his B.S. in engineering from the University of Minnesota and then his J.D. from Lyola University in 1935 (van Matre, 1995).

There are similarities between Juran and Demings in both their background and achievements. Juran began his career at the Hawthorne plant of Western Electric and then manufacturing arm of AT&T which gave him the opportunity to learn from Walter A. Shewhart, the Bell Lab physicist responsible for developing the control chart and the PDCA cycle exactly like Deming (van Matre, 1995; and Butman, 1997).

Like Deming, Juran made a significant contribution to the quality revolution in the post Second World War reconstruction of Japan. His work with the Japanese started in 1954 when he conducted seminars for top and mid-level managers. Also, like Deming he was decorated by the Emperor of Japan in recognition of his contributions to quality management in Japan by being awarded the Second Order of the Sacred Treasure (Logothetis,1992; van Matre, 1995; & Pike& Barnes, 1996).

Juran retired in 1994 at the age of 89. Juran wrote many books that cover a wide range of quality topics. Some of those books are: "Quality Planning and Analysis" in 1980, "Planning for Quality" on 1988, "Quality Control handbook" in 1988, and "Leadership for Quality" in 1989.

According to Juran, industry is caught up in a quality crisis. He identifies two wrong assumptions that are preventing managers from finding solutions to their problems:

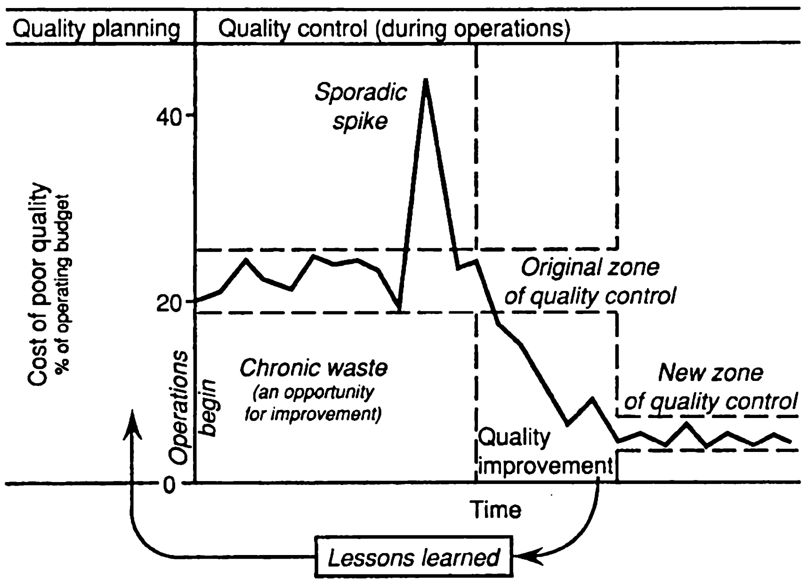
1. Many managers do not accept the fact that they must shoulder most of the responsibility for the performance of their companies. Juran concludes that until top management redirects its energies toward planning quality into their products, the quality crisis will continue.
2. Managers' failure to realise that great financial gains can be made once quality becomes their top priority (Hunt, 1993).

Juran's triology was derived from financial management to undertake financial planning, financial control and financial improvement. This translates to quality planning, quality control and quality improvement. Juran believed that this three-part approach (i.e. quality planning, quality control, and quality improvement) would reduce the cost of quality over time. (Costin, 1994; Flood, 1993; & Juran, 1995).

3.3.2.1 Juran's Quality Triology:

This section details Juran's Quality Triology and his breakthrough sequence as illustrated in both Figure 3.6 (The Juran Triology Reduces the Cost of Quality) and Table 3.3 (Juran's Breakthrough Sequence).

Figure 3.6: The Juran Quality Triology Reduces the Cost of Quality



SOURCE: Juran, 1988.

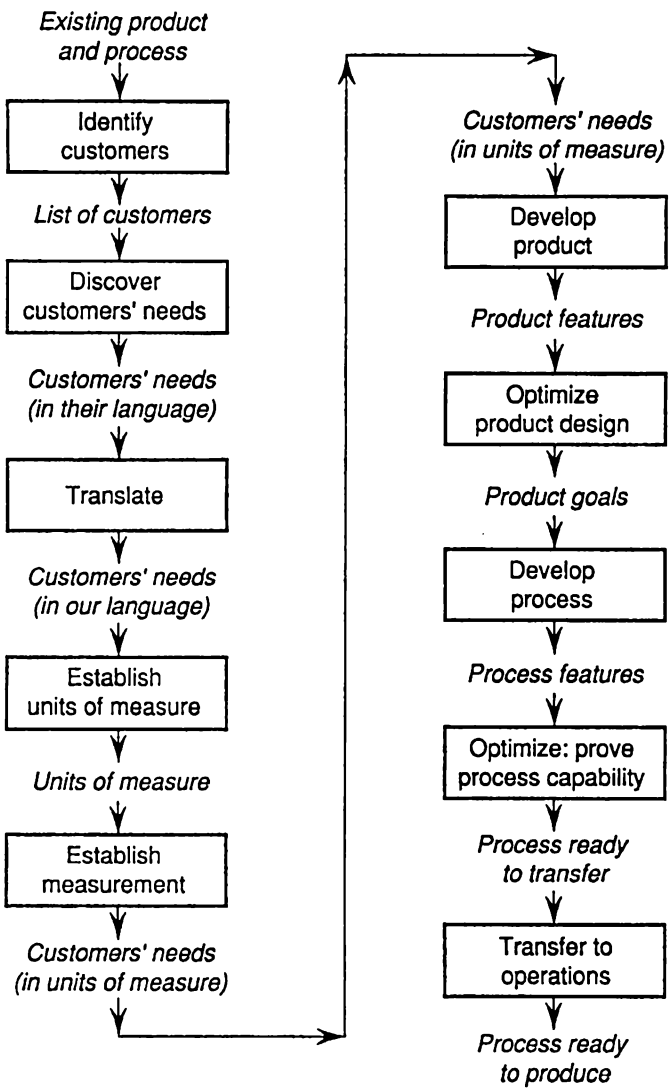
1. **Quality Planning:**

The central task of Juran's approach to quality management is developing the products and processes required to meet customers' needs. Accordingly, quality planning has the following steps:

1. Determine quality goals.
2. Develop plans to meet those goals.
3. Identify the resources to meet those goals.
4. Translate the goals into quality.
5. Summarise 1 to 4 into a quality plan.

To accomplish this task, Juran recommends the road map shown below in Figure 3.7 (Flood, 1993; & Hunt, 1993).

Figure 3.7: Juran's Quality Planning Road Map



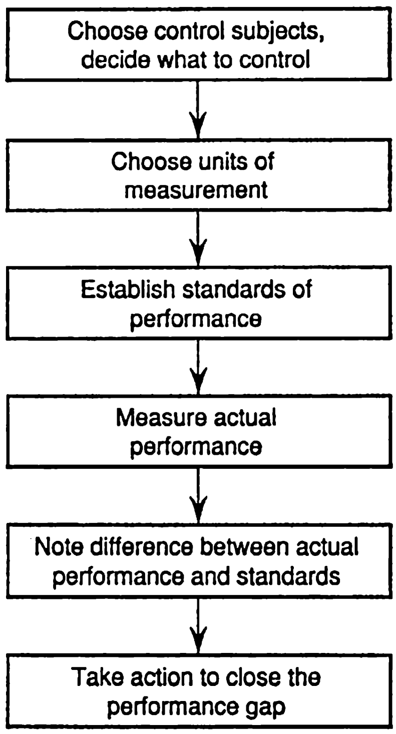
SOURCE: Juran, 1988

2. Quality Control:

The control processes are designed to ensure that the quality goals set in the planning stage are met during the actual production or rendering of the firm's products and services (Hunt, 1993 & Butman, 1997). Quality control means having simple feedback structure to evaluate performance, compare performance with set goals and take action on the difference.

The following figure (Figure 3.8) shows Juran's quality control process (Flood, 1993).

Figure 3.8: Juran's Quality Control Process



SOURCE: Juran, 1988

3. Quality Improvement:

While quality planning and quality control establish a stabilised product quality throughout the organisation, quality improvement is the means by which a firm selectively identifies and implements change on a subsystem level. This part of the trilogy is the means of achieving unprecedented levels of quality performance in an organisation. It is known as both quality improvement and Juran's "breakthrough sequence." The following table (Table 3.2) summarises Juran's breakthrough sequence which is used in conjunction with Juran's planning (Figure 3.7) and control (Figure 3.8) processes while the trilogy is first being installed in an organisation (Hunt, 1993).

Table 3.3:	**Juran's Breakthrough Sequence**

1. *[Urge a] breakthrough in attitudes.* Managers must first prove that a breakthrough is needed and then create a climate conductive to change. To demonstrate need, data must be collected to show the extent of the problem; the data not convincing to top management are usually cost of quality figures. To get the resources required for improvement, expected benefits must be presented in terms of cost and return on investment.
2. *Identify the vital few projects.* Pareto chart analysis is used to distinguish the vital few projects from the trivial many and to set priorities based on problem frequency.
3. *Organise for breakthrough in knowledge.* Two organisational entities should be established: a steering group and a diagnostic group. The steering group, composed of people from several departments, defines the program, suggests possible problem causes, gives the authority to experiment, helps overcome resistance to change, and implements the solution. The diagnostic group, composed of quality professionals and sometimes line managers, is responsible for analysing the problem.
4. *Conduct the analysis.* The diagnostic group studies symptoms, develops hypotheses, and experiments to find the problem's true causes. It also tries to determine whether defects are primarily operator controllable or management controllable. (A defect is operator controllable only if it meets three criteria: operators know what they are supposed to do, have the data to understand what they are actually doing, and are able to regulate their own performance.) Theories can be tested by using past data and current production data and by conducting experiments. With this information, the diagnostic group then proposes solutions to the problem.
5. *Determine how to overcome resistance to change.* The need for change must be established in terms that are important to the key people involved. Logical arguments alone are insufficient. Participation is therefore required in both the technical and social aspects of change.
6. *Institute the change.* Departments that must take corrective action must be convinced to co-operate. Presentations to these departments should include the size of the problem, alternative solutions, the cost of recommended changes, expected benefits, and efforts taken to anticipate the change's impact on employees. Time for reflection may be needed, and adequate training is essential.
7. *Institute controls.* Controls must be set up to monitor the solution, see that it works, and keep abreast of unforeseen developments. Formal follow-ups is provided by the control sequence used to monitor and correct sporadic problems.

SOURCE: Hunt, 1993, p.79

Juran's approaches presented in the quality trilogy diagram (Figure 3.7), the quality planning road map (Figure 3.8), the quality control process (Figure 3.9) and the breakthrough sequence table (Table 3.2), are all sequential in nature. Consequently, if Total Quality leaders follow Juran's teachings, they will become sequentially oriented. Moreover, they will have very specific knowledge for getting the job done according to the predetermined time table (Madu, 1998).

Juran received many honours from professional societies for his work on quality. One of the highest honours came in 1992 when President Bush awarded him the National Medal of Technology for providing the key principles and methods by which enterprises manage the quality of their products and processes. In his nineties, Juran was still working as a consultant and writing his autobiography (Butman, 1997).

Hatila, Nordlund & Yli-Hukkala (2002) criticised Juran's quality management approach from the following two angles : a) wideness and b) practical usefulness.

a) Wideness: Juran's definition of quality as *"fitness of use"* limits improvement especially in product development because the aspect of setting objectives and requirements for quality is missing.

b) Practical usefulness: Juran presents all quality planning activities in accordance with the hierarchical model of organizations (i.e. importance of upper management's leadership in implementing quality management). According to Hatila, Nordlund & Yli-Hukkala (2002) such an approach makes it difficult to separate innovative ideas from common concepts. Moreover, they state that Juran does not compare his quality management methods to the earlier theories of quality management which is an essential part of any research cycle.

3.3.2.2 Deming's and Juran's Fundamental Assumptions:

Madu (1998) in his attempt to compare Deming's and Juran's philosophies to the formation of total quality leaders' world views presented the following Table 3.4 which summarises Demings's and Juran's fundamental assumptions:

Table 3.4: Deming's and Juran's Fundamental Assumptions

Shared assumptions about the nature of	Deming	Juran
Human nature	• Willing to pursue knowledge • Willing to continuously improve • Not act on their economic self-interest • Inherently good/cooperative • Theory Y	• Willing to pursue quality • Towards economic self interest (top executives); toward tasks self-interest (general employees) • Resistance to change
Reality/truth	• Theory of knowledge • Empirical scientific test • Enumerative study • Analytic study • Operational definition is a basis for social reality • Not from individual reality • Truth is from revealed dogma • Truth derived by a rational process (P-D-C-A) • Truth as established by the scientific method	• Quality council (social reality) • Surveys and analysis (objectives reality) • A flaw in determining individual subjective reality (top executives) • Truth about quality derived by rational processes (quality planning road map, the phased sequence) • Truth as established by the scientific measurement method
Time dimension	• Past, present, near future and distant future-oriented time owner • Towards development time	• Past, present, near future and distant future-oriented time owner • Sequentially-oriented time owner • Towards planning time
Human relationships	• Win-win • Group cooperative • Trust • Theory of variation • Theory of psychology • Not universalistic, but particularistic • Management of people • Not self, but collectively oriented	Triple role concept Cross-function concept Big Q concept
Human activity	• Theory of system • Being-in-becoming	• Being-in-becoming

SOURCE: Madu, 1998, p 37

3.3.3 Philip B. Crosby (1926 -----)

The determined executive has to have a brain transplant where quality is concerned. **(Philip B. Crosby)**

Although Philip B. Crobsy is not as well known by academics and quality professionals as Deming and Juran, he is admired by the American management community and is a sought-after consultant (van Matre, 1995). Philip B. Crosby along with Edwards Deming, Armand V. Fiegenbaum, Kaoru Ishikawa, Joseph M. Juran and Genichi Taguchi took the quality movement beyond statistical control to the broader realm of reliability engineering and quality assurance (Garvin, 1988; Gehani, 1993; Hunt, 1992, 1993; & Reed, Lemak, & Montgomery, 1996).

Crosby was born in 1926 in West Virginia, USA. He earned a degree in podiatry but afterwards, chose to follow a career in industry. He began as an inspector until he became a vice-president for quality at ITT in 1965 upon which he left to start Philip Crosby Associates and its Quality College in Winter Park, Florida. Books Crosby wrote about quality include: "Quality is Free", Quality without Tears", and "The Art of Getting Your Own Sweet Way" (Logothetis, 1992 and van Matre, 1995).

Crosby is well known for his concept of "zero defects" often referred to as ZD. Some of his most encouraged slogans are: "do it right the first time", and "conformance to requirements" (Crosby, 1979; Costin, 1994; Logothetis, 1992; Flood, 1993; & Pike & Barnes, 1996).

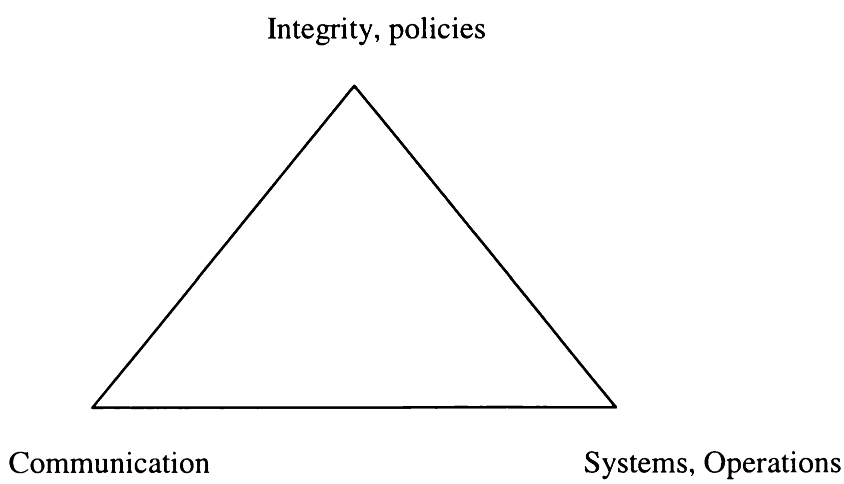
Neither Deming nor Juran accept the zero defects standard of Crosby. Juran rejects it on the grounds that there is a law of diminishing returns on quality and that a point can be reached where further improvements in quality are more expensive than tolerating a level of failure. On the other hand, Deming disapproves of using the zero defect as a slogan targeted at the workforce. His disapproval lies behind his belief that the individual worker has limited control over the factors which can cause quality failings and that management must take the primary burden of building in quality to the systems, tooling and materials the workers use (Pike & Barnes, 1996).

Like Deming and Juran, Crosby attributes the majority of quality problems to management. Crosby estimates 80% of the problems are caused by management and accordingly the cure for these problems lies with management leadership (Pike & Barnes, 1996). Crosby in his book "The Eternally Successful Organisation" (1988) emphasises the fact that while it is necessary for a company to conduct formal education and training in order to build an implementation process for Quality Improvement, the essential ingredient is executive integrity (Pike & Barnes, 1996).

3.3.3.1 Crosby's Quality Vaccination Serum:

Logothetis (1992) in "Management for Total Quality" states that Crosby offers a vaccination serum to companies who have symptoms indicative of problems with quality. The following figure (Figure 3.9) illustrates that the main ingredients of the "Crosby vaccination serum" are based on integrity and dedication to customer satisfaction and a company-wide system of policies and operations. Those systems and operations are designed to achieve and communicate quality improvements.

Figure 3.9: Crosby's Triangle of Vaccination Serum



SOURCE: Logothetis, 1992, p.83

Crosby believes that the administration of the quality serum requires the following three management actions:

1. **Determination** - awareness that the management needs to take the lead in the new economic age.
2. **Education** - for the managers, who should become the educators and modern leaders.
3. **Implementation** - concentrating on the effort of creating guidance on the never-ending road to quality improvement and involving everybody (Crosby, 1984 & Logothetis, 1992).

3.3.3.2 Crosby's Four Absolutes for Quality Management:

Crosby's four absolutes are the core of his philosophy towards a simple and effective TQM system that can be applied to any situation in which one finds oneself in business or organisational life. The following are Crosby's four absolutes:

1. **The definition of quality is conformance to requirements, not goodness**

   A product is considered a quality product only when it conforms to the customer's requirements. These requirements should be made known to the workforce who should be provided with the necessary tools to achieve them.

2. **The system of quality is prevention**

   Studying the process and performing an analysis to identify possible errors is the secret of success because in such cases you could avoid errors. Moreover, contingency plans can be drawn, so that if a problem materialises, the damage is controlled and restricted to the minimum possible.

3. **The performance standard is zero defects**

   A feeling of determination coupled with a system of management which provides the communication needed and tools to do things right first time, on time and every time is important. Crosby admits that many managers misunderstood the concept of "zero defect" (ZD) and used it as a slogan. Actually, Crosby didn't want the ZD concept to be seen as a motivation programme, but to be seen as a management performance standard, to indicate that there is no room for imperfection, complacency or the attitude that "that's close enough".

4. **The measurement of quality is the price of non-conformance**

   Quality has to be measured in financial terms in order to attract the attention of senior management. If the cost of consequences involved in doing things wrong (as a result of rejects, reworking, warranty costs etc.), it could represent 20 - 40% of the total operating costs. This is the price of non-conformance (PONC) i.e. not doing things right the first time. If a rough calculation of the PONC is done initially, it could be so high that it would surely prompt the top management to do something about quality (Crosby, 1984; Logothetis, 1992; Flood, 1993; & Pike & Barnes, 1996).

3.3.3.3 Crosby's Fourteen Steps for Quality Improvement:

Crosby laid down fourteen steps to assist in the establishment of a quality ethic to be embedded throughout the organisation. The first six steps are made by management, stressing the important role-played by management in quality improvement, according to Crosby's philosophy.

1. **Management Commitment**

   Senior management has to demonstrate a commitment to quality to convince the workforce that management is not only serious about quality, but also prepared to be involved in the process.

2. **The Quality Improvement Team**

   Setting up a team to guide the process of quality improvement in crucial to the process of quality improvement. Moreover, this team will require a definite direction and leadership to enable it from achieving its required tasks like: changing attitudes and practices of those who run the company, set up educational activities and co-ordinate and support the whole effort.

3. **Measurement**

A clear method of measurement helps avoid frustration and hassle. It also helps facilitate precise communication. People associated with the activity can decide upon the type of measurement. Upon deciding on the measurement, a level of reference can be created, reasonable targets set, progress monitored and accordingly comparisons can be made easily.

4. **The Cost of Quality**

The cost of quality is evaluated by providing an indication of where corrective action will be profitable for a company. On the other hand, Crosby admits that if the concept of the cost of quality is not handled properly, it could actually cause more trouble rather than save money.

5. **Quality Awareness**

Quality awareness of employees is established by training supervisors and communicating through booklets, films and posters. Awareness about quality should be spread throughout the organisation and adapted to the company's culture.

6. **Corrective Action**

Prevention of errors or identifying and eliminating causes of problems to put right defects should be the main purpose of corrective action. Corrective activities need to be based on analyses of past data so that causes of problems are determined and taken care of permanently.

7. **Zero Defects Planning**

Zero defect (ZD) starts with commitment of the top management to the concept. For the ZD concept to be properly embedded in the company culture and taken seriously, it requires proper planning.

8. **Employee Education**

Supervisor and employee training is undertaken so that all managers understand and can explain each step in the quality improvement programme. Crosby summarises the education process in what he calls "the six Cs":

- Comprehension (understanding of what is necessary, abandonment of the old way of thinking and of outdated practices).
- Commitment (management-led dedication to cultural change).
- Competence (methodical and scientific implementation of the improvement process).
- Communication (complete co-operation throughout the production process, including suppliers and customers).
- Correction (elimination of all causes of problems and prevention of new ones arising).
- Continuance (never-ending effort for improvement).

9. **Zero Defects Day**

A ZD day should be planned at least once annually to reward serious efforts, act as a reminder of the importance of quality and demonstrate the commitment towards the principle of ZD.

10. **Goal Setting**

Employee goal setting (i.e. zero defects when it comes to quality) should take place usually on a 30, 60, 90 day basis.

11. **Error Cause Removal**

Team effort is required to remove the causes of errors permanently. This requires an adequate means of communication to ensure sharing the necessary information to help preventing the same problems arising in the future.

12. **Recognition**

Recognition for those who meet goals or perform outstandingly is established by (non-financial) award programmes. This can act as an incentive to others and an example to imitate.

13. **Quality Council**

Regular meetings of Quality Councils composed of quality professionals and team chairpersons are held to communicate and to determine action necessary to improve the quality programme.

14. **Do it All Over Again**

Continued effort for quality improvement should become the culture of the company. In other words, the process of learning, participating, experimenting with new methods and improving should never end (Crosby, 1984; Logothetis, 1992; & Flood, 1993).

Hunt (1993) presented the following table (Table 3.5) to illustrate Crosby's Quality Management Maturity Grid. He adapted the table from Crosby's book "Quality is Free" in 1979. The grid is divided into five stages of maturity while six management categories serve as measurement categories. This leads to the identification of key issues characterising a business context.

Table 3.5: Crosby's Quality Management Maturity Grid

Measurement Categories	Stage I: Uncertainty	Stage II: Awakening	Stage III: Enlightenment	Stage IV: Wisdom	Stage V: Certainty
Management Understanding and Attitude	Fails to see quality as a management tool.	Supports quality management in theory but is unwilling to provide the necessary money or time	Learns about quality management and becomes supportive.	Participates personally in quality activities	Regards quality management as essential to the company's success.
Quality Organisation Status	Quality activities are limited to the manufacturing or engineering department and are largely appraisal and sorting.	A strong quality leader has been appointed, but quality activities remain focused on appraisal and sorting and are still limited to manufacturing and engineering.	Quality department reports to top management, and its leader is active in company management.	Quality manager is an officer of the company. Prevention activities have become important.	Quality manager is on the board of directors. Prevention is the main quality activity.
Problem Handling	Problems are fought as they occur and are seldom fully resolved; "fire fighting" dominates.	Teams are established to attach major problems, but the approach remains short term.	Problems are resolved in an orderly fashion, and corrective action is a regular event.	Problems are identified early in their development.	Except in the most unusual cases, problems are prevented.
Cost of Quality as Percentage of Sales	Reported: unknown Actual: 20%	Reported: 5% Actual: 18%	Reported: 8% Actual: 12%	Reported: 6.5% Actual: 8%	Reported 2.5% Actual: 2.5%
Quality Improvement Actions	No organised activities.	Activities are motivational and short term.	Implements the 14-step program with full understanding.	Continues the 14-step program and starts Make Certain.	Quality improvement is a regular and continuing activity.
Summation of Company Quality Posture	"We don't know why we have quality problems."	"Must we always have quality problems?"	"Because of management commitment and quality improvement programs, we are identifying and resolving our quality problems."	"We routinely prevent defects from occurring."	"We know why we don't have quality problems."

SOURCE: Crosby, 1979, pp. 32-33; March, 1989 in Costin, 1994, pp.150-151; Hunt, 1993, pp. 62-63

This section presented three of the main quality management gurus who had influence on shaping the quality movement. It is obvious that Deming and Juran had a lot of commonality in beliefs and techniques related to quality. They even shared the disagreement with Crosby in relation to the zero defects standards as illustrated earlier. Nevertheless, the three agree that the key for a successful quality management in any organization depends on its leadership and its commitment to achieving quality. Saunders (1995) also stresses that leadership is a key issue in achieving quality and that commitment is required from all levels of the organisation.

Deming, Juran and Crosby stressed different issues that would help organizations to detect their problems and furnished them with various tools to tackle those issues as a means of solving their problems. All those tools revolved around the same notion of how to obtain customer satisfaction through quality improvement.

3.3.3.4 Analysis of TQM Success

This section reports on some of the counter discussions/arguments in relation to the limitations of the application of the TQM paradigm.

Filippini (1997) stated that although TQM has been regarded as a tool for improving quality and improving market share and profit rates, the success rate has been low. Ahire, Waller & Golhar (1995) gave an example of a Fortune 500 company survey showing less than one-third of the respondents had accomplished any progress and about two-thirds of the TQM programmes had ceased to operate.

Furthermore, Cuningham & Ho, (1996), Huff, Fornell & Anderson (1996) and McCracken & Kayank (1996) maintain that although many studies were conducted to investigate the impact of TQM on performance, more research is required to look at the relationship between quality and productivity.

Vardeman (2001) stated that it is possible for an organisation to lose perspective by pushing too far the TMQ emphases or by applying some of its tools where it is not appropriate; as a result creating harmful consequences. He gave an example of the application of the TQM customer focus paradigm where it could be harmful by embracing immoral positions in the educational system. He further illustrated that point by mentioning that most adults want their children to go to a school that offers serious content teaching and targets real academic achievement and development. On the other hand, they do not want a popular school because it feels good to the students who are the customers because it is like MTV [Music Television (a cable TV channel)]. Catherine Daily (1996) has a similar but somewhat different view point which she expresses in an article where she comments on a research conducted by Clayton M. Christensen and Joseph L. Bower (1995) suggesting that listening to the customer may stifle technological innovation and hinder long-term organizational success. Hence, managers should sometimes ignore the advice of their customers who are interested in incremental product improvements. According to that point of view, the customer is not always right.

Furthermore, Vardeman (2001) criticised the preoccupation and emphasis of TQM with improvement of processes, analysis of processes and what he called *"the almost cultish guru-laden nature of the TQM scene."*

A study conducted by Lee & Skarke (1996) showed that some of the reasons behind TQM falling on hard times are: a) high costs of overhead, b) too much bureaucracy, and c) cumbersome processes. Another study reported by McConnell (1992) stated that managers shifted away from the standardized procedures which resulted in workers not embracing TQM as part of the culture which is an essential issue to TQM philosophy. Another article by Snell & Dean (1992) suggests that there is evidence that the system failure could be attributed to mismanagement of people rather than to problems with technical systems.

Choi & Behling (1997) claim that results of surveys (conducted in the early 1990s in U.S. and U.K.) of executives in the manufacturing and service firms implementing quality programs revealed that TQM failed to reduce defects by 10 percent or more. On the other hand, several articles in professional journals tended to give explanations behind such failure by attributing it to the following reasons:

1. Overselling of TQM;
2. Managers were disappointed because their hopes were too high;
3. Unrealistic expectations;
4. Errors in design and implementation;
5. Providing inadequate training to employees;
6. Failing to appreciate the complexity of the changes involved; and
7. Failing to understand the organization's mission, goals, and objectives.

Therefore, in order for companies to reach their competitive edge and be successful in the long run, it has been suggested by Neal and Tromley (1995) that organizations' quality programs must involve more than superficial, isolated, behaviour changes i.e. the paradigm shift should involve the company's fundamental operations, beliefs, and values. Nevertheless, TQM is not a panacea i.e. organizations need to wrestle with both the concept and the practice at a general level and the specific level. This wrestling requires considerations of the base from where the organization is starting. Some start with an established base of quality ethics and practice whilst others have a minimal foundation to build on.

3.4 The Relationship between TQM and the Quality Management Standards and Awards:

TQM installation in most organisations involves paradigm shifts. A paradigm shift means a huge change in the organization from their old systems to a more comprehensive system committed to improving quality. The following are some of the examples of paradigm shifts an organisation could encounter:

- Using a system to measure and achieve customer satisfaction (Zhu & Scheuermann, 1999; Lenginck-Hall, 1996; & Hart, 1993).
- Installing methods for continuous improvement of all organisational processes on an integrated basis (Anderson et al., 1994; Dean & Bowen, 1994; Deming, 1986; NIST, 1999; and Saraph, Benson, & Schroeder, 1989).
- Involving employees at all levels in achieving quality and empowering them to act to ensure quality (Hanson, Porterfield, & Ames, 1995; & Lawler, 1994)).
- Moving toward team management.
- Changing traditional human resources systems to create an egalitarian culture.
- Taking enough care and time in installation of the change to get it right (Mahoney & Thor, 1994).

After considering the kinds of changes or paradigm shifts, the organisation should identify the management model that can be integrated and synthesized to create a highly credible and effective management system. The following section illustrates some of the most popular and well known quality management models that different organisations are applying.

3.4.1 ISO 9000 Series Standards:

The term ISO 9000 is often used to refer globally to a series of five international standards for quality management. The ISO 9000 Series (Refer to Appendix 3) of quality standards was created in 1987 by the International Standards Organisation. ISO is the International Organisation for Standardisation founded in 1947 (Dale & Oakland, 1994). Its headquarters is in Geneva, Switzerland. The companies with managerial systems that meet those standards have their managerial systems registered to the standard. The focus of the international standards is on basic organisation and policy in regard to quality. Due to the fact that little concern is given about how the organisation chooses to manage itself and its customer relations, ISO 9000 certification cannot be used to imply that a company is best, elite or world-class (Mahoney & Thor, 1994).

Another generic management system series of standards is the ISO 14000 series which is primarily concerned with environmental management. The International Organisation for Standards (ISO) (1999) defined the term "generic" by saying that the same standards can be applied to any organisation, large or small, whatever its product or service, in any sector of activity, and whether it is a business enterprise, a public administration, or a government department. (Refer to Appendix 4 for further detail on the ISO 14000 Series Standards.) Similarly, the British Standard 7750 introduces itself firstly as a specification for the various stages of developing an Environmental Management System (EMS) and secondly as guidance on implementation and assessment. Sayre (1996) in his book "Inside ISO 14000" mentions that British Standard 7750 is compatible with BS 5750 which is the mother of ISO 9000. He further illustrates the idea by stating that both standards take parallel approaches to achieving and demonstrating compliance with specified requirements.

Before going into further details it is important to clarify what the term "standards" means in the ISO context. Standardisation is an activity to improve efficiency by bringing consistency to the product, services or processes. Moreover, it helps make things operate in a certain way to prevent unexpected or dangerous surprises. The activity consists of the process of formulating, issuing and implementing standards. There are three basic tiers of standardisation: company, national and international. The ideal is that the three co-exist together, but each tier should make the maximum use of standards issued by the appropriate organisation in the next tier (Dale& Oakland, 1994; & Morris, 1997).

The following table (Table 3.6) illustrates how extensive the scope and opportunities for standardisation could be to the organisation.

Table 3.6 The Use of Organisation Standards

Application	Method	Purpose	Benefits
Management control	Directives, procedures, codes of practice	To communicate rules from management; Company and product rationalisation	Efficient and effective control, better industrial relations
Environment	Codes of practice	Health and safety standards that relate to the environment	Health and safety
Plant and equipment	Catalogue, specifications, standards, codes of practice	Identity and control plant, its maintenance and use of spares	Process quality and reliability, environmental protection, health and safety
Design	Specify materials, components, processes, codes of practice	Meet market requirements; Maintain optimum design possibilities, product liability, manufacturing efficiency	Product quality and reliability, environmental protection, health and safety
Drawing office	Use of design and manufacturing standard, classification and coding	Information retrieval, design codes of practice, variety control	Better product design, design control
Material control	Catalogue, identification coding, handling, codes of practice	Stock control, quality assurance, health and safety	Availability of parts, reduced stock investment, COSHH* controls
Purchasing	Purchase and material specifications, coding	Purchase specification supplier approval, quality control	Quality and availability of components and materials at the right price
Manufacture	Specifications, codes of practice, coding, health and safety	Production control, education, and training, quality control, testing	Productivity, quality, health and safety of employees
Packaging	Codes of practice, coding	Protection in transit, cost-effectiveness	Customer satisfaction
Sales	Codes of practice, instruction manuals	Communication with customer, quality assurance	Delivery, better customer relationships
Accounting	Catalogue, procedures	Control of capital and depreciation	Financial control
All	All	Quality management	To employees, customers and company

* Control of substances hazardous to health (COSHH)

SOURCE: Adapted from PD 3542: 1991 *The role of standards in company quality management.* In Dale and Oakland, 1994

ISO 9000 provides guidelines, concepts and definitions for selecting and using ISO 9001 to ISO 9003. ISO 9001, 9002 and 9003 cover specific aspects of a quality assurance program. ISO 9004 is also a document providing guidelines on creating and sustaining a quality management system (Morris, 1997; & Lamprecht, 1992). For companies to compete internationally, its necessary to be registered under quality standards. There are two phases of registration for the ISO 9000. The first phase involved choosing the appropriate Standard to the organisation, creating a quality system and installing the system according to the relevant objectives sited in the quality manual. The second phase entails a third-party certification that acknowledges the organisation's registered status under ISO 9000. Registration is renewed periodically every two to three years depending on the site visits of the certifying agency. (Mahoney & Thor, 1994).

ISO 9000 focus is on the ability to achieve standards negotiated in a sales contract (Uzumeri, 1997), while the Deming Prize and Baldrige Award focus on continuous improvement toward achievement of world-class quality levels (Mahoney & Thor, 1994). The main limitation of international standards is that people and organizations can comply with standards but not change their attitudes. Attitudinal change is an essential part of a paradigm shift towards improving quality. It is not helpful when organizations just focus on achieving a standard rather than the more demanding goal of improving quality.

3.4.1.1 Kinds of Quality Systems Audits:

This section presents the three kinds of quality system audits available.

1. **Internal Quality Audits**

   The internal quality audits are Quality System audits carried out by the organisation on itself through its own auditors. Usually this auditing is introduced in preparation for ISO 9000 certification as it is one of the requirements of the Standard. After obtaining the certification, internal auditing should continue on a planned basis. Evidence of such internal auditing will be required on subsequent visits by the certification body.

2. **Second Party Quality Audits**

   The second party quality audits are carried out by an organisation on subcontractors to evaluate their ability to satisfy the needs of the organisation. The organisation requires evidence that the subcontractor is able to satisfy the following aspects: adherence to a specification, product or service assurance, delivery on time and at a competitive price.

3. **Third Party Quality Audits**

The third party quality audits are carried out by independent certification bodies to determine the following:

a) Does an organisation have a Quality System in place?

b) Does the Quality System satisfy the requirements of the relevant ISO 9000 Quality Standard?

c) Is the Quality System effective in achieving the organisation's objectives?

If the organisation satisfies the above mentioned criteria, a certification body will award it the relevant ISO 9000 certification (Green, 1997).

3.4.2 Deming Prize:

The Deming Prize was created by the Japanese Union of Scientists and Engineers (JUSE) in 1951. They created it to honour W. Edwards Deming for his contribution to Japan's post-World War II recovery and its adoption and standard use of quality principles. The two broad categories of Deming Prize are the Individual Person and the Application Prize. The Application Prize is further divided to the following four categories: Overall Organisation, Overseas Company, Division, and Small Enterprise. Moreover, there is a Quality Control for Factory Prize. The following is the procedure to attain the Deming Prize:

- Coaching period by JUSE ranging from two to five years.
- A team of examiners are assigned to the applicant to interpret the organisation's current business situation and the status of a series of checklist items.
- The applicant is recognised as an organisation with a certain quality standard.

Hence, the Deming Prize is not an annual contest. There is also no limit to the number of winners in any year. The main emphasis of the Deming Prize is on rigid statistical approaches and aggressive problem solving throughout the line operation of the organisation. There is no mention of customer satisfaction (Mahoney & Thor, 1994; & Burrill & Ledolter, 1999).

3.4.2.1 The Deming Checklist

Mahoney and Thor (1994) presented the following Deming Prize Checklist as the conditions required for implementation of quality assurance in an organisation applying for the prize.

1. **Policies**

   How are policies determined and transmitted? What results have been achieved?

2. **Organisation and its management**

   How are scopes of responsibility and authority defined? How is cooperation promoted and quality control managed?

3. **Education and dissemination**

   How is quality control taught, and how is training delivered to employees? To what extent are Quality Control and statistical techniques understood? How are Quality Control circle activities utilised?

4. **Collection, dissemination, and use of information on quality**

   How is information collected and disseminated at various locations inside and outside the company? How well is it used? How quickly?

5. **Analysis**

   Are critical problems grasped and analysed against, overall quality and the production process? Are they interpreted appropriately, using the correct statistical methods?

6. **Standardisation**

   How are standards used, controlled and systematised? What is their role in enhancement of company technology?

7. **Control**

   Are quality procedures reviewed for maintenance and improvement? Are responsibility and authority scrutinised, control charts and statistical techniques checked?

8. **Quality Assurance**

   Are all elements of the production operation that are essential for quality and reliability examined, along with the quality assurance management system?

9. **Effects and results**

   Are products of good quality being sold? Has there been improvement in quality, quantity and cost? Has the whole company been improved in quality, profit, scientific way of thinking and will to work?

10. **Future plans**

    Are strong and weak points in the present situation recognised? Is promotion of quality control planned and likely to continue?

3.4.2.2 The Differences between the ISO 9000 Registration and the Deming Prize

This section sums up the differences between the ISO 9000 Registration and the Deming Prize as stated by Mahoney and Thor (1994). The following table (Table 3.7) compares ISO 9000 with the Deming Prize:

Table 3.7 Differences between ISO 9000 Registration and the Deming Prize

	ISO 9000 Registration	Deming Prize
Purpose	"Effectively document the Quality System elements to be implemented or in place needed to ensure an ability to perform; voluntary registration by an accredited third party."	"Award prizes to those companies recognised as having applied Company Wide Quality Control based on Statistical Quality Control." Emphasises "world-class" accomplishments.
Emphasis	Validation of ability to perform according to contract.	Statistical process control.
Eligibility	Companies, divisions, locations in countries signatory to the ISO protocol (includes U.S.A, Canada).	Individuals, factories and companies - global since 1984; only non-Japanese winner has been Florida Power and Light.
Participants	Typically organisations involved in international trade that wish to be acceptable as vendors, especially those wishing to trade with EC '92.	Any number of companies that meet the standard established by the Union of Japanese Scientists and Engineers (JUSE).
Evaluation Criteria	ISO 9001/Q91" Definitions. ISO 9001-3; Q91-93: Standards at three levels of depth and breadth. ISO 9004/Q94: Guidelines.	One page of guidelines (Particulars) - very succinct, with some subjective interpretation (JUSE personnel judgements).
Orientation	Process (80 percent) at 9001 level; heavy on quality assurance initiatives; management and administration (20 percent).	Process (60 percent) plus results (40 percent); heavy on statistical process control.
Mechanics	Select registration agency, pre-assessment choice of standard, submission of quality Master Manual, site assistance visit; on-site assessment of three to five days.	Qualification based on review off/on-site by JUSE.
Examiners	Select staff of registration agency; ASQC maintains a list of recommended registrars; some companies prefer to use an EC '92 source.	Select panel senior members of JUSE.
Cost	Low to moderate dollars with sound quality assurance program in place; some consulting on system may be useful.	High dollars and effort; consulting fees from JUSE are a major component (training has a major impact in any case).
Time Frame	Registration takes six to twelve months depending on starting point and urgency.	Two to five years (preparation with JUSE; application when "ready").
Common emphases	Administration, procedures, controls, training.	

SOURCE: **Mahoney and Thor, 1994, pp.53-55**

3.4.3 Malcolm Baldrige National Quality Award:

The Malcolm Baldrige National Quality Award was named after former United States Secretary of Commerce Malcolm Baldrige. He pushed for a U.S. quality award as part of a national strategy to increase U.S. quality. Accordingly, the Award was created by an act of Congress in 1987 to stimulate quality awareness in the United States. The

American Productivity and Quality Center (APQC) and the American Society for Quality Control (ASQC) along with other quality professionals helped in the development of the Award. The Award process is funded from a private foundation created by interested companies and individuals and is administered by the ASQC. The judges and examiners are mostly drawn from private sector companies. There can be a maximum of two winners in any year, in the following categories:

- Manufacturing
- Services
- Small business

Candidates are judged according to major criteria categories, sub-criteria, and specific areas to address (Mahoney & Thor, 1994). The points assigned to each category of the award add to a total of 1000 (Costin, 1994). Unlike the ISO 9000 Standards and the Deming Prize, the Award places great emphasis on customer satisfaction.

In a report written by the Council on Competitiveness (July, 1995) it was mentioned that the main purpose of the Baldrige Award is educational through encouragement of competitive learning and creating an evolving body of knowledge nationwide. The main criteria for the Award is based upon a seven part framework which in turn focuses on key requirements for organisational excellence. The seven parts are:

1. Leadership
2. Information and analysis
3. Strategic Planning
4. Human Resource Development and Management
5. Process Management
6. Business Results
7. Customer Focus and Satisfaction

Judgement is made on the following criteria:

1. **Approach:**

   It considers the methods used. Are they prevention-based, effective, and well measured and evaluated?

2. **Deployment:**

   It requires total quality management throughout the organisation. In other words not only on the plant floor but also in support areas and offices.

3. **Results:**

   It includes quality level and trend, evidence of sustained improvement (not only over the previous year), and a demonstrable link between quality practice and result (Mahoney & Thor, 1994).

3.4.3.1 The New Zealand Quality Award:

The New Zealand equivalent to the U.S. Malcolm Baldrige Award is the "National Business Excellence Awards" established in 1992 by private enterprise with the endorsement of Government. The Prime Minister is Honorary Patron. It is funded by patron and member organisations (New Zealand Quality Foundation, 2000a) The Awards used to be called the "New Zealand National Quality Awards" before the year 2000 (New Zealand Quality Foundation, 2000b). They are annual awards to recognise New Zealand organisations for performance excellence through quality management. The awards are open to all organisations and business units that meet the eligibility criteria (New Zealand Quality Foundation, 1998).

Table 3.8 presents the National Business Excellence Award Ladder as per the New Zealand Quality Foundation (2000a):

Table 3.8: National Business Excellence Award

GOLD LEVEL

- International recognition of a "World class" organisation
- Comprehensive approach with significant and consistent results evident across the organisation

ACHIEVEMENT AWARD

SILVER LEVEL

- Comprehensive approach with results evident across most of the organisation

COMMENDATION AWARD

BRONZE LEVEL

- Comprehensive approach with some results in key areas of the organisation

PROGRESS AWARD

RECOGNITION OF PROGRESS

- A sound approach to organisational excellence has been developed and deployed across the organisation. Results are beginning to be evident.

SOURCE: New Zealand Quality Foundation, 2000a

3.5 International Research on Quality Management:

This section presents the various studies conducted on quality management in different countries in various fields (e.g. industrial, educational, and health) as a means of showing a deeper insight in the diversity of its applications.

Green (1997) notes that ISO 9000 certification has advantages other than ensuring that the quality of the organisation's products or the quality of its services are quality assured. He emphasised that the 1994 revision to the Standards were aimed not only at satisfying contractual requirements, but also aimed at satisfying the needs of customers. He further stated that some organisations who achieved ISO 9000 certification claim that they became more efficient as a result of having been certified. Others even claimed that they became more efficient merely by preparing for ISO 9000 certification. He gave an example of independent research conducted by the University of Surrey on behalf of Lloyd's Register of Quality Assurance (LRQA) on 200 mechanical engineering manufacturing companies which had been ISO 9000 certified by the LRQA. The results of this research showed that the companies which have achieved ISO 9000 certification are more profitable and do significantly better than uncertified companies.

Ismail and Hashmi (1999) conducted a study researching the implementation and implication of quality management in the Irish manufacturing industry. The research study involved designing a postal survey questionnaire that was mailed to 1800 manufacturing firms in the Republic of Ireland. The study results from the perspective of competitive advantage, showed that firms with ISO 9000 and TQM in place are 52% better off in performance than those firms without, and are 24% over those with only ISO 9000. The firms with ISO 9000 only are 22% better off than those without TQM and ISO 9000. On the other hand, the installation of TQM and its corresponding effectiveness, depend on the site size, industry type and ownership.

Another significant result of the study shows that firms with ISO 9000 had an increase in mean performance reaching its peak in the fourth year of its registration, followed by a downward trend. Ismail and Hashmi (1999) argued that implementation of TQM should start not later than 4 years after ISO 9000 registration. In order for firms not to have a decline in their performance, they should maintain and sustain the TQM drives continuously (Ismail and Hashmi, 1999). In other words a quality system such as ISO 9000 is an essential feature of TQM (Dale, 1994).

James W. Kolka (August, 1999) wrote an article entitled "ISO 9001 and health care". This article analysed how ISO 9001 Quality Management Systems (QMS) are being applied in the diverse US health care industry. The technique he used involved taking the 20 elements of the ISO 9001 and analysing them to understand:

a) Quality gains for health care providers by the application of the 20 elements.

b) Health care customer service benefit from the application of the 20 elements.

c) The bottom-line benefits of certification for health care providers.

Kolka (August, 1999) stated that the first hospital to register to an ISO 9001 quality management system was in January 1996 which means that ISO 9001 registration is relatively new to the health care providers. He concludes by stating that ISO 9001 registration offers improvements to other accreditation programs. Its registration offers a disciplined and systematic approach to health care as it has to other manufacturing and service industries. He believes that an internally managed ISO 9001 quality management system subject to frequent external review, is easier to maintain, less demanding financially and capable of offering better service to its customers.

Kanji, Tambi and Wallace (1999) conducted exploratory research on quality practices at higher education institutions in the US and Malaysia. The research was conducted between December 1997 and February 1998 with 216 Malaysia High Educational Institutions (HEI) and 294 US institutions. The research explored the extent of implementation of TQM in HEIs and its contribution to the organizations' performance and business excellence. The research also examined the quality cultural differences between US and Malaysian higher education systems and finally presented a TQM model especially suitable for HEIs. This research also showed that there is a higher proportion of TQM institutions that have good to excellent organizational performance and a lower proportion of fair to poor organizational performance (Kanji, Tambi & Wallace, 1999).

The results of Kanji, Tambi and Wallace (1999) are consistent with previous research conducted earlier in 1996 by Terziovski, Sohal, and Samson and by Kanji and Yui in 1997 in other sectors of the economy.

Adjieva and Wilson (2002) also investigated the characteristics of quality initiatives in the higher education systems of four countries: UK, North America, New Zealand and Australia. Research results showed that each country demonstrates variety in its practices and a quality evolution from a low quality, low organisational learning environment towards organisational learning capabilities. Moreover, the research outlined key organisational transformation areas (i.e. Leadership, culture and infrastructure).

Hongyi Sun (1999) reports on a survey of 900 companies conducted in Norway with the support of the Norwegian Quality Association (NFK) and the Rogaland Research Institute (RF) in early 1997. The study identified the components of TQM applied in different companies and compared the results with other studies conducted in the US, China, India and Mexico. The survey questionnaire was designed according to the US Baldrige Quality Award Model (Hart & Bogan, 1992) by Toledo University. Furthermore, some additional questions were added according to the European Quality Model (EFQM, 1997) and Norwegian specialists. The Norwegian study showed that the components of a TQM programme may vary from country to country. Accordingly, Sun (1999) suggested that the Quality Award Model should be used for guidance and not a model to copy. The following are further findings of the study:

- TQM practices such as quality leadership, human resource development and quality information contribute to the increase of customer satisfaction and to business performance.
- None of these TQM practices guarantee better results on its own i.e. improvement can only be achieved when all practices are implemented collectively.
- The longer ISO 9000 and TQM are applied in the company the better the results.
- ISO 9000 standards are taken as part of a TQM programme.
- All sampled companies of the study have not implemented TQM fully.

After exploring the various quality management studies conducted in different countries in the different fields, it is important to focus on quality management in the water utilities field as it is directly related to the subject matter of this research. It is clear that some other sectors are well ahead of the New Zealand Water Utilities in implementing quality management practices. Hence, the researcher is investigating to what extent the TQM philosophy is adopted rather than certification of ISO Standards being applied in water utilities. The researcher believes that there is quite a difference between TQM and ISO certification as TQM is a philosophy that should be institutionalised within the whole organisation in contrast to implementing certain requirements in order to obtain the ISO certification.

3.6 New Zealand Water Utilities Management:

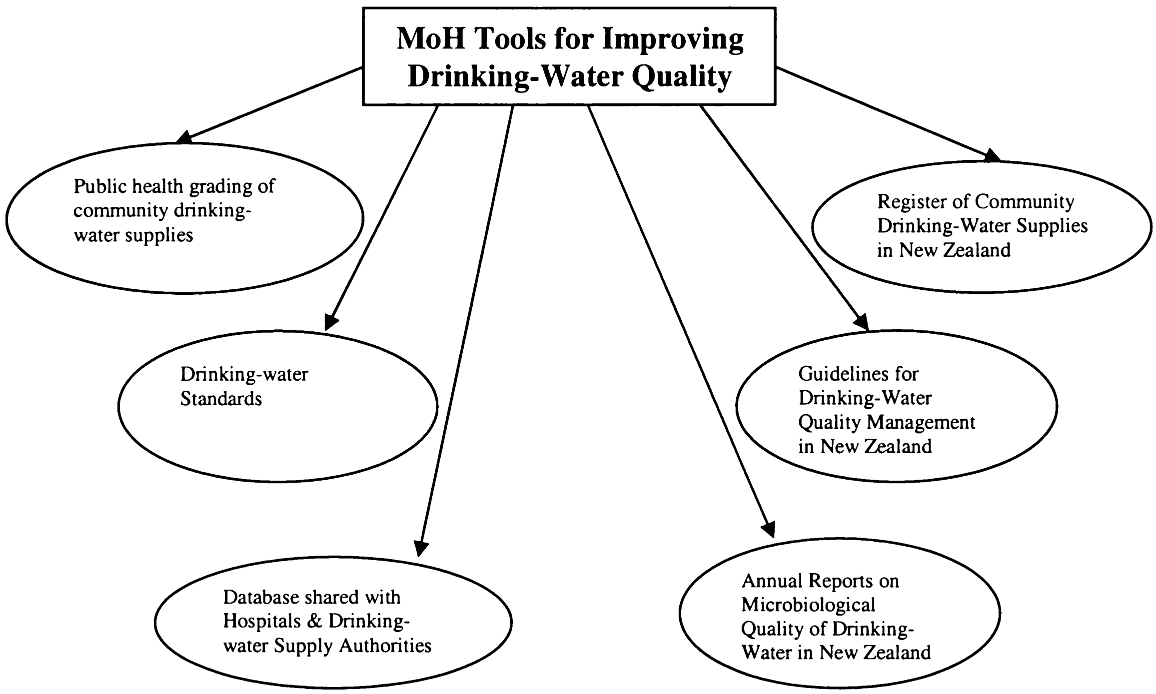
This section discusses New Zealand regulations in relation to water utilities management as set by the regulatory body in New Zealand i.e. the Ministry of Health. The aim is to illustrate the concept of quality management in the water industry as a means of setting the scene for the thesis analysis of the water utilities' management systems.

3.6.1 The Ministry of Health (MoH) Regulations:

The Ministry of Health (MoH) in New Zealand is the regulatory body responsible for the regulation of public health under the Health Act 1956 and its later amendments. Safe drinking-water supply is a fundamental pre-requisite of public health. Although most of the people in large communities get safe drinking-water, there has been some problems with some of the smaller supplies. Accordingly the Ministry of Health (MoH) began a strategy to improve the quality of drinking-water management and monitoring in 1992 (MoH, 1995a).

In 1993, the World Health Organisation (WHO) published "Guidelines for Drinking-Water Quality" (Second Edition) which contained new information on drinking-water quality requirements. The MoH in New Zealand used both the WHO Guidelines and the knowledge of deficiencies in the public health management of drinking-water to develop a strategic plan and tools to improve the public health safety of New Zealand drinking-water. The following figure (Figure 3.10) illustrates the MoH tools for improving the drinking-water quality:

Figure 3.10: MoH Tools for Improving Drinking-Water Quality



SOURCE: Author's figure based on MoH Guidelines for Drinking-Water Quality Management for New Zealand (1995c) in El-Kafafi, Nov. 2000b

The Ministry of Health (MoH) (1995a) stated in its *Guidelines for Drinking-Water Quality Management for New Zealand* that good management practices for community drinking-water supplies depends on proper management of the following:

1. **Water Source:**

   A community water supply may gather raw water from rainwater, surface water or groundwater. Surface water is frequently contaminated by micro-organisms. Shallow groundwater and some springs are microbiologically equivalent to surface water, along with rivers, streams, lakes and reservoirs. Secure groundwater is usually free from microbiological contamination (MoH, 1995b).

2. **Treatment Plant:**

The Treatment plant is the facility that treats raw water to make it safe and palatable for drinking. This can range from a full scale water treatment plant comprising chemical coagulation, sedimentation, sand filtration, pH adjustment, disinfection and fluoridation, to simply being the point in a pipeline where the water main changes from a raw water main to drinking-water supply main.

3. **The Distribution System:**

Once the water leaves the treatment plant, it enters one or more distribution zones. The distribution zone is part of the water supply network within which all consumers receive drinking-water of identical quality from the same similar source, with the same treatment and usually at the same pressure.

3.6.2 Definition of Quality Management from the Water Industry Perspective:

Quality management is an approach to management that produces a product and service that meets the customer's requirements for quality as economically as possible. Moreover, it provides a structure and method for the improvement of a company's, or organisation's processes products and services (Stebbing, 1990).

As stated by the Ministry of Health (1995a) in its *Guidelines for Drinking-Water Quality Management for New Zealand* quality management of drinking-water endeavours to manage every aspect of the drinking-water supply in a way which minimises the possibility of mistakes and corrects incipient errors in the process at an early stage as much as possible.

The New Zealand MoH quality management of drinking-water supplies is structured and designed to achieve the following:

1. Develop management methods for improving quality.
2. Improve quality and productivity.
3. Ensure compliance with the "Drinking-Water Standards for New Zealand 1995".
4. Meet and create consumer expectations.
5. Reduce quality related costs.

Drinking-water quality management involves:

1. **Quality of design:**

   This is to ensure that the water treatment and distribution system can produce water and meets with the customer's expectations.

2. **Quality of Conformance:**

   This is to operate the treatment process so that it consistently produces water that meets these expectations.

3.6.3 Key Features of Drinking-Water Quality Management:

The following table (Table 3.9) illustrates the key features of the drinking-water quality management system as stated by the MoH (1995a) *Guidelines for Drinking-Water Quality Management for New Zealand*:

Table 3.9 Key Features of Drinking Water Quality Management

Task Unit	Function
People	• Skills • Knowledge • Training • Responsibilities allocated • Motivation
Equipment	• Capability • Calibration • Fail Safe • Backup and spares • Maintenance • Easy Access • Performance monitoring
Materials/Consumables	• Specification • Certification • Quality • Condition • Suitable storage • Inventory Control • Right Place • Right time
Methods/Procedures	• Appropriate • Fail safe • Written authorised procedures • Performance monitoring • Contingency plans • Complaints register
Surroundings	• Hygienic • Safe • Equipment and services accessible
Quality Control	• Responsibilities defined and allocated • Appropriate Monitoring program • Trend/control charts • Action criteria and plans • Prompt feedback • Performance Audit

SOURCE: Adapted from the Ministry of Health (1995c) Guidelines for Drinking-Water Quality Management for New Zealand.

In order to achieve a working approach of the quality management system, the sources or causes of variation of the processes should be understood. In general those causes of variation will relate to one or more of the task units mentioned in Table 3.9 (i.e. people, equipment, materials, procedures/work instructions, accommodation/environment and quality control). Hence, at every point of the water treatment and distribution process, each of these elements must be systematically managed to ensure that the whole process is under proper control (MoH, 1995a).

3.6.4 Elements of a successful Drinking Water Quality Management System:

The following elements have been advocated by the MoH as the best ingredients for success of a drinking water quality management system:

1. **Team Work:**

   Everybody within the organisation must be committed to working together towards a common goal i.e. quality. Involvement and participation by the team members create better ownership and result.

2. **Training and Education:**

   Principles of quality management must be well understood from top management through to all levels of the organisation.

3. **Communication:**

   Successful implementation of quality management depends on clear and accurate communication with customers and suppliers.

4. **Management Role and Responsibility:**

   Since management has the information and authority to make decisions, set policies and allocate resources necessary to improve the system, it is of vital importance that it participates in the following actions:

   - Involvement and commitment to quality management
   - Active and positive participation in the process
   - Acceptance of responsibility for making changes to the operating systems
   - Maintains momentum
   - Recognising people as important assets worthy of investment through training and education.

5. **Quality Control:**

Tests should be carried out to check whether product should be released to the customer, stopped for remedial action or fixed up. For example spot chlorination of a contaminated pipe or reservoir.

6. **The Costs of Quality:**

The main objective of any Quality Programme is to maximise the social gain by improving quality. This means increasing prevention costs so that quality is designed in the process itself; hence reducing failure costs.

The following are four types of quality costs:

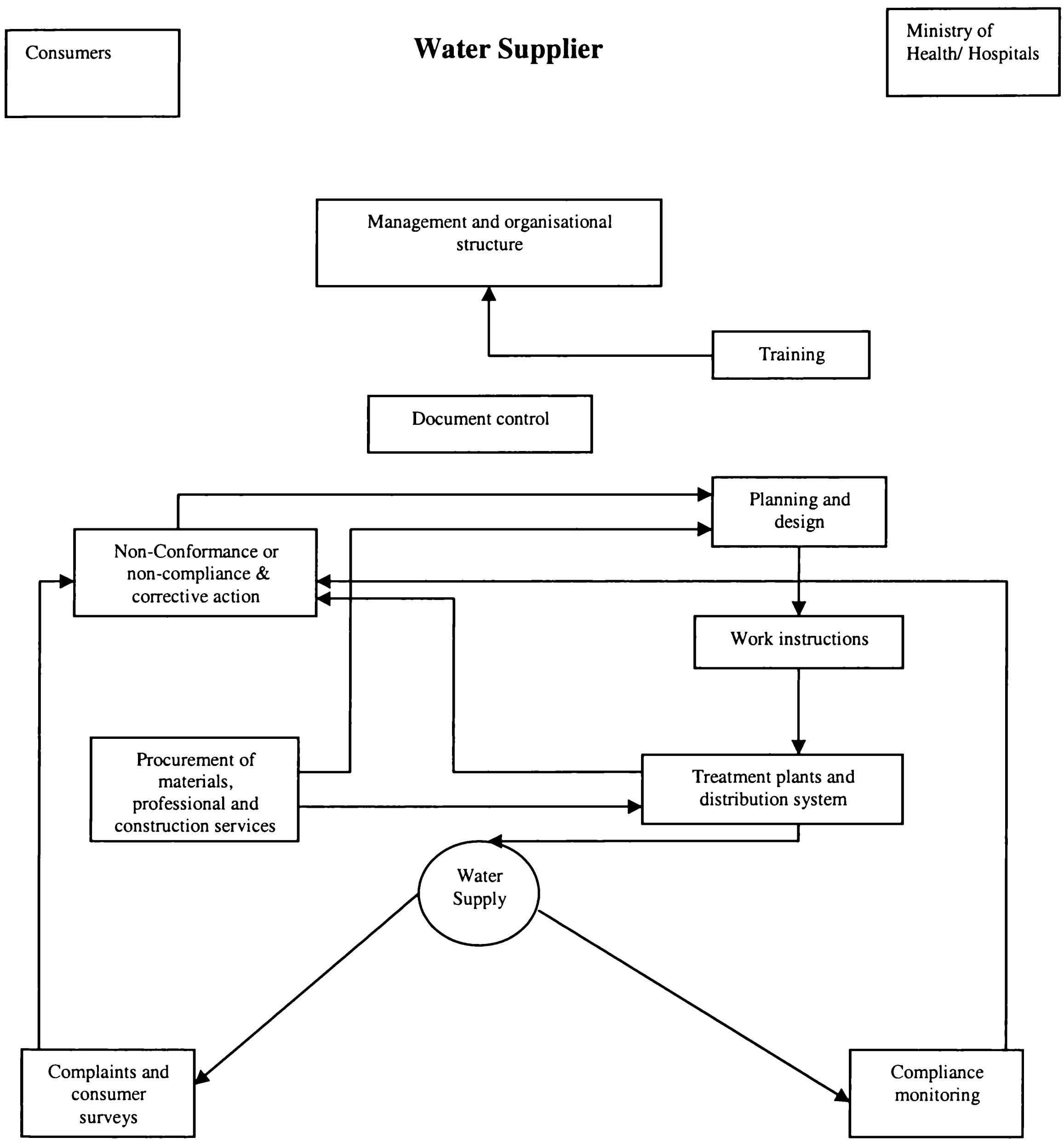
- Failure costs - the costs of systems which produce defective water.
- Appraisal costs - the costs of repeatedly finding out what went wrong.
- Remediation costs - the costs of repairing the mistakes and pacifying the public and politicians.
- Prevention costs - the cost of doing it right the first time, every time.

The basic structure of a quality management system which is appropriate for a community drinking-water supply is shown in the figure below (Figure 3.11).

Some water utilities in New Zealand started working toward ISO 9002 accreditation in 1995. The following is the approach they applied:

- Review of the existing system against the requirements of ISO 9002. Review was carried out by consultants specialising in quality management.
- Appointment of a person to manage and co-ordinate the process.
- Formation of task groups within the organisation to create awareness, and agree policy and objectives.
- Development, implementation and documentation of the quality management system.
- Internal audit of the system.
- External audit.

Figure 3.11: Drinking-Water Quality Management



SOURCE: Ministry of Health (1995c) Guidelines for Drinking-Water Quality Management for New Zealand and El-Kafafi, 2000b

3.7 TQM in the Health Sector and the Water Sector

Since the considerations in water supply management are similar to those in the health industry, it is useful to briefly review the way in which ISO 9000 Standards have been taken up in the health sector in the USA and the extent to which this is applicable in the water supply management sector.

The following table (Table 3.12) illustrates the findings of Kolka (August, 1999) in his research and relates it to the applicability of the ISO 9000 elements in the Health Sector to the Water Supply Sector in New Zealand. The results are based upon the researcher's informal face to face interviews with the Water Supply Sector Managers in the Waikato Region of New Zealand. Those informal interviews were conducted during the initial phase of the research i.e. late 1999 and early 2000.

Table 3.10: The Similarities between the application of the Key Elements of ISO 9000 in the Health Sector and the Water Supply Sector

Health Sector	Water Supply Sector
Management responsibility which applies to both administrative and clinical operations	Yes – Leadership determines where the organisation is going.
Quality system i.e. establishing a quality manual documenting quality management system and determining how the organisational structure, procedures and processes will satisfy quality objectives.	Yes – even the district councils who are not ISO certified are abiding by the annual plan which sets some sort of rules to follow to provide a good service (water quality up to the NZ Drinking water Standards 1995 issued by the NZ MoH) to the customers.
Contract review. This requirement is for ensuring that all written materials creating patient expectations are accurate.	Yes – contracts are regularly reviewed.
Design control defines the steps that must be taken by an organisation when new or additional services are considered for implementation.	Yes – Councils are very dependent on external expertise.
Document and data control. In other words, the right documents must be available and indexed so they are readily accessible whenever required.	Yes – even the district councils who are not abiding by that are aware of the problem and working towards fixing it.
Purchasing. It is imperative that the quality management system ensures the accurate and timely purchase of materials and supplies from approved vendors. If this is not effectively controlled, it can create runaway costs.	Yes – actually in some of the cases the NZ MoH provides a list of approved vendors to abide by especially in the cases of chemicals for water treatment. In few cases cost sometimes if not supersedes quality as the main criterion for choice, goes along with the criterion of quality.
Control of customer supplied product. Identifying and controlling items that are used in the delivery of services, but are not the property of the organisation should be given serious attention.	Yes – controls over subcontractors with subcontracting a major part of the water supply sector. Most of the district councils subcontract their lab testing procedures to ISO 9000 certified laboratories.
Product identification and traceability	Yes – changes to internal practices required
Process control. This item could include controlled conditions concerning the use of suitable equipment and working environment or monitoring. It could also include control of suitable process parameters and service conditions.	Yes – processes are carefully controlled and monitored.
Inspection and testing which includes quality checks. Assessments and inspections at all process stages.	Yes – critical to health quality control for water but also a source of high costs.
Control of inspection, measuring and test equipment.	Yes – but to a variable standard.

SOURCE: Author's table – information obtained from Kolka (August, 1999) and informal interviews conducted by the author with the Water Utilities Managers within the Waikato Region.

Table 3.10: The Similarities between the application of the Key Elements of ISO 9000 in the Health Sector and the Water Supply Sector (Continued)

Health Sector	Water Supply Sector
Inspection and test status. In other words, verification that assessments, inspections and test have been performed.	Yes – crucial in the water sector.
Control of non-conforming product or service.	Yes – both product and service are crucial given the different types of quality and their inter-relationship. Most of the councils if not abiding by the ISO 9000 standards abide by the NZ Drinking Water Standards 1995 issued by the MoH setting the rules and actions to be taken to control non-conformity.
Corrective and preventive action in ISO 9001 systems is driven by internal audit process. This process identifies non-conformities, drives corrective and preventive action and reports corrective actions, processes and any quality trends to management review on a periodic basis.	Yes – requires considerable investment and change in organisations which are technically oriented and scientific in focus.
Handling, storage, packaging, preventing, preservation and delivery.	Yes – totally adapted to the water industry.
Control of quality records. Management should consider regulatory requirements and what is not stored for liability purpose. The absence of key records can be extremely damaging to liability exposure.	Yes – all councils are conscious of the seriousness of that and are working on computerising all their data records for easier access and accurate retrieval of information.
Internal quality audits. An ISO 9001 quality management system us audited regularly using the three tiers of first party, second party and third party quality audits.	Yes – time consuming and expensive so not all of the councils are conducting internal auditing.
Training with a specific focus related to quality. Training here is not only directed towards employees to have the requisite skills to do their jobs, but also internal auditors must have quality training certificates on record.	Yes – this is very crucial; accordingly more allocation of resources should be considered especially for small size councils where the subject matter is totally ignored.
Servicing which could cover servicing, equipment, providing services to customers and internal suppliers.	Yes – service controls are common.
Statistical techniques that can provide significant insight to the efficacy of the system and areas that should be addressed.	Yes – this is one of the areas that need tending to in the water industry because it is not fully utilised.

SOURCE: Author's table – information obtained from Kolka (August, 1999) and informal interviews conducted by the author with the Water Utilities Managers within the Waikato Region.

3.8 Conclusion

This chapter paved the road for shaping the methodological considerations and the practical research (i.e. field work) conducted in this thesis. It provided a brief review of the relationship between the TQM concept and the management of the water treatment and supply industry in New Zealand in general. There is reference to research conducted world wide and related to initial research conducted in the Waikato Region (i.e. informal interviews with water utilities managers). The aim was to help establish a link between the applicability of quality management in the water arena as it has been applied earlier in other sectors. Both the literature review and previous studies' results show that there is room for TQM to contribute to enhancing consumer satisfaction, economic efficiency and also environmental performance and public health. However, the design and implementation of TQM practices should be carefully scrutinized as quality systems are no simple panacea.

CHAPTER FOUR:
METHODOLOGICAL FRAMEWORK

4.1 Introduction

This chapter outlines the research question, and describes the methodological framework used in order to answer it. It explains the choice of the research paradigm. Furthermore, it goes into detail explaining the mixed methodological methods used for data collection and analysis.

4.2 Research Question

As mentioned in Chapter 1 Section 1.5.1, the major research question of this study is: "What managerial systems are used in the New Zealand Water Utilities and how do these management systems affect the quality of drinking water delivered to the community?"

In order to respond to this research question, further investigations are undertaken to answer the following sub-research questions:

1. What perceptions do water utilities managers have about quality management in general and TQM in particular?
2. To what extent are TQM practices actually applied in the water utilities?
3. Is there a relationship between the use of specific TQM procedures/models and water quality?
4. What other quality factors do managers in water utilities identify as crucial for improvement of water quality?

4.3 Paradigm Choices

The purpose of this study is to explore the impact of introducing and applying Total Quality Management (TQM) techniques and models in the New Zealand Water utilities and its impact on the improvement of drinking water provided to the community. The research paradigm selected must be consistent with the achievement of this purpose. Candy (1989) suggests that the selection of any one paradigm for research depends on its goodness of fit. In other words, its appropriateness to the subject of inquiry. Accordingly, the researcher examined the three major paradigms in social sciences in order to choose the suitable approach that would that allow her to understand, interpret and at the same time answer the research question.

Guba and Lincoln (1994 and 1998) define a paradigm as a set of basic beliefs or metaphysics that deal with ultimates or first principles. They also state that it represents a worldview that defines, for its holder, the nature of the "world", the individual's place in it, and the range of possible relationships to that world and its parts as cosmologies and theologies do. Patton (1990) states in simple terms that a paradigm is a set of propositions that explain how the world is perceived; it contains a world view, a way of breaking down the complexity of the real world, telling researchers and social scientists in general what is important, what is legitimate and what is reasonable.

The following Table 4.1 illustrates the three main paradigms in the social sciences as defined by Sarantakos (1996):

Table 4.1: The Three Main Paradigms in Social Sciences

Positivistic	Interpretive	Critical
Positivism	Symbolic interactionism	Critical sociology
Neopositivism	Phenomenology	Conflict school of thought
Methodological positivism	Ethnomethodology	Marxism
Logical positivism	Hermeneutics	Feminism
	Psychoanalysis	
	Ethonography	
	Sociolinguistics	

Source: Sarantakos, 1996, p. 31

Sarantakos (1996) explained positivism through the following four angles: a) how positivism defines reality, b) how positivism perceives human beings, c) the nature of science, and d) how positivism perceives social research. Positivism defines reality as everything that can be perceived through the senses. In other words, reality is objective, built on order, is governed by strict, natural and unchangeable laws and is independent of human consciousness. Positivism perceives social science as a tool for studying social events so that general causal laws can be discovered, explained and documented. This paradigm is relevant to this study because it is appropriate to use and analyse quantitative data concerning water quality management practices and outcomes.

Guba and Lincoln (1994) state that for positivists, research involves the verification of hypotheses, the search for invariant causal relationships between variables, and the establishment of theories which can be used to predict and hence to control outcomes. This approach faces the problem of sufficiently robust data. This limits the usefulness of the positivist paradigm, but does not rule out evaluative purposes. On the other hand, Guba and Lincoln (1994) explain that the aim of inquiry in the critical paradigm is to critique and transform social, political, cultural, economic, ethnic and gender structures that constrain and exploit humankind through engagement in confrontation and conflict. Sarantakos (1996) added that the critical perspective's approach is to enable the researcher to get below the surface, to expose real relations, to disclose myths and illusions, to show people how the world should be and how to achieve social goals in order to change the world. The radical version of the critical paradigm is not relevant to this study as its approach is to explain and criticise social reality and to empower people to overthrow it.

According to Burell and Morgan (1979), the interpretive paradigm's primary concern is to understand the subjective experience of individuals. This paradigm views social reality as an extension of human consciousness and subjective experience. Interpretivists want to get close to the phenomenon they are studying because they believe that only by understanding human experience, at the level at which it occurs, can they understand the world as it is (Martin and Nakayama, 1999). In its approach to science, the interpretive paradigm is nominalist, anti-positivist, voluntarist and ideographic, and sees the world as an emergent social process created by individuals. *"Everyday life is accorded the status of a miraculous achievement"* (Burrell and Morgan, 1979).

Sarantakos (1996) explains that the interpretive social scientists' approach is inductive, proceeding from the specific to the general and from the concrete to the abstract. This research help to interpret and understand the reasons behind the social actions and how the actors construct their lives and the meanings they attach to them as well as comprehend the social context of the social action. The emphasis here is not the social actions, but the subjective meaning behind such actions. This paradigm is relevant to this study because the focus in this study is on managerial perceptions.

The literature on Total Quality Management (TQM) and the application of its techniques and models has been in large measure focused on the manufacturing sector, the hospitality industry, and lately on the education sector. There has not been related research in the water arena.

Understanding and exploring water utilities managers' perceptions and practices and linking them together is the focus of this study. In order to reach an answer to the research question, the researcher resorted to the use of mixed methodological methods utilizing aspects of both the positivistic and the interpretivist paradigms.

4.4 Methodological Considerations

This research engaged in methodological triangulation which Stern defined as follows:

> *Because different "lenses or perspectives result from the use of different methods, often more than one method may be used within a project so the researcher can gain a more holistic view of the setting. Two or more qualitative methods may be used sequentially or simultaneously, provided the analysis is kept separate and the methods are not muddled. For example, Wilson and Hutchinson (1991) compared the use of grounded theory and Heideggerian hermeneutics to illustrate how the philosophical and methodological features of each method are distinct, yet complementary* (Denzin and Lincoln, 1994, p. 224).

The term triangulation is taken originally from land surveying where it is used often. Knowing a single landmark only helps locates the person somewhere along a line in a direction from the landmark. On the other hand, knowing two landmarks helps the person take bearings in two directions and locate themselves at the intersection (Fielding & Fielding, 1986).

Denzin (1978) identifies four basic types of triangulation:

1. Data Triangulation: the use of a variety of data sources in a study.
2. Investigator Triangulation: the use of several different researchers or evaluators.
3. Theory triangulation: the use of multiple perspectives to interpret a single set of data.
4. Methodological Triangulation: the use of multiple methods to study a single problem.

This research will be using two types of triangulation i.e. data triangulation (face-to-face interviews, observations, and document review, and methodological triangulation (Qualitative and quantitative data collection and analysis). Data triangulation and methodological triangulation will be described in more detail in the data collection and data analysis sections.

4.4.1 Methodological Triangulation

Rossman and Wilson (April, 1984 and 1991) advocate the link between qualitative and quantitative data to enable confirmation of findings via triangulation. This provides richer detail which develops better analysis and finally they help initiate new lines of thinking by turning ideas around and providing fresh insight.

Firestone (1987) emphasises the importance of combining both qualitative and quantitative methods. He illustrated, by saying that quantitative studies persuade the reader through de-emphasizing individual judgement and stressing the use of established procedures that leads to precise and generalised results. Qualitative research, on the other hand, uses rich depiction and strategic comparison across cases as a means of persuasion. This helps overcome the abstraction inherent in quantitative studies.

The researcher opted to use the qualitative data collection method for the following reasons as emphasised by Miles and Huberman (1994):

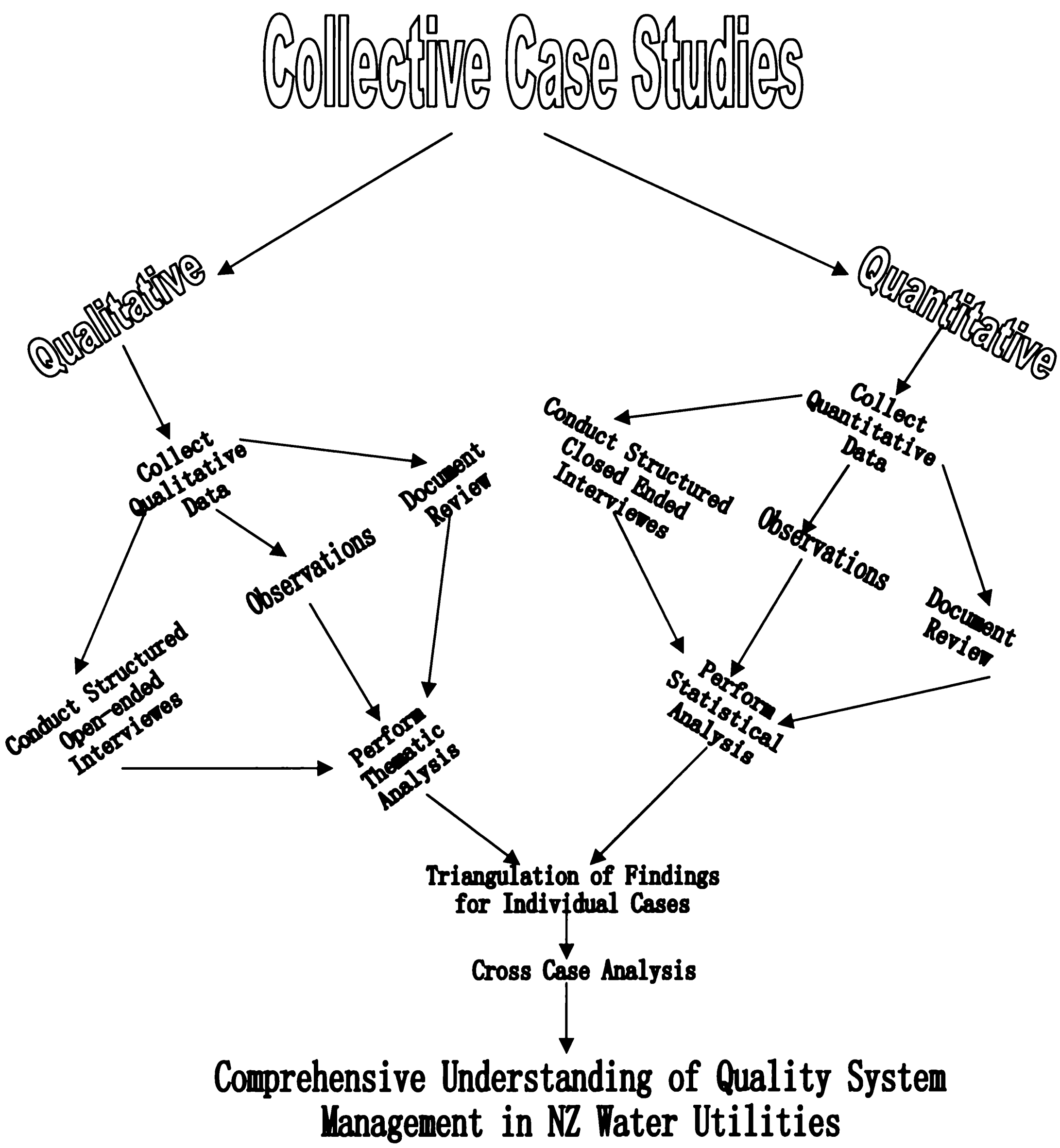
1. Qualitative data focuses on events in natural settings.
2. A focus on nine cases in a specific region provided a bounded phenomenon embedded in its context. Hence, the possibility for understanding underlying or non-obvious issues is stronger.
3. Qualitative data are known to have significant potential for revealing complexity due to their thick descriptions of the context, which has an impact on the reader.
4. Because data are collected over a sustained period of time, they are more compelling.
5. Qualitative data puts a great emphasis on people's lived experience, perceptions, assumptions, prejudgements, presuppositions and connecting these meanings to the social world around them (van Manen, 1997).

Furthermore as stated by Miles and Huberman (1994) the link between quantitative and qualitative data helps especially during the data collection by making access to data easier. It also helps validating, interpreting, clarifying, and illustrating quantitative findings during the data analysis stage. Furthermore, it helps in strengthening and revising the theory.

The rationale behind triangulation is that the researcher is following the advice of Denzin (1978) when he said that no single method adequately solves the problem of rival causal factors. Hence, by the use of multiple methods the researchers aspires to reveal the different aspects of empirical reality and at the same time help validate the research findings. Moreover, triangulation is the best means of answering the four sub-questions of the research which have both qualitative and quantitative aspects.

The following Figure 4.1 illustrates the holistic nature of the process i.e. the relationship between qualitative/quantitative and interpretive/positivist in this research.

Figure 4.1: Measurement, Design and Analysis: Mixed Methods Combination



SOURCE: Author's Figure

The following sections of this chapter show how the researcher primarily used the qualitative approach to answer sub-questions one and four and the quantitative approach to primarily answer sub-questions two and three.

4.5 Research Design

A research strategy is a way of investigating an empirical topic by following a set of pre-specified procedures (Yin, 1984). This section will discuss how the researcher utilised the case study strategy and its relevant research instruments [data collections methods] (Robson, 1993; Sellitz et al, 1976; and Yin, 1994), data validity and reliability and finally data analysis methods.

4.5.1 Case Study Strategy

The researcher chose the case study strategy because as mentioned by Merriam (1998) it approaches a problem of practice from a holistic perspective. The researcher used the case study design in order to gain an in-depth understanding of the situation from data, observations and documentation of the perceptions of those involved (i.e. water utility managers). This is an exploratory, investigative, descriptive, interpretive study of the existing quality systems in water supply organizations of the different District Councils of the Waikato Region. It also analyses ways to enhance the achievement of better quality drinking water in a sustainable and efficient manner. Such insight into aspects of the Waikato Councils' managerial practices can have a direct influence on policy, practice and future research. Hence, this research is based on both qualitative and quantitative approaches to reach a holistic picture of the situation.

A case study approach is often the best methodology for addressing problems in which understanding is sought in order to improve practice [see Merriam (1988)]. This is relevant to the Waikato Region Case studies where understanding of their managerial practices and their implementation of TQM Models is an important step in the improvement of water quality management by water utilities.

4.5.2 Characteristics of Case Study Research

The following case characteristics show how they are relevant and accordingly help to answer the research question.

a) **Particularistic:** A case study focuses on a particular situation, event, program, or phenomenon. This specificity of focus makes it a good design for answering our research question by concentrating attention on the way the managers in the water utilities confront their problems and how they view the situation. Although it is a collective case study of nine territorial authorities, it deals with the case of the Waikato Region.

b) **Descriptive:** The end product of a case study is a rich description of the phenomenon under study. Guba and Lincoln (1981) state that a case study interprets the meaning of demographic and descriptive data in terms of cultural norms (i.e. management perception of quality), community values (i.e. versus community perception of quality), and deep-seated attitudes and notions (i.e. the difference between both perceptions). This characteristic as we will see further in the analysis helps illustrate the complexity of the situation, the influence of managerial perception on the issue, the differences of opinions and perceptions and its influence on results.

c) **Heuristic:** A case study helps illuminate the reader's understanding of the phenomenon under study. As mentioned by Stake (1981), a case study can give insight into how things get to be the way they are.

d) **Inductive:** A case study relies on inductive reasoning i.e. discovery of new relationships, concepts, and understanding rather than verification of predetermined hypotheses (Merriam, 2002). This research is aiming at discovering the relationship between the application of managerial systems (i.e. TQM and its Models and specifically ISO 9000) and the quality of drinking water delivered to the community.

4.5.3 Investigator/Researcher Characteristics

As the investigator/researcher is the primary instrument for gathering and analysing data in a qualitative case study, he/she must have the following characteristics:

a) **Tolerance for ambiguity:** Throughout the case study process, from designing the study, to data collection, to data analysis, there are no set procedures or protocols that one follows step by step. The researcher had to make decisions as to what constituted the case, how data was to be collected, who would be interviewed and what documents would be read and analysed.

b) **Sensitivity:** The researcher has been sensitive to the information gathered either through indirect interviews, face-to-face formal interviews and relevant documents. The researcher has been sensitive to what this gathered information tells, how it is directed to the next piece of data and how well it is reflecting what is happening. The researcher acted as a qualitative evaluator. In other words, the researcher attempted to emphasize, describe, judge, compare, portray, evoke images and create for the reader or listener, the sense of having been there.

c) **Good Communicator:** The researcher sought to empathize with respondents and establish rapport with them through several visits before the formal interviews were conducted, asked good questions related to the subject under study and listened intently while conducting the interviews. Guba and Lincoln (1981) emphasized the importance of listening as a vital communication skill by saying that a good qualitative researcher looks and listens everywhere. They further added *"it is only by listening to many individuals and to many points of view that value-resonant social contexts can be fully, equitably, and honourably represented"* (p.142).

4.5.4 Sample Selection of the Case Studies

The Waikato Region was chosen for study in this research as it contains a range of water utilities, managed in different ways and providing drinking water of a range of qualities. The water sources of the region are abundant but the region has a problem with its downstream water quality, particularly in intensively used catchments (OECD, 1996; Waikato Regional Council, March, 1996 and Waikato Regional Council, September, 1998). Moreover, since the researcher lives in this area it was also chosen for its strategic convenience due to limited financial resources to complete the fieldwork required for the research. In order to get the full picture, the researcher decided to include all the nine territorial local authorities (TLAs) of the Waikato Region in the study.

There is a range of approaches to sampling which can be used (El-Kafafi, October, 2001a). Snowball, chain, or network sampling (Patton, 1990) is the form of purposeful sampling used in this research. The researcher identified the participants through contacting people in the different territorial local authorities and asking about the most suitable and knowledgeable person in the area to be interviewed. Due to their knowledge from their daily contact in the field, Managers of Water, Drainage and Refuse and the Water Treatment Managers of the different territorial local authorities around the Waikato Region were selected. The result was that twenty one Managers from the nine territorial local authorities were interviewed.

The researcher then chose to visit 3 water treatment plants for her participant observation data collection. The restrictions behind not visiting all the water treatment plants of the nine district councils were time restrictions (i.e. some of the territorial local authorities had seven plants) and financial restrictions.

4.5.5 Ethical Approval

Before starting data collection through fieldwork, the researcher submitted a proposal to the Waikato Management School Ethics Committee requesting approval for the research. The proposal summarised what the study was about, how the participants would be recruited, how many would be involved, incentives for participants involved in the study, participants rights of withdrawal, means of protecting participants anonymity, and means of data storage. The researcher also attached a copy of the Consent Form for Participants (Refer to Appendix 6), a copy of the letter of Invitation for Participants in Research Project (Refer to Appendix 7), and a copy of the questionnaire used in the face-to-face interview (Refer to Appendix 8: Waikato Water Utility Managers Survey Questions).

As soon as the researcher obtained the Ethics Committee approval, the first part of data collection through face-to-face interviews commenced. Waikato Region Water Utility Managers were interviewed from September 2000 to November 2000.

4.5.6 Becoming an Informed Participant

The researcher recruited two groups of informed participants: 1) Managers for the Territorial Local Authorities and 2) Water treatment plant operators. Territorial Local Authorities' managers participated in face-to-face interviews. During the phase of observational data collection, the water treatment plant operators were acting as informed participants in the research as the researcher spent time observing their duties at the plant and asking them in depth questions related to work.

4.5.7 Right to withdraw

The researcher made it clear to the two groups of informed participants that they had the right to withdraw from participating in the research at any time, or to decline to answer particular questions in the study. This was written in the consent form they signed (Refer to Appendix 6: Consent Form for Participants).

4.5.8 Anonymity and Confidentiality

To maintain anonymity, the researcher developed a system of identification codes so as not to mention the actual names of councils and participants. In relation to confidentiality, the researcher has not discussed the participant's identity with any unauthorised or related person to the research. Having said that, the participants in this research will potentially be identifiable given the small sample. Publications and reports will not attribute quotations to any particular respondent unless their approval is obtained in writing.

4.5.9 Storage of Data and Information

The information collected (paper files and/or tapes) were saved in a locked drawer. The information was then stored on the researcher's computer with a password known by the researcher only.

4.6 Data Collection

To obtain the data necessary for robust triangulation, (Easterby-Smith, Thorbe, & Lowe, 1991; Patton, 1990; Mathison, 1988; and Denzin, 1970) the study included the following data collection methods: 1) informal interviews with Waikato Regional Council, Health Waikato Officials and Territorial Local Authorities 2) a pilot study, 3) pre-test analysis, 4) face-to-face interviews with managers of the territorial local authorities of the Waikato Region, 5) observation of water treatment procedures at water treatment plants and in depth interviews of plant technicians on site, and 6) document review.

The following Table 4.2 illustrates how the researcher went about answering the four sub-research questions under the utilisation of two paradigms and the use of mixed methodological methods.

Table 4.2: How the Sub-Research Questions Were Answered Through the Utilisation of Two Paradigms and Mixed Methodological Methods

No.	Question	Paradigm	Data Collection Method	Qualitative	Quantitative
1	What perceptions do water utilities managers have about quality management in general and TQM in particular?	Interpretive	• Interviews (Open ended questions) • Observation • Document Review	Yes Thematic Analysis	No
2	To what extent are TQM practices actually applied in the water utilities?	Positivist	• Interviews (closed questions) • Observation • Document Review	No	Yes Statistical Analysis
3	Is there a relationship between the use of specific TQM procedures/models and water quality?	Interpretive and Positivist	• Interviews (closed and open ended questions) • Observation • Document Review	Yes Comparison between results from different data collection methods	No
4	What other quality factors do managers in water utilities identify as crucial for improvement of water quality?	Interpretive	• Interviews (open ended questions) • Observation	Yes Thematic Analysis	No

SOURCE: Author's table

The following Table 4.3 sums up the perceptions, benefits and problems related to the three different approaches/methods of data collection (i.e. face to face interviews, observations and document review) used in this research:

Table 4.3: Perceptions, Benefits and Problems of the Three Different Approaches of Data Collection Used in the Research

Method	Advance Perception	Benefits	Problems
Face-to-face Interviews	Direct contact with experts in the field would render in-depth understanding and insight of their perceptions and motivating factors	• Getting close contact in the field • Helpful insight of management systems in the water utilities • Getting actual behaviour • 100% reply rate • Gaining their trust and confidence which helped latter in the participant observation phase of the research i.e. permission from gatekeepers to enter the water treatment plants	• Time consuming to locate experts in the field • Trying to organize interview schedules to fit the busy working schedule of the mangers • Small size of samples • Cannot be sure if those managers are saying the exact truth or giving information to make them look good • Personal opinions and personal values cannot be generalised • Lots of travelling among the different TLAs in the region to obtain interviews which was time consuming
Observations	Relating between theory and practice. Learning more about the process of water treatment. Getting closer contact with technicians who do the job to gain more in-depth perception in the subject matter.	• The previous year contacts helped in making it easier in approaching the water treatment plant managers • Relating between the theory and practice • A real life experience or exactly what happens in those water treatment plants • Helping in the understanding of the laws and procedures around the plants • Assisting in the data analysis and giving an compete perception of what actually happens • Comparing notes with what the managers said in the face-to-face interviews • Learn more about the water treatment process and how it happens in reality versus what mangers behind desks talk about it. • Validating and verifying findings from the face-to-face interviews	• Extremely tedious and time consuming; hence, couldn't observe all the nine TLAs in the region • Organizing visit schedules to the different plants located all around the region • Reluctance of some managers to give permission to observe their plants and making excuses • Ignorance of some water treatment plant technicians and accordingly difficulty in gaining the exact information • Discussion all the non conforming situations and keeping anonymity at the same time. • Matching information together i.e. the discrepancies between what some managers said and what actually happens in real life in the water treatment plants.
Document Review	Helping in getting a full picture of the whole process and the management system applied in the TLAs Checking the documents procedures available to public	• Validating and verifying the findings from the other two sources of data collection (i.e. face-to-face interviews and participant observations)	• Obtaining confidential documents and keeping anonymity • Tracing old documents of importance • Tracing unpublished documents with valuable information to research

SOURCE: Author's table

4.6.1 Face-to-Face Interviews

The researcher used the interviewing technique as the main data collection instrument because it yields rich insights into people's experiences, opinions, aspirations, attitudes and feelings (Lindolf, 1995 & May, 1997). Generally there are four types of interviews: 1) the structured interview; 2) the semi-structured interview; 3) the unstructured or focused interview; and 4) the group interview (May, 1997). In accordance with the research requirements, the researcher formed the structured interviews to serve both quantitative and qualitative dimensions that vary from the formal standardized example of surveys (May, 1997). Hence, the researcher created a situation in which respondents (i.e. Water Utilities Managers) are encouraged to answer questions in their own terms. The theory behind this method is that each person is asked the same question in the same way so that any differences between answers are held to be real ones and not the result of the interview situation itself. Hence, the neutrality of the researcher's role is maintained (Dunne, 1995). (Refer to Appendix 9: A Sample Interview with one of the Water Utilities Managers within the Waikato Region) Moreover, the researcher felt more confident with a structured interview format where the questions were written ahead of time in the form of an interview schedule. That allowed the researcher to gain the experience and confidence needed to conduct participant observation and unstructured open ended questions the following year (2001). The following are as some of the objectives of interviewing as mentioned by Thomas Lindolf (1995):

1. Learning about things that cannot be observed directly by other means.
2. Understanding a social actor's perspective.
3. Inferring the communicative properties and processes of interpersonal relationships.
4. Verifying, validating, or commenting on data obtained from other sources.
5. Eliciting the distinctive language – vocabularies, idioms, jargon, and forms of speech – used by social actors in their natural settings.
6. Achieving efficiency in collecting data.

The researcher used the questionnaire as a means of motivating respondents to share their knowledge of the phenomenon under study (drinking water quality) by utilizing the following kind of questions as advocated by Patton (1980 & 1990) to obtain answers relevant to all the sub-research questions.

1. **Experience/behaviour questions:** to elicit descriptions of experiences, behaviours, actions, and activities that would have been observable had the observer been present.
2. **Opinion/value questions:** to find out what people think about the world or about a specific program (i.e. mangers opinion and definition of quality and the relation between their managerial systems and drinking water quality). These questions tell people's (for this research purpose it is the district managers) goals, intentions, desires, and values.
3. **Knowledge questions:** they help find out what a respondent (water utilities District Managers) considers to be factual information (their management systems) regarding the research topic (drinking water quality).

The researcher followed the following steps to reach the final stage of face-to-face interviews with participants in the research. The first step was the exploratory stage where the researcher visited and contacted either by phone or face to face, the nine territorial local authorities in the Waikato Region to find out about the most suitable and knowledgeable candidates in this field for interviewing. Using the information collected, the researcher organised an interviewing schedule containing the names, addresses and phone numbers of the management team to be recruited from the nine territorial local authorities for participation in the research. The researcher then contacted each one of these managers in turn to introduce herself and her research topic before mailing to them a letter outlining the research purpose and objectives and inviting them to participate in the research (Refer to Appendix 7). Upon agreement from the participants, the researcher set timing for meeting and mailed the letter accordingly. Finally the interviewer met with each candidate for face-to-face interviews at the specified time. On the interview day, the participants were given a consent form to sign as a means of agreement to their participation in the research (Refer to Appendix 6). They were also given a copy of the interview questionnaire (Refer to Appendix 8) to enable them to follow with ease while the interviewer was posing the questions to them.

The questionnaire used for the interview was a combination of structured, open ended and closed ended questions. The open-ended questions were conducted so that respondents answer the same questions, thus increasing comparability of responses (May, 1997) and data would be complete for each participant on the topics addressed in the interview. As mentioned by Patton (1990), this technique helps to reduce interviewer effects and bias when several interviewers are used. Moreover, it permits evaluation users to see and review the instrumentation used in the evaluation and facilitates organization and analysis of the data. This part of the questionnaire (i.e. open-ended questions) was conducted for the sake of answering two of the sub-research questions and for the qualitative data analysis i.e. number 1 and 4. (Refer to Table 4.3: How the Sub-Research Questions were answered through the utilisation of two paradigms and mixed methodological methods.)

The closed questions were designed on a five point Likert scale where the response categories were determined in advance. Those questions were conducted for the qualitative part to reply to the other two sub-research questions i.e. number two and three. Although Patton (1990) considers that this method is weak due to the fact that respondents must fit their experiences and feelings into the researcher's categories, the researcher resorted to this techniques as a means of supporting and validating findings from the qualitative part of the research.

The researcher opted to use face-to-face interviews because they offered the possibility of modifying one's line of enquiry, following up interesting responses and investigating underlying motives in a way that postal and other self-administered questionnaires cannot (Robson, 1993). Moreover, non-verbal cues may give messages which help in understanding the verbal response which is of vital important to the analytical technique of thematic analysis used by the researcher.

Although the interviews were tape-recorded, the researcher took notes during the interviews. Patton (1990) noted that the use of tape recording in qualitative methods is important because it helps in increasing the accuracy of data collection and permits the interviewer to be more attentive to the interviewee.

4.6.2 Observation

Observations are another source of data collection utilized in this study. Collecting data through observation is referred to as "participant observation" (Merriam, 1988 and 1998; Dane, 1990; and Fetterman, 1998). Kidder (1981) added that observation is an appropriate research tool when the following components are present: a) observation serves a formulated research purpose, b) observation is planned deliberately, c) observation is recorded systematically, and d) observation is subjected to checks and controls on validity and reliability. The researcher used the observation method when visiting the water treatment plants within the Waikato Region as a means of check and control on the validity and reliability as part of her data triangulation process. It was also used as a means of supporting the answers to the research question by relating the analysis derived from the face-to-face interviews (i.e. what the managers said about their organizations) to the observations conducted (how management really does function and act in the real setting).

Lindlof (1995) defines the process of participant observation as the preferred means of experiencing and recording events in social settings. He states that the process entails being in the presence of others on an ongoing basis and having some status for them as someone who is part of their lives. Becker (1970) expressed his definition by saying:

> *The participant observer gathers data by participating in the daily life of the group or organization he studies. He watches the people he is studying to see what situations they ordinarily meet and how they behave in them. He enters into conversation with some or all of the participants in these situations and discovers their interpretations of the events he has observed* (p.398).

Merriam (1988 & 1998) said that there are good reasons and benefits from gathering data through observation. The researcher, as an outsider, can observe and notice things that have become routine to the participants themselves. The participant observer tends to see things firsthand and to use his/her knowledge and expertise in interpreting what is observed. Selltiz, Jahoda, Deutsch, & Cook (1959) supported the same idea by saying that observation makes it possible to record behaviour as it is happening. (Refer to Appendix 10: Sample of Council A Water Treatment Plant Participant Observation Notes and Appendix 11: Sample of Council G Water Treatment Plant Participant Observation Notes.)

What to observe usually depends on the purpose in conducting the study, its conceptual framework, the problem, or the questions of interest (Merriam, 1988 and 1998; Goetz & LeCompte, 1984). Merriam (1988 & 1998) explained further by saying that as there is a range of structure in interviewing, there is also a range of structure in observation and it all depends on how structured the observer wants to be. The researcher followed the following elements in her observations in accordance with the recommendations of Selltiz, Jahoda, Deutsch, and Cook (1959); Goetz and LeCompte (1984) Patton (1980); Taylor and Bogdan (1984); and Merriam (1988 & 1998). Moreover, the researcher considered those elements serve the purpose of answering her research question:

1. **The Setting:** This element included the physical environment and the kind of behaviour that existed. The researcher's visits to the water treatment plants were to examine the surroundings in which the participants worked.

2. **The Participants:** This element refers to who was in the scene, how many people, their roles, what brought them together and who was allowed there. The researcher watched the participants, established rapport and was able to ask questions to help her understand their reasons for particular actions.

3. **Activities and Interactions:** This element refers to what was going on, if there was a sequence of activities, how did people interact with the activity and with one another and how this was interrelated either from the participants' points of view or the researcher's point of view. That was the most important element of observation to the researcher as she was interested to know about the actual activities taking place in the process of water treatment (i.e. application of TQM tools and conformance verus non-conformance) which was related in the analysis chapter with the results of other data collection tools (i.e. face-to-face-interview and document review).

4. **Frequency and Duration:** This element concentrated on the situation. How did an event or a practice begin? How long did the event or practice last? If it was a recurring type of situation or a unique situation. This element was of use to the

researcher to relate specifically to the answers of the qualitative part of data analysis and how the managers rated themselves in comparison to the real life actions taken by their employees.

5. **Subtle Factors:** This refers to the informal and unplanned activities; symbolic and connotative meanings of words; nonverbal communication such as dress and physical space; unobtrusive measures such as physical clues; and what did not happen especially if it ought to have happened.

The following are the stages the researcher passed through in her process of collecting data through observation as suggested by Merriam (1988 & 1998).

1. **Entry to Field of Research**

   The researcher gained confidence and permission to the field entry through her initial contact (i.e. year 2000) when she was conducting the face to face interviews with the water utilities mangers in the Waikato Region. The researcher contacted a mutual contact person who recommended her to the "gatekeepers". The researcher used this method all the way through from one treatment plant to the other. After gaining the trust and confidence of the workers in the treatment plant, she would ask them for a contact person and then start contacting the person for a new observational visit to another field site. That helped the researcher to gain entry in all field visits conducted.

2. **Data Collection through Observation**

   Once the researcher gained entry into the field, she tried to be passive and unobtrusive to be able to put the staff on site at ease until they got used to her. At first, data collection was secondary to becoming familiar with the surrounding and setting of the water treatment plant through visits and rounds around the place. She tried to be as honest as possible in her notes and simplify the technicality of the water treatment process. The researcher managed to establish rapport with the participants (i.e. technicians working on site) by being friendly, showing interest in their daily activities (e.g. filter cleaning, calibration of equipments) attending coffee breaks with them and even giving a helping hand on occasions. Then the researcher started serious data collection by intense concentration on her observations and note-taking while in the field and then word processing the same day at home while the information and memory was still fresh in her mind. Observational comments helped later in the data analysis stage.

3. **Exiting the Field**

The researcher followed the recommendations of Taylor and Bogdan (1984) to exit the field. They believed that exiting the field could be interpreted by the informal participants as breaking attachments and sometimes even offending by leaving them feeling betrayed and used. Hence, the researcher after her observational visits were coming to a conclusion at each water treatment plant, started gradually cutting down on the frequency of visits and letting people know that the research was coming to an end.

4.6.3 Document Review

Document review was the third data collection technique utilised in this study. As Merriam (1988 and 1998) stated documents refer to written materials in case study research. On the other hand, the term artifact has been used by Goetz and LeCompte (1984, p. 153) as referring to *"the range of written and symbolic records kept by or on participants in a social group."* Selltiz, Jahoda, Deutsch, and Cook (1959) referred to it as available materials or data. They advocated that the researcher may make use of historical documents or journalistic accounts or analyse the records of corporations or already completed studies of other scholars. The researcher has followed their advice in the selection of documents for analysis (e.g. territorial local authorities' reports, research studies of public opinion surveys and Ministry of Health Community Register).

Determining the authenticity and accuracy of documents is an important part of the research process to select the documents to be used in the research (Guba & Lincoln, 1981). The researcher asked the following questions during the phase of collecting documents for analysis to ensure its authenticity:

1. What is the history of the document?
2. How did it come into the researcher's hands?

3. What guarantee is there that it is what it pretends to be?
4. Is the document complete, as originally constructed?
5. Has it been tampered with or edited?
6. If the document is genuine, under what circumstances and for what purposes was it produced?
7. Who was the author?
8. What was the author trying to accomplish? For whom was the document intended?
9. What were the author's information resources? Does the document represent an eyewitness account, a second-hand account, a reconstruction of an event long prior to the writing, or an interpretation?
10. What was the author's bias?
11. To what extent was the author likely to want to tell the truth?
12. Do other documents exist that might shed additional light on the same story, event, project, program, context? If so, are they available, accessible? Who holds them?

The researcher found that the two types of document that could be best used for this research are public records and previous studies.

1. **Public records:** Welsh (1981) described public records as the ongoing, continuing records of a society e.g. census, agency records, program documents, mass media, and government documents. The researcher used a combination of the following documents: a) public documents (i.e. census statistics and council general records); b) archival records (i.e. service records from labs and records of water utilities); and c) administrative documents (i.e. proposals, progress reports and some internal documents from regional and territorial local authorities water utilities). The documents were gathered from the following governmental organizations: The New Zealand Ministry of Health, Environment Waikato, the nine Territorial Local Authorities of the Waikato Region, the University of Waikato Library and the Hamilton City Public Library. The researcher used the above mentioned documents as a substitute for records of activities that the researcher could not observe directly (Stake, 1995).

2. **Previous studies:** Merriam (1988 & 1998) mentioned that the researcher often has to rely on someone else's description and interpretations of data rather than having the rather than having the raw data as a basis for analysis. On the other hand, Murdock, (1974) emphasised that for large-scale or cross cultural research, relying on previous studies may be the only realistic way to conduct the investigation. The researcher chose to use results of existing community surveys conducted by market research companies regarding opinions of the drinking water quality service delivered by territorial local authorities. It would not have been realistic for the researcher to survey all the communities involved.

The documents used in this study are considered secondary material; hence, their analysis is called secondary analysis (Sarantakos, 1996 & Stergios, 1991).

4.7 Data Validity and Reliability

4.7.1 Internal Validity

Internal validity deals with the question of how one's findings match reality. In other words, do the findings capture what is really there (Merriam, 1988)? The researcher used the following strategies to ensure internal validity of this research:

1. **Triangulation:**
   The researcher used multiple sources of data collection (i.e. face-to-face interviews, observation and document review) as mentioned in the previous section (Section 4.4 Methodological Considerations). The researcher also used mixed methods (i.e. quantitative and qualitative analysis) as illustrated earlier to confirm the emerging findings.

2. **Member checks:**

   The researcher took the data (i.e. transcribed interviews) and interpretations back to the interviewees for comment to find out if the interpretations were plausible.

3. **Peer examination:**

   The researcher asked colleagues to comment on findings as they emerged. Furthermore, some of the results were presented at international conferences as a means of getting feedback and obtaining advice about the ongoing research.

4. **Participatory modes of research:**

   The researcher involved the participants (i.e. quality managers and water treatment mangers of the territorial local authorities) in all phases of research from conceptualising the study to writing up the findings.

5. **Researcher bias:**

   The researcher attempted to minimize distortion from her bias through clarifying her assumptions, worldview and theoretical orientation at the outset of the study.

4.7.2 Reliability

It is impossible to have internal validity without reliability; hence, a demonstration of internal validity amounts to a simultaneous demonstration of reliability (Guba & Lincoln, 1981). The researcher used the following techniques to ensure that the results are dependable:

1. **The researcher's position:**

   The researcher explained in the sample selection section (Section 4.5.4 Sample Selection of the Case Studies) the basis or criteria upon which the participants were chosen to participate in this research.

2. **Triangulation:**

   The researcher used multiple methods of data collection and analysis as mentioned previously (Section 4.4 Methodological Considerations). This method was used to strengthen both the reliability and internal validity of the research.

3. **Audit trail:**

   The researcher endeavoured to describe in detail how data were collected, how categories were derived, and how decisions were made throughout all the phases of the research.

4.7.3 External Validity

External validity is concerned with the extent to which the findings of a study can be applied to other situations i.e. how generalizable the results of a research study (Guba and Lincoln, 1981). From this perspective the study has limitations, given that it is focused on a limited set of water utilities.

However, the main purpose of this case study was to reach an in depth understanding of the issue under investigation, the reasons behind it and the factors affecting it. The researcher attempted to strengthen the external validity of the research through conducting cross-case analysis of the nine territorial local authorities of the Waikato Region. The researcher's main goal was not to generalize the knowledge gained from the results but to give more insight on a situation that could be similar to others. Given this approach the analysis provides significant insight into how water utilities managers interpret and practise quality management.

4.8 Data Analysis

As this research is engaged in both data triangulation (the use of a variety of data sources in a study) and methodological triangulation (the use of multiple methods to study a single problem) as illustrated earlier in the previous sections, several data analysis techniques have been utilized. The researcher used qualitative [i.e. thematic analysis for face-to-face interviews (open ended questions) and participant observation; content analysis for document review; and cross case analysis] and quantitative data analysis [statistical analysis for face to face interviews (closed question)]. Moreover, the researcher used for both the qualitative and quantitative analysis manual coding at the initial stage then it was supported by computer softwares for the final stage. For the qualitative data analysis the N5 (NUD*IST) software was utilised, while Excel Spreadsheet (Microsoft Windows Software) was utilised for the quantitative data analysis.

The following Table 4.4 presents a list of similarities and differences of the qualitative and quantitative analysis research methods as a means of explaining their usefulness to answer the sub-research questions of this study. These differences, although derived from the literature should not be overrated. Arguably they are relative rather than absolute.

Table 4.4: List of Relative Similarities and Differences of Qualitative and Quantitative Analysis

Qualitative Research	Quantitative Research
Its purpose is to understand social life.	Its purpose is to explain social life.
Is ideographic – describes reality as it is.	Is nomothetic – interested in establishing law-like statements, causes, consequences etc.
Aims at theory-building.	Aims at theory-testing.
Employs a subjective approach	Employs an objective approach.
Is interpretative – interested in how things happen.	Is etiological – interested in why things happen.
Is historical – interested in real cases.	Is a historical – interested in explanations over space and time.
In open and flexible in all aspects.	Is a closed approach – is strictly planned.
Research process is influenced by the respondent.	Research process is predetermined.
Research is close to the respondent.	Research is distant from respondent.
Uses a dynamic approach.	Uses a static and rigid approach.
Is a flexible process.	Is an inflexible process
Is holistic – studies whole units.	Is particularistic, studies elements, variables.
Employs theoretical sampling.	Employs random sampling.
Places priority in studying similarities.	Places priority on studying difference.
Employs an explicative data analysis.	Employs a reductive data analysis.
Employs low level of measurement	Employs high level of measurement.
Employs an inductive approach.	Employs a deductive approach.

SOURCE: Adapted from Bryman, 1992; March and Stoker, 1995; Flick, 1998; and Black (1999).

4.8.1 Qualitative Data Analysis

The researcher used the interpretivist approach in her qualitative data analysis i.e. human activity was seen as a collection of symbols expressing layers of meaning as mentioned by Miles and Huberman (1994). The research used this approach in analysing the face-to-face structured interviews of the nine territorial local authorities, the observations and in depth interviews with the plant technicians of the water treatment plants and the document review (Wolcott, 1992).

4.8.2 Thematic Analysis

Thematic analysis was used by the researcher to interpret the face-to-face interviews, notes taken during the interviews and transcription of tapes recorded during the face-to-face interviews conducted by the researcher. Owen (1984) and Zorn and Ruccio (1998) note that this method of data analysis allows the researcher to identify themes within individual interviewees' responses, thus preserving individual perspectives, in addition to finding themes common to all or most interviewees. The researcher followed the advice of Leininger (1985), Taylor and Bogdon (1989), and Constas (1992) while searching and identifying themes i.e. there are discrepancies between insider and outsider views in relation to a specific phenomena; hence, explore the underlying philosophies at work (managerial perceptions of quality systems) and how it is observed externally.

The researcher followed the following steps in her analysis:

As previously mentioned, the interviews conducted with the Water Utilities Managers of the nine territorial local authorities were tape recorded and transcribed. The transcriptions were segmented according to the questions presented at the interview i.e. in accordance with question schedule, for each water utility.

Two copies of the interviews transcript were posted to each respondent, the duplicate copy for validation and return. At the time of posting, the researcher telephoned each respondent, explaining the return procedure.

Upon return of validated text the process of analysis proceeded as follows:

1. Two copies of the text to be analysed were made.
2. On a notepad, the sub-research questions were written. Different colour ink was used for each sub-research question.
3. Following Owen's (1984) method of analysing respondents' discourse, the researcher wrote the themes when the following three criteria were present:
   - **Recurrence**: at least two parts of the discourse reflect the same thread of meaning, even though different words are used.
   - **Repetition**: key words, phrases, or sentences are repeated in at least two parts of the discourse.
   - **Forcefulness**: in oral discourse, significant changes in volume (whisper or speaking loudly), inflection, positioning (especially, putting an idea first in a list or explanation), or the use of dramatic pauses or introductory/follow-up phrases that indicate the importance of a segment of discourse.

The researcher underlined answers to the research questions (same colour of ink of the research question) while reading through the text. The same colour of highlighter was used each time the same theme appeared. This process was repeated twice to make sure that all the themes were deducted from the text.

4.8.3 Using N5

N5 was selected to facilitate analysis of the data collected. N5 is the latest version in the NUD*IST software series which stands for Non-numeric, Unstructured, Data Indexing, Searching and Theorising. It works with textual documents, and facilitates the indexing of components of these documents. It is also able to search for words and phrases very quickly and claims to support theorising through enabling the retrieval of indexed text segments, related memos, and test and index searches; and through the construction of a hierarchically structured tree to order index categories (Richards & Richards, 1994; Richards, 1995; Weitzman & Miles, 1995; Qualitative Solutions and Research, 2000).

The researcher found NUD*IST an attractive software due to its capacity to handle large amounts of unstructured text data in diverse ways while allowing users to stay close to the original text documents at all times. On the other hand, Kelle (1997) argues that software programs like NUD*IST are simply tools to mechanise the clerical tasks of ordering and archiving texts used in hermeneutic sciences for hundreds of years and that we should use these programs as software for data administration and archiving rather than as tools for analysis.

The researcher decided upon the use of N5 for the following reasons:

1. Data Management

The N5 Software is designed to help researchers manage data and ideas coming from it. The following Table 4.5 illustrates the research goals and how N5 Software helped.

Table 4.5: N5 Data Management

Research Goals	N5 Tools
Gather, store, explore, and manage small or large quantities of text and other unstructured data.	Document system in which the researcher can define, browse and explore, list and review data documents.
Interpret, abstract, and discover ideas about the data. Gather all material related to a topic by coding. Manage codes and their relation to the data. Store memos about ideas.	Node system for holding ideas. Create, shift, define and order nodes. Code units of documents. View and review everything coded at a category, store and edit memos.
Ask questions, find patterns and develop explanations and theories about the data.	Searching text or coding, point the search just where you want to ask a question. Results are coded, building and testing theories about the data.

SOURCE: Adapted from Qualitative Solutions and Research (N5 Software User Manual), 2000.

2. Storing and Exploring Data

Qualitative data in this research came from many sources (Refer to Sections 4.4 Methodological Considerations and 4.4.1 Why Methodological Triangulation) interviews, filed notes, diaries, and report. The following Table 4.6 shows how N5 is capable of storing such data and making access to them in an easy manner.

Table 4.6: N5 Storing and Exploring Data

Type of Data	How it is Handled in N5
Data in word processor files (e.g. transcripts of unstructured interviews, evidence, historical or literary documents, personnel records, field notes).	Import documents in plain text files, automatically formatted to preferred units for coding and editing. Append other files. Edit, annotate, add or delete units of text. Store headers and information, write memos and edit those as ideas grow. Code on-screen.
Data in other files (e.g. email, web texts, or material copied from other applications).	Copy text and create document from clipboard text. Append text on clipboard to documents in the project.
Text on the computer which is difficult to manage or access, for example, online abstracts of articles.	Create external documents, representing data not on computer. Store headers and information about the data presented. Write memos, (e.g. summaries of the tape, notes on the photos) and edit those as ideas grow. Code by reference to units chosen (page, tape count).

SOURCE: Adapted from Qualitative Solutions and Research (N5 Software User Manual), 2000.

3. Creating and Managing Ideas

N5 is designed to not only code and retrieve document and parts of documents, but also allows reviewing and developing categories and themes. The following Table 4.7 shows those capabilities.

Table 4.7: N5 Interpreting and Coding Data

Interpreting and Coding Data	How it is done in N5
Discover new ideas, build on them, link these with ideas from literature or prior study. Record and build on hunches, guesses, and theories.	Create and define nodes keep them 'free' or order and arrange in 'tree-structured' catalogues. Write a memo on any node. List or selected nodes with descriptions.
Code all the material on a topic. Review and rethink coded data, recoding and developing understanding, refining dimensions of concepts.	Code documents at new existing nodes. Browse all the text at a node, and re-code, or refine the coding. View material in context, jump to source.
Develop ideas flexibility, altering, merging and shifting the categories, as the story of the project becomes clearer.	Build an index system of nodes, ordering them logically, combining and collapsing categories, re-coding documents – without losing any coding.

SOURCE: Adapted from Qualitative Solutions and Research (N5 Software User Manual), 2000.

4. Searching Documents and Ideas

Making the results of an inquiry available for further inquiry and supporting the construction of new ideas from combinations of old are essential features of both qualitative methodology and N5 (Qualitative Solutions and Research, 2000). The following Table 4.8 shows how N5 is designed to integrate searching and build on searches to bring the emerging understanding into the project.

Table 4.8: N5 Searching Documents and Ideas

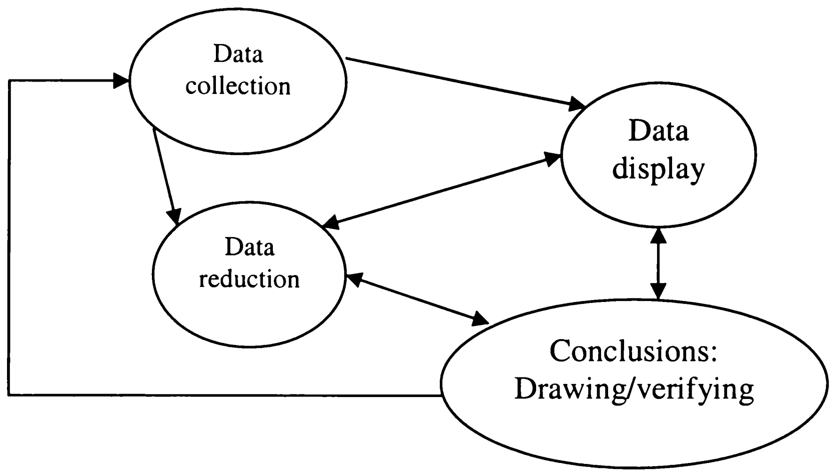
Questions Asked by the Researcher	How Use of N5 Can Offer Answers
Where is this word used, this person mentioned, this keyword inserted – and what is the context?	Text Search searches the document's test for occurrences of words or strings of characters. Restrict searches to particular text or documents.
How do topics and categories relate to each other? (Where do these topics occur together, and can we understand their relations?)	Node search (index search) searches the patterns in your coding of data. Restrict searches to particular test or documents.
How does the researcher's discovery in the data relate to some other aspect of it? How to build question on the answer?	Results are coded: browse and report. See finds in required context. Save finds for more questions.
Is there a statistical association here?	Export coding patterns to any software for statistical analysis.

SOURCE: Adapted from Qualitative Solutions and Research (N5 Software User Manual), 2000.

4.8.4 Interactive Analysis

The researcher used the "Interactive Model" (Refer to Figure 4.2: Interactive Model for Data Analysis) advocated by Miles and Huberman (1994) for the document review content data analysis.

Figure 4.2: Interactive Model for Data Analysis



SOURCE: Miles and Huberman, 1994, p.12

Miles and Huberman's Interactive Model

Miles and Huberman's (1994) Interactive Model consists of the following stages:

1. **Data Reduction**

   This stage is also called "data condensation" by Tesch (1990). It refers to the process of simplifying, abstracting and transforming the data collected (i.e. public documents and previous studies related to the research topic). Data reduction is considered part of the analysis process. Miles and Huberman emphasise that it is a form of analysis that sharpens, sorts, focuses, discards, and organizes data in a way that final conclusions can be drawn and verified.

2. **Data Display**

   This stage refers to the organized and compressed information that permits conclusion drawing and action. Miles and Huberman explain that the most frequent display used to be in text format which makes it difficult to withdraw information and conclusions from it. The reason they gave was that humans are not very powerful in processing large amounts of information. Accordingly, the researcher followed Miles and Huberman's advice (1994) by reducing complex information into selective and simplified gestalts by using different types of matrices, graphs, charts.

That technique helped the researcher to organise her data in a more accessible, compact for which helped in the final analysis stage i.e. draw justified conclusions. It also aided in the researcher's cross case analysis.

3. **Conclusion Drawing and Verification**

This is the third stage undertaken by the researcher in the analysis to reach a conclusion and verify it. In actuality, this stage begins with the start of data collection when the researcher is thinking continuously about the meaning of things by noting regularities, patterns, explanations, possible configurations, causal flows and common themes. Nevertheless, final conclusions do not appear until data collection and analysis is complete. Conclusions are verified by the researcher by constant return and comparison between the document review analysis and the other results of thematic analysis and statistical analysis.

4.8.5 Quantitative Data Analysis

The researcher used the positivist approach in her quantitative data analysis i.e. research is a tool for studying social events, and learning about them and their interconnections so that general causal laws can be discovered, explained and documented. According to this approach, knowledge of events and social laws allows society to control events and to predict their occurrence (Sarantakos, 1996). The researcher relied mainly on the quantitative analysis of the data obtained from the closed questions section of the face-to-face interview questionnaires of the nine territorial local authorities. The results of this statistical analysis (i.e. the water utility managers' scores) were then compared with the findings from the observations and in depth interviews conducted with the plant technicians of the water treatment plants (i.e. the practical part of what actually happens) and the document review (other research conducted stating the results of public opinion on services provided by the councils and the Ministry of Health Water grading of those specific territorial local authorities).

4.8.5.1 Statistical Analysis

As the general purpose of quantitative data analysis is summarising and relating data, the researcher followed the following steps advocated by Sarantakos (1996):

1. **Data Preparation:**

   This is the first step taken to prepare the data collected for the quantitative analysis so that it can be done manually (i.e. using manual calculator) or electronically (i.e. using computer). In the case of this study, clarifying the collected data and allowing analysis and interpretation is done through data preparation and reduction. In other words, translation of the collected information into a form that can be further manipulated by the analyst and/or computer, which leads us to the next step i.e. coding.

2. **Data Coding:**

   Coding is the process in which statements and answers are translated into numbers. This helps in facilitating reduction, analysis, storage and dissemination of the data. In this study the values of 0, 1, 2, 3 and 4 were given to the Likert scale response categories for the close-ended questions. These values were manipulated when data was reduced and analysed. The data was analysed where 0 was the lowest score and 4 the highest score.

3. **Editing and Checking Data:**

   The researcher made sure that the standard of information appearing on the face-to-face interview questionnaire was clear, legible, relevant, and appropriate to the research subject. Hence, reliability (i.e. that the coder maintains a stable and uniform pattern of coding and that variability in coding is avoided) of the coder (i.e. the researcher) and validity of data coding were given high priority by the researcher who coded the data herself for the sake of consistency.

4. **Feeding the Computer:**

   After data was coded (i.e. all responses were given numerical codes), it was fed to the computer for further processing and analysis. This was done through the help of Excel spread sheet program. According to the questions there were eight quality management variables that occupied one column across the nine territorial local authorities.

5. **Storing Data:**

This step refers to the data storage on computer disks where they can be kept there for a long period of time. For the sake of safety reasons, the researcher made sure to have data stored in a duplicate form (hard disk of computer at university, hard disk of personal computer at home and computer disks as back up) to ensure that information would not be lost if a disk was erased, broken or damaged.

6. **Counting Data for Final Results:**

This process refers to electronic analysis employed by the computer which depends on the instructions given to the computer such as grouping, relating and testing. The characteristic of this approach is that instruments, including the answers of each respondent, are studied separately, so that the researcher can observe the total response of the subject, and can make judgement about the position of the subject in the context of the research issue. The researcher in this study calculated all the scores of the eight quality management criteria under study (i.e. variables) for each water utility. Then all the means of variables across the councils were calculated to reach final results that helped in answering sub-research questions three (Refer to Section 4.6 Data Collection, Table 4.3 How the Sub-Research Questions Were Answered Through the Utilisation of Two Paradigms and Mixed Methodological Methods).

4.8.6 Combining Qualitative and Quantitative Analysis

4.8.6.1 Cross Case Analysis

One of the main aims of conducting cross case analysis was mentioned by Miles and Huberman (1994) to enhance generalizability. On the other hand, Denzin (1983) and Guba and Lincoln (1981) argued against that goal by saying that it is not appropriate for qualitative studies. Nevertheless, Firestone and Herriot (1983) supported this goal with their term "radical particularism" in which they illustrate that cross case analysis helps researchers to know the relevance or applicability of their findings to other similar settings.

Miles and Huberman (1994) further state that cross case analysis deepens understanding and explanation of cases. Glaser and Strauss (1967 & 1970) stress the importance of cross case analysis as a means of helping the researcher calculate when a given order of events or incidents are likely to occur or not to occur. They state that it also helps the researcher to built similarities and difference across the different cases, which helps later on in strengthening the theory.

The researcher used mixed strategies in the cross case analysis. She started with "Case-oriented strategies (Yin, 1984) where Yin advocates a replication strategy. In other words study one case in depth, then successive cases are examined to see whether the pattern found matches that in previous cases. The researcher also used "Variable-oriented strategies as advocated by Pearsol (April, 1985) by locating recurring themes across the nine cases she is studying. Finally the researcher used the "stacking comparable cases strategy mentioned by Miles and Huberman (1994) by writing up the nine case studies using a standard set of variables/categories. The researcher then used matrices and diagrams to analyse each case in depth. After each case was well understood, she stacked the case level displays in a meta-matrix, which helped condensing, and permitting systematic comparison across the nine cases.

4.9 Limitations of Study

The following are the limitations of the study:

- The initial informal interviews conducted with the regional council and district councils within the Waikato Region were not documented in detail. Hence, the researcher depended mostly on the formal face-to-face interviews conducted with water utilities management in the year 2000 and the participant observation to the water treatment plants conducted on 2001/2002.

- Participant Observations were conducted with only three case studies of the total nine case studies. The reason behind that is the large number of water treatment plants under the jurisdiction of the different territorial local authorities. The number varied between four to nine water treatment plants.

- Document Review was limited to the main documents that could help the research directly (i.e. Ministry of Health Documents, Environment Waikato Documents, Water Utilities Annual Plans and Strategic Plans and Community Surveys). Refer to Section 4.6.3 Document Review for further details.

- Only three quality management gurus were chosen in the literature review of this thesis. The researcher chose those three only (although there are several others in the field) so as to be more focused and to limit the expansion of the thesis.

- The research did not include detailed explanation of the water treatment process, the chemicals used in treating the drinking water, and the percentages set by the Ministry of Health in cases of non-conformance due to its complexity and requirement of going into further scientific explanations which is not the main target of this research at this point (i.e. the research is investigating the managerial systems and the scientific conformance).

4.10 Conclusion

This chapter communicated the paradigms and mixed methodological approaches upon which this study is based. It served as an explanation of the methods utilised to enable the researcher to answer the four sub-research questions through both qualitative and quantitative data collection and data analysis. This chapter also sets the ground rules that guided the field work of this research in order to obtain clear and deep insight into the quality management systems that are being used and adopted by the water utilities in the Waikato Region of New Zealand.

CHAPTER FIVE:
FINDINGS AND DISCUSSION OF INDIVIDUAL CASES

5.1 Introduction

This chapter reports how triangulation has been employed in the analysis of the nine Waikato Region Case Studies. This is the application of the mixed methods. First the chapter explains the methods used in analysing each case and the general framework of themes employed. It then presents the analysis and findings of each case study in accordance with those themes. Finally, it ends with a summary and conclusion.

The information in the case studies presented in this chapter is derived from the main data collection methods applied in this research i.e. face-to-face interviews with the members of the management teams at the Waikato Region territorial local authorities, observations conducted at the water treatment plants, and documents obtained from the territorial local authorities and the Ministry of Health. Furthermore, the researcher contacted the councils within the Waikato Region again in August and September 2002 to check and update data where necessary. Statements from the members of the management teams expressing their opinions or from other employees at the council are italicized. Furthermore, all councils are reported anonymously as per the research method approved by Waikato Management School Ethics Committee and participating councils.

5.2 Qualitative Analysis Method

Two methods of qualitative analysis were conducted in this research. The first method was manual coding as per the Miles and Huberman Interactive Model (1994) (Refer to Chapter 4, Section 4.8.4) and then computerised coding through N5 computer software (Refer to Chapter 4, Section: 4.8.3) as the second method of analysis. The following steps were undertaken:

Step 1:Transcription

The first step of analysis was transcribing the data (i.e. face-to-face-interviews or field observation notes) from the original forms (i.e. the tapes and field notes) onto the computer. Following this, the researcher 'cleaned' and edited the manuscripts by eliminating typographical errors and other errors in the text like inappropriate sentence structures and grammar.

Step 2:Exporting data to N5

The documents were prepared in a specific format to be exported to the computer software N5 for coding and analysis.

Step 3:Individual Analysis

The analysis of the individual transcripts, integration and evaluation of the information was undertaken following the thematic analysis approach (Refer to Chapter 4, Section: 4.8.2 Thematic Analysis).

Step 4: Coding

The researcher followed the Strauss and Corbin (1990) approach of three forms of coding (open coding, axial coding and selective coding) to fit the framework of the research themes.

Open Coding

The researcher first began by studying the data and assigning codes for them using the "free nodes" facility in N5 (computer software). At this stage, the researcher coded words, lines and paragraphs by giving them certain names. During this stage, the researcher managed to condense data into categories and certain themes started coming to the surface. The researcher still considered that the work needed more refinement and modification which led to the second stage of coding.

Axial Coding

At this stage the coding was conducted on a higher level since there was sufficient information to work on. In other words, the initial codes were studied and the axis of key concepts were identified. The researcher then discovered interrelationships in the form of causes and consequences, underlying patterns of interaction, strategies, categories and concepts clustered together in which she managed to develop the dimensions of categories and subcategories. Clear concepts became evident. Concepts and themes were tested through empirical evidence, and major themes were identified.

Selective Coding

At this stage, focus was directed towards the discovered themes to be checked by comparing them with others. Finally, major themes were expanded in the context of the whole study, as such themes gradually became evident.

5.3 Qualitative Themes

As a result of the initial data analysis conducted through the three steps of coding (the open coding, the axial coding and the selective coding) the following themes were used in further analysis of the nine case studies.

1. **Deductive Themes**

   These themes were mainly identified from the literature review i.e. TQM Guru Teachings. The results reported here are for both the face-to-face interviews and participant observations.

   1. Quality Definition
   2. Innovativeness
   3. Teamwork
   4. Responding to Opportunity
   5. Common Vision
   6. Expertise
   7. Leadership

2. **Inductive Themes**

   Those are the Eureka themes i.e. results of investigations. They are the surprises that came out of the data analysis of both face-to-face interviews and observations.

   1. Organisational Attitudes and Goals
   2. Organisational Forms and Activities
   3. External Factors
   4. Human Resources
   5. Technology
   6. Cost
   7. Problems

5.4 Quantitative Variables

The following are the variables used in the quantitative analysis of this research. The findings concerning these variables will be compared with qualitative data results of both the face-to-face interviews and the participant observations to ensure the reliability and validity of the research.

1. Training
2. Customer Satisfaction
3. Purchasing Equipment/Chemicals
4. Process Control
5. Inspection and Testing
6. Calibration
7. Corrective/preventive action
8. Control of Quality Records

The following Table 5.1 sums up the sources of information (i.e. data collection methods) across all the nine Territorial Local Authorities (TLAs) and how they were employed to serve the mixed method analysis (i.e. triangulation) (Refer to Chapter 4, Section: 4.4 Methodological Considerations).

Table 5.1 **Data Type, Themes, and Data Analysis Correlation Across the Nine TLAs**

Data Type	Theme Served	Type of Analysis
Face-to-face Interviews (semi-structured open ended questions)	• Deductive Themes • Inductive Themes	Qualitative Analysis
Face-to-face Interviews (structured likert scale questions)	• Eight Quality Variables/Criteria	Quantitative Analysis
*Participant Observations	• Deductive Themes • Inductive Themes	Qualitative Analysis
Participant Observations	• Eight Quality Variables/Criteria	Quantitative Analysis
Document Review	• Deductive Themes (partial) • Inductive Themes • Eight Quality Variables/Criteria	Qualitative Analysis

*** Participant Observations were conducted only in 3 TLAs (i.e. TLA 'A', 'G', and 'H'.**

SOURCE: Author's Table

5.5 Case Study 1 (TLA 'A')

This TLA serves a population of 120,000. Five managers were interviewed from this TLA. Although the Works and Services Group is serving different communities, it operates one standardised water supply system. It was the first TLA in the region to adopt quality management systems and use TQM improvement techniques and tools. It has been ISO 9002 certified for 5 years, and since March 2000, has been ISO 9001 certified (Refer to Chapter 3, Section: 3.4.1 ISO 9000 Series Standards). The TLA is working towards incorporating the elements of the National Business Excellence Award (Refer to Chapter 3, Section: 3.4.3.1 The New Zealand Quality Award). Participant observations were conducted in this council in July-August 2001. Sporadic visits were paid to the water treatment plant until the end of the 2001 year. The water treatment plant was visited again in January/February 2002 to check on a few issues in relation to participant observations.

5.5.1 Deductive Themes

These themes were identified from the literature review i.e. TQM Guru Teachings and then compared with the answers of the water utilities managers to find out their perceptions in relation to their managerial systems. Moreover, they were also compared against the participant observation notes to validate and support the theoretical findings with operational practice actually taking place in the water treatment plants.

1. **Quality Definition**

   In theory and practice, both managers and technicians believe in quality of service and compliance to the New Zealand Drinking Water Standards to minimise health risk. They also believe in customer satisfaction. The following are some of the quotations taken from the data:

   Quality is about consistency and getting things right the first time.
   Quality is providing a product up to a specific standard.
   Quality is fitness of service.

2. **Innovativeness**

   The utility is adopting a strategy of continual change to improve the process of water treatment to reach the best results. This has been mentioned by the management team while being interviewed and then confirmed through participant observation that was conducted in the water treatment plant.

For example the utility built a new water reservoir (i.e. clear water storage tank) with capacity of 5 million litres of water. The water reservoir was complete and ready for use by January 2002. The aim of building this tank was to increase the chlorine contact time, to abide by the regulations of the NZ Drinking Water Standards and also to improve the taste of water before it reaches the consumer (i.e. the community). This is a sign of the council striving for continual improvement and for using the quality feedback loop by asking for customers' feedback, then improving accordingly.

Another example is that this utility is the first one in the region to work towards the "National Business Excellence Award" accreditation as a whole corporation.

3. Teamwork

A good communication system between the employees was seen as door to a good working environment with all information shared and jobs done in a timely fashion. This aspect has been stated by the management team and verified by both participant observation and documentation (i.e. interdepartmental memos and circulars) through the following examples.

Every Tuesday morning from 8:30 to 9:30 there is a team meeting of all employees in the water treatment plant with the Plant Manager. The main aim of these regular weekly meetings is to give information to the employees about what is going on in the council and discuss safety issues in the plant (e.g. first aid training course, BA Training (Breathing Apparatus). They get such training approximately every 2 years paid by the council for the safety of its employees.

The Plant Technicians (there are always 3 on roster) usually make rounds and have a look at both the filters and sedimentation tanks daily and they decide then concerning the sedimentation tanks as to when they need cleaning. This is one example that has been observed illustrating how the technicians work as a team to deliver a quality job.

There is a good channel of communication between both the management and the staff which has been verified through observation and document review. It can be through memos or circular on notice boards and also through a log book where the staff members leave important information for each other to inform the other staff member of an incident that happened while they were not on shift roster. That helps the whole group to work as a team.

4. Responding to Opportunity

TLA 'A' took the opportunity to be the first in the Region to be ISO 9000 Certified and keep a good reputation that made it earn customers' trust. The following is a quotation of how management had an opportunity and took it:

> *As part of the group we want to achieve a certain benchmark that we can relate to and we obviously picked an international standard. This is how we started at the Works and Services Group and bearing in mind that we are in a monopoly situation therefore we want to prove to the customers our national grade is up to a certain standard, certainly our work, the way we do things is up to a certain standard and that we are trying to provide service to a certain consistent standard.*

5. Common Vision

TLA A's vision is in line with its employees' and customers' expectations. An evidence of such an attitude is the utility requesting regular feedback from the customers to keep in line with their requirements and expectations. The quality system is adopted in the whole organisation through the support of the CEO. The following is how they stated their vision:

> *I believe it is essential to have the staff and management all as one team. Now that everything is in place we have SOPs (Standard Operating Procedures), check lists and we do regular reviews to make sure that they are up to date.*

6. Expertise

The ability of the TLA 'A' employees to react professionally in a crisis has been noticed through observations. A good example was during the phase of working on the new water reservoir. The Plant Manager called for a meeting with all the plant technicians to discuss the shut down of the plant on the next day. He wanted to plan ahead since the plant pumps were not going to be functioning for approximately 6 hours. He wanted to give instructions to prepare for that shut down e.g. all filters need to be washed in preparation for the next day and another water reservoir has to be totally full to cover the city's water demand while the plant was shut down.

7. **Leadership**

TLA 'A' is taking positive action to facilitate organisational change by adopting the teaching of the Total Quality Management Gurus as stated by the management team and the knowledge of general staff of the importance of quality management in their field of work and service they provide to the community.

Moreover, management is keen on employees views of their own performance e.g. conducting regular surveys (i.e. Climate Survey) asking their employees on their views and how to improve their performance within the system.

5.5.2 Inductive Themes

These are the Eureka themes i.e. results of investigations. They are the surprises that came out of the data analysis of both face-to-face interviews and observations.

1. **Organisational Attitudes and Goals**

Quality improvement is initiated on an informal basis through weekly meetings where they discuss problems and try to come to a solution as a group. It happens through group discussions and brainstorming by people who are affected by the procedure and who require the improvement. Quite often this procedure is not documented as mentioned by management and general staff.

> *We have some traditional techniques e.g. fishbone charts, the five petal process (it's just a terminology adopted within council) it's a technique where we have to consider five elements when we are considering quality improvement initiatives. We have a lot of team meetings where we talk about quality systems where we use OFI Forms (Opportunity for Improvement Forms) that we use when we need to adopt a change in relation to quality.*

2. Organisational Forms and Activities

TLA 'A' has a system for communication between the water treatment plant and its head office in order to keep the information up to date in relation to the demand and consumption of water. That system helps in informing the management of the needs of the plant and the customers to be able to cater for the public's need in relation to water. One of the highlights of that is the construction of the new water tank to accommodate the increase in water demand by the public. Also, the way documents are kept and shared shows that there is good storage and ease of retrieval of documents and there is continual updating of the latest changes. This has been verified through participant observation.

TLA 'A' is aspiring to continual improvement through applying the quality management system. In 2000, it adopted a new system to check water quality at each stage of the treatment process i.e. installing meters for filtered water, settled water, and the final stage of treated water before it leaves the clear water tank to the city. Previously TLA 'A' used to have one meter for the whole water treatment plant. This has been mentioned by council employees and verified by actual viewing of meters on site.

3. External Factors

The customer has one of the biggest impacts on the quality of water they receive as mentioned by one of TLA A's management team. The following are some of the issues that have an impact on water quality:

- Customers' plumbing systems within their houses vary.
- Customers may have left hoses connected which results into a backflow in the main system
- Customers may have recently purchased new dishwashers or washing machines where the hoses are left connected to the taps. This impacts on the taste of water.
- Customers may have installed an irrigation system in their yards that is left connected to a tap which backflows in their main system.

- Some old houses have got lead or copper high zinc components in the welding used in some of the joints in the houses.
- The depth that the water pipe is buried when it is installed in the properties varies.
- Some customers use water filters and do not change the element filaments often enough which leads to bacterial growth. The water may taste odd.
- Kitchen taps, where bacteria may flourish in the wire gauze really impacts on the taste and quality of water.

4. Human Resources

The number of employees working in TLA A's water treatment plant is nine: the Operations Manager, 3 plant technicians, 2 maintenance technicians and 3 plant attendants. The plant technicians work 8 hours daily on a roster basis that is updated every three months. After 5:00 p.m. the plant is run automatically through a special computer program attached to a pager system accessed by one plant technician on call in case a problem arises.

It seems that the utility managers are keen on their employees' opinions about them as leaders and managers. For example when the results of the "Climate Survey" were not satisfactory, the head of the section took the time to meet with the employees to have feedback and to try to find out the reasons behind the low rating, and to improve their techniques as managers.

This issue is in accordance with TQM and ISO certification requirements in relation to the effect of leadership in running an organisation towards a total quality integrated system.

5. Technology

Although the water treatment plant in TLA 'A' is mostly computerised, there are some maintenance and quality assurance jobs that have to be done manually by the plant technicians e.g. cleaning of sedimentation tanks.

On the other hand, filter cleaning is done through the computer with a click of a button. The filters are cleaned every 45 – 60 hours when the computer screen alerts the technician on duty of the filter that needs to be cleaned. The technician immediately goes to the required page and clicks the right button which enables the process of washing to start in the automatic mode.

It has been noticed through the participant observations that there are rules governing every action taking place in the plant. Employees are well-informed of those rules and regulations and were seen to be abiding by them. That supports the idea that although everything is computerised, the human element is also important i.e. well trained and knowledgeable operators of the system. The emphasis the TQM Guru teachings place on the importance of training the employees on processes would appear to be taking place.

6. **Cost**

TLA 'A' management considers cost plays a great role in their decisions related not only to running their units but also in purchasing equipments and chemicals for the water treatment plants.

> *Cost, is important, but not the main criteria. Quality is the main important criteria. The cost is important because you have to spread the cost out over the life of the product. So if something costs twice as much, but will last 3 times as long, then it is actually cheaper.*

7. **Problems**

Since TLA A's water treatment plant is mostly computerised and uses the latest technology, sometimes malfunctioning of the computer programs can happen as observed during the participant observation period. Sometimes the program doesn't function properly and requires attendance from outside engineers. That may result in delay of work. It has been noticed that technicians know their process quite well and tend to do it in a timely manner that has minimal effect on the flow of work.

5.5.3 Quantitative Variables

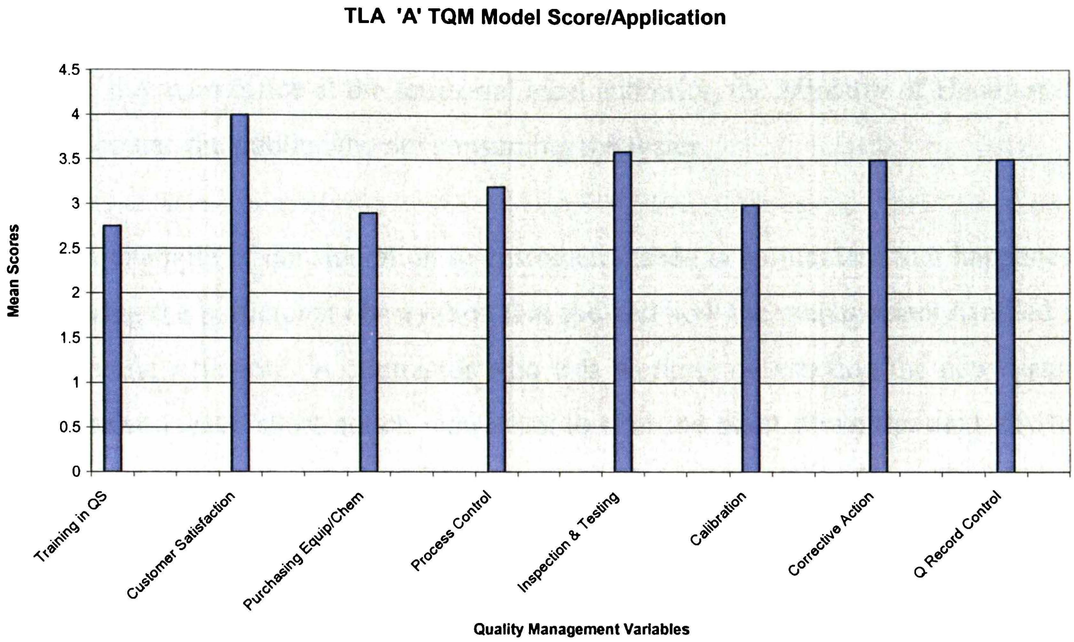
This part of the analysis is dealing with the structured part of the face to face interviews. The questions related to the following quality management variables (i.e.

TQM Model) were coded and analysed on an Excel spread sheet to get the mean of each variables of the personal assessment tool of TLA 'A'. These findings were compared with qualitative data results of both the face-to-face interviews and the participant observations as a support for the reliability and validity of the research.

- ***Training personnel in Quality Systems***
  - Money allocation
  - Courses funded
  - Frequency of training
- ***Customer satisfaction with water***
  - Review of customer requirements
- ***Purchasing equipment/chemicals***
  - Quality criteria for selecting suppliers/subcontractors
  - Monitoring of suppliers/subcontractors
- ***Process Control***
  - Procedures relating to water treatment plant
- ***Inspection and Testing***
  - Phases of monitoring by qualified personnel
- ***Calibration***
  - Frequency of accuracy of equipment
- ***Corrective/preventive action – drinking water below standard***
  - Accuracy of investigation
  - Effectiveness of corrective action
- ***Control of Quality Records***
  - Quality monitoring records
  - Ease of retrieval of information
  - Retention of records

The data was analysed where 0 was the lowest score and 4 the highest score. The following Figure 5.1 shows the mean score across all eight variables on a 5 point likert scale. It is worth mentioning here that although the analysis for this model was formulated by the researcher, the outcome is according to how the utility management scored itself in relation to the TQM Model.

Figure 5.1: **TLA 'A': Average Mean of all Quality Variables**



SOURCE: Author's Figure (El-Kafafi and Scrimgeour, 2002 and El-Kafafi, 2002a and 2002b).

According to this analysis, "customer satisfaction" scored the highest (i.e. 4) while "training in quality systems" scored the lowest (i.e. 2.75).

The following are the findings after comparison with data from both the face-to-face interviews and observations used in the qualitative analysis of this research.

1. **Training (Score: 2.75)**

   It seems that TLA 'A' is keen on the safety of its employees and on their training to issues not only related to work but also safety [e.g. first aid training course and BA Training (Breathing Apparatus)]. This is in line of with the TQM "continual improvement" approach in the workplace. This was also verified through management who stated that:

   > *We do have discussions and PPR Forms i.e. Performance Planning & Review. We do those every six months. We also do set goals by checking what has been done through those six months and from there arises any concerns regarding capability of doing a certain job or any training they need.*

2. **Customer Satisfaction (Score: 4.0)**

   The whole organisation (i.e. TLA 'A') is driven by customer satisfaction as stated by the management team and verified by both participant observation and document review (i.e. regular customer surveys conducted through commissioned market research companies). The management team stated that the water treatment plant in this utility has several customer types to satisfy i.e. the main office at the territorial local authority, the Ministry of Health and of course the public who are consuming the water.

An example of consideration to customers needs is an incident that happened during the participant observation that showed how the management handled a specific situation. A contractor who was working on erecting the new water reservoir gave short notice requesting to shut the plant down the next day to conduct work on the low lift and high lift pumps. The Plant Operations Manager called for an urgent meeting to prepare the staff and plan in order things would run smoothly in the plant and the community would have their regular requirements of water.

That incident shows that the management is considering the customer requirements and needs i.e. water supply to city. Also, there is some sort of design and planning ahead of time. Although this is a short notice due to the contractor who didn't inform the operations management with ample time, the situation was taken well care of by acting immediately and preparing the plan for the shut down.

3. Purchasing Equipment/Chemicals (Score: 2.9)

Price plays a substantive role in managerial decisions as stated by both management and employees.

4. Process Control (Score: 3.2)

The process is continually controlled by water treatment technicians during regular working hours as per participant observations. After hours it is on automatic mode that is connected to a pager system to enable technicians to be contacted immediately in case of problems. Some of those cases were documented in the participant observation notes as told by technicians the next morning of the incident.

5. Inspection and Testing (Score: 3.6)

During the week, the lab tests are done daily from 7:30 a.m. to 10:30 a.m. On Tuesdays and Fridays, the lab tests are carried out by a laboratory technician from the Waste Water Treatment Plant. The rest of the week, the tests are done by the plant technicians from the drinking water treatment plant (there are 3 technicians on roster). On week-ends, it is usually done by the person who is on duty in the week-end. This has been verified by the participant observation.

In accordance with the participant observations, since the beginning of the year 2002, all sedimentation tanks were cleaned and the raw water channels were cleaned. This shows regular maintenance and compliance to specifications in accordance with the NZ Drinking Water Standards.

6. Calibration (Score: 3.0)

It is practised regularly according to a set schedule that is always documented in a specific log book kept for each and every piece of equipment that has been noticed during the participant observation. It is done by the water treatment plant technician who happens to be on duty according to their 3 monthly rosters. The technicians usually calibrate according to procedures related to each equipment that they pull out of their quality manual and follow all steps accordingly.

In the case of sedimentation tank maintenance, it has been noticed that there is no log book for this manual process because the technicians have daily rounds to check the tanks to if they need cleaning.

7. Corrective/preventive action (Score: 3.5)

The TLA endeavours to use the quality tools to find out the main source of the problem as mentioned by the management team. This helps in tailoring corrective action that also helps preventing the recurrence of the same problem in the future.

8. Control of Quality Records (Score: 3.5)

Employees abide by filling in all the required forms to document all steps of all processes taking place in the water treatment plant as mentioned by management and viewed by participant observation. The whole system is computerised for easy access and retrieval of information. It has been noticed through participant observations that technicians are even documenting actions and movements in a daily log book to share information among each other.

Management stated that there is an internal auditing system in the water treatment plant to check regularly on calibration log books since they are written manually and not computerised.

There is a weekly trends report (i.e. the turbidity, system pressures, systems levels, reservoir residuals, reservoir levels) that is printed from the water treatment plant computer at 8:00 a.m. and sent to the TLA's main office. The aim of this report is to keep the main office in line with all the movements happening in the plant. This has been verified through participant observations.

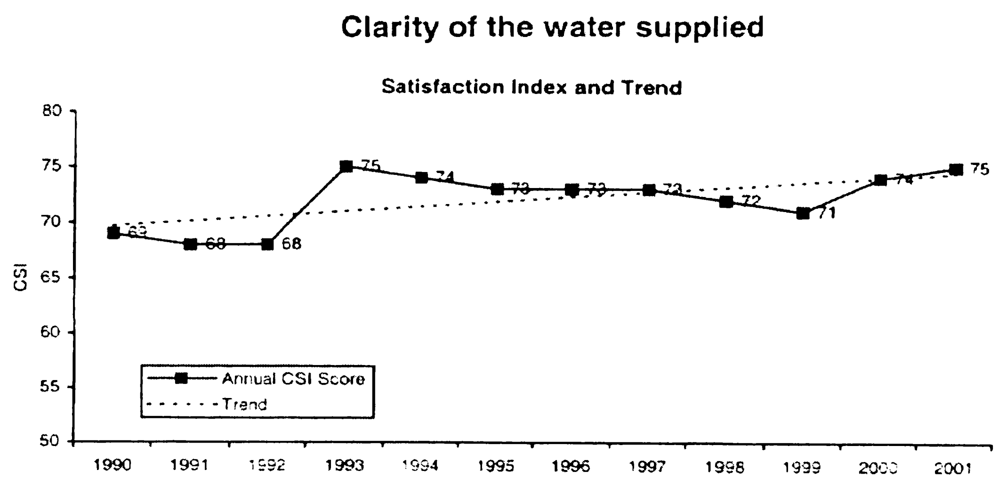
5.5.4 Document Review

This TLA, besides adopting quality systems, is abiding by the New Zealand Drinking Water Standards as mentioned in the data analysis. The water grading for TLA 'A' is "A" "a".

This TLA pursues continual improvement through the use of the "Quality Feedback Loop". It conducts regular surveys to obtain feedback from its customers to help find the points that require strengthening. The following figures 5.2, 5.3, 5.4, and 5.5 sums up the customers' surveys conducted from 1990 until 2001. The four figures shows that there is a slight trend of increased satisfaction over the twelve years. These surveys also capture respondent comments. The following are illustrative descriptions and comments from the community that lie behind the poor rating for the clarity of water. Those comments are excerpts from the 2002 Customer Surveys conducted by a market research company and commissioned by TLA 'A' (Refer to Chapter 4, Section: 4.5.8 Anonymity and Confidentiality).

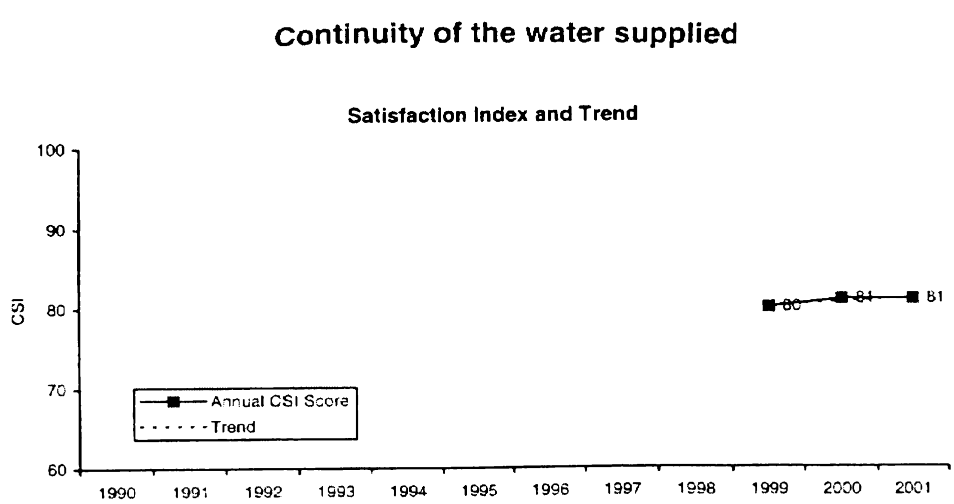
> *I can see organic pieces of stuff when I hold it up to a light.*
> *Sometimes it has got things floating in it.*
> *It's got too much chlorine in it.*
> *We had black gunk in the water recently when the pipes were being flushed.*

Figure 5.2: Water Clarity Satisfaction Trend (1990-2001)



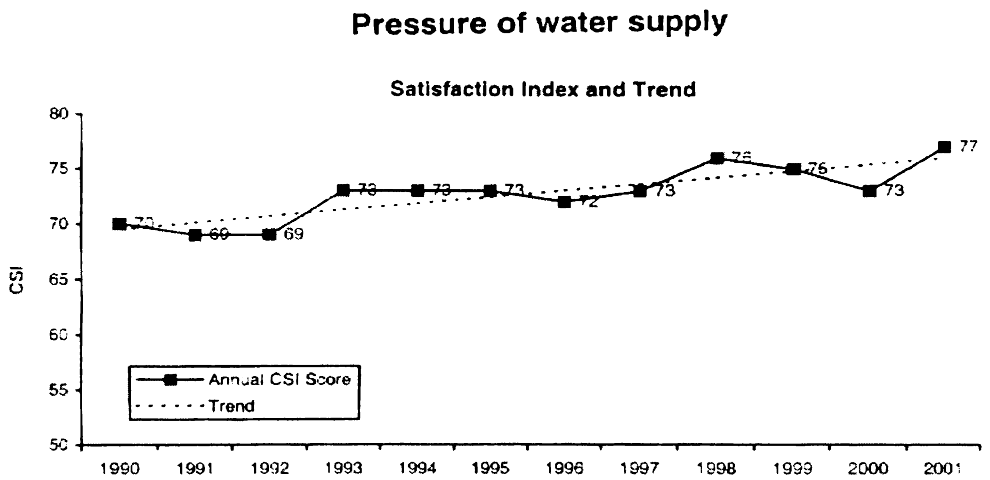
SOURCE: TLA 'A' Customer Survey, 2002. and El-Kafafi and Scrimgeour, 2002.

Figure 5.3: Water Continuity Satisfaction Trend (1990-2001)



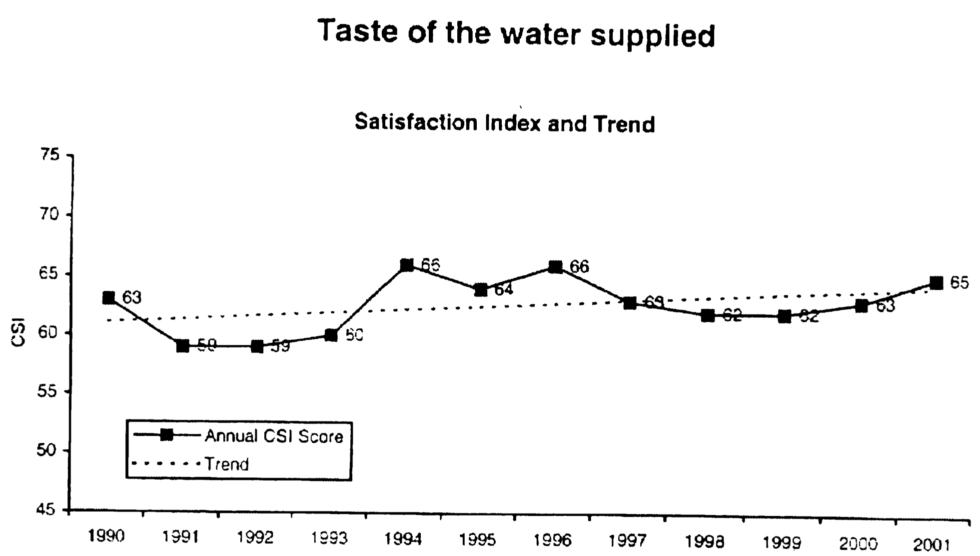
SOURCE: TLA 'A' Customer Survey, 2002 and El-Kafafi and Scrimgeour, 2002.

Figure 5.4: Water Pressure Satisfaction Trend (1990-2001)



SOURCE: TLA 'A' Customer Survey, 2002 and El-Kafafi and Scrimgeour, 2002.

Figure 5.5: Water Taste Satisfaction Trend (1990-2001)



SOURCE: TLA 'A' Customer Survey, 2002 and El-Kafafi and Scrimgeour, 2002.

5.5.5 Summary and Conclusion

TLA 'A' abided by the New Zealand Drinking Water Standards (NZWS) from 1995 until 2001 and when it adopted the NZWS 2000. TLA 'A' is adopting the TQM Model in its managerial system for water treatment as verified by the use of two types of triangulation as per the main research methodology (i.e. the face-to-face interviews and the participant observations of the water treatment plant). The data shows that this TLA is keen on changing their old managerial systems towards the new paradigm of improving quality. This observation is supported by their high water grading score (i.e. conformance to the MoH regulations) and customer survey comments (i.e. their understanding of the importance of customer feedback and customer satisfaction).

Its Water Treatment Department has been ISO 9000 certified for approximately 8 years. On the other hand, it is not ISO 14000 certified. The whole water utility is working toward applying for the New Zealand Business Excellence Award which is equivalent to the Malcolm Baldrige National Quality Award (Refer to Chapter 3, Section: 3.4.3). These observations indicate the TLA is implementing TQM type practices.

5.6 Case Study 2 (TLA 'B')

This TLA serves a population of 23,895. Two managers were interviewed from this TLA. The Asset Management Department is responsible for six water treatment systems serving different sized communities. Officially this water utility has not got a quality system and is neither ISO 9000 certified nor ISO 14000 certified. Nevertheless, it does apply a lot of the total quality management techniques recommended by the TQM Gurus which will become clear in the analysis.

There was no participant observation conducted in the water treatment plants under the supervision of this water utility (Refer to Chapter 1, Section: 1.6 Limitations of Study).

5.6.1 Deductive Themes

1. **Quality Definition**

   Although TLA 'B' is not ISO certified, it believes in quality of service and work towards its achievement. Management defined it as:

   > *Fitness for use.*
   > *Quality is providing perfection and pure water.*

2. **Innovativeness**

   TLA 'B' innovation was limited to:

   > *Getting quality plans in place. Getting improvements in techniques and service, and locking them into place.*

3. **Teamwork**

   TLA staff are working towards the implementation and success of the "Learning Experience Program" where business excellence is nurtured. The Management team stated that in order to encourage their own staff towards business excellence, this program has been created where awards are given within the council for the best performance.

4. **Responding to Opportunity**

   TLA B management is moving towards a cultural change as they emphasised. They are in the process of developing a quality culture through forming quality plans that will help standardising operating procedures and eventually help develop a quality system. Some confidential written drafts were presented for viewing during the interview.

5. **Common Vision**

   The management of this TLA recognises that the whole organization needs to change and develop a culture of quality and excellence of service. Hence, they developed what is called the "Learning Journey" which is a program advocating the use of quality management tools and supported by staff. Management claim:

   > *The Learning Journey aims to equip all staff with the skills and knowledge necessary to work effectively and with satisfaction in a changing organisation.*

6. Expertise

Through data analysis of face-to-face interviews and documents, it has been noticed that this TLA is still in the early stages of adopting informally the TQM culture. Hence, there is no reference to this theme.

7. Leadership

Although this TLA is not officially ISO certified and has not applied for any quality awards, interviewees mentioned that its leadership is keen on incorporating the quality awards principles. This is especially true in the Department which is responsible for the water supply to the community. The following is one of the comments:

> *It was part of the study that I was doing at the time. I believe in it, but our organisation culture was not ready for it. I did papers on how to introduce TQM in the various departments of the council. The only thing that has sprung out of that has been the adoption of the TQM tools.*

There is a 'quality team' group that works within the council to ensure the health of the informal quality system. This team is headed by the CEO. This quality team has been elected and nominated by all the staff and represents their interest as mentioned by the management team who said:

> *We are developing the culture through education and by the internal quality award, but it hasn't been pushed too hard.*

5.6.2 Inductive Themes

1. Organisational Attitudes and Goals

The organisation's main goal is to provide a quality service to its customers as emphasized by management and suggested in their mission statement in some of their annual reports. The sub-contracting unit responsible for water service believes in doing the job smarter while improving quality and minimising cost at the same time. This also goes in line with their Learning Journey Program as stated on the back of an internal leaflet distributed to employees inviting them to attend the meetings.

> *The Learning Journey has the corporate focus on working in the best interests of the community providing services which exceed providing services which exceed customer expectations through the participation of all parties.*

2. Organisational Forms and Activities

The organisation in general and the Asset Management Department in specific are run by a generic quality plan written by a consultant to suit the department. Management stated that:

> *The plan says how we should do our work properly. Accordingly, we write SOPs i.e. standard operating procedures for every little thing we do. We are trying to standardize methods.*

3. External Factors

It has been mentioned by management that customers i.e. community can play a role in affecting drinking water quality. This could be related to both residential areas and farm areas. Concerning the residential area, customers may not maintain their own home pipes which may lead to backflow in the main water system. Farms are also considered as *"hazardous sites"* where farmers add other ingredients to their water supply or in other cases their stock may contaminate the water. In such cases the council request backflow prevention devices to be fitted in their water supply.

4. Human Resources

TLA management stated that the Water Treatment Section is being subcontracted out. No in depth details are available in relation to their water treatment plants since there was no participant observations conducted in this TLA.

5. Technology

Conversations with management suggested that technology is used to a minimal standard in this TLA. The document retrieval system is not computerised. Moreover, TLA 'B' tends to use outside expertise e.g. accredited laboratories for water analysis and sub-contractors for equipment calibration since its laboratory does not possess the required technology and expertise.

6. Cost

Cost plays a role in training issues. The following quotation was mentioned by management in relation to training:

> *...ongoing training based on qualification required and budget restraints*

Cost also plays a role in selecting suppliers and subcontractors; therefore, it is considered the main criteria in decision making over quality as stated by management.

> *... because price still dominates our industry. That's not to say it is correct, but still it does dominate it.*

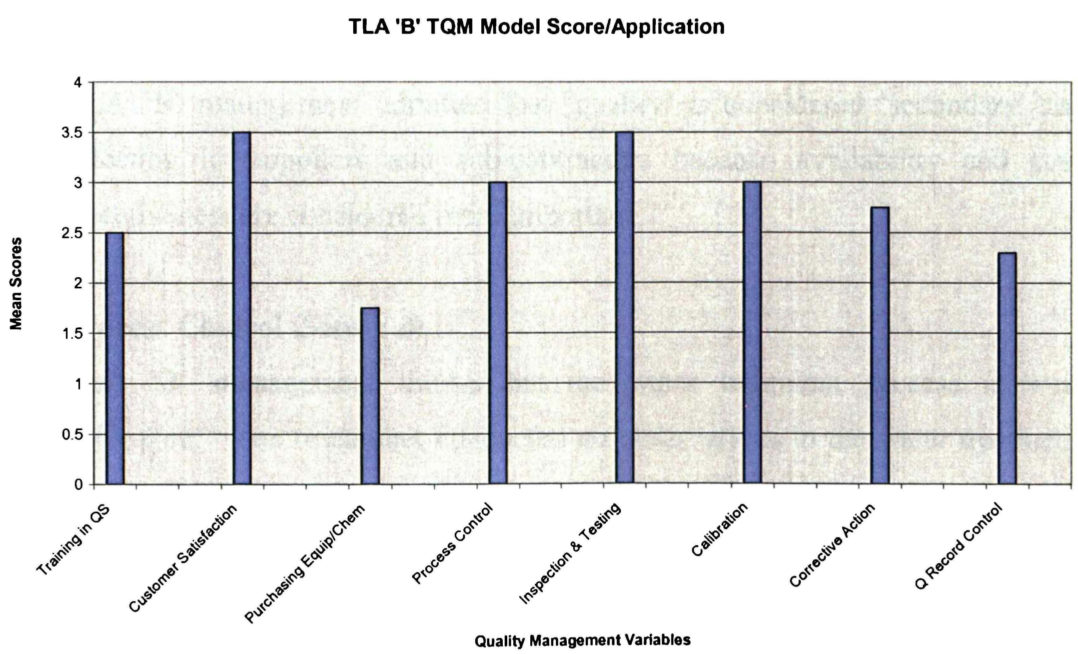
7. Problems

Management believes that the source of water in this region is very good. They supported their belief by mentioning that the majority of bottled water in NZ is from this region. Hence, water is not chlorinated and the community insists on that also. Nevertheless, they admitted that there is a problem of storage and reticulation i.e. there is a problem with pipes and storage.

5.6.3 Quantitative Variables

The following Figure 5.6 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.6 <u>TLA 'B': Average Mean of all Quality Variables</u>



SOURCE: Author's Figure

According to this analysis, both "customer satisfaction" and "Inspection and Testing" scored the highest (i.e. 4) while "purchasing equipments/chemicals" scored the lowest (i.e. 1.75).

1. Training (Score: 2.5)

TLA 'B' management stated that it provides training through Opus for C, B, and A levels which is a technician certificate for water treatment operators.

> *We give the staff the opportunity to express their needs and we continually up-skill operation of water treatment.*

2. Customer Satisfaction (Score: 4)

TLA B management stated that Customers' surveys are done every 1 to 3 years and they get interviewed over the phone. The customers are asked only one question in relation to water i.e. *"What do you think of the water supply?"* If the TLA gets an acceptance of 80%, it does not ask this question in the survey of the following year.

TLA 'B' is not very active in pursuing customers' satisfaction with drinking water (e.g. one question asked every 3 years). The main avenue for customer feedback is direct complaints to the TLA.

3. Purchasing Equipment/Chemicals (Score: 1.75)

TLA 'B' management admitted that 'quality' is considered 'secondary' for selecting its suppliers and sub-contractors because availability and cost effectiveness are considered more important.

4. Process Control (Score: 3)

TLA 'B' management thinks that the water treatment process is well controlled. The researcher conducted no observations in the water treatment plants of this TLA; hence cannot or reject this claim.

5. Inspection and Testing (Score: 4)

TLA 'B' management team confirms that the testing is done in accordance with the New Zealand Drinking Water Standards. Furthermore, there are informal reviews to meet the Quality Plan which is part of the policy and planning section of Asset Management.

TLA 'B' management stated that sub-contractor has not got an accredited laboratory; hence, minimal chemical analysis is conducted in site. All micro-bacterial analysis is sent to accredited laboratories in a bigger city. They do six monthly and yearly screening of water to meet the New Zealand Drinking Water Standards 2000.

6. **Calibration (Score: 3)**

TLA 'B' management stated that equipment calibration (e.g. scales, photometers and meters) is contracted out annually to independent instrument technicians from certified laboratories. Hence, scoring would be approximate.

7. **Corrective/preventive action (Score: 2.75)**

TLA 'B' requires the sub-contractor to abide by the standard operating procedures provided for crisis events and also to respond to the guidelines of the NZ Drinking Water Standards in cases of non-conformity. The Sub-contractor believes that it has good working habits where there is a regular checking of chemicals and requirements as per the contract with the relevant department of TLA 'B'.

8. **Control of Quality Records (Score: 2.3)**

Management admitted that the control of quality records is done manually and is not computerised in this council. The records are retained for only 3 years.

5.6.4 Document Review

TLA 'B' uses the New Zealand Drinking Water Standards as its main guidelines for water treatment. Since the supplying of water to the community is contracted out, there is a "Service Agreement for Water Supply" that binds the subcontractor to abide by specific standards. This agreement outlines for the subcontractor the standards expected from them as follows:

1. Chemical dosing: It is normal practice in only one water supply out of the six in this area. The reason is that water supply regularly has problems and it requires chlorination, while with the other water supplies the source of the water is of high standards and the community refuse vehemently any chlorination of the water.
2. Six monthly preventative maintenance: This is done by engaging a qualified electrical contractor to undertake maintenance checks on all installed electrical plant and equipment including telemetry on each water pump.
3. Laboratory testing: To be carried out monthly in accordance with the NZ Drinking Water standards and documented in the sub-contractor's "Quality Plan".
4. External laboratory testing: Is conducted by a "Quality Assured" laboratory.
5. Meetings and Reports: A monthly report is presented by the Unit Manager reporting on testing, emergencies, faults and other scheduled and unscheduled activities.
6. Quality Plan: The sub-contractor (i.e. Business Unit) should develop, maintain, and audit a suitable Quality Plan with documented procedures for:
   a. Inspection and reporting procedures to ensure compliance with the Service Agreement.
   b. Sampling and laboratory test procedures.
   c. Standby, callout, and emergency response procedures.
   d. Preventative maintenance.
   e. Spot inspections and rectification – of non-complying work.
   f. Management of other sub-contractors.

TLA 'B' Management stated that the WINZ Program [i.e. Water Information New Zealand. WINZ is a database management system for handling information on all aspects of New Zealand community drinking-water quality. It stores and retrieves data, presents information, and automates repetitive tasks.] is used as a means of documenting all the water treatment findings and reporting it directly to the Ministry of Health.

The other document reviewed for the purpose of triangulation of this research was the Register of Community Drinking-Water Supplies in New Zealand. The Ministry of Health water grading in this TLA varies between 'Aa', 'Bc' and 'Db'.

5.6.5 Summary and Conclusion

Although TLA 'B' is neither ISO 9000 nor ISO 14000 Certified, it has created its own organisational Quality Award System through a program called the "Learning Journey" where staff are rewarded for excellent progress towards high quality performance.

The water supply management is being run by a sub-contractor to the TLA who abides by standard procedures to follow besides following the NZ Drinking-Water Standards 1995 guidelines. All this is within the signed Service Agreement for Water supply which details the maintenance procedures and reporting requirements (Refer to Section 5.6.4 for further details).

5.7 Case Study 3 (TLA 'C')

TLA 'C' serves a population of 5,211. Two managers were interviewed in this TLA One Department is responsible for six water supply systems which have different standards i.e. water in one of the plants is only filtered before supply to consumers who elected not to have chlorine added to their water, while in the other five plants the water is being chlorinated. TLA 'C' is not applying any of the TQM teachings or quality tools. It is neither ISO 9000 nor ISO 14000 certified. None of its laboratories is accredited. It is still abiding by the World Health Organisation (WHO) Drinking Water Standards 1984. The Department in turn manages the contractor Waste Management through specific Key Performance Indicators mentioned in the TLA's Annual Plan and in the agreement between the two partners.

There was no participant observation conducted in the water treatment plants under the supervision of this council (Refer to Chapter 1, Section: 1.6 Limitations of Study).

5.7.1 Deductive Themes

1. **Quality Definition**

   During the interview it was noticed that management had difficulty defining quality and finally said: *"Quality would be an agreed set of standards or a standard which is maintained to prevent illness in the consumers."*

2. **Innovativeness**

   This theme does not exist in TLA 'C'. It is still abiding by WHO 1984 Drinking Water Standards and is working toward applying the NZ Drinking-Water Standards 1995. In other words, it is even below the minimal standards that could be acceptable to the Ministry of Health regulations and requirements. The Following is their comment:

   > *The system is very basic because the supplies are small and only complying with the 1984 Drinking Water Standards. We are not trying to comply with the 1995 Standards for the time being. When we do comply with the 1995 Standards, obviously the frequency of water sampling will increase.*

3. **Teamwork**

   The management believes that they are applying the team based problem solving techniques and gave the following example:

   > *We are continually looking at ways of improving the intakes on our supplies, to minimise sediment intake. And we're doing that as a team based approach. We also utilise our contractor, Waste Management, by using their expertise.*
   >
   > *Well it is an informal system, but we're definitely utilizing a team based problem solving approach.*

4. **Responding to Opportunity**

   It has been suggested by management in the council that top management are not keen on applying any quality management tools or models:

   > *I guess we haven't found a need to, or seen a definite need to as yet. We really haven't had any directions from the top management on it as yet.*

5. **Common Vision**

   The utility management team stated that they work in accordance to set standards of specific key performance indicators as per their annual report. The following excerpt related to the council's goal, objectives and performance measures was taken from their 2000/2001 annual plan:

> *To provide potable water within Council's defined water supply areas which meet agreed standards for quality and reasonable expectations of consumers for volume and pressure.*

Another example was given by management in relation to performance measures:

> *...the measures are things like, no loss of supply for more than 12 hours.*

6. **Expertise**

   TLA 'C' water facilities has no evidence of expertise revealed by qualified people and skilled work in its operations.

7. **Leadership**

   It has been suggested by TLA 'C' management that its leadership (i.e. CEO) does not see a need for adopting either TQM or any of its tools at the present stage.

5.7.2 Inductive Themes

1. **Organisational Attitudes and Goals**

   It has been mentioned by TLA 'C' management and verified through documents (i.e. Council 2000/2001 Annual Plan) that the main goals and objectives of the TLA are to operate and maintain water supplies to meet requirements of the community with respect to quality and quantity by meeting the requirements of the New Zealand Standards 1984 for drinking water with no more than 6 incidences of non-compliance notices.

2. **Organisational Forms and Activities**

   The Department which is responsible for water supply and services is contracted out to a company, which abides by specific Key Performance Indicators that are mentioned in its contract with TLA 'C'.

3. External Factors

Management stated that one of the small communities under the jurisdiction of this TLA requires its water to be filtered only. TLA 'C' has to respect its wishes and deliver such a standard of water in accordance to the community's request.

4. Human Resources

TLA 'C' management stated that the Department which is responsible for water supply and services is being subcontracted out. No in depth detail is available in relation to the water treatment plants since there were no participant observations conducted in this TLA.

5. Technology

Technology is basic in this TLA. For example the laboratory is not even capable of conducting the simplest tests; hence, most of the work related to water supply and service is contracted out.

6. Cost

Although management admits the importance of quality of a product especially if it is related to purchasing chemicals, cost can be a constraint. The following are management views in relation to cost:

> *But cost comes into it as well, you haven't introduced cost in there, but cost is very important in today's environment as well. Particularly in local authorities, like we're working. You know we've got the constraints of working with public money. It would be nice to say that quality is the most important one but cost is probably just as important.*

> *Quality system is adapted to our organisation by being cost effective. Because most of the supplies are very small, they have very few Consumers. Hence, the costs fall on only a few numbers of people, so they try and keep the cost down as low as possible. And that's the problem with getting them to comply with 1995, because there are only a few people that consume the water. See. That's why smaller supplies, will find difficultly coming up to a new standard that requires more and more capital, for treatment equipment and for monitoring.*

Furthermore management believes that cost plays a crucial role in water quality standards and conformance. It was specifically stated:

> *When supplies were first installed they used to meet the standards, but now the standards are higher so they no longer meet the required standards. They will cost a lot of money to bring them up to the new standards.*

7. Problems

Management stated they could have some seasonal problems affecting the water taste which depends on the weather and time of year. The following example was given:

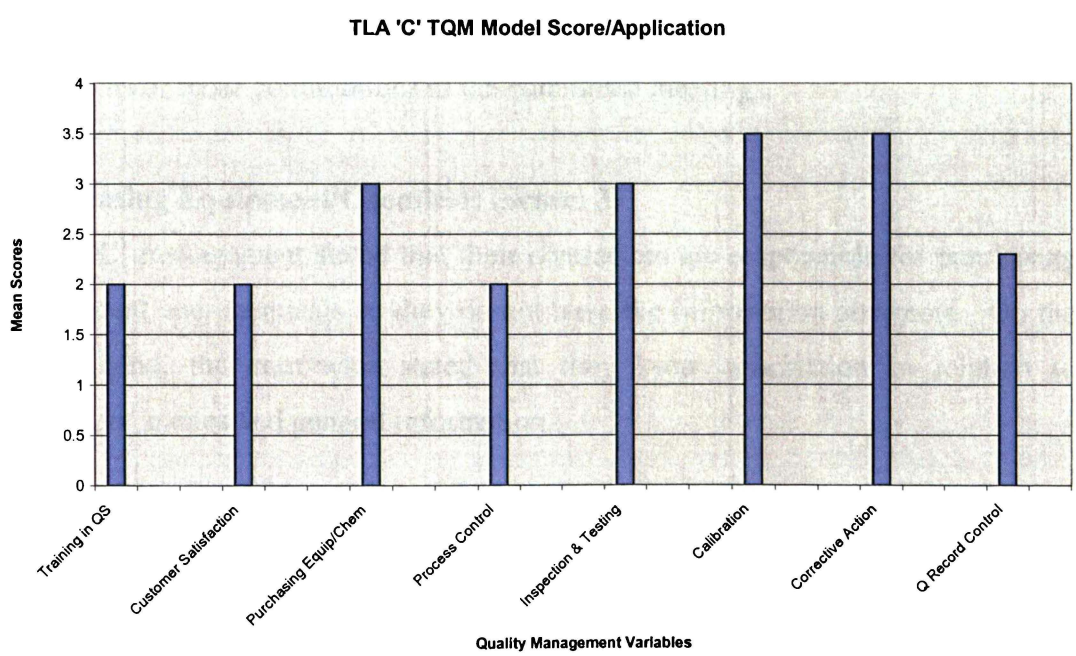
> *We get isolated problems with dirty water in summer. We do suffer from a poor taste in the water, when the river gets low. The reason behind that is that the temperature of the water becomes warm at this time of the year which affects the water taste and we can do nothing about it.*

As mentioned in the "Cost" theme by TLA 'C' management, one of the problems facing this TLA to upgrade its drinking water standards from the 1984 to the 1995 is related directly the small community size it serves.

5.7.3 Quantitative Variables

The following Figure 5.7 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.7 **TLA 'C': Average Mean of all Quality Variables**



SOURCE: Author's Figure

According to this analysis, both "Calibration" and "Corrective Action" scored the highest (i.e. 3.5) while "Training in Quality Systems", "Customer Satisfaction, and "Process Control" scored the lowest (i.e. 2).

1. **Training (Score: 2)**

   Management stated there are no direct financial resources allocated for training personnel on quality systems. On the other hand there is some budget allocated to in house seminars and general training. The exact words mentioned were:

   > *Each department has a budget for training but not specifically for quality.*

2. **Customer Satisfaction (Score: 2)**

   Management admitted that they don't conduct any customer surveys, but they have a customer services team whose job is to reply to customers' complaints and referring them to the relevant staff in the council. The exact words were:

   > *We can't tell what the actual customers' requests are, other than the ones who take the time to ring the council.*

   On the other hand, TLA 'C' management stated that concerning small communities, there are elected community boards of 6 or 7 members who meet twice a year with the council. Those community boards may convey any problems of those communities in the committee meetings.

3. **Purchasing Equipment/Chemicals (Score: 3)**

   TLA 'C' management stated that their contractors are responsible for purchasing equipment and chemicals so they do not have the information any more. On the other hand, the contractor stated that they keep information in relation to suppliers' names and general information.

4. **Process Control (Score: 2)**

   Communication between the different departments is not clear. For example the Environmental Health Officer does not see the reports of the water treatment plant technicians to be able to verify that the process is well controlled. Management replied by saying that that process control is not conducted on a regular basis. Moreover, it is conducted manually i.e. not computerized.

5. Inspection and Testing (Score: 3)

Although TLA 'C' management stated that "most of the phases" undergo inspection, the following are some of its comments:

> *The contractor has a C grade certificate in water treatment, but there might be another guy that works for him and do some of the sampling and testing.*
>
> *Inspection procedures in the treatment plant were not documented. They didn't even have a trained person, but now they specify a qualified person.*

6. Calibration (Score: 3.5)

TLA 'C' management stated that equipment are calibrated regularly through sending it to its suppliers for regular calibration according to the equipment's requirement. This issue is totally monitored through the contractor.

7. Corrective/Preventive Action (Score: 3.5)

TLA 'C' management stated they give great importance to complying to the performance measures stated in their annual plan. They make sure it is circulated around not only to the council employees, but also to all their contractors. They illustrated by giving the following example:

> *Employees are aware of what we have to do to comply. We also pass those performance measures on to our contractors. One of those measures is related to water supply i.e. if there is any interruption to water supply, they are to rectify it within 8 hours of receiving the notice. Our contractors' monthly report, should have details of the incident i.e. time a call for no water was received and the time the water went back on.*

On the other hand, the Contractor stated that there is no formal processes for correcting or preventing problems from occurring; nevertheless they believe the action taken is effective. The following is their words:

> *It is very effective except if the treatment equipment is not able to cope with some weather conditions, then it will happen again, but the action taken is effective because we re-test the water and make sure that it is back up to standard.*

8. Control of Quality Records (Score: 2.3)

The following was the TLA 'C' management reply:

> *We don't have a formal documentation system, so it is probably never.*

5.7.4 Document Review

TLA 'C' conducts no customer surveys and it abides by its Annual Plan. The following are the objectives and performance measures according to the 2000/2001 Annual Plan:

- Operate and maintain water supplies to meet requirements of the community with respect to quality and quantity.
    - To ensure that the supply of water to the reticulation systems (with the exception of the community where they particularly requested their water to be only filtered and not chlorinated) meets the requirements of the New Zealand Standards 1984 for drinking water, with no more than 6 incidents of non-compliance notices.
    - To resolve all complaints concerning lack of supply within 8 hours of notice.
    - To minimise water consumption and reduce peak water demands by implementing water conservation measures, if required, over summer period.
- Operate and maintain community water supplies cost effectively.
    - To ensure that the water treatment plants comply with Resource Consent Conditions.
    - To complete programmed pipe renewals.

TLA 'C' management stated on several occasions that its systems are basic. It does not have the WINZ Program, instead the management uses a simple database to record their monthly water tests results.

The Ministry of Health water grading in this TLA varies between 'Cc', 'Ec', 'Bb', 'Dd' and 'Cb'.

5.7.5 Summary and Conclusion

TLA 'C' does not have any Quality System in place. It has not adopted any TQM tools and it is neither ISO 9000 nor ISO 14000 certified. Responsibility for supplying and delivering water is contracted out by the TLA to a third party. This TLA is still following the NZ Drinking-Water Standards of 1984 (i.e. they are not conforming to the latest MoH standards). The result is poor water quality.

5.8 Case Study 4 (TLA 'D')

TLA 'D' serves a population of 6,314. Two managers were interviewed from this TLA. A department manages the provision of drinking water and is responsible for four water supply systems. Another area within TLA 'D' also monitors two other semi-public water supplies besides the four main ones taken care by the main TLA Department.

TLA 'D' is not applying any of the TQM teachings or quality tools. It is neither ISO 9000 nor ISO 14000 certified. None of its laboratories are accredited. It is abiding by the New Zealand Drinking water Standards 2000 as stated by the Environmental Health Officer. The Department has some processes and plans is in the process of improving its documentation system. Although it is not ISO certified, it is planning to contract out its main water treatment plant once upgrading is conducted to an ISO certified contractor.

The researcher contacted TLA 'D' during September 2002 to check and update the data since there was no participant observation conducted in this utility (Refer to Chapter 1, Section: 1.6 Limitations of Study). The researcher found out that the Department had undergone restructuring. Moreover, the management team had been changed. The researcher was informed that the updating to the main water plant was not done as was planned in the year 2000. When the researcher asked for the reason she was told *"there is no need for it"*. Moreover, the plant was contracted out to a local contractor who is not ISO certified.

5.8.1 Deductive Themes

1. Quality Definition

TLA 'D' management defined quality as:

> *Something that have some standards, written standards and then probably if you comply with those standards then you comply with the quality I would say.*
>
> *Quality in my view is whatever standard complies with the drinking water standards.*

2. Innovativeness

Although this TLA 'D' is not ISO certified the management team mentioned that they are *"somehow adopting asset management plan improvement programme over three years in which they are currently identifying the assets which are prone to risk and in accordance to those risk assessments we will prioritise some of the renewals programmes."*

3. Teamwork

There were no clear views or opinions suggested through the interviews to lead to any concrete ideas in relation to this theme.

4. Responding to Opportunity

Management believes that TLA 'D' is not ISO certified because it would require the whole TLA to be certified and not only the water utility department which would be costly for such a *"too small TLA"*. Nevertheless, they are taking another opportunity to guarantee quality as they stated by contracting out their main water treatment plant to an ISO 9000 certified contractor once the upgrading is finalized.

5. Common Vision

TLA 'D' management and employees' common vision is to supply water to the community in compliance with the New Zealand Drinking-Water Standards 2000.

6. Expertise

TLA 'D' is in the early stages of improvement; hence, this theme is not quite applicable.

7. Leadership

TLA 'D' management believes in improvement but cost effectively i.e. they believe that since they are a small council they are limited financially. The following is how they expressed their view:

> *I think we are too small a council and it would be a too costly process to get certified. I think we can manage probably by developing something down the line which wouldn't cost so much, but would probably have the same effects.*

It appears from the interviews that the top management is not keen on any of the principles of quality awards.

5.8.2 Inductive Themes

1. **Organisational Attitudes and Goals**

   TLA 'D' management believes that the main goal of the organisation is to provide suitable water quality to the community within the standards and requirements of the New Zealand drinking Water-Standards 2000 and in a cost effective manner.

2. **Organisational Forms and Activities**

   TLA 'D' management believes that the organisation is taking the approach of improvement through the planned asset management plan and by adhering to it.

3. **External Factors**

   TLA 'D' management stated that customers can play a role in affecting the quality of water and gave the example of backflow from the customer's say swimming pool to the main reticulation system in cases of low water pressure. Hence, the utility tries to prevent these incidents from happening by requiring from those customers to connect a special standard backflow prevention system. This is applied when customers apply for a building consent where they are required to install a backflow prevention. They also have to present a certificate of compliance in accordance with the building consent.

   TLA 'D' management stated that ratepayers, especially with regard to small rural supplies would not be happy to increase the rates for a better water quality standard and that they are happy with the water they are receiving now. The manager supported his ideas by referring to a discussion during a meeting with ratepayers who were concerned about increased charges because of the new treatment plant upgrade. The Manager said that the ratepayer who happened to be a meat company representative was happy with what was provided before and that they do not want to pay more for higher quality water.

4. Human Resources

This TLA underwent restructuring which adversely affected previous plans for upgrading their water treatment plant. This is consistent with the Gurus' teachings that leadership plays an important role in organizations.

5. Technology

It has been suggested from the interviews that technology is basic in TLA 'D' due to its small size. Nevertheless, the council was in the process of updating its main water treatment plant in the year 2000. The researcher checked again in the year 2002 in relation to this updating and was told that the updating was not conducted due to further management restructuring.

6. Cost

TLA 'D' management believes that cost plays a great role in not applying for any ISO certification for such a small council.

7. Problems

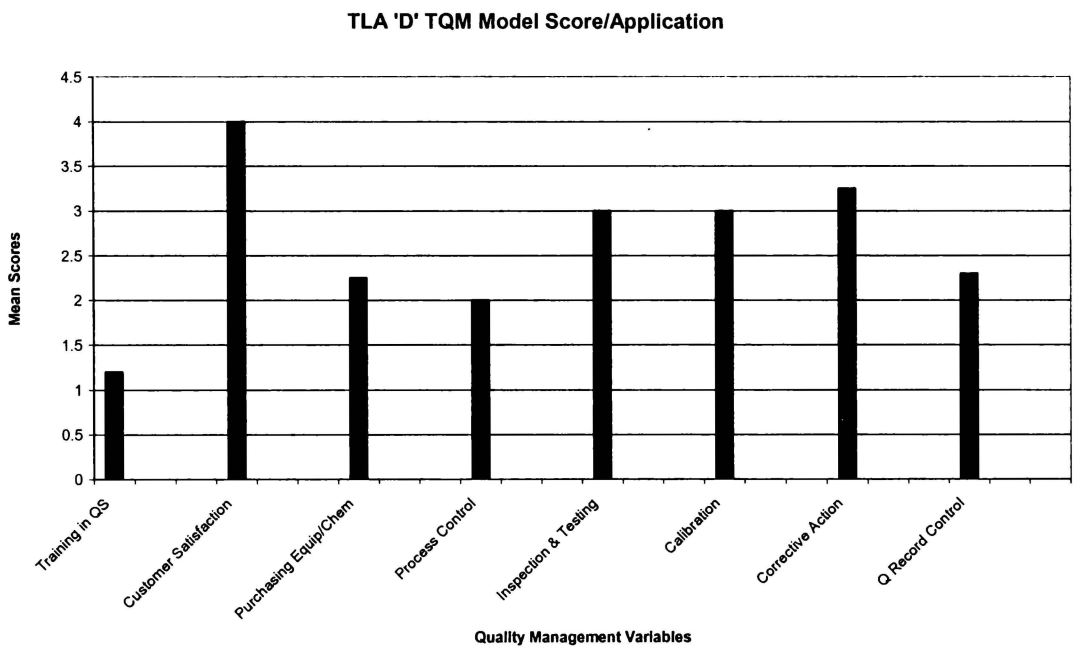
TLA 'D' management gave an example of one of the problems they had for years with a little village miles from the main community where the water there was always below the New Zealand Drinking Water Standards. They had a continual bacteriological problem. Management related the reason behind that was that their water supply system was *"extremely primitive i.e. it was basically raw water taken from a stream and chlorine was put into it. The community thought they would be able to kill off anything in it by adding chlorine, but of course it didn't work. Chlorine really only is a tertiary treatment rather than a primary treatment."* They installed a filtration system with the help of their engineers, which improved the whole water supply system. This problem took four years to resolve. They said that the water grading in this specific community was "e" which is totally unsatisfactory and hazardous to health. Now the water grading for this community is "c"

Another recent incident was mentioned by TLA 'D' management where they found faecal coliforms at one of the water reservoirs. When TLA 'D' investigated the incident, it found that there was organic material at the pump station which took two days to clean and to regain the water quality to the required standard.

5.8.3 Quantitative Variables

The following Figure 5.8 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.8 <u>TLA 'D': Average Mean of all Quality Variables</u>



SOURCE: Author's Table

According to this analysis, "Customer Satisfaction" scored the highest (i.e. 4) while "Training in Quality Systems" scored the lowest (i.e. 1.2).

1. **Training (Score: 1.2)**

   Management admitted that there is no direct funding allocated to any quality training in TLA 'D'.

2. **Customer Satisfaction (Score: 4)**

   So far they have conducted only three customer surveys in which there is only one question asking customers about their opinion in relation to water supply. Customer surveys are fairly recent in TLA 'D' to comply with the annual plan.

3. **Purchasing Equipment/Chemicals (Score: 2.25)**

   Management stated that quality is a '*somewhat important criteria*' in purchasing equipment and chemicals. The following were the exact comments:

   > *When you contract out, you have certain non-price attributes. One is management and quality, and some others like track record and technical ability. It is known in any tender process as CPP i.e. Competitive Pricing Procedures.*

4. **Process Control (Score: 2)**

   Management admitted that process control in TLA 'D' is moderate (i.e. not all the phases are monitored and they are not all documented). They mentioned that they are working towards improving it. Nevertheless, they inspect the water quality at the customer level by taking samples randomly from houses and reservoirs for testing.

5. **Inspection and Testing (Score: 3)**

   TLA 'D' management informed that water testing and inspection is conducted through an outside certified laboratory since they do not have the facilities in its own laboratory that is not accredited. Inspection reports are kept within the department and they are not reported externally to the Ministry of Health. Management stated that *"if the Medical Officer of Community Health asks for some information, we have to provide it."*

6. **Calibration (Score: 3)**

   Some minor equipment is calibrated in-house in accordance to supplier manual, but most calibration is contracted out.

7. **Corrective/Preventive Action (Score: 3.25)**

   TLA 'D' management believes that it investigates cases of failure to find out the source of the problem through its engineering staff that advises the corrective processes to be taken.

8. **Control of Quality Records (Score: 2.3)**

   TLA 'D' management believes that although records are kept for nearly 3 years and could be retrieved moderately easy, they are *'poorly monitored"*.

5.8.4 Document Review

TLA 'D' has conducted only 4 customers surveys so far since 1999. The customer surveys are conducted over the phone through a market research company commissioned by TLA 'D' in which the customers are asked only one question to state their opinion of the water provided to them by council. In 2002, the question asked was:

"Water treatment and supply – Does the TLA supply your water? Yes/No
If Yes,
"How satisfied are you with the quality of water?
Excellent good average poor or very poor"
If poor or very poor then explanation sought.

The following Table 5.2 presents the summary as presented by the market research report.

Table 5.2: TLA'D' Summary of Customer Survey Results (1999 – 2002) Water Quality

Year	Percentage of Customer Satisfaction with Water Quality and Supply
2002	50%
2001	71%
2000	68%
1999	67%

SOURCE: TLA 'D' Customer Survey, 2000.

The reports of 1999 and 2000 mentioned that overall TLA 'D' generally meets the pre-defined criteria as indicated in the annual plan. The only exception is the "quality of water", where several sites responded as having a quality of water that did not meet requirements. The part of the report available for the researcher did not indicate any reasons behind such responses from the customers' part.

This shows that there is a great discrepancy between the management point of view and the customers' point of view in relation to satisfaction with the quality of water provided by TLA 'D'. Management stated earlier that they believe customers are satisfied with the quality of water they are getting and do not want a higher quality of water if it is going to cost them more money (Refer to no. 3 External Factors under Section 5.8.2 Inductive Themes for details).

There has been a change in the reports of 2001 and 2002 where customers are asked for their reasons for rating of either "poor" or "very poor". The following are some of the customers' comments:

> *If it rains the water runs brown – or any repair it runs brown. They need a better filter system.*
> *The taste is up and down, the clarity is not great*
> *The source of water gives us some concern. We lose our water on average about twice per month.*
> *Taste and colour are terrible. We boil ours but it is horrible even to shower in.*
> *Disgusting – muddy and smelly and in the morning it tastes like plastic.*

The Ministry of Health water grading in this TLA varies between 'Ba', 'Db', 'De', 'Dc' and 'Ca'.

5.8.5 Summary and Conclusion

TLA 'D' did not adopt any TQM tools and they are neither ISO 9000 nor ISO 14000 certified.

The water utility responsible for water supply and service takes care of 4 main water supply systems. Another sub-department is responsible for the monitoring of not only the main 4 water supplies, but also another two rural supplies. TLA 'D' water utility developed a three year Asset Management Plan in order to improve the programme. Part of that plan was updating the main water treatment plant, which was finalised early 2002. It also follows the NZ Drinking-Water Standards 2000. TLA 'D'

Management has gone through a departmental restructure, which has impacted quality management performance in the short run.

5.9 Case Study 5 (TLA 'E')

TLA 'E' serves a population of 27,043. Two managers were interviewed from this TLA. One Department is responsible for four water treatment systems serving different size communities. TLA 'E' is a good example of how leadership can play a role in the organisational attitude and structure. TLA 'E' was ISO 9002 certified in 1998 but lapsed in 1999 since its top management believed that it was not necessary to be ISO certified (Refer to Chapter 3, Section: 3.4.1 ISO 9000 Series Standards). When the management underwent change, the new leadership believed in ISO certification; hence, the TLA was recertified in the year 2000. It also adopts some of the total quality management tools recommended by the TQM Gurus which is illustrated further in the analysis.

There was no participant observation conducted in the water treatment plants under the supervision of this council, despite efforts to arrange such observations.

5.9.1 Deductive Themes

1. **Quality Definition**

   Management defined quality as:

   Goodness
   Quality relates to the standard of the product whether it is high or low quality
   What is required and what is the minimum level

2. **Innovativeness**

   Management believes that since TLA 'E' has been ISO 9002 certified the water treatment quality system has been in place and helps keeping things documented in more details i.e. keeping a track record of everything happening to help regulate the monitoring instead of it happening before at *"some point in time with no regulations what so ever"*.

3. Teamwork

Management believes that team work in TLA 'E' was nearly non-existent until the recent changes happening in which the whole organisation is working towards improvement in the framework of ISO 9000. They gave the following example:

> *Top management was planning to privatise water and they have been discussing that for 4 years. The council even advertised that they are progressing to about 95% and then at the last moment they stopped it. So because of this process, we had six managers, so because of that the system has gone down very badly. Nevertheless, since the new General Manager took over in January 2000, it has been decided that the Council should not go for privatisation and that we should try to improve our in house department; hence we launched a huge efficiency development which is part and parcel of quality improvement. For example after we got back our ISO 9000 certification we have lost previously.*

4. Responding to Opportunity

TLA 'E' top management found a good opportunity in ISO 9000 certification when they found out that their previous system was dragging performance to the lowest standard.

5. Common Vision

TLA 'E' believes in the importance of quality improvement through the adoption of ISO 9000 certification to put systems in place whether in relation to their water treatment plant operation or their general managerial systems in relation to maintenance, monitoring, reporting systems.

6. Expertise

TLA 'E' is still new in the application and adoption of the quality systems and ISO 9000 certification; hence, this theme does not apply here.

7. Leadership

Leadership played a crucial role in the improvement of the quality system in TLA 'E'. They have worked with all departments to regain the ISO 9000 certification after they have failed prior to the year 2000. Employees of the whole TLA are following in their leadership foot steps toward a more integrated quality system.

5.9.2 Inductive Themes

1. **Organisational Attitudes and Goals**

   TLA 'E' is working towards providing a sufficient potable water to meet the demand of its four areas/communities they are responsible for to meet the New Zealand Drinking Water Standards 1995 and to provide an uninterrupted water supply. Management believes that it should re-apply for ISO certification because some of its commercial customers were keen about water quality and producing foods for international markets. It also wants to improve the quality in terms of customer delivery.

2. **Organisational Forms and Activities**

   TLA 'E' has four different Water Supply Asset Management Plans for the four different communities it is responsible for. These plans control all its activities and requirements in relation to water supply, treatment and storage. It is issued every three years as mentioned by TLA 'E' management.

   Management stated that there are weekly meetings between groups who deal with quality where Opportunity for Improvement forms are used if needed to change anything. Moreover, there are regular audits on the organisational quality systems that are conducted every six months.

3. **External Factors**

   TLA 'E' management mentioned that sometimes there are external factors that could affect the quality of water delivered to the customers. They are:

   - Customers' water pipes may be very old.
   - Customers' pipes maybe aligned to an old leak.
   - Rural areas have their own tanks, in which customers have to make sure they are well protected or else they could affect the quality of water.

4. **Human Resources**

   There has been a high turn over in the managerial staff as indicated by TLA 'E' new management team. Some of the employees who were interviewed on the year 2000 were fairly new. Moreover, when TLA 'E' was contacted again by end of 2001, there were changes again in personnel.

5. Technology

TLA 'E' management stated that they are using WINZ data base, which helps documenting the test results directly to the Ministry of Health.

TLA 'E' management mentioned that one of its future plans is to introduce more technology especially in the monitoring and testing area.

6. Cost

TLA 'E' management believes that cost plays a role in decision making in relation to the criteria for selecting their suppliers or subcontractors.

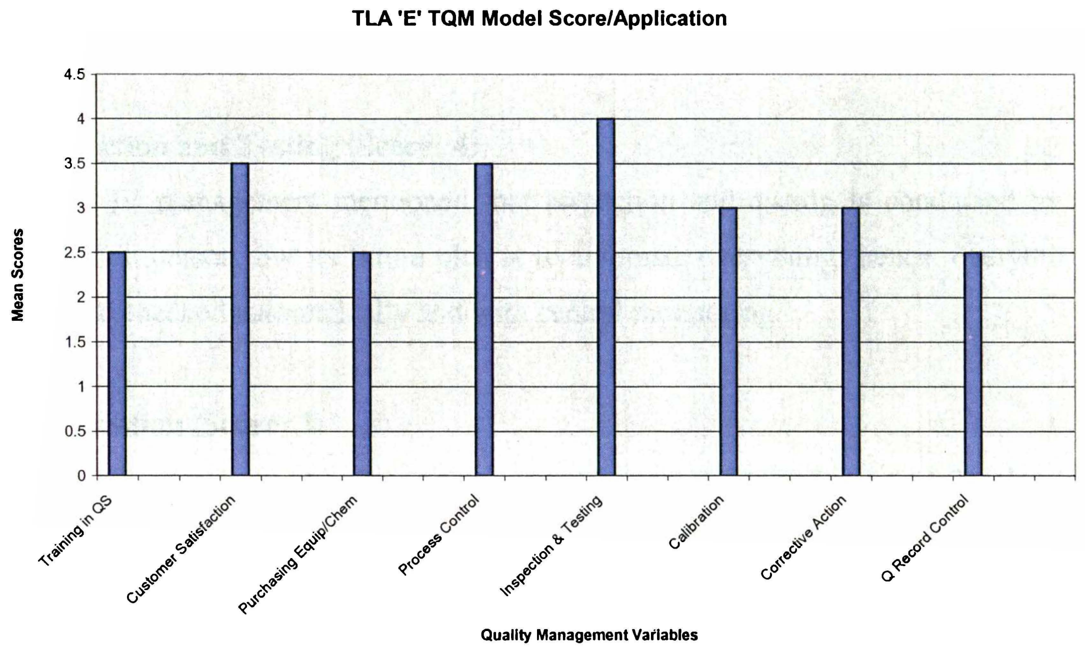
7. Problems

TLA 'E' management stated that sometimes it receives complaints from customers related to the taste of water. The reason behind the customer's complaint is the chlorine added to the water which the customers do not like it.

5.9.3 Quantitative Variables

The following Figure 5.9 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.9 TLA 'E': Average Mean of all Quality Variables



SOURCE: Author's Figure

According to this analysis, "Inspection and Testing" scored the highest (i.e. 4) while "Training in Quality Systems", "Purchasing Equipment/Chemicals", and "Quality Record Control" scored the lowest (i.e. 2.5).

1. **Training (Score: 2.5)**

   TLA 'E' management stated that there is no money specifically allocated for quality training; however, there is training budget in the organisation that can be used for that.

2. **Customer Satisfaction (Score: 3.5)**

   TLA 'E' has an internal customer and external customers (i.e. the communities served by the four water schemes maintained by the TLA). TLA 'E' management stated that it conducts annual reviews in accordance with the Drinking Water Standards by conducting customer surveys. Those customer surveys started in TLA 'E' since 1991.

3. **Purchasing Equipment/Chemicals (Score: 2.5)**

   TLA 'E' management stated that quality, deliverability and price go hand in hand when taking a decision in relation to purchasing equipments and chemicals.

4. **Process Control (Score: 3.5)**

   TLA 'E' management believes that its water treatment process is well controlled, monitored and documented as per the ISO 9000 requirements.

5. **Inspection and Testing (Score: 4)**

   TLA 'E' management mentioned that inspection and testing is conducted by a qualified person, but its future plan is to automate everything; hence, everything will be checked automatically and with central monitoring.

6. **Calibration (Score: 3)**

   TLA 'E' management believes that equipment get calibrated most of the time in accordance with the ISO 9000 certification requirement.

7. **Corrective/Preventive Action (Score: 3)**

   TLA 'E' management stated that it endeavours to do its best. It gave an example of an incident that usually happens in one of its water supplies in relation to low chlorine in the water which affects its quality. It monitors the chlorine daily but it does not always get it right. Management said the reason behind that is that it know when the chlorine in the cylinder is very low but it does not know always when it is out.

8. **Control of Quality Records (Score: 2.5)**

   TLA 'E' management believes that controlling of quality records is moderate and it is working for improving the system especially that the records are not kept in the TLA which makes it very difficult to return and check for certain information. They stated that the records are kept in another site away from the main TLA offices.

5.9.4 Document Review

TLA 'E' has been conducting customers' surveys since 1992 to have feedback from the different communities about its water supply service. The following Table 5.3 provides a summary of the customer surveys conducted by TLA 'E' since the year

1992 until the year 2000. The percentages given are for the satisfied customers with the water supply service provided by TLA 'E' in the four different schemes under its control and maintenance.

Table 5.3: TLA 'E' Summary of Customer Survey Results (1992 – 2002)

Water Quality

Year	Percentage of Customer Satisfaction with Water Quality and Supply
2002	63%
2001	60%
2000	63%
1999	68%
1998	69%
1997	69%
1996	70%
1995	68%
1994	76%
1993	89%
1992	87%

SOURCE: TLA 'E' Customer Survey, 1992 - 2002

Customer satisfaction is generally decreasing. The following are some of the reasons given by the customers as to why they are not satisfied with their water supply by TLA 'E' as reported by the market research company that conducted the customer surveys. Customers concerns fall under the following four points:

- Cost involved/meters

  Water Rates just keep increasing – not good enough.
  Everybody should be rated. Cost very high.
  If they had kept the promises made when they sold the water scheme to us, it was good, but it's become an expensive exercise. It's gone up horrendously for the cubic metre.
  The water should be on rates, not separate.

- Poor quality of water

  Giardia. Water quality is poor because of spray residue.
  Quality of summer water – struggle to maintain same level of water quality in summertime.
  Undrinkable, need water filer.

- Tastes terrible

  Tastes like dirt.
  Some days of the week (Monday and Wednesday), water tastes terrible.
  Tastes like chemicals in the morning.

- Too much chlorine/too many chemicals

  Can smell chlorine even in mid winter.
  Sometimes chemicals are yuck. Good for a time, then not good for a few days when it has just been treated.

The Ministry of Health water grading in this TLA varies between 'Ab', 'Aa', 'A1a', 'Ab' and 'Au'.

This TLA is really fortunate in that its water source and origin is 'A' meaning it is of good and high quality. Nevertheless, when it is delivered to the customer its not always of the same calibre of quality.

5.9.5 Summary and Conclusion

TLA 'E' used to be ISO 9000 certified in 1998 then its certification lapsed in 1999 due to managerial disagreements when the council was studying the issue of privatising water services. They were ISO 9002 certified in the year 2000 after top management changed and felt the importance of improving their quality system. It also uses some of the TQM tools e.g. OFI forms (i.e. opportunity for change) and it is in the process of improving there monitoring and reporting systems in accordance with the ISO 9000 certification.

5.10 Case Study 6 (TLA 'F')

TLA 'F' serves a population of 19,801. Nevertheless, this population number rises to 100,000 during the summer season (more specifically November and December as stated by a Contracting Company Manager). Two managers were interviewed from this TLA. This is another unique case in the region where most of the TLA services are contracted out and only managed by staff from the TLA. TLA 'F' was undergoing a complete restructuring to all its departments. The contractor is responsible for all asset management functions including water service and provision. The Contractor of TLA 'F' is responsible for 12 water supply systems in which nine are urban and three are rural systems.

TLA 'F' is not ISO Certified, but the Contractor is both ISO 9001 certified and ISO 14001 certified since 1998. It also adopts some of the total quality management tools recommended by the TQM Gurus which will be illustrated further in the analysis.

There was no participant observation conducted in the water treatment plants under the supervision of this TLA.

5.10.1 Deductive Themes

1. **Quality Definition**

   TLA 'F' management defined quality as follows:

   Quality is a measurement of what we provide from commodities and services.
   Quality is a level of standard.

2. **Innovativeness**

   TLA 'F' and contractor are still at the stage of picking up where the previous management left after restructuring; hence, the requirement to master first what is gong on before they start improvising and innovating new techniques.

3. **Teamwork**

   It has been suggested by Council Management that there is high work collaboration between them and the Contractor to deliver a quality service to the community.

   > *Although the Contractor is ISO 9000 certified, there has been minimal improvement because of what happened approximately three years ago. The council went through complete restructuring where they got rid of all their own staff and contracted things out. It has taken me and the Contractor some time to actually pick up the knowledge that the previous staff had before they left. ... all of the utilities staff in the council opted to depart out of the organisation and opted not to be part of the Contractor.*

4. **Responding to Opportunity**

   TLA 'F' Contractor believes that applying for the ISO 9000 certification was a means of remaining competitive in the new environment and that it definitely improved its service delivery as a company. Its exact words were:

> *There has been an improvement in quality. We've improved the incidence of water loss, or lack of service. We are far better able to meet our consent requirements.*

5. Common Vision

TLA 'F' Management and Contractor share the same common vision of supplying a potable water supply to the community meeting the requirements of the New Zealand Drinking Water Standards 1995.

6. Expertise

This theme does not apply to TLA 'F' since it has undergone a recent restructuring of its departments and the new management and contractor are trying to *"pick up where the previous management left"*.

7. Leadership

TLA 'F' Management believes that there is no need to apply for the ISO 9000 certification since its contractor is already certified.

5.10.2 Inductive Themes

1. Organisational Attitudes and Goals

TLA 'F' Management stated that it is looking at its long term planning of the various water schemes to meet the community board expectations i.e. the Service Level Agreement signed between the TLA' F' Management and the Community Board.

2. Organisational Forms and Activities

TLA 'F' contracts out water treatment and supply. The Contractor mentioned that the quality system and conforming to the New Zealand Drinking Water Standards is only applied in the urban water schemes, while it is more relaxed in the rural schemes. The exact words were:

> *The rural schemes generally are not treated. We don't try to apply the TLA's minimum standards to the rural water supplies. We basically collect the water from a raw water site and pipe it to the consumer.*

3. External Factors

TLA 'F' Management stated that its water grading is 'Aa' but it has not been changed by the Ministry of Health Register; hence, there is a discrepancy. It stated that the Ministry of Health visit councils to upgrade its grading system approximately every five years although the Community Register is published annually. Hence, if the council believes its water system has improved, it has the responsibility of contacting the Ministry of Health and requesting it to conduct a formal visit to upgrade its water grading.

Another external factor mentioned by TLA 'F' management was the fact that there is no accredited laboratory in the nearby area for faecal coliform testing. Hence, the sample takes a long time to be tested and the results reported to the council. The whole incident could occur and pass before the sample is returned to the council.

4. Human Resources

The water utility in TLA 'F' consists of two employees only. It is responsible for the quality of servicing and delivery of water treatment and supply to the community by the Contractor.

5. Technology

TLA 'F' management stated that most of its water treatment plants have an online monitoring system (i.e. automatic telemetry station) which downloads information into a computer system. For example its water reservoirs have water level monitors, which is all recorded on the computer system for easy access.

6. Cost

TLA 'F' management said: *"Because we don't know what ISO 9001 certification involves, we are not going to spend the money. Well, the council with contracting the work out, effectively makes the contractors become part of us, and we are presumably paying for that in our contractual arrangements."*

Moreover, management confirmed that cost plays a role in decisions concerning purchasing of equipment and chemicals.

7. **Problems**

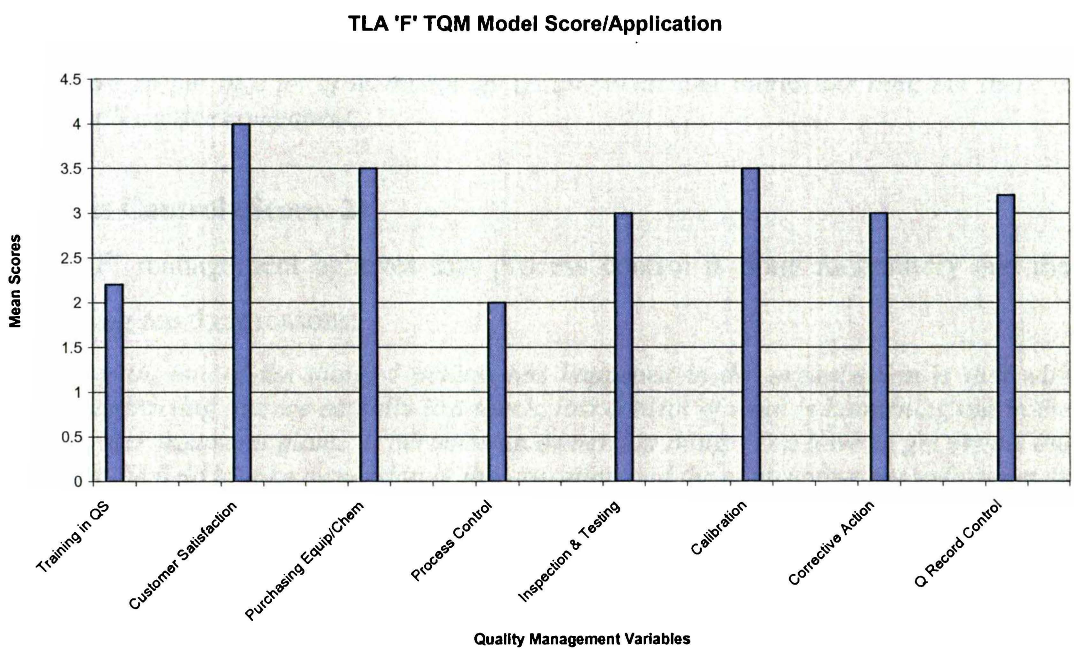
TLA 'F' management believes that one of its problems is the customer demands. It said:

> *We have several of our small communities where the consumers don't want chlorinated water, and we have to battle to actually implement drinking water standards.*

5.10.3 Quantitative Variables

The following Figure 5.10 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.10 TLA 'F': Average Mean of all Quality Variables



SOURCE: Author's Figure

According to this analysis, "Customer Satisfaction" scored the highest (i.e. 4) while "Process Control" scored the lowest (i.e. 2).

1. **Training (Score: 2.2)**

   TLA 'F' management stated that there is no financial resources allocated for training personnel on quality systems and the reason behind that is that it neither has a quality system nor ISO Certified. On the other hand, the Contractor confirmed that there are financial resources allocated for quality systems training.

2. **Customer Satisfaction (Score: 4)**

   The Contractor stated that it has two customers; TLA 'F' and the community. Concerning the TLA, it has to review its requirements on a monthly basis. In the case of the community, TLA 'F' Management has a service agreement signed with the community boards which is reviewed annually. It also started conducting customer satisfaction surveys since 1999.

3. **Purchasing Equipment/Chemicals (Score: 3.5)**

   Both Management Team in TLA 'F' and the contractor stated that quality is secondary while purchasing equipments and chemicals while cost is considered the primary determinant. The following are some of the management comments:

   > *When getting approval for purchase from council, cost plays a role in their decision.*
   > *Most of our contracts are actually done under a competitive pricing structure these days.*
   > *We do put in a lot of methodology requirements and things like that, but there is still a price component.*

4. **Process Control (Score: 2)**

   TLA 'F' management believes that process control is done moderately and the following are their reasons:

   > *Again, one of the things I believe has happened in the organisation is that with contracting out, we actually lost touch, lost control of what is happening out in the water treatment plant. It becomes an ownership thing. You have to get people out in the field to take ownership of the operation and the contracting out unfortunately does have financial implications that if you can save money on one hand, but there is other implications that may affect the operation.*

   The TLA 'F' Contractor also mentioned that its process control is moderately and that it is striving to improve it.

5. **Inspection and Testing (Score: 3)**

   The TLA 'F' Contractor believes that all the phases of inspection, monitoring and testing of water quality are conducted by qualified personnel and reported to Council F management.

   On the other hand, the TLA 'F' management disagrees with the Contractor concerning inspection and testing. It believes that only some of the phases are conducted through qualified personnel. The reason behind that is that some of the plant operators are not C grade (a qualification for water treatment technicians). It is then the responsibility of Council F management to report the results externally to the Ministry of Health.

6. **Calibration (Score: 3.5)**

   TLA 'F' management stated that calibration of minor equipment is subcontracted out to a company while most of the equipment is contracted out to a certified laboratory which it believes is accurate most of the time.

7. **Corrective/Preventive Action (Score: 3)**

   TLA 'F' management believes that the corrective and preventive actions taken in cases of transgression (which does not occur frequently in this region) is under good control and in accordance to the Drinking Water Standards 1995 regulations.

8. **Control of Quality Records (Score: 3.2)**

   TLA 'F' management admitted that it is a totally new system that it started applying recently. The exact words are:

   > *It is a new system and we haven't documented who's got copies of documents. Because this is the first year it has been done, we don't have any old documents to pull out. We are going to make sure we document data regularly and its issue date.*

   On the other hand, the Contractor believes that the quality records are well monitored since most of it is computerised.

5.10.4 Document Review

According to the Water Supply Management Plan signed between TLA 'F' and the Contractor, the main objective is to achieve the minimum water grading required by the Health Department and plan for future improvement. The grading differs between the different water service schemes i.e. urban and rural.

TLA 'F' management stated that the WINZ Program is being used as a means of documenting all the water treatment findings and reporting it directly to the Ministry of Health.

TLA 'F' started conducting customers' surveys on 1999 to have feedback from the different communities about their water supply service. The following Table 5.4 provides a summary of the customer surveys conducted by TLA 'F' since the year 1999 until the year 2000. The percentages given are for the satisfied customers with the water supply service provided by TLA 'F' in the nine different schemes under their control and maintenance.

Table 5.4: TLA 'F' Summary of Customer Survey Results (1999 – 2002)

Water Quality

Year	Percentage of Customer Satisfaction with Water Quality and Supply
2002	68%
2001	61%
2000	54%
1999	60%

SOURCE: TLA 'F' Customer Survey, 1999, 2000, 2001 and 2002.

From the above Table 5.4 we notice that the trend of customer satisfaction has improved that last two years. The following are some of the reasons given by the customers as to why they are not satisfied with their water supply by TLA 'F' as mentioned in the 2002 report of the market research company that conducted the customer surveys. Customers' responses fall under the following six points:

- No water supply/own supply/on tank water

  No water supply where we are.
  We are on tank water, any new subdivisions get piped water, they don't bother with existing homes.
  Not available, even though paying rates for this.

- Health risk/has to be boiled

  Giardia bugs in water.
  The Council said the water is AA standard, but there are still doubts within the community about that. I myself wouldn't drink that water unless it's boiled.
  Where water is taken from is unacceptable – it's often farm runoffs.

- Poor quality/not up to standard/undrinkable

  Have a water filter, would not drink out of the tap.
  Wouldn't drink it or recommend anyone else to drink it.
  Buy water in winter for drinking.

- Poor Council performance/lack of information

  The whole water scheme – pussy footing around and the amount of money being absolutely wasted, not enough notice of local expertise in setting up of the scheme, the manner of raising finds – the extra amount of cost overruns involved in developing the scheme – poor performance.

- Chlorine taste/too much chlorine

  They pump chlorine in after storms, can taste it in the water.
  People are not happy that the health standard has to be achieved by chlorination.

- Dirty/cloudy water/leaves residue

  The water comes out brown and dirty, water filter needs cleaning regularly.
  Colour and condition – leaves a brown residue, especially if it's been raining, general condition is very cloudy.

The Ministry of Health water grading in this TLA varies between 'Ba', 'Ca', 'Bd', 'De', 'Ee, 'Dd and 'Db'.

5.10.5 Summary and Conclusion

TLA 'F' has undertaken a total restructuring. As a result all its services have been contracted out. The Contractor which is responsible for the maintenance and delivery of water has been ISO 9001 and ISO 14001 certified for 4 years.

The Contracting Company runs the nine water treatment plants belonging to the nine urban water supply systems that provide community with water. They are obligated to the "Water Supply Asset Management Plan" which is an agreement signed between Council F management and the Contractor management. They also incorporate the requirements of the New Zealand Drinking Water Standards 1995.

5.11 Case Study 7 (TLA 'G')

This TLA serves a population of 17,992. Two managers were interviewed from this TLA. TLA G's Utilities Assets Department is responsible for the provision of water. Nevertheless, the operation and maintenance of the seven water treatment plants which provides water to seven townships in this area is contracted out. TLA 'G' is adopting TQM tools and is ISO 9001 certified since 1997 (Refer to Chapter 3, Section: 3.4.1 ISO 9000 Series Standards). Participant observations were conducted at all the seven water treatment plants of TLA 'G' during August-September 2001. Sporadic visits were paid to the water treatment plants until the end of the year.

5.11.1 Deductive Themes

1. **Quality Definition**

   TLA 'G' Management defined quality as:

   Supplying a product to an agreed standard
   Product of high standard

   It has also been noticed through participant observation in some of the water treatment plants that the technicians are keen on following the New Zealand Drinking water Standards as a means of delivery a high quality of drinking water to the small communities they are serving.

2. **Innovativeness**

   TLA 'G' is still in the initial phase of adopting the TQM tools and in the early phases of changing from the old paradigm of management to the new one; hence, innovation is still a long way from now.

3. **Teamwork**

   It has been noticed through participant observations that the water treatment technicians of the different seven plants work as a team to deliver a good service. There are always three technicians on roster and they meet daily either in the main office or a specific meeting place depending on the situation of their site i.e. plant. During those daily meetings, technicians discuss with each other the incidents that happened earlier and if there is an issue that needs to be taken care of. Also, they arrange the days work schedule and different responsibilities.

4. **Responding to Opportunity**

   TLA 'G' management suggested that they took the opportunity to adopt TQM tools and get ISO 9001 certifications as a means of having a quality system in place.

5. **Common Vision**

TLA 'G' management believes in the continuous improvement process through adopting a sound quality system. Moreover, it seeks feedback from employees and water treatment operators for the purpose of improvement.

6. **Expertise**

This theme is similar in status to the innovation theme

7. **Leadership**

TLA 'G' Management Team stated that it sought the ISO 9000 certification to put systems in place and help improve quality. The Utilities Asset Manager said:

A credence, or support that we are meeting a high standard.

5.11.2 Inductive Themes

1. **Organisational Attitudes and Goals**

TLA 'G' management suggested that the whole organisation's goal is presenting a quality service to the public. They are proud of their inquiry response system, a system managed through the phone to deal with problems or complaints of a query or request by the community. This system makes sure that an action is taken and a response given to the complainant.

2. **Organisational Forms and Activities**

Through participant observations it has been noticed that two of the towns under the jurisdiction of this council are fed through gravity i.e. there is no pumps in the water treatment plants.

Although there are 3 technicians on roster duties responsible for checking each of the eight plants, the schedule varies from one plant to the other depending on the size of the plant and the size of community served. For example, in one plant only the technicians work for a full day and are on pager system to be notified in case of problems. At other plants the technicians visit only once a day in the morning while other plants get to be visited once a week. Moreover, in the week-ends the technicians work between three to four hours only. The technicians who do not work full days on the water treatment plant are being utilized by the contractor to do jobs in the town other than maintenance of the water treatment plants.

Plant technicians stated that they add only chlorine and lime to the water but no fluoride which used to be added 6 years ago, due to consumers requests.

3. **External Factors**

The weather plays a role in the quality of drinking water. TLA 'G' Management gave an example of the areas that have a dam and how in spring and early summer that water quality is not up to the standards because of growth of algae which affects the water taste and odour. Nevertheless, TLA 'G' management is trying its best to resolve this problem. The exact words were:

> *At the moment we are carrying out a study of the dam, over 18 month period, looking at different levels and different readings at different levels of the dam. At the end of the day, we are hoping to come up with a Management strategy to minimise the effects of the algae.*

Moreover, rain also affects the turbidity of the water as mentioned by several water treatment plant technicians.

4. **Human Resources**

There are three technicians working on roster for each of the seven water treatment plants. The eighth plant is very small. This small plant gets its water from a bigger water treatment plant close by. It has been mentioned by technicians that since this is a little plant, they are not strict on checking it everyday as with the other plants which means that the size of the community plays a role on how things run.

5. **Technology**

It has been noticed through participant observations that TLA 'G' technology is basic. This is obvious through its use of manual systems which are not computerised and leave a lot of room for human errors. Several of its water treatment plants are small with simple equipment.

6. Cost

It has been confirmed by management that TLA 'G' is still abiding by New Zealand Drinking Water Standards 1995 and that it has not received the 2000 version yet. In 2001, TLA 'G' received the New Zealand Drinking Water Standards 2000. Its management said that they have until 2005 to bring everything up to that new standard. TLA 'G' management said the reason behind that is:

> *Because otherwise it would cost local councils a lot of money to change from one standard to the other instantly. A huge amount of money.*

7. Problems

TLA 'G' Services Engineering Management indicated that customers could play a role in affecting the quality of drinking water through faulty practices. The example given was when customers store water in an insecure tank which could get contaminated easily and not only affect the household, but also may affect the waterline going along a street. Accordingly, the Council G took measures to make sure those customers especially farms to install non-return backflow prevention device.

It has been noticed through participant observation that one of the plants always had problems with blockages especially when it rained. The plant operators had to quickly come and clear the filters.

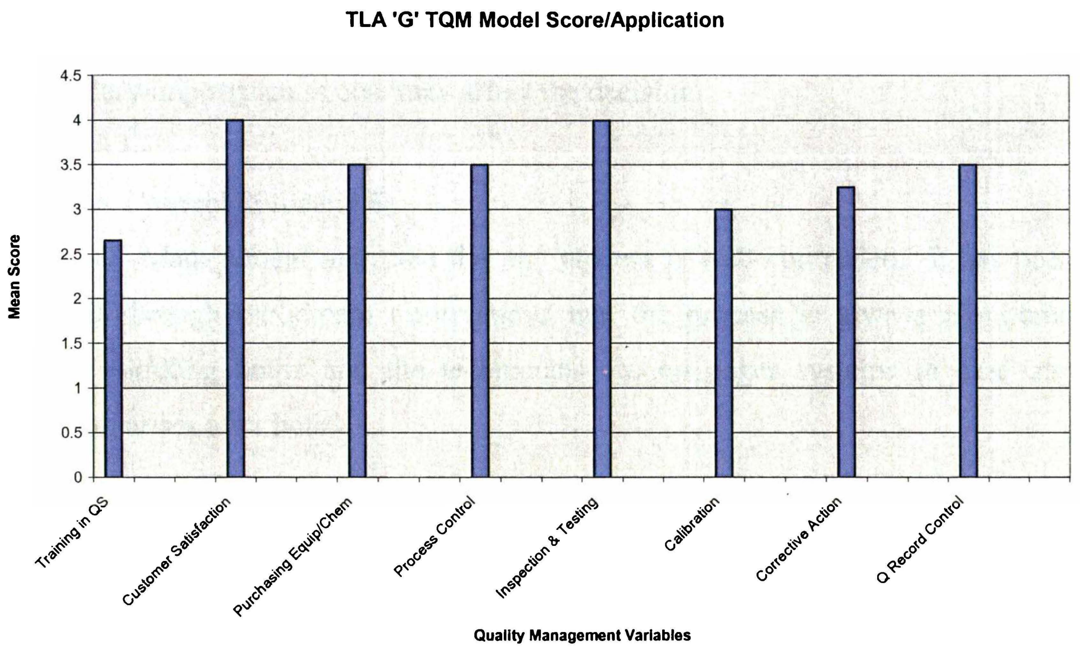
Moreover, it has been noticed that there is lack of information and knowledge among plant operators of TLA 'G'. The following incident supports that:

When the plant technician was taking a water sample from outside the plant, the researcher asked him about what he was doing to which the reply was to measure how much it rained overnight. When the researcher asked him the reason behind this procedure he did not know the reason behind it. He said: *"its part of my daily routine and I don't know what they are doing with it."*

5.11.3 Quantitative Variables

The following Figure 5.11 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.11 **TLA 'G': Average Mean of all Quality Variables**



SOURCE: Author's Figure (El-Kafafi, 2002a and 2002b).

According to this analysis, both "Customer Satisfaction" and "Inspection and Testing" scored the highest (i.e. 4) while "Training in Quality Systems" scored the lowest (i.e. 2.65).

1. **Training (Score: 2.65)**

   TLA 'G' Management Team was not very clear or knowledgeable when asked about training funding for quality systems. Through observation, it has been noticed that water treatment technicians get trained by going to workshops and on job training.

2. **Customer Satisfaction (Score: 4)**

   TLA 'G' has been conducting customers' surveys since 1991 seeking the community's feedback in relation to their satisfaction with their water quality provided by the TLA. Moreover, the Management Team added by saying that when TLA 'G' is conducting any project or further studies, it sends questionnaires to the community seeking their feedback.

3. **Purchasing Equipment/Chemicals (Score: 3.5)**

   TLA 'G' Management had a split opinion in relation to this category i.e. some said quality demonstrates the main criteria in selecting suppliers or subcontractors of equipment and chemicals. On the other hand, others said that quality is of secondary importance as cost may affect the decision.

4. **Process Control (Score: 3.5)**

   TLA 'G' Management indicated that the process is well controlled. It has been noticed through participant observations that the process is always monitored during working hours and the technicians are on pager systems in case any problem arises after hours.

5. **Inspection and Testing (Score: 4)**

   TLA 'G' Management Team confirmed that all the phases of monitoring and testing the drinking water quality are under control and conducted by qualified personnel all the time. It has been noticed through participant observation that the council has got both an internal and external auditing system to support quality assurance of the system.

6. **Calibration (Score: 3)**

   TLA 'G' Management Team stated that the calibration of equipment is contracted out to four different companies depending on the instrumentation. It has been noticed through participant observation that equipment is calibrated correctly, regularly maintained and documented to keep track of next time it is required to be done.

7. **Corrective/Preventive Action (Score: 3.25)**

   TLA 'G' Management stated that "corrective actions" is always on the agenda for the team management meeting which is held once every two weeks. It has been confirmed through participant observation that the council employees endeavour to use quality improvement tools e.g. fish bone and statistical analysis for finding out the source of the problem and taking the right measures to prevent it in future.

8. **Control of Quality Records (Score: 3.5)**

   TLA 'G' Management Team stated that quality records are well monitored. It has been verified through participant observation that every step of the process is documented and the important steps are then compiled to be fed in a computer system on a weekly basis to enable easy access and retrieval whenever information is required.

5.11.4 Document Review

TLA G's goal is to provide an adequate, reliable, potable water supply to consumers as per their annual report. The following are its performance measures:

1. Maintain the minimum and maximum quality standards (as outlined in the New Zealand Drinking Water Standard) for 95% of the recorded tests.
2. To restore 95% of interruptions to the supply to affected consumers within 12 hours of notification.
3. Implement the actions identified in the Asset Management Plan improvement programme.
4. Improve overall customer satisfaction of Council water supplies as measured by the annual satisfaction survey.
5. Undertake the capital and renewal works identified in accordance with contractual specifications and within the annual budget.

TLA 'G' Management stated that the WINZ Program for documenting all the water treatment findings and reporting it directly to the Ministry of Health has just been installed but still not in use.

TLA 'G' started conducting customers' surveys on 1991 to have feedback from the different communities about their water supply service. The following Table 5.5 provides a summary of the customer surveys conducted by TLA 'G' since the year

1992 until the year 2002. The percentages given are for the satisfied customers with the water supply service provided by TLA 'G' in the nine different schemes under their control and maintenance.

Table 5.5: TLA 'G' Summary of Customer Survey Results (1991 – 2002)

Water Quality

Year	Percentage of Customer Satisfaction with Water Quality and Supply
2002	59%
2001	61%
2000	52%
1999	51%
1998	58%
1997	58%
1996	62%
1995	60%
1993	66%
1992	64%

SOURCE: TLA 'G' Customer Survey, 1992 - 2002.

Table 5.5 shows that there is a slight decrease in customer satisfaction and the reason behind it is unknown since the customer satisfaction reports do not mention the reasons behind their dissatisfaction. The 1993, 1995 and 1996 reports mentioned the reasons behind customers' dissatisfaction with the water provided by the council, while the rest of the reports do not mention it. The 1994 report was missing.

The following are excerpts of customers' replies taken from those three reports. They fall under the following five points:

- Discoloured/brown/dirty water

  Turns whites brown, stains.
  In the summer months the water is disgusting.
  Water takes days to clean after flushing, needed to have a purifier installed.

- Poor quality of water

  Inconsistency in water quality.
  Quality of water is poor – unattractive to point where I'm buying water.

- Tastes awful

  Nasty taste.
  Doesn't taste too well – don't drink as much as a consequence.

- Chemicals in water/smell chlorine

Gets very chlorinated sometimes – then it is impossible to drink.
Chemicals a bit strong sometimes – in the morning chlorine smell is a bit overpowering.

- Supply needs improving/lacks maintenance

They've said they're going to fix it and they haven't – two years ago it started.
Engineering much up, lines filled up with much, blown out regularly.

The Ministry of Health water grading in this TLA varies between 'Aa', 'Ba' and 'Cc'.

5.11.5 Summary and Conclusion

The Case study analysis shows that TLA 'G' has been abiding by the New Zealand Drinking Water Standards (NZWS) 1995. Council G is definitely adopting the TQM Model in their managerial system for water treatment. Its operation and maintenance of its eight water treatment plants has been contracted out and been ISO 9001 certified for approximately 5 years. However, they are not ISO 14000 certified.

Participant observations conducted in this TLA revealed issues that were not obvious in the other two TLA's observed (i.e. TLA 'A' and 'H'). For example, it seems that the size of population plays a great role in the water treatment system i.e. how many visits by plant operators and how simple or sophisticated the water treatment system is. This may be related to costs, TLA resources, or something else. Maybe it has something to do with the fact that the treatment system is contracted out to another company other than the TLA. More research should be conducted to find answers for such questions.

It has also been noticed that the plant operators are used to do maintenance work all around the town besides their responsibility of taking care of the water treatment plants. Why? Is this the policy with all subcontractors? Is it a financial issue? Is this the system? It appears that in seeking to be cost effective, they may be incurring adverse outcomes which may be greater than the cost savings. That is another area that requires further research.

5.12 Case Study 8 (TLA 'H')

TLA 'H' serves a population of 22,714. Two managers were interviewed from this TLA. One department is responsible for four water treatment systems i.e. they serve different sized communities.

TLA 'H' is not applying any of the TQM teachings or quality tools. It is neither ISO 9000 nor ISO 14000 certified. None of its laboratories are accredited. TLA 'H' is abiding by the New Zealand Drinking Water Standards 1995.

Participant observations were conducted at the four water treatment plants of Council H during September-October 2001. Sporadic visits were paid to the water treatment plant until the end of the year.

5.12.1 Deductive Themes

1. **Quality Definition**

   TLA 'H' management team defined quality as:

   To meet the New Zealand Drinking Water Standards 1995
   Quality is water that is fit to drink by whatever standard we set or is imposed on us
   Quality is a class product, its not ordinary

2. **Innovativeness**

   That theme does not apply to TLA 'H'. The management team confirmed that TLA 'H' is content with applying the traditional system as long as it conforms to the New Zealand Drinking Water Standards 1995.

3. **Teamwork**

   It has been noticed through the participant observations that the water treatment plant technicians work as a team work, helping each other to achieve their mutual goal i.e. providing a quality drinking water to the community.

4. **Responding to Opportunity**

   This theme does not apply to TLA 'H'.

5. Common Vision

Both Management and employees of TLA 'H' share the common goal of providing a high quality water treatment to the community through the application of the New Zealand Drinking Water Standards 1995.

6. Expertise

This theme does not apply to TLA 'H'. During the interviews the management team stated that they have been lucky and did not have any major problems. They said *"We haven't had to do anything major to achieve the grading that we have got now compared to what traditional methods we have been always using."*

7. Leadership

TLA 'H' Management believes that they do not need to apply any TQM Models i.e. ISO 9000 or ISO 14000 certification and that it is enough abiding by the New Zealand Drinking water Standards 1995 and at the same time they are trying to improve and continuously update their procedures.

5.12.2 Inductive Themes

1. Organisational Attitudes and Goals

Both TLA 'H' Management and water treatment technicians' main goal is to provide a quality treatment water conforming to the council's annual plan and the New Zealand Drinking Water Standards 1995.

2. Organisational Forms and Activities

It has been noticed through observations that the two computerised plants are the bigger ones who are serving larger populations. It has also been noticed that the technician on duty travels daily checking three water treatment plants. The fourth plant which is over an hours drive away in the middle of the bush, is visited once a month only. There are some exceptions and one of them was during one month of the observation period when the water treatment technicians went there once every week to add a new chlorine cylinder and to be present while the plant is being audited by an engineer representing the company providing chemicals to the council for the purpose of water treatment. This company audits their clients annually. This plant is different from the other three plants. There are no filters in this plant and they only add chlorine to the water after it is extracted from a spring nearby. The plant is situated on the bank of the spring.

3. External Factors

TLA 'H' Management stated that at one stage they had lots of complaints from customers in relation to the taste of drinking water provided to the community in one of the rural areas. When investigated they found out that the cause of the problem was caused by the water getting dirty at the south end of the river which affects the taste and odour created by the soil and clay in the water. TLA 'H' managed to deal with this problem by increasing the chlorine dose in the water.

4. Human Resources

There are five technicians taking care of water treatment in the four water treatment plants under the supervision of TLA 'H'. The technician on call usually has a lap top computer and a mobile telephone to be able to check and adjust things in case of emergencies. The water treatment plant technicians mentioned that the lab top is not good because the program is set up to work on a 14" screen; hence, they cannot see everything on the lap top screen. This system applies to only two water treatment plants that are computerised and can be controlled by the plant technicians after working hours.

5. Technology

The two big water treatment plants are computerised. Nevertheless, the biggest of the two plants has a problem with two if its filters i.e. it was not filling automatically with water as it should; hence, the technicians has to close the filter valves manually to enable it to fill with the required water. This issue has been noticed during observation and there was no indications that any other action is going to be taken to rectify the issue other than filling the filter manually once it is completely dry.

6. **Cost**

TLA 'H' Management stated that one of the main reasons for not applying for the ISO 9000 certification is the additional cost that the TLA's budget cannot handle at the time being.

Moreover, according to management, price plays a role in decisions related to equipment and chemical purchases.

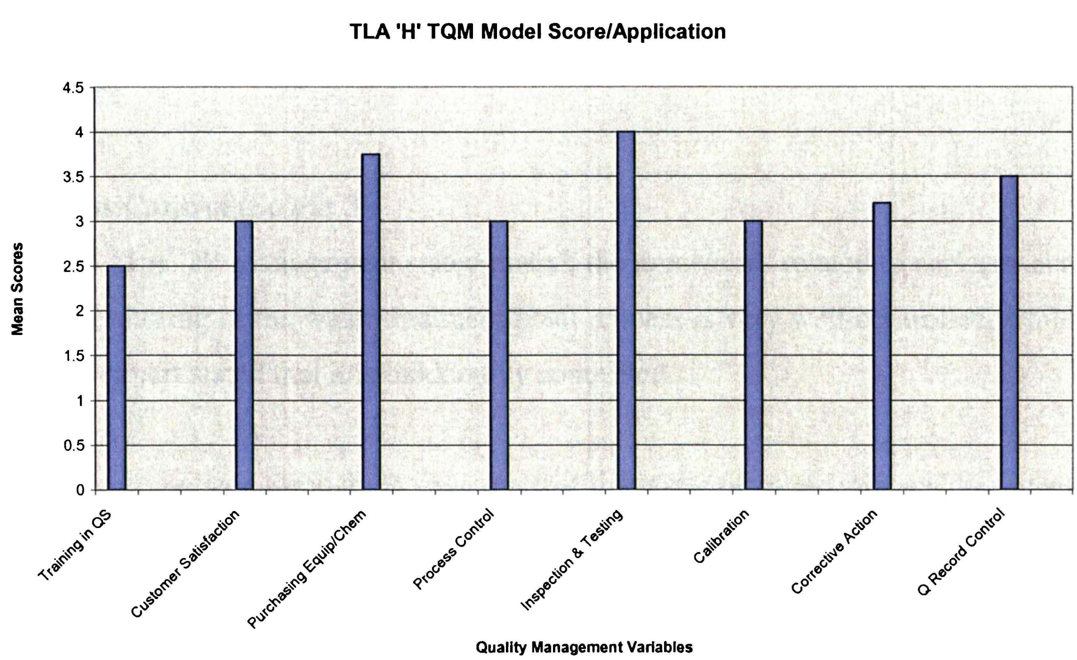
7. **Problems**

It has been mentioned by TLA 'H' water plant technicians and also noticed during the participant observations that plant operators spend a big portion of their working day travelling around the water treatment plants to maintain them. This could have an effect on the speed of tending to problems.

5.12.3 Quantitative Variables

The following Figure 5.12 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.12 **TLA 'H': Average Mean of all Quality Variables**



SOURCE: Author's Figure (El-Kafafi, 2002a and 2002b).

According to this analysis, "Inspection and Testing" scored the highest (i.e. 4) while "Training in Quality Systems" scored the lowest (i.e. 2.5).

1. **Training (Score: 2.5)**

   TLA 'H' does not allocate a budget for quality training of its employees. However, they make sure that their water treatment plant technicians get their required grading (i.e. A, B& C certificates) of water treatment certification.

2. **Customer Satisfaction (Score: 3)**

   The Management Team admitted that TLA 'H' does not conduct annual surveys of customer satisfaction. The exact words were: *"If the council feels they have to do a customer survey, they will do it."* On the other hand, TLA 'H' has a phone system in which the community could phone and report on problems and complaints. Management also mentioned that there was a customer survey conducted in 1989 but no trace of the document would be found. The next customer survey conducted by TLA 'H' was the one of the year 2000 (Refer to Section 5.12.4: Document Review).

3. **Purchasing Equipment/Chemicals (Score: 3.75)**

   Part of TLA 'H' Management Team stated that quality is the main criterion in selecting suppliers or subcontractors for equipment and chemicals purchase, while the other part stated that quality comes secondary because they have to consider the price.

4. **Process Control (Score: 3)**

   Part of TLA 'H' Management stated that all the procedures related to performance and monitoring of the water treatment plant process is very well controlled, while the other part stated that it is moderately controlled.

   It has been noticed through observation that the water plant technicians document all the steps of the process. The forms are left on site so that the next technician on duty follows what happened in the earlier shift. The plant operators also mentioned that it's a good way to trace problems when occurring.

5. **Inspection and Testing (Score: 4)**

TLA 'H' Management Team stated that all the phases of monitoring and testing the drinking water quality are controlled and conducted by qualified personnel. This has been confirmed through the participant observation. TLA 'H' has an alarm system that is computerised and attached to a pager system to inform the technicians on duty in case of a problem arising i.e. an alarm is triggered when any instrument in below the quality standard.

6. **Calibration (Score: 3)**

TLA 'H' Management stated that the accuracy of all measuring equipment is calibrated most of the time according to the manufacturers' instructions.

7. **Corrective/Preventive Action (Score: 3.2)**

TLA 'H' Management stated that it does not have a documented problem sheet to instigate a remedial action on specific problems. When a problem occurs it is discussed within the group of operations and engineering to see if anybody's come across the problem before and work to solve it. If the group could not come up with a solution for the problem, they refer to others who may have encountered the same problem, may even do that first because it's usually a lot faster to ask somebody else then to think about it yourself. The following case was given as an example:

> *Well, the problem there was the dirty water... We had a continuing problem with iron and manganese deposits breaking free periodically and building up in the distribution system and causing slugs of dirty water, which is unacceptable to the consumers. What we basically did to resolve the situation was to do research into different methods of removing the iron and manganese before it got into the reticulation system. The system that was easiest for us to try was moving the chlorine point from half the filtration to just prior to the filters which oxides the iron and manganese before it should be trapped in the filters. Unfortunately, our filters at that time were sand filters and the iron and manganese were not trapped in there. The next improvement was to refurbish the old filters. The system we chose for refurbishment was a dual media system of sand and silicon sponge. Three out of the five filers were refurbished. The silicon sponge filters managed to absorb all the iron and manganese and eliminated it from the system. It traps it and it doesn't go anywhere from there. So that was the measures taken for that situation.*

8. **Control of Quality Records (Score: 3.5)**

TLA 'H' Management team indicated that since it does not have a quality system, there is no real control of quality records. On the other hand, TLA 'H' management stated that documents are reviewed and re-authorised whenever there is a change or modification in any of their processes.

5.12.4 Document Review

As mentioned in TLA H's Annual Plan (2002/2003), their main aim is to provide high quality water treatment and distribution to both urban and rural areas. The following are the TLA's performance targets to ensure that a continuous supply of drinking water is provided to customers:

1. Maintain reservoir levels above 40% at all times.
2. Resolve all complaints concerning lack of water supply within three hours of notice.
3. Limit duration of planned shutdowns to a maximum of eight hours per day.
4. Sample and test water to achieve compliance with the Drinking Water Standards for New Zealand 2000, in accordance with the prescribed schedule in the Standards.
5. Give customers at least 24 hours notice before any planned shutdown of the water reticulation system.

TLA 'H' Management stated that they use the WINZ Program for documenting all the water treatment findings and reporting it directly to the Ministry of Health has just been installed but still not in use.

TLA 'H' has conducted only two customers' surveys; one in the year 1989 and the second in 2000. The 1989 document could not be traced by management. In the 2000 Customer Survey, the customers were only asked one question about their satisfaction with the water supply and nothing was mentioned in relation to the quality of water. Moreover, there was no overall percentage provided for the satisfaction rate in this district. The total number of respondents was 473. The following Table 5.6 shows their rating in relation to water supply.

Table 5.6 TLA 'H' Customers' Respondents Rating of Water Supplies

	Very Poor	Poor	Average	Good	Very Good	Don't know
Respondents (473)	5.9%	7.6%	20.7%	39.1%	25.4%	1.3%

SOURCE: TLA 'H' Customer Survey, 2000.

Since there is only one lot of data, it is impossible to compare it against any other to decide if there is any improvement in TLA 'H' drinking water quality.

The Ministry of Health water grading in TLA 'H' varies between 'Aa', 'Ad' and 'Bd'.

5.12.5 Summary and Conclusion

The Case study analysis shows that TLA 'H' has been abiding by the New Zealand Drinking Water Standards (NZWS) 1995 and has upgraded recently to the NZWS 2000 as stated in their 2002/2003 Annual Plan. Council H is not adopting any TQM Models in their managerial system for water treatment as verified by the use of two types of triangulation as per the main research methodology.

The operation and maintenance of its four water treatment plants are taken care of by five technicians in total who work on roster and travel daily among the three main plants but visit the fourth plant only once a month. It seems that the size of the community determines not only the size of the plant and the number of visits, but also the number of technicians working.

5.13 Case Study 9 (TLA 'I')

Council I serves a population of 15,394. Two managers were interviewed from this TLA. A Department is responsible for the management and provision of drinking water in this district. TLA 'I' is responsible for eight different water supply systems. Nevertheless, TLA 'I' has four *"full treatment plants"* as specified by the management team. The rest are considered *"partial treatment plants"*. When the researcher asked for an explanation, she was told that those partial schemes have coarse filters, not fine ones and that only chlorine is added to the water before it is delivered to the community. On the other hand, the other four water treatment plants get a full treatment process i.e. coagulation, filtration, chlorine and pH in accordance with the New Zealand Drinking Water Standards 1995.

TLA 'I' has not adopted any TQM Models i.e. it is neither ISO 9000 nor ISO 14000 certified. It only follows the New Zealand Drinking Water Standards 1995 in its main 4 water treatment plants as mentioned by its management team who were interviewed from both the Engineering Services Department and the Planning and Environmental Services Department.

There was no participant observation conducted in the water treatment plants under the supervision of this TLA.

5.13.1 Deductive Themes

1. **Quality Definition**

   TLA 'I' Management team identified quality as:

   The level of contamination within the water
   Fit for purpose

2. **Innovativeness**

   This theme does not apply to TLA 'I'.

3. **Teamwork**

   The management team stated that TLA 'I' uses the team based problem solving technique in general and not in relation to quality because they do not have a quality system.

4. **Responding to Opportunity**

   Again this theme does not apply to TLA 'I' due to the belief of management that they do not really need to pursue any system that may create economic problems for their small sized council.

5. Common Vision

TLA 'I' Management believes that the since TQM became popular five years ago it started making small improvements for the sake of continual improvement. Management stated that TLA 'I' started monitoring its key parameters, monitoring trends to see what is going wrong and make corrections.

6. Expertise

As stated in the face-to-face interviews, TLA 'I' management believes that *"quality management doesn't necessarily need to be formalised to the extent of a written document. I mean just the annual plan, annual reporting process is a quality management system in its broadest context."*

7. Leadership

TLA 'I' Management believes that it is not a good idea for small size councils to apply for any ISO certification because *"it takes a lot of work and you are not sure of the end result."* TLA 'I' management thinks that there is no benefit in adopting TQM guru teachings or being ISO certified.

5.13.2 Inductive Themes

1. Organisational Attitudes and Goals

As stated in the face-to-face interviews, the main goal of TLA 'I' is to provide quality drinking water to its community in its district and to conform with the New Zealand Drinking Water Standards 1995, only for its main 4 water treatment plants. The following is a quotation from one of TLA I's management team:

> *...the council's statement, vision for the future and its values encapsulate a quality system. They talk about the successful provision of services, at facilities, on behalf of the community and the wise use of management resources. Then it talks about a range of services and facilities and the communities' needs and realistic expectations.*

2. Organisational Forms and Activities

The Environmental Managers stated that in the Planning and Environmental Services Department they have been looking at some of the Malcolm Baldrige Award principles and considering applying for it.

The following quotation was taken from the face-to-face interviews conducted with the management team explaining the reason behind not applying full treatment in the rural areas.

> *The quality of the water is something, but the customer expectation is quite different, because they're farming supplies, and they only expect something ·good enough for drinking cows. Their prime objective for the water is not for human consumption but for cow consumption, and they happen to use it in their houses. So even though its very poor quality of water, they're quite happy with the standard.*

3. External Factors

The customer can have an impact on the quality of water they receive as mentioned by one of the council's management team. The following are some of the issues discovered that impact on the quality of water:

- Customers' plumbing system within their house.
- Customers leaving their hose connected to the tap results into backflow in the main system.
- Substandard pipes and fittings within the property i.e. some taps may have very high lead and cadmium which can affect the water if customers do not flush it before drinking. Eventually this affects customers' health and well being.

Another TLA 'I' management team member stated that in the rural areas it is the customers' responsibility to store their drinking water and if they do not store it properly, the water quality is poor.

4. Human Resources

Since there was no participant observations conducted in TLA 'I', this theme could not be commented on.

5. Technology

Through conversations with the management team it seems that technology in TLA 'I' is basic. The management team emphasized that only one treatment plant meets the New Zealand Drinking Water Standards while the other 3 plants don't. The partial treatment plants are *"not even close to meeting any standard."* Hence, TLA 'I' management team feels that it is not necessary to have any sophisticated technology and stick to basics since the community are not complaining and are satisfied with things the way they are.

6. Cost

In the face-to-face interviews, management indicated that adopting ISO 9000 certification is *"not appropriate"* for small organisations like TLA 'I' who has only 4 small water treatment plants and if they apply it, there would be *"a real economic problem."*

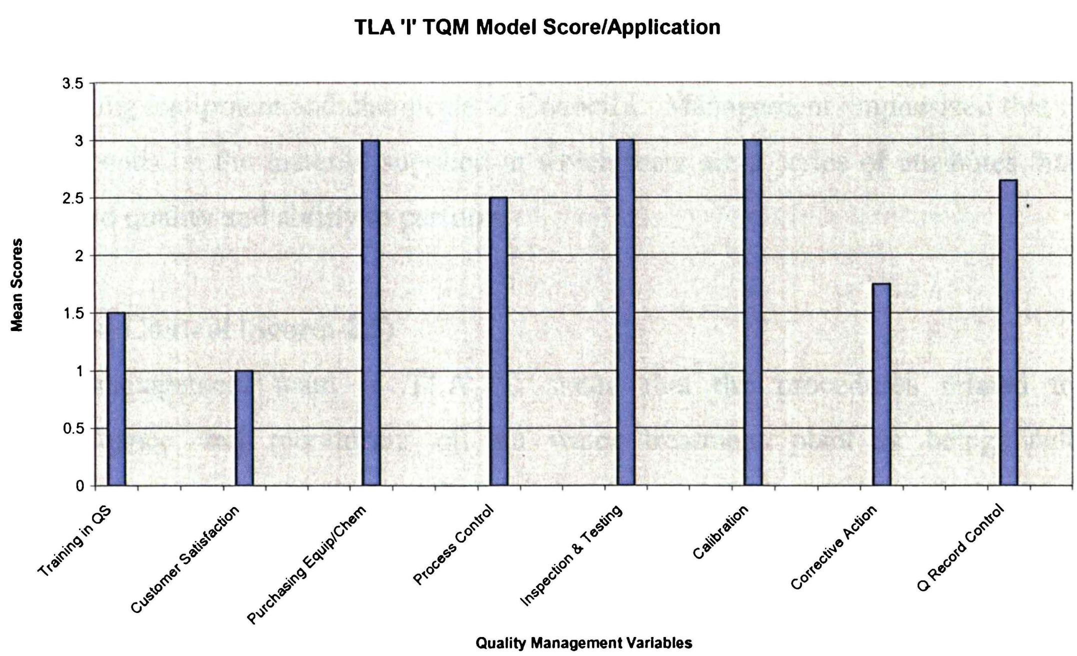
7. Problems

It has been mentioned by one of the management team in the face-to-face interviews that a while ago TLA 'I' had a problem with its chlorinator so the dosing failed. Hence, TLA 'I' issued a boiling water warning to the community. It took the TLA three days to return the drinking water back to the required standard. The problem was solved by purchasing a different brand of chlorinator.

5.13.3 Quantitative Variables

The following Figure 5.13 shows the mean score across all eight variables on a 5 point likert scale.

Figure 5.13 <u>TLA 'I': Average Mean of all Quality Variables</u>



SOURCE: Author's Figure

According to this analysis, "Purchasing Equipment/Chemicals", "Inspection and Testing", and "Calibration" scored the highest (i.e. 3) while "Customer Satisfaction" scored the lowest (i.e. 1).

1. **Training (Score: 1.5)**

   TLA 'I' Management confirmed that there is no budget allocated for training personnel to perform the work of the quality system.

2. **Customer Satisfaction (Score: 1)**

   It has been noticed through the face-to-face interviews that the management team was not really sure of the exact dates of customers' surveys conducted by the TLA 'I'. Management stated that the first customer survey was conducted either in 1994 or 1995 and it was an informal survey and not documented. Another phone survey was conducted in 1998/1999. The last survey was conducted on the year 2000. TLA 'I' Management confirmed when asked that there is no mention of water in this survey. Management even admitted that TLA 'I' moderately satisfies customers' requirements and specifications. TLA 'I' management explained that this is due to the partial treatment schemes in the rural areas of this district that do not conform to the New Zealand Drinking Water Standards 1995.

3. **Purchasing Equipment/Chemicals (Score: 3)**

   The management team stated that the quality could either be the main or the secondary important criteria for selecting their suppliers or subcontractors for providing equipment and chemicals to Council I. Management emphasized that it all depends on the material supplied in which there are a series of attributes that relate to quality and ability to perform.

4. **Process Control (Score: 2.5)**

   One management team in TLA 'I' stated that the procedures related to performance and monitoring of the water treatment plant is being well documented and controlled, while the other part said that it considered it only controlled moderately.

5. **Inspection and Testing (Score: 3)**

   TLA 'I' Management stated that most of the phases of monitoring and testing the drinking water quality are controlled and conducted by qualified personnel.

6. **Calibration (Score: 3)**

   TLA 'I' Management stated that minor equipment (e.g. thermometers and scales) are being calibrated on site and it is accurate most of the time. Most other equipment is being calibrated by the supplier and management believed it was accurate most of the time.

7. **Corrective/Preventive Action (Score: 1.75)**

   One management team was not able to give a direct answer concerning whether or not TLA 'I' has any procedures to be applied when a problem arises and if they take any preventive action so it does not reoccur. On the other hand, another management team stated that they do have an investigative process when problems arise. Depending on the size of the problem they would go about the investigation and try to find a solution.

8. **Control of Quality Records (Score: 2.65)**

   Another controversy arose among TLA 'I' management team when replying to this theme. Part of them mentioned that quality control records are very well recorded and monitored and that they can easily retrieve accurate information which is kept for more than five years in the council. On the other hand, another management team member stated that documents are poorly controlled. He gave an example when staff failed to locate certain document when management was introducing an audit trial for the TLA's KPIs (Key Performance Indicators).

5.13.4 Document Review

TLA 'I' Management team stated that they have WINZ Program but they are not using it yet because one of the rules is that they should get training from the Ministry of Health before starting to use it. Management mentioned that even the TLAs who are using it are not very satisfied with its performance. Hence, the TLA uses an excel spreadsheet to store their data results.

It is mentioned in TLA I's Asset Management Plan for Engineering Water Supplies (November 2000) that a market research company undertook a survey on behalf of the council in June 1992. Four hundred telephone interviews were undertaken throughout the district. Eleven percent of the people surveyed indicated dissatisfaction with water. *"The level of satisfaction with the water supply is relatively high, 85% with 51 very satisfied."* The main reasons emerging for dissatisfaction were:

- Poor quality of water (mentioned by 5% of residents)
- A shortage of water – water runs out or is turned off (3%)

Furthermore, the reports states that the council is proposing to undertake a further survey in the 1998-2001 period.

If we compare the document review with what was mentioned in the face-to-face interview with the management team, we would find there were some small discrepancies. This raises doubts about the management practice.

The Ministry of Health water grading in TLA 'I' varies between 'Ba', 'Cb', 'Db', 'Dc', 'Dd' and 'De'.

5.13.5 Summary and Conclusion

The Case study analysis shows that TLA 'I' has been abiding by the New Zealand Drinking Water Standards (NZWS) 1995 in relation to its four fully treated water treatment plants. As stated by management, only one plant is up to the standards. TLA 'I' also abides by its Asset Management Plan for Engineering Water Supplies. TLA 'I' is not adopting any TQM Models in their managerial system for water treatment as verified by the use of two types of triangulation as per the main research methodology.

5.14 Conclusion

This chapter presented the triangulation (mixed methodology) analysis of the nine case studies within the Waikato Region. Moreover, it detailed each case with its themes, categories, findings and conclusions. It also helped set the basis for the next chapter where cross case analysis is used to discover the similarities and differences among the nine cases under investigation. These findings can potentially enhance quality management practices in New Zealand water utilities.

CHAPTER SIX:
CROSS CASE ANALYSIS

6.1 Introduction

The purpose of this chapter is to derive learning from the set of cases as opposed to focusing on the individual cases themselves. This involved cross case analysis of the nine case studies within the Waikato Region. The chapter reports on the cross case analysis method and rationale and the analysis of the nine case studies. Furthermore, this chapter includes Lewin's Change Model which was also used in analysing the organisational change taking place in the case studies under investigation.

6.2 Cross Case Analysis Method and Rationale

The researcher used mixed strategies in the cross case analysis. She started with "Case-oriented strategies" (Yin, 1984) where Yin advocates a replication strategy. In other words study one case in depth. Then successive cases are examined to see whether the pattern found matches that in previous cases. The researcher also used "Variable-oriented strategies" as advocated by Pearsol (April, 1985) by locating recurring themes across the nine cases studied. Finally the researcher used the "stacking comparable cases strategy" mentioned by Miles and Huberman (1994) by writing up the nine case studies using a standard set of variables/categories. She then used matrices and diagrams to analyse each case in depth. After each case was well understood, she stacked the case level displays in a meta-matrix, which helped condensing, and permitted systematic comparison across the nine cases.

The rationale behind using cross case analysis was that the researcher followed the advice of Miles and Huberman (1994) who stated that cross case analysis deepens understanding and explanation of cases. Also, Glaser and Strauss (1967 & 1970) stressed the importance of cross case analysis as a means of helping the researcher calculate when a given order of events or incidents are likely to occur or not to occur. They stated that it also helps the researcher to build similarities and difference across the different cases, which helps later on in strengthening the theory.

6.3 Lewin's Change Model

This section discusses the relationship between Total Quality Management (TQM) and change. It also presents Lewin's Change Model, which was used in analysing and assessing the level of organisational change that took place in the nine case studies.

6.3.1 The Relationship between TQM and Change

Total Quality Management (TQM) is a management philosophy of change which: emphasises continuous improvement (Deming, 1986; Juran, 1991; Blackmore, 1989; Tenner & DeToro, 1992); focuses on internal and external customer-suppliers relations (Albrecht, 1992); develops and applies systematic measurement techniques (Taguchi, 1987; Sohal, 1991; Crosby, 1988; Deming, 1982); uses group problem solving teams to tackle process issues; and is committed to employee involvement and the development of high trust relationship through the maintenance of a non-adversarial system of industrial relations (Deming, 1986; Blackmore, 1989; Crosby 1988).

6.3.2 Lewin's Change Model

Kurt Lewin had a major influence on research within the behavioural sciences and on the development of tools for the effective management of change within organisations (Board, 1978). Lewin's work on inter-group dynamics and change proved influential in the field of Organisational Development and many theories of organisational change originated from his landmark work on planned change (Kreitner & Kinicki, 1992).

Kurt Lewin (1951) argued that in order for change to be successfully managed it is necessary to follow the following three steps:

1. **Unfreezing**

   This stage represents the recognised need for change and action is taken to unfreeze existing attitudes and behaviour. This preparatory stage is deemed essential to the generation of employee support and the minimisation of employee resistance.

2. **Changing**

   According to Lewin's technique of force-field analysis (Lewin, 1947), there are two sets of forces in operation within any social system:

   a) driving forces that operate for change and
   b) restraining forces which attempt to maintain the status quo.

   If these two opposing forces are equal in strength, then they are in a state of equilibrium. Consequently, to bring about change you either need to increase the strength of the driving forces or decrease the strength of the resisting forces.

   In practice, Organisational Development Specialists have emphasised providing data that would unfreeze the system through reducing the resisting forces rather than increasing the driving forces (Gray & Strake, 1988; & Weisbord, 1988).

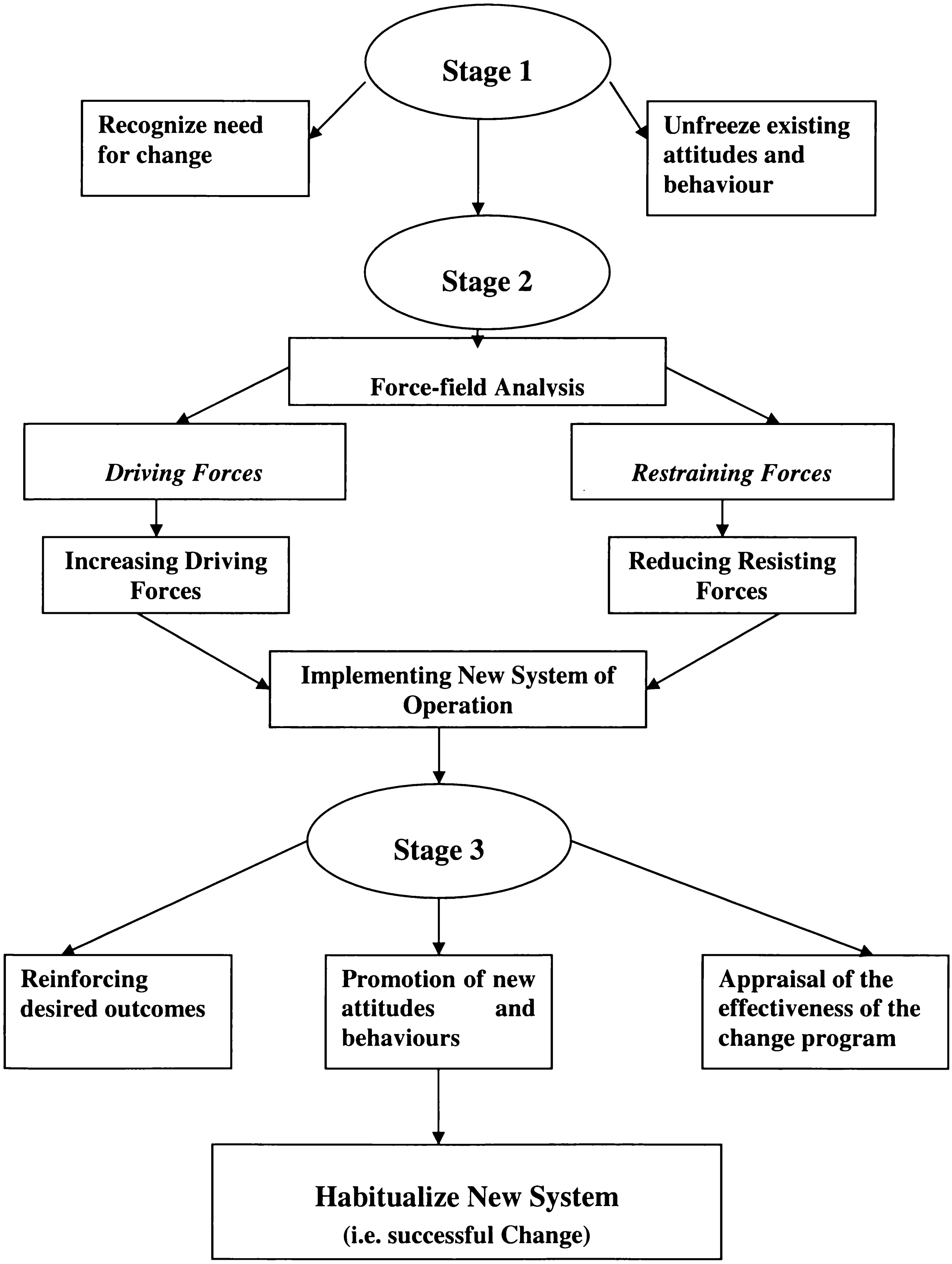
   As soon as the negative forces are removed then the organization embarks on the second stage by being involved in the actual implementation of the new systems of operation.

3. **Refreezing**

   This is the final stage of change, which involves the reinforcement of desired outcomes to promote the internalisation of new attitudes and behaviours. An appraisal of the effectiveness of the change programme is the final element used in the last step to ensure that the new way of doing things becomes habitualised (Lewin, 1947).

The following figure (6.1) illustrates Lewin's Change Model:

Figure 6.1: Lewin's Change Model



SOURCE: Author's figure (El-Kafafi, 2002b and El-Kafafi, 2002c).

6.4 Cross Case Analysis Findings

This section presents all the findings of the nine case studies within the Waikato Region. It reports on the information and findings of both the qualitative and quantitative analysis of the face-to-face interviews, participant observations and document review. This is shown in the shape of matrices to facilitate ease of findings display.

6.4.1 Qualitative Case by Case Matrices

The following matrices present each and every TLA's definition of "Quality', if they are applying any quality management systems and if they are adopting any TQM Models (i.e. ISO 9000 Certification, ISO 14000 Certification and Quality Awards). Finally it shows the benefits of adopting and applying such systems while making a correlation between their managerial systems and their water grading as per the Ministry of Health Register of Community Drinking Water Quality. It also shows if they are conducting any annual surveys seeking customer feedback in relation to the water provided by the council. In a nut shell those matrices are combining the qualitative findings of the three data collection methods utilised in this research (i.e. face-to-face interviews with the water utilities management teams, participant observations of the water treatment plants, and document review). (Refer to Appendix 2 Register of Community Drinking Water Supplies and Water Grading System in New Zealand)

Table 6.1: TLA 'A' – Population: 120,000 – 1 Water Treatment System (Face-to-face Interviews, Participant Observations and Document Review)

Attribute	Evidence
Water Grading	Aa
Community Surveys	Annually since 1990
Definition of Quality	• Meeting customers need • Consistency of product • Continual improvement
Quality Management Systems	• 5 Petal process • Fish Bone Charts • OFI Forms
TQM Models Adopted	• Treatment Lab IANZ accredited (ISO 17025 • ISO 9002 for 6 years • ISO 9001 since March 2000
Benefits	• Consistency • IANZ accredited Laboratory • Customer satisfaction with quality of service provided • Committed to continual improvement organisational change

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.2: TLA 'B' – Population: 23,895 – 6 Water Treatment Systems (contracted out) (Face-to-face Interviews and Document Review)

Attribute	Evidence
Water Grading	Aa, Bc, Db
Community Surveys	Since 1990 sometimes every alternating year or every 3 years (1 question about water supply)
Definition of Quality	• Fitness for use • Perfection & pure
Quality Management Systems	• Informal application of TQM tools (e.g. Pareto Flow Charts, histograms, Fish bone) • Developed a quality program called 'Learning Journey' with internal awards for excellence within council departments
TQM Models Adopted	• None but have their own monthly awards for employees excelling in the quality field
Benefits	• Although council is not ISO 9000 or ISO 14000 certified, their leadership is very keen on TQM & its application informally. • They even have their own monthly award system & quality program as a means of motivating their staff • Committed to continual improvement and organisational change

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.3: TLA 'C' – Population: 5,211 – 6 Water Treatment Systems (Face-to-face Interviews and Document Review)

Attribute	Evidence
Water Grading	Cc, Ec, Bb, Dd, Cb
Community Surveys	None
Definition of Quality	• Agreed set of standards between two parties • Water maintained to prevent illness in consumer
Quality Management Systems	• Performance measures of District Annual Plan • WHO Drinking Water Standards 1984
TQM Models Adopted	• None
Benefits	• Their goal is to upgrade their lab to be able to reach the NZ Drinking Water Standards 1995

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.4: **TLA 'D' – Population: 6,314 – 4 Urban Water Treatment Systems and Two Rural Systems (main treatment plant contracted out) (Face-to-face Interviews and Document Review)**

Attribute	Evidence
Water Grading	Aa, Ad, Bd
Community Surveys	Annually since 1999
Definition of Quality	• Written standards to comply to quality • Complying with the NZ Drinking Water Standards 2000
Quality Management Systems	• None official
TQM Models Adopted	• None • In 2000 management stated that they are going to upgrade their main water treatment plant and contract it out to an ISO 9000 certified contractor • Follow up on 2002 plan was not followed through and management team changed
Benefits	• N/A • New Management believes that for such a small council there is no need to adopt any TQM Models

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.5: **TLA 'E' – Population: 27,043 – 4 Water Treatment Systems (Face-to-face Interviews and Document Review)**

Attribute	Evidence
Water Grading	Ab, Aa, A1a, Ab, Au
Community Surveys	Annually since 1992
Definition of Quality	• Good standard of product • What is the requirement and the minimum level
Quality Management Systems	• OFI Forms
TQM Models Adopted	• ISO 9002 (1998) lapsed in 1999 • ISO 9002 Recertified in 2000
Benefits	• More attention to details in the treatment plants • Consistency • Regular calibration schedules • Working towards organisational change and continual improvement goals

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.6: TLA 'F' – Population: 19,801 and 100,000 during summer – 9 Urban Water Treatment Systems and 3 Rural Systems (Urban Systems are contracted out) (Face-to-face Interviews and Document Review)

Attribute	Evidence
Water Grading	Ba, Ca, Bd, De, Ee, Dd, Db
Community Surveys	Annually since 1999
Definition of Quality	• A measurement of provided commodities and services • A level of standard
Quality Management Systems	• Continuous monitoring according to District Annual Plan • No Quality System
TQM Models Adopted	• Contractor ISO 9001 & ISO 14001 certified since 1998
Benefits	• Improvement of service delivery and remaining competitive in the new environment • Working toward organisational change after the restructuring that took place in the council

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.7: TLA 'G' – Population: 17,992 – 7 Water Treatment Systems (contracted out) (Face-to-face Interviews, Participant Observations and Document Review)

Attribute	Evidence
Water Grading	Aa, Ba, Cc
Community Surveys	Annually since 1992
Definition of Quality	• Supply product to an agreed standard • Product of high standard
Quality Management Systems	• Corrective Action Forms • "Quetzal" a system to action public complaints
TQM Models Adopted	• ISO 9001 certified since 1997
Benefits	• Created a system in place which will improve quality on the long run i.e. organisational change • Introduced the continual improvement process • Better documentation process • Regular monthly audits in place • Total compliance of testing procedures in accordance with the NZ Drinking Water Standards 1995

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.8: TLA 'H' – Population: 22,714 – 4 Water Treatment Systems (Face-to-face Interviews, Participant Observations and Document Review)

Attributes	Evidence
Water Grading	Aa, Ad, Bd
Community Surveys	Two surveys only: 1989 & 2000 (one questions asked in relation to water supply and not water quality)
Definition of Quality	• Meeting the NZ Drinking Water Standards 1995 • A high class product
Quality Management Systems	• Continuous monitoring according to District Annual Plan • No Quality System
TQM Models Adopted	• None
Benefits	• This council is lucky in a way that the source of their water is already of high quality.

SOURCE: Author's Table (El-Kafafi, 2002c).

Table 6.9: TLA 'I' – Population: 15,394 – 4 Urban Water Treatment Systems and 4 Rural Systems (Face-to-face Interviews and Document Review)

Attribute	Evidence
Water Grading	Ba, Cb, Db, Dc, Dd, De
Community Surveys	One in 1992 Planning to do another survey
Definition of Quality	• Level of contaminants in the water • Fitness for purpose of usage
Quality Management Systems	• NZ Drinking Water Standards 1995 • Performance Targets • Department Business Plan
TQM Models Adopted	• None
Benefits	• N/A

SOURCE: Author's Table (El-Kafafi, 2002c).

6.4.1.1 Summary of Findings

This section presents the key findings of the qualitative case by case matrices.

- All TLAs mentioned the importance of conforming to the New Zealand Drinking Water Standards issued by the Ministry of Health. Only one council out of the nine councils within the Waikato Region still relies on the WHO Drinking Water Standards 1984. The rest of the councils are either conforming to the 1995 Standards or upgraded to the latest Standards 2000.
- Five TLAs are adopting TQM techniques and systems in their managerial systems.
- Four TLAs are ISO 9000 certified.

- Only one TLA has a certified laboratory to conduct all required water testing.
- There is no consistency among TLAs in relation to conducting community surveys requesting feedback (i.e. two TLAs are conducting annual surveys since 1990, two TLAs are conducting annual surveys since 1992, one TLA started conducting annual surveys since 1999, one TLA conducted only two surveys, one TLA conducted one survey and one council never conducted any surveys).
- The management team in the councils who are not certified justify their decisions on the size of the TLA, the small population of community they serve and their budget constraints.

6.4.2 Themes Across the Nine Case Studies

This section sums up all the qualitative data analysis in relation to the themes across the nine case studies (i.e. the deductive and inductive themes). As mentioned earlier, the themes were derived from three data sources (face-to-face interviews, participant observations, and document review) in line with the main research methodology by using triangulation to enhance the validity and reliability of the research results.

6.4.2.1 Deductive Themes Across the Nine Case Studies

The following matrix illustrates the application of the deductive themes (fully applied, partially applied or not applied at all) in the nine case studies within the Waikato Region. When the theme is fully applied it will be referred to as "functional". When the theme is partially applied, it will be referred to as partially functional. When evidence is lacking for the application of a specific theme, it will be referred to as "not applied".

Table 6.10: Application of Deductive Themes Across the Nine Case Studies within the Waikato Region

TLAs	Themes						
	Quality Definition	**Innovativeness**	**Teamwork**	**Responding to Opportunity**	**Common Vision**	**Expertise**	**Leadership**
A	Functional	Functional	Functional	Functional	Functional	Functional	Functional
B	Functional	Partially functional	Functional	Partially functional	Functional	Not applied	Functional
C	Partially functional	Not applied	Not applied	Not applied	Partially functional	Not applied	Not applied
D	Partially functional	Not applied	Not applied	Not applied	Partially functional	Not applied	Not applied
E	Functional	Partially functional	Functional	Functional	Partially functional	Not applied	Partially functional
F	Partially functional	Not applied	Partially functional	Functional	Functional	Not applied	Not applied
G	Functional	Partially functional	Functional	Functional	Functional	Partially functional	Functional
H	Partially functional	Not applied	Functional	Not applied	Functional	Not applied	Not applied
I	Partially functional	Not applied	Not applied	Not applied	Partially functioning	Not applied	Not applied

SORCE: Author's Table

6.4.2.2 Summary of Findings:

This section presents the key findings concerning the deductive themes across the nine case studies within the Waikato Region.

- *Quality definitions* are functional across all the nine case studies, which shows management teams awareness of the importance of quality in the water industry.
- *Common vision* is another highly acknowledged theme among TLAs, which shows that the management teams work in collaboration with their employees to achieve specific set goals within a strict framework.
- *Teamwork* is not applied in three of the TLAs and partially applied in two TLAs, which means that this is an area that needs to be strengthened further.
- *Responding to opportunity* is not applied in four TLAs and one is adopting it partially. This suggests that the TLAs are not taking full advantage of opportunities that come their way and need to give importance to this area.
- *Leadership* is one of the most important themes that shape the direction of the management systems in the TLAs and yet it is not applied in five out of the nine TLAs. This suggests there is an opportunity to recruit suitable leadership for future gain and improvement.
- *Innovativeness* is only functional in one TLA and partially functional in another one. This signals TLAs are not thinking beyond the immediate and innovation will require significant work.
- *Expertise* is the weakest theme of all the themes (i.e. seven TLAs out of the nine do not apply it at all). This is an indicator that the TLAs have to be more selective with regard to their employment criteria i.e. getting the right employee in the right position.

Given these findings it is clear that water grading is an important issue.

6.4.2.3 Inductive Themes Across the Nine Case Studies

The following matrix illustrates the application of the inductive themes in the nine case studies within the Waikato Region.

Table 6.11 A Application of Inductive Themes Across the Nine Case Studies within the Waikato Region

Case A

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Regular meeting for quality improvement • Providing quality service to customer	• Good communication between management and employees • Aspiring to continual improvement	Customers practices play a role in water quality	Management conducts surveys for staff opinion of management practices	Latest technology in water treatment plant i.e. totally computerised	Plays a role in decisions related to purchasing of chemicals and equipment for water treatment	Minor problems related to computer programs at the water treatment plants

SOURCE: Author's Table

Table 6.11 B Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)

Case B

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Provide quality service to customer • "Learning Journey" i.e. exceed customer expectations	Detailed standard operating procedures for all activities	Community can play a role in affecting drinking water quality	Water treatment plant contracted out	Minimal use of technology	• budget constrains in relation to training • plays a role in selecting suppliers and subcontractors	Problems with storage and reticulation of water

SOURCE: Author's Table

Table 6.11 C **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case C

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Maintain water supply to community • Meet requirements of New Zealand Drinking Water Standards 1984	• contractor abides by key performance indicators as per contract with council	One of their communities require water to be filtered only	Services contracted out	Very basic technology	• Cost affects management decisions related to purchasing equipments, chemicals and maintenance • Cost affects upgrading their NA Drinking Water standards from 1984 to 1995	Seasonal problems with water quality during summer i.e. poor taste during the summer season

SOURCE: Author's Table

Table 6.11 D **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case D

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Provide suitable water to community • Meet requirements of NZ Drinking Water Standards 2000	• Improvement approach	• Customer practices affect quality of drinking water • Ratepayers refuse upgrading water treatment plant accept so as not to pay higher charges	Recent restructuring in the council different departments	Basic technology used in council	• Cost is a reason given by management for not applying for ISO certification	• Bacteriological problems in rural communities • Problem with water reservoir

SOURCE: Author's Table

Table 6.11 E **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case E

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Provide sufficient potable water to community • Meet requirements of NZ Drinking Water Standards 1995 • Re-applied to ISO certification	• Regular meetings seeking continual improvement • Regular audits for quality assurance	• Customer practices affect quality of drinking water	High turn over in managerial staff	• Using WINZ data base • Future plans by management to introduce higher technology in monitoring and testing areas	• Cost plays a role in managerial decision in relation to suppliers and subcontractors selection	• Customers complain about taste of water i.e. chlorine taste is not accepted by customers

SOURCE: Author's Table

Table 6.11 F **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case F

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
Meet Community Board expectations i.e. Service Level Agreement signed between Council Management and the Community Board	• Water treatment and supply is contracted out • Contractor conforming to the NZ Drinking Water Standards in urban water schemes • Not applying standards in rural schemes	• Although council improved their water standard it is still low standard in the Community Water Register because Ministry of Health visits councils every 5 years to upgrade their systems	Water treatment and supply is contracted out	• Water treatment plants are computerised and easily monitored	• Management believes that no need to double cost by being ISO certified since the contractor is already ISO 9000 and 14000 certified	• Customers in small communities refuse to chlorinate their water which affects the drinking water standards

SOURCE: Author's Table

Table 6.11 G **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case G

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Providing quality service to community • "Quetzal System" i.e. dealing with community complaints and problems through the phone	• Water treatment plants are scattered around the area • Technicians are utilised by the contractor to do other jobs besides water treatment • One of the treatment plant is situated on top of a hill in the middle of a privately owned farm	• Weather plays a role in the quality of drinking water i.e. growth of algae during spring and summer which affects water taste and odour • Rain affecting turbidity of water	Water treatment plants are contracted out	Basic technology used in most of the plants of this council	Management stated that they are not upgrading to the New Zealand Drinking Water Standards 2000 immediately because it costs a lot to upgrade from the 1995 standards	• Customers store water in insecure tanks which gets contaminated easily and affects water quality • On plant has a problem of regular blockage during rain season • Some technicians are not highly qualified in a manner that they don't know the reasons behind their water treatment practices

SOURCE: Author's Table

Table 6.11 H **Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)**
Case H

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Provide a quality treated water • Meet requirements of NZ Drinking Water Standards 1995	• Water treatment technicians travel a lot between the plants daily • Systems differ from one plant to the other	• Source of water i.e. river may get dirty at certain locations	Technicians travel a lot daily to monitor the different treatment plants	• Two plants out of the five plants are computerised for easy access by technicians on call	• Cost is the reason behind management not applying for ISO certification	• Travelling by technicians around plants for monitoring and maintenance I could affect the speed of tending to problems

SOURCE: Author's Table

Table 6.11 I Application of Inductive Themes Across the Nine Case Studies within the Waikato Region (continued)
Case I

Organisational Attitudes and Goals	Organisational Forms and Activities	External Factors	Human Resources	Technology	Cost	Problems
• Provide quality drinking water to community • Meet requirements of NZ Drinking Water Standards 1995	• Management looking at some of the Baldrige Award principles for future application • Not applying full treatment in rural areas	• Customer practices affect quality of drinking water	No comments	• Basic technology since only one plant is conforming to the New Zealand Drinking Water Standards • Management stated that they are sticking to basics and no sophisticated technology	• Management indicated that it is not appropriate for a little council to adopt ISO 9000 certification because it would create an economic problem	• Some problems occur with equipment at treatment plant i.e. dosing of water by chlorinator

SOURCE: Author's Table

6.4.2.4 Summary of Findings:

This section presents the key findings of the inductive themes across the nine case studies within the Waikato Region.

- *Organisational attitudes and goals theme:* reference to the community and providing the best service has been mentioned across all the TLAs. This repetition or agreement shows the importance of the customer to the business and in this case it is the community served by the TLAs.
- *External factors:* a common factor among TLAs in the role played by the customer in affecting the quality of water they receive. This theme highlights the importance of education and how the TLA should inform their customers of crucial issues related to their domestic habits and how it could affect the quality of water they receive. Other external factors like the weather could also be remedied by extra precautions by the TLA.
- *Cost:* it is a common theme across all the TLAs. Either managerial staff or general staff or technical staff stated that it affects decisions related to overall expenditure in TLAs and purchasing of chemicals and equipment for water treatment in particular.
- *Organisational forms and activities:* there is no common form or structure among the nine case studies i.e. each TLA has its own unique activities that suit its own situation and whether or not the water treatment plant is contracted out. Nevertheless, "continual improvement" and "quality assurance" practices appeared several times in three TLAs.
- *Human resources:* some of the TLAs contract out their water treatment plants. This makes communication between the TLA and the water treatment plants more challenging. It appears there is much to be learnt in developing good practice in this area.
- *Technology:* technology is basic among most of the water treatment plants. Management often stated that since they had small plants serving small populations, they should not spend a large amount of money on sophisticated technology. This issue also relates to the employees. If there is more advanced technology the TLA will have to hire more highly skilled technicians.

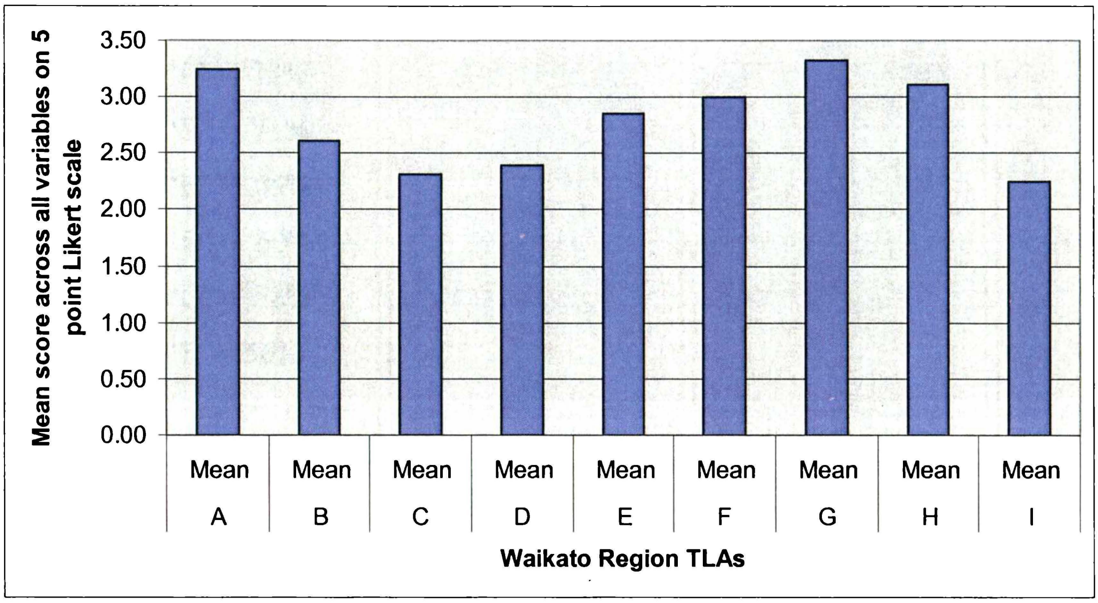
- *Problems:* problems vary from one TLA to the other. They include minor problems related to computer program malfunction, or problems related to water storage and reticulation systems, or seasonal problems related to changing weather or rainy season, or specific customer requirements like refusing to add chlorine to water because it affects the taste and smell of the water or inefficiency of technicians in dealing with problems in a timely manner.

6.5 Quantitative Cross Case Analysis

After summing up all the qualitative data analysis it is appropriate to summarize the quantitative analysis conducted across the nine TLAs of the Waikato Region. The closed questions relate to the quantitative variables used in the analysis of the data (Refer to Appendix 8: Waikato Water Utilities Managers Survey Questions) were taped, transcribed and coded. These questions were coded with a likert scale where 0= very bad, 1=bad, 2= good, 3= very good, and 4= excellent. The numbers were fed into an excel spreadsheet for the analysis.

The data was analysed where 0 was the lowest score and 4 the highest score. The following Figure 6.2 shows the mean score across all eight variables on 5 point likert scale. It is worth mentioning here that although the analysis was formulated by the researcher, the outcome is according to how each TLA scored themselves in relation to that model.

Figure 6.2: Mean Scores Across all Variables in the TLAs in the Waikato Region.



SOURCE: Author's Figure (El-Kafafi, Dec 2001b).

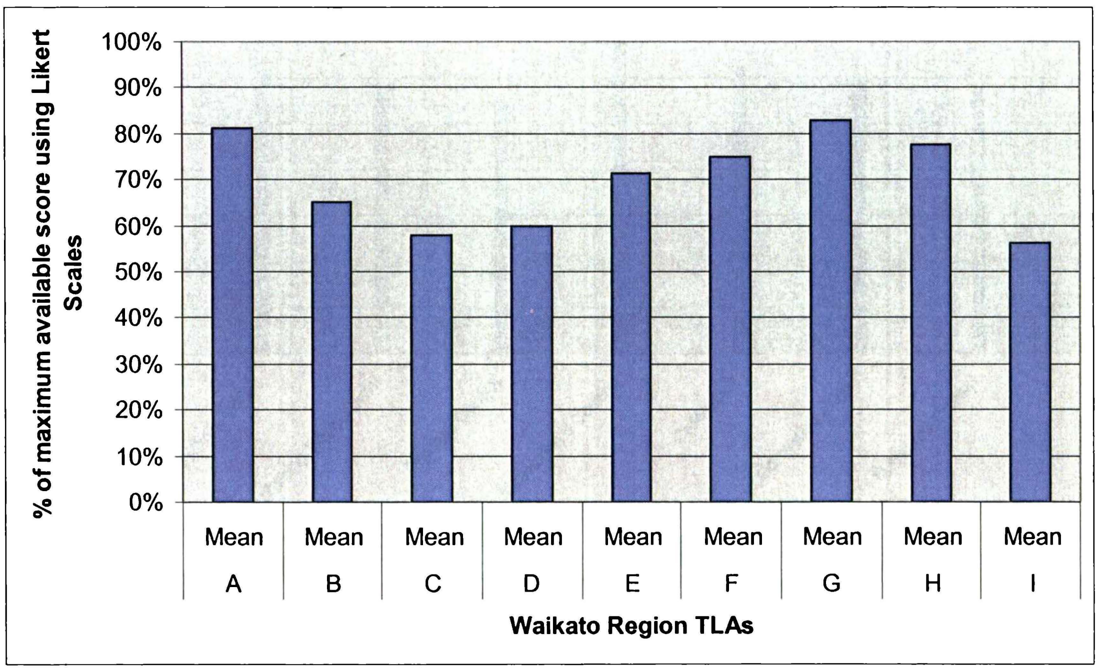
After calculating all the means of quality management variables across the TLAs the total score was 39.05 from 56 which is the total number of questions asked to the interviewed candidates. According to Figure 6.2 the following are the scores in descending order of the different TLAs:

1. TLA 'G' = 46.50
2. TLA 'A' = 45.45
3. TLA 'H' = 43.50
4. TLA 'F' = 42.00
5. TLA 'E' = 40.00
6. TLA 'B' = 36.50
7. TLA 'D' = 33.50
8. TLA 'C' = 32.50
9. TLA 'I' = 31.50

Figure 6.3 not only illustrated the same data through presenting it in percentages of possible scores, but also confirmed the results of Figure 6.3 by giving the following scores in descending order:

1. TLA 'G' = 83%
2. TLA 'A' = 81%
3. TLA 'H' = 78%
4. TLA 'F' = 75%
5. TLA 'E' = 71%
6. TLA 'B' = 65%
7. TLA 'D' = 60%
8. TLA 'C' = 58%
9. TLA 'I' = 56%

Figure 6.3: Percentage Maximum Score Using Likert Scale.



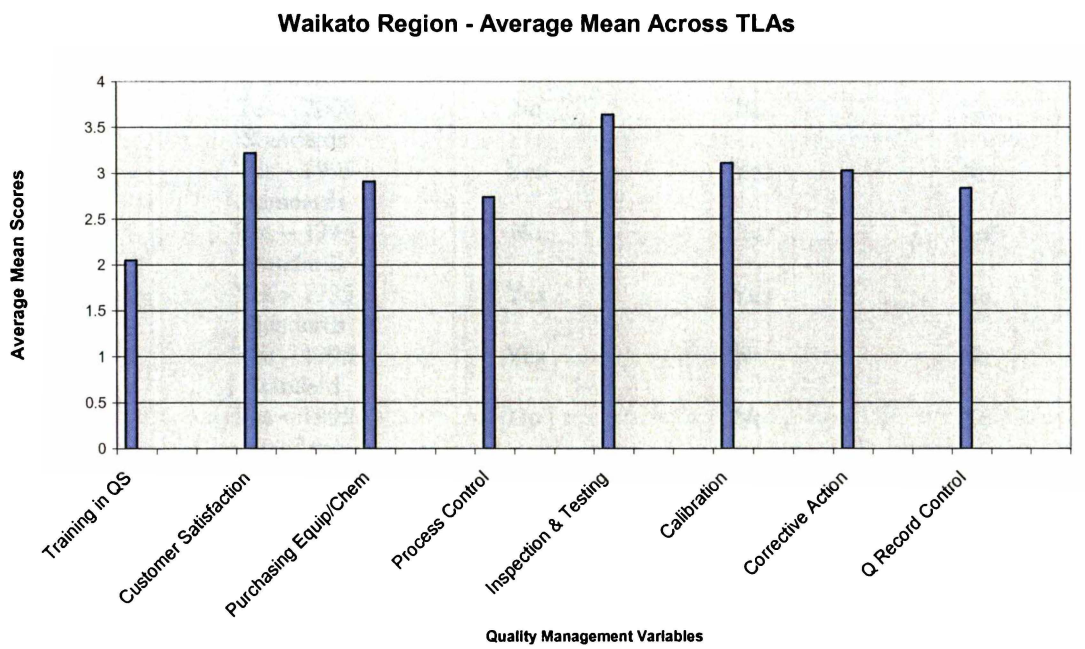
SOURCE: Author's Figure (El-Kafafi, Dec 2001b).

The aim of using the percentages is to discriminate between the different TLAs who are adopting the model and the ones who are adopting it partially.

A further analysis of the scores of the eight variables across all the nine TLAs was conducted to find out which quality variable are more likely to be met by TLAs. Figure 6.4 shows the scores starting with the highest to the lowest score: (1) inspection and testing (3.46); (2) Customer satisfaction (3.22); (3) calibration of equipment (3.11); (4) corrective/preventive action (3.03; (5) purchasing equipment/chemicals (2.91); (6) control of quality records (2.84); (7) process control (2.74); and (8) training personnel in quality systems (2.05). We notice from the scores that inspection and testing of equipment scores the highest among all the TLAs. On the other hand, training personnel in quality systems scores the lowest across TLAs.

Figure 6.4 shows to what extent TQM and its Models are actually applied in the water utilities which replies to the first sub-research question stated earlier.

Figure 6.4: Waikato Region – Mean of TQM Variables Across TLAs.



(For each variable the mean has been calculated for each TLA. This figure reports on the means of all the TLAs' means.)

SOURCE: Author's Figure (El-Kafafi, Dec 2001b).

Table 6.12 aims at illustrating the application of quality systems in the Waikato Region TLAs. It presents the different quality systems applied across the water utilities in the Waikato Region. It shows that all of the councils are bound by the Ministry of Health Drinking Water Standards [2000 a and b]. Moreover, none of the water supply departments within councils have any quality awards apart from TLA 'A' who are preparing to apply for a quality award for the whole organization. If we compare the mean scores illustrated earlier in Figure 6.2 and in this table, we see that there is a tendency for high scores for those councils who are adopting not only the quality management system, but also its models i.e. ISO 9000 Standards, ISO 14000

Standards, and the Quality Awards. If we look at the two top scores they belong to councils who are adopting both a quality management system and are ISO certified. Moreover their water grading ranges are: 'Aa', 'Aa', 'Ba' and 'Cc'. On the other hand, the lowest score belongs to a council that is not adopting a quality system or any of its models. The water grading in this council ranges from 'Ba', 'Cb', 'Db', 'Dc', 'Dd', and 'De'.

Table 6.12: Quality Systems across Water Supply Utilities (TLAs) in the Waikato Region

TLA	NZ Drinking Water Standards	Quality System (TQM)	ISO 9000	ISO 14000
A	Yes – 2000 Standards	Yes	Yes	No
B	Yes – 1995 Standards	Yes	No	No
C	No – 1984 WHO Standards	No	No	No
D	Yes – 2000 Standards	No	No	No
E	Yes – 1995 Standards	Yes	Yes	No
F	Yes – 1995 Standards	No	Yes*	Yes*
G	Yes – 1995 Standards	Yes	Yes	No
H	Yes – 1995 Standard	Yes	No	No
I	Yes – 1995 Standard	No	No	No

*Treatment Plant Contractor is ISO 9000/ISO 14000 Certified

SOURCE: Author's Table (El-Kafafi, Dec 2001b).

The results show that there is a positive relationship between the adoption and adaptation of TQM and its models to the quality of water.

6.6 Lewin's Model: Where do TLAs Fit?

This section shows a priliminary assessment of where each of the nine TLAs of the Waikato Region fit in accordance with Lewin's Change Theory and the application of TQM and its models (i.e. ISO 9000 and ISO 14000 Certification and the Quality awards). The information has been compiled in the following Table 6.13.

Table 6.13: Where do TLAs Fit in Terms of Lewin's Change Theory

TLA	Unfreezing	Changing	Freezing	Future Requirements
A	Yes	Yes	Yes	Evaluate/upgrade/minor unfreezing in the future
B	Yes	Partially	No	Completing the change process before freezing
C	No	No	No	Unfreezing before changing before freezing
D	No	No	No	Unfreezing before changing before freezing
E	Yes	Partially	No	Completing the change process before freezing
F	Yes	Partially	No	Completing the change process before freezing
G	Yes	Yes	Yes	Evaluate/upgrade/minor unfreezing in the future
H	No	No	No	Unfreezing before changing before freezing
I	No	No	No	Unfreezing before changing before freezing

SOURCE: Author's Table

Table 6.13 shows that only two TLAs (i.e. TLA 'A' and 'G') went through the full three stages of change according to Lewin's Change theory (i.e. unfreezing, changing and freezing). TLA 'A' and 'G' are adopting TQM and are ISO 9000 certified (Refer to Table 6.12: Quality Systems across Water Supply Utilities in the Waikato Region). TLA 'B', 'E' and 'F' started in the process of change toward a more integrated quality management system which is exemplified in their adoption to TQM and ISO 9000 and ISO 14000 certification (Refer to Table 6.12: Quality Systems across Water Supply Utilities in the Waikato Region). On the other hand the TLAs who are not adopting any quality systems need to work more towards change as per Lewin's Change Theory. There is scope for further work analysing the interface between quality management and orgaqnizational change.

6.7 Conclusion

This chapter is a summation of analysis of the nine case studies of the thesis. It sits between the analysis of each individual case and the final findings of the whole research. This helps put the findings in perspective to give a clearer picture of the research as a whole.

CHAPTER SEVEN:
SUMMARY AND CONCLUSIONS

7.1 Introduction

The purpose of this chapter is to report the findings of the entire thesis and its conclusions. The findings will be presented by showing how the research answered all the research sub-questions. It will finally conclude by considering Total Quality Management (TQM), its implications and the effects of the adoption and adaptation of its models (i.e. ISO 9000, ISO 14000 and Quality Awards) on the New Zealand water industry.

7.2 Research Findings

The use of triangulation in this research was effective in disentangling the components of TQM and their relevance for water utility management. Moreover, it helped answer the research sub-questions as well as validating and verifying the research findings. The following sections will present the four sub-research questions and how the research endeavoured to answer them.

7.2.1 What perceptions do water utilities managers have about quality management in general and TQM in particular?

The following are the research findings in relation to the water utilities managers' perceptions about quality management in general and TQM in particular:

- All managers believe in the importance of providing a quality potable water to the community they are serving.

- Some managers believed in providing the minimal quality that conforms with the New Zealand Drinking Water Standards, while others were aspiring to a high quality of service. In other words, adopting some of the TQM Gurus teachings e.g. zero defects, consistency of product, and continual improvement.

- Some managers believed that it is essential to adopt international standards (i.e. ISO 9000 Certification) to earn the respect and trust of their clients (i.e. the community).

- The difference between the two strands of management (i.e. managers who believe in providing high quality of service and managers who believe in delivering the minimum quality) is related to the work place environment (i.e. either those managers are satisfied and motivated in their jobs or not). The TLA training policy and allocation of funds plays a role in directing those managers. It is also shaped by their managerial background, experience in the field and education.

- Some managers do not show any evidence of a commitment to change and are still practising old techniques. They appear reluctant to adopt any TQM teachings or apply for ISO certification. They justify keeping the status-quo with the following reasons: a) the small size of the community they are serving, b) community contentment with the existing quality, and c) financial constraints.

7.2.2 To what extent are TQM practices actually applied in the water utilities?

TQM and its models (i.e. ISO 9000/14000 certification and quality awards) are examples of 'new' managerial paradigms. As mentioned in Chapter 6, Lewin's Change Theory (Refer to Chapter 6, Figure 6.1) was utilized as a framework to show the extent of the application of quality systems exemplified in TQM and its models and its effect on the TLAs' journey towards change. The information compiled in Table 6.13, showed the position of the nine TLAs of the Waikato Region and where each TLA positions itself in the 3 different stages of Lewin's Change Theory (i.e. unfreezing, changing, or freezing). Moreover, it identifies future requirements i.e. actions required by the different TLAs to achieve better water quality through the effective adoption of quality management practices (i.e. Those practices include the application of TQM Guru teaching to water treatment capital investment and operations practice and monitoring in accordance with best international standards).

The results shows that two TLAs have already passed through the three phases of Lewin's Change Theory (i.e. they have adopted change towards the new managerial paradigm), three TLAs are at midway range (i.e. require more work to fully integrate the new managerial paradigm) and four TLAs have not made any significant change to their management systems (i.e. those are the TLAs who are against any change).

7.2.3 Is there a relationship between the use of specific TQM procedures/models and water quality?

Table 7.1 sums up the results of the nine TLAs within the Waikato Region, their application of TQM and its models and their community water grading ranges as presented in the Register of Community Drinking Water Supplies published by the Ministry of Health. It also relates all this information to the scores taken from the quantitative data analysis.

The results shows that the adoption of TQM and its models is correlated with the quality of drinking water provided to the community exemplified in their water grading. For example the TLAs who are adopting TQM and some of its models i.e. ISO 9000/14000 Standards and the quality awards, have both high score results in the quantitative analysis results and their water grading is either high or with minimal risk (Refer to Appendix 2: Register of Community Drinking Water Supplies in New Zealand).

On the other hand, the TLAs that are not adopting TQM or its models, do have low scores in the quantitative analysis and lower water grading with higher risk factors (Refer to Appendix 2: Register of Community Drinking Water Supplies in New Zealand).

Nevertheless, the results show that the quality of drinking water does not depend on quality management systems alone. The following are some of those factors:

- customer practices in their own homes and lack of awareness of the role they play in the quality of water they receive;
- customer requests to some TLAs i.e. refusing to treat their water by adding any chlorine or fluoride to their drinking water;
- original source of water is of high quality; hence, no effort exerted from TLA's management;
- weather conditions and how it could affect the quality and source of water derived from river or water ways e.g. rain, warm water during summer season and growth of algae;

Where TQM procedures are not in place many problems emerge. These include:

- deteriorating pipes and lack of regular maintenance;
- incompetence of employees;
- lack of water treatment plant technicians training due to budget constraints;
- lack of technology due to financial reasons;
- extremely basic infrastructure;
- infrequent monitoring of water treatment plants;
- lack of system standardization among plants under the jurisdiction of the same TLA; and uncooperative leadership.

Table 7.1: Quality Systems and Water Grading across Water Supply Utilities within the Waikato Region

TLA	NZ Drinking Water Standards	Quality System (TQM)	ISO 9000	ISO 14000	Water Grading	Quantitative Analysis Scores
G	Yes – 1995 Standards	Yes	Yes	No	Aa, Ba, & Cc	46.50
A	Yes – 2000 Standards	Yes	Yes	No	Aa	45.45
H	Yes – 1995 Standard	Yes	No	No	Aa, Ad, & Bd	43.50
F	Yes – 1995 Standards	No	Yes*	Yes*	Ba, Ca, Bd, De, Ee, Dd, & Db	42.00
E	Yes – 1995 Standards	Yes	Yes	No	Ab, Aa, A1a, Ab, & Au	40.00
B	Yes – 1995 Standards	Yes	No	No	Aa, Bc, & Db	36.50
D	Yes – 2000 Standards	No	No	No	Aa, Ad, & Bd	33.50
C	No – 1984 WHO Standards	No	No	No	Cc, Ec, Bb, Dd, & Db	32.50
I	Yes – 1995 Standard	No	No	No	Ba, Cb, Dd, Dc, Dd, & De	31.50

*Treatment Plant Contractor is ISO 9000/ISO 14000 Certified

SOURCE: Author's Table

7.2.4 What other quality factors do managers in water utilities identify as crucial for improvement of water quality?

Management identified the following factors as important to water quality:

- The size of community served by the council.
- The community dictating their willingness or unwillingness to add chemicals to drinking water.
- Budget allocations and restrictions.
- The Ministry of Health only visits councils every 5 years to revise their water grading.
- The WINZ program (i.e. a data base installed by the Ministry of Health to facilitate data information [testing and monitoring of water treatment] being transferred from the TLAs to the Ministry of Health through the network) is not being applied in all TLAs. Some TLAs mentioned that the data base has been in their premises for over a year and is not yet functioning because according to the rules they have to get training first by one of the Ministry of Health personnel before they can start using it. Hence, the program is there and they are still awaiting the training.

- Training budget constraints in relation to quality training.
- Water Treatment Plants are not certified to conduct all the required testing; hence, delays occur when they send samples to the nearest cities for testing. The reasons for laboratories not being certified are the financial, equipment and employee expertise requirements.

The following are the key findings in relation to TLAs' documentation systems:

- The oldest annual report issued by councils in the Waikato region and publicly available goes back to the year 1988/1989 i.e. there is no official documentation available before that year. Although this does not mean that quality was not important before that date, it does show that there is no historical data available for comparison.
- Water quality was not given much importance until 1990/1991 when some of the TLAs started adopting the World Health Organisation (WHO) Drinking Water Standards to maintain regular testing for water provided to the community.
- The year 1991/1992 marks another change in the reporting of some of the TLAs' documents where they started commissioning market research companies to enquire about the consumer satisfaction with their provision of water according to the WHO standards i.e. taste of water, clarity of water, pressure of water, and continuity of water supplied to the consumer.
- The year 1995 is considered another land mark i.e. most TLAs adopting the New Zealand Drinking Standards (NZDWS) 1995, which was published by the Ministry of Health along with its guidelines.
- In 1995 another important publication came out from the Ministry of Health, the Register of Community Drinking-Water Supplies in New Zealand. This register reports water grading results for New Zealand.
- In 2000 the Ministry of Health published an updated New Zealand Drinking Standards (NZDWS) 2000, which raised the requirements to be met by water utilities for a higher quality grading for drinking water. Those standards became effective from 2001.

Particularly important are the following results:

- Not all the TLAs have fully adopted the quality management approach within their structures.
- According to the data analysis there are three types of TLAs:

  Category 1 TLAIs: These TLAs are fully adopting the TQM teachings and Models (ISO 9000/14000 certification and Quality Awards);

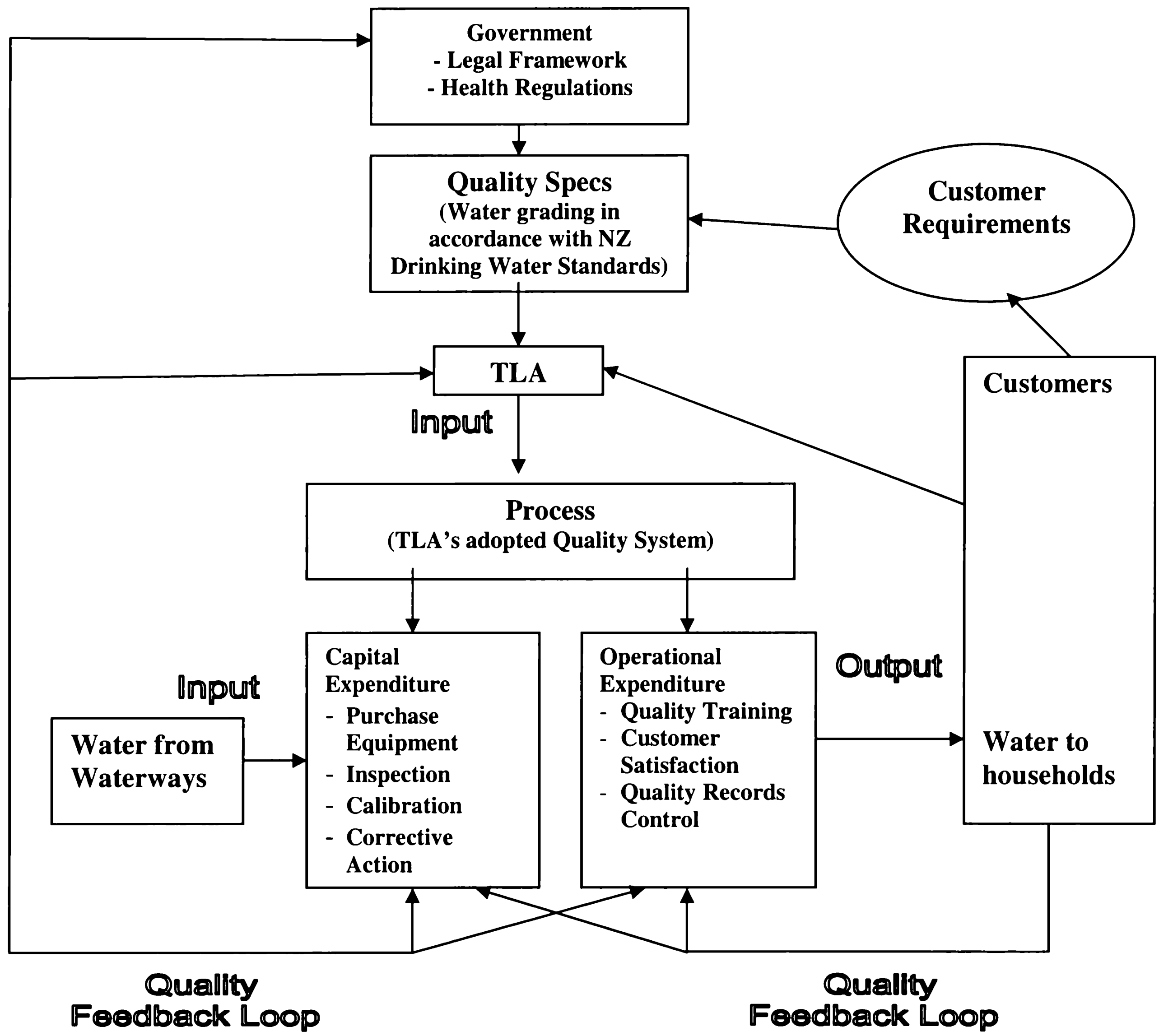
  Category 2 TLAs: These TLAs are partially adopting either the TQM teachings and/or the Models; and

  Category 3 TLAs: The TLAs that are not adopting any TQM teachings nor are they applying any TQM Models.
- A diversity of formal quality management systems (QMS) approaches are in use amongst the nine TLAIs reflecting the diversity of QMS approaches in the marketplace (i.e. ISO 9000, ISO 14000, and Quality awards).
- A quality management approach is emerging which seeks to adopt QMS philosophies to water supply management without necessarily adhering to any of the formal QMS systems and approaches – the emergence of an approach called the "Learning Journey." (Refer to Chapter 5, Council B Inductive Theme: Section 5.6.2, "Organisational Attitudes and Goals")
- Economic factors, especially cost play an important role in the adoption, adaptation and use of QMS approaches by the TLAs.
- Inspection and testing of equipment is of high priority to all TLAs.
- Training in quality systems seems to be somewhat ignored by most of the TLAs. This is an area that could be targeted for future improvement.
- Only one TLA (serving the largest population) has its laboratory certified i.e. could conduct all kinds of testing internally. Hence, financial considerations, community served and size of the TLA plays a role in deciding which systems to be adopted.
- The analysis of the nine case studies is relevant to the 3 categories of TLAs. Organisational change also applies to the TLA and its class i.e. Category one TLAIs have gone a full circle and undergone a total organisational change in accordance with Lewin's Theory of Change (refer to Chapter 6, Figure 6.1), while

Category two are still in the mid range of this theory. On the other hand, since Category three have not changed and are still using an old managerial paradigm, significant change is still ahead of them.

Figure 7.1 sums up the findings of this research into the application of TQM in water utilities. It presents a framework for successful organisational change toward the new management paradigm through the adoption and adaptation of TQM and its models. This requires incorporating all the required components. (Refer to Chapter 4, Figure 4.1: Measurement, Design and Analysis: Mixed Methods Combination)

Figure 7.1: TQM and Organization Change in the Waikato Region Case Studies



SOURCE: Author's Figure (El-Kafafi, 2002b and El-Kafafi, 2002c).

7.3 Implications for Water Utility Managers

Management plays a crucial role as it ties the knots that hold the whole organization. The role it plays in water utilities is of no less importance as the decisions management makes impacts the performance of the whole organization and accordingly customer satisfaction.

Given the research findings (Section 7.2.1), the researcher believes that water utilities managers should investigate the following problems that occur in facilities and result in non compliance with quality goals.

- Lack of system standardization among plants under the jurisdiction of the same TLA;
- Uncooperative leadership;
- The role played by budget allocation and restriction in the water industry and its effect on the drinking water quality (e.g. requirement of quality training for employees and technicians;
- Deteriorating pipes and lack of regular maintenance;
- Incompetence of employees;
- lack of water treatment plant technicians training;
- Inferior technology;
- Extremely basic infrastructure;

7.4 Implications for Further Research

The following are some of the areas that require further investigation:

- Comparing the NZ Government water grading for all the 136 authorities who are ISO 9000/2000 certified and then compare results with the Waikato Region.
- Further investigation of Micro-organisms in the NZ water supply.
- The relationship between the Maori groups in the Waikato Region and drinking water quality.
- Further investigation into the problems facing the water utilities in cases of non conformance.
- The valuation and pricing of water and wastewater assets and services after the transfer of water supply management to other agencies or firms.

7.5 Discussion and Conclusion

The research findings illustrate that effective implementation of TQM could play a vital role in the New Zealand water industry. Successful implementation is important because:

- Water and wastewater systems are large irreversible investments that also cost a lot to maintain on a day-to-day basis.
- The Resource Management Act has also resulted in a need to upgrade sewage treatment and disposal systems and consider new solid waste disposal arrangements.
- The NZ Drinking Water Standards 2000 highlight the need to upgrade water supplies. (One of the Waikato TLAs is not yet even following the NZ Drinking Water Standards 1995.)
- Public expectations of acceptable levels of service delivery are increasing. (In some of the small communities, they refuse the treatment of their water but when incidences of non-conformity occur they require high quality service.)
- Asset Management concepts have highlighted the need for replacing/upgrading ageing infrastructure (Several water treatment plants are in the upgrading process for providing better service).

TQM based reviews can also help assess the long term economic sustainability of service delivery by identifying and documenting:

1. Realistic levels of Service
2. Opportunities for meeting service needs
3. Cost implications

TQM therefore feeds back into processes to ensure that satisfying immediately apparent upgrading needs does not occur in a manner that threatens the long-term sustainability of service delivery. It is important to remember that asset management plans can bring together asset management planning activities and outline optimum long term maintenance, rehabilitation, renewal and capital works and corresponding cash flows required to maintain infrastructure assets at a defined level of service. Asset management planning is one way of systematically determining future requirements and service levels.

Local government reforms, new financial management legislation for local authorities (Local Government Amendment Act 1996), financier concerns about risk, all impact the development of asset management plans. Customers of other monopoly industries such as power industries and telecommunications are having increasing input into determining the level of service they receive. TQM with its customer focus can help asset management planning in the water services sector through focusing on what customers want (i.e. high quality of drinking water and reasonable price) by putting more emphasis on their quality management systems and its full application and investment in upgrading water treatment plants. Future planning based merely on assumed levels of service exposes the service provider to a major business risk (i.e. several TLAs are not requesting any feedback from their customers). Achieving agreed levels of service (i.e. conformance to NZDWS and customer requirements) would ensure that meaningful asset management plans with minimised risk can be developed to ensure that customers consistently receive what they want.

It is critical that TQM be integrated within the complete set of activities undertaken by the water utility because TMQ cannot be implemented in isolation. Service levels that customers of water utilities demand are related to their costs. Enhancing the quality of drinking water provided by water utilities in New Zealand is possible by the further use of TQM methods. This requires the ongoing development of managers' perceptions towards quality and careful attention to the application of TQM methods. The success of this approach depends on careful integration of TQM into organizational life, including budgeting and asset management.

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Appendix 1[1]

REGISTER LISTINGS: New Zealand Water Gradings1
2The Gradings

NORTHLAND HEALTH	Source/Treatment	Distribution System
Bream Bay	B	b
Dargaville	C	d
Kaikohe	D	e
Kaitaia	D	e
Kawakawa/Moerewa	D	d
Kerikeri	D	d
Paihia	D	e
Whangarei	B	b

AUCKLAND HEALTHCARE	Source/Treatment	Distribution System
Auckland City	A	b
Manukau City	A	a
Helensville/Parakai	D	e
North Shore	A	b
Onehunga	A	a
Hibiscus	A	a
Papakura	A	b
Pukekohe	D	b
Snells Beach/Algies Bay	D	a
Tuakau	A	b
Waitakere City	A	b
Warkworth	D	d

HEALTH WAIKATO	Source/Treatment	Distribution System
Cambridge	A	b
Hamilton	A	a
Hauraki Plains	D	c
Huntly	B	a
Kihikihi	A	a
Matamata	B	a
Matapuna/Manunui	A	d
Morrinsville	B	a
Ngaruawahia	B	a
Otorohanga	C	c
Paeroa	C	b
Pukerimu Rural	A	a
Putaruru	B	c
Raglan	A	a
Taumarunui	E	d

[1] Appendix 1 Source: Consumer, 1997.

Te Aroha	B	a
Te Awamutu & Pitongia	A	b
Te Kuiti	B	a
Thames	A	a
Tirau	D	b
Tokoroa	C	a
Waihi	B	a
Whangamata	u	
Whitianga	u	

WESTERN BAY HEALTH	Source/Treatment	Distribution System
Omokoroa	E	b
Tauranga	A	b
Mt Maunganui	A	a
Te Puke (1)	E	d
Athenree	E	b
Katikati	E	d
Waihi Beach	B	d

EASTBAY HEALTH	Source/Treatment	Distribution System
Kawerau	u	
Murupara	u	
Opotiki	u	
Edgecumbe	u	
Whakatane	u	

LAKELAND HEALTH	Source/Treatment	Distribution System
Ngongotaha	B	b
Omori/Kurarau	u	
Rororua Central		a
Rotorua East	B	b
Taupo	E	a
Turangi	D	a

TAIRAWHITI HEALTH	Source/Treatment	Distribution system
Gisborne	A	a

TARANAKI HEALTHCARE	Source/Treatment	Distribution System
Eltham	E	b
Hawera	E	d
Inglewood	E	b
New Plymouth	A	b
Waitara	A	b
Stratford	E	b
Waimate West	E	d

HEALTH CARE HAWKES BAY	Source/Treatment	Distribution System
Hastings	B	e
Havelock North	B	b
Napier	B	b
Taradale	B	b
Waipawa	D	b
Waipukurau	D	b
Wairoa	A	a

GOOD HEALTH WANGANUI	Source/Treatment	Distribution System
Marton	E	d
Taihape	E	c
Waiouru	B	a
Wanganui	D	a

MIDCENTRAL HEALTH	Source/Treatment	Distribution System
Ashhurst	A	a
Dannevirke	E	b
Feilding	E	a
Foxton	D	c
Levin	C	b
Massey University	D	c
Pahiatua	E	b
Palmerston North	A	b

HUTT VALLEY HEALTH	Source/Treatment	Distribution System
Lower Hutt	B	b
Wainuiomata	C	a
Otaki	D	b
Paekakariki	B	a
Paraparaumu	A	a
Porirua (2)	A	d
Upper Hutt	A	a
Waikanae	A	a
Wellington (3)	C	d

WAIRARAPA HEALTH	Source/Treatment	Distribution System
Carterton	u	
Featherston	u	
Masterton	A	a

NELSON-MARLBOROUGH HEALTH	Source/Treatment	Distribution System
Hope/Brightwater	A	a
Nelson	E	d
Richmond	E	c
Blendeim	D	e
Picton/Waikawa	E	b

COAST HEALTH CARE	Source/Treatment	Distribution System
Greymouth	D	d
Hokitika	D	c
Westport	A	a

HEALTHLINK SOUTH	Source/Treatment	Distribution System
Christchurch	B	a
Kaiapoi	D	b
Kaikoura	E	e
Lincoln University	D	b
Lyttelton	B	e
Rangiora	E	c

HEALTH SOUTH CANTERBURY	Source/Treatment	Distribution system
Ashburton	D	b
Downlands	E	c
Geraldine	D	e
Temuka	E	d
Timaru	E	b
Waimate	E	e

HEALTHCARE OTAGO	Source/Treatment	Distribution System
Alexandra	E	d
Balclutha	C	b
Cromwell	E	c
Dunesin	E	e
Milton	C	b
Mosgiel	B	e
Oamaru	E	d
West Taieri	E	d

SOUTHERN HEALTH	Source/Treatment	Distribution System
Gore	D	c
Invercargill	B	a
Bliff	b	c
Mataura	D	d
Queenstown	E	b
Wanaka	E	b
Winton	D	c

GUIDE TO THE TABLE

1 The Register

Report on communities of over 2000 people. The information was taken from the *Register of Community Drinking Water Supplies in New Zealand,* which lists the gradings of supplies serving communities of over 25 people.

2 The Gradings

Capital letters grade the *source* and *treatment*: how well the source is protected from contamination and how it is treated and monitored at the plant.
Lower case letters grade the *distribution system:* the quality of the piping, monitoring of the supply and whether microbiological or chemical contamination has been found.

A or a	Completely satisfactory, very low level of risk.
B or b	Satisfactory, low level of risk.
C or c	Marginal, moderate level of risk, may be acceptable in some small communities.
D or d	Unsatisfactory, high level of risk.
E or e	Completely unsatisfactory, very high level of risk.
u	Not yet graded, or being graded.

Larger communities may have several distribution zones delivering water from different sources or treatment stations, each with a different grade. Some communities have a mix of satisfactory and unsatisfactory grades.

(1)	Te Puke	Ed in Te Puke zone. Eb in Te Puke (Bush) and Eastern districts.
(2)	Porirua	Ad in Porirua High Levl Zone. Other zones have Aa or Ab.
(3)	Wellington	Cd in Eastern Wellington. Ca in Onslow, Wadestown, Wellington Central. Cb in Southern Wellington. Elsewhere Aa or Ab.

Appendix 2[1]

Register of Community Drinking-Water Supplies in New Zealand

Definition and Purpose of the Register:

The Register contains information concerning the Ministry of Health's public heath grading of community drinking water supplies and the presence of substances at concentrations that may be of public health significance. It is published on a yearly basis. It is maintained as a part of the WINZ database system by the Water Group of ESR, a Crown Research Institute. The work is done under contract to Public Health Regulatory Services of the Ministry of Health.

The information presented in the Register is gathered by heath protection officers of the Public Health Service Providers with the co-operation of officers of the territorial local authorities.

The Register provides professionals, drinking water professionals and the general public with a summary of the health risk status of all community drinking water supplies. Community drinking water supplies as defined by the Ministry of Health means "all drinking water supplies serving more than 25 people for more than 60 days a year."

The register records the following information:

- the name of the community (i.e. the people served by the supply);
- the components of the supply (i.e. sources, treatment plants & distribution zones);
- codes for each component (for the sake of identification);
- who owns and operates the supply;
- how many people use the supply.

If the community served is over 500 the register also records the public health grading and the substances of public health significance that requires monitoring in the supply. The public health grading is a means of evaluating both the actual water quality and the underlying measures taken to minimise risk. This is to ensure that the New Zealand drinking water remains safe now and in the future.

In order to understand the water quality grading, it is essential to understand the meaning of the public health grading system. Beside each area or zone there is a two letter grading. The first in capital letter and the second in small letter. The capital letter (A1, A, B, C, D or E) represents the grade of the water coming into the zone i.e. source quality

[1] Appendix 2 Source: Ministry of Health, 1998.

and treatment. The lower case letter (a, b, c, d or e) identify the quality of the water received at the consumers gate. The following is the meaning of the letters in the grading system:

Source and Treatment Grading:

A1 Completely satisfactory, negligible level of risk, demonstrably high quality
A Completely satisfactory, very low level of risk
B Satisfactory, low level of risk
C Marginal, moderate level of risk, may be acceptable in some small communities
D Unsatisfactory, high level of risk
E Completely unsatisfactory, very high level of risk

Distribution Zone Grading:

a Completely satisfactory, negligible level of risk, demonstrably high quality
b Satisfactory, low level of risk
c Marginal, moderate level of risk, may be acceptable in some small communities
d Unsatisfactory, high level of risk
e Completely unsatisfactory, very high level of risk

An ungraded supply is indicated by "u" in the Register.

Gradings are calculated using a complicated algorithm consisting of multiple tables. Grading factors include:

- water's origin,
- characteristics,
- compliance with Ministry of Health Standards, and
- degree of treatment and process supervision.

Appendix 3[1]

ISO 9000 Series Standards

1. ISO 9000 - Quality Management and Quality Assurance Standards - Guidelines

[British standard: BS.En.ISO 9000, European standard EN.ISO 9000, USA Standard: ANSL/ASQC Q9]

It is published in four separate parts. Part 1 (ISO 9000-1) gives general guidance about quality management and the implementation of quality assurance procedures. It assists in understanding the requirements of the set of ISO 9000 (ISO 9001 - ISO 9003) quality assurance standards and advises which one is applicable in different situations required as a contractual quality agreement between the supplier and the customer.

Part 2 (ISO 9000-2) provides more detailed guidelines on the implementation of ISO 9001 - 9003. Part 3 (ISO 9000-3) gives specific guidance about the application of ISO 9001. Part 4 (ISO 9000-4) gives guidance on developing and managing a programme that assures customers about the reliability and maintainability of products.

2. ISO 9001 - Quality Systems - Quality Assurance in Design, Development, Production, Installation and Servicing Functions

[British standard: BS.EN.ISO 9001, European standard EN.ISO 9001, USA Standard: ANSL/ASQC Q91]

This quality standard describes the procedures associated with all aspects related to manufacturing a product in order to assure its quality. Thos aspects include product design, development, production, inspection, test, installation and servicing. The following is a summary of the ISO 9001 requirements:

1. Design. The company must insure that the specified requirements are met by maintaining the required procedures and controlling the product design.
2. Production processes should be under controlled conditions to guarantee its quality.
3. Rigid control of product installation procedures so as not to have any negative effect on quality.
4. Careful design and control of handling, storage, packaging and delivery functions to avoid damage to products.

[1] Appendix 3 Source: Morris, 1997

5. Establishing a records system and maintaining it as an evidence that the product has passed inspections and functional tests.

6. Control of equipment used to make quality-related measurements at any stage of production. The aim is to measure the uncertainty and to ensure calibration to be carried out at defined intervals of time.
7. Ensure that a product is meeting the customer's expectations by agreeing with the customer on all design, manufacture and testing procedures.
8. It's the responsibility of executive management to define the company's quality policy. This quality policy should be understood, implemented and maintained at all levels of the company.
9. Adequate resources for the operation and auditing of the quality system implemented must be provided by the company.
10. The responsibility, authority and interrelation of all personnel who manage, perform or verify work affecting quality must be specified.
11. Adequate training must be given to all personnel involved in procedures affecting quality control.
12. Periodical revision of quality system to ensure its effectiveness. Records of reviews must be kept.
13. The company must provide equipment testing to demonstrate the performance of the product according to the specified requirements.
14. Measurement and calibration of equipment must be done in a controlled and documented procedure.
15. Inspection of products must be done through a documented marking system. This system must be able to deal with products that fail quality tests.
16. Aspects of the quality assurance system must be documented properly in a form of quality manual.
17. Copies of the quality manual must be available to all locations where the quality system is carried out.
18. All documentation must be dated, its revision number identified and maintained in a clean and legible condition.
19. A documented system must be established whereby the quality manual is modified or has additions made to it to keep it up to date. This responsibility should rest with the person who originally produced the manual.
20. Disposing of obsolete documentation must be provided by the quality management system.

3. ISO 9002 - Quality Systems - Quality Assurance in Production, Installation and Servicing Functions

[British standard: BS.EN.ISO 9002, European standard EN.ISO 9002, USA Standard: ANSL/ASQC Q92]

ISO 9002 requirements are almost identical to the ISO 9001 with one exception. Clauses related to control of design and development procedures are dropped.

4. **ISO 9003 - Quality Systems - Quality Assurance in Final Inspection and Test Functions**

[British standard: BS.EN.ISO 9003, European standard EN.ISO 9003, USA Standard: ANSL/ASQC Q93]

ISO 9003 requirements are almost identical to the ISO 9001 with one exception. Clauses related to control of design and development procedures are dropped.

5. **ISO 9004 - Quality Management and Quality System Elements**

[British standard: BS.EN.ISO 9004, European standard EN.ISO 9004, USA Standard: ANSL/ASQC Q94]

ISO 9004 consists of four parts providing guidance on requirements of quality system management, documentation, audits, costing, training and control of measurement and testing equipment.

Part 1 (ISO 9004-1)provides general guidelines. Part 2 (ISO 9004-2) provides more specific guidelines in relation to suppliers providing a service. Part 3 (ISO 9004 -3) provides more specific guidelines to suppliers who are providing processed materials. Part 4 (ISO 9004-4) provides advice on how to implement a system designed to achieve continuous improvements in quality.

The Benefits of ISO 9000:

The following are some of the basic benefits of ISO 9000 certification mentioned by Applied Quality Strategies (2000), an American Company based in New York specialised in Quality Management Systems:

1. ISO requires from organisations to document work procedures which helps in the process of continuous improvement.

2. Documented processes eliminate variation with the process; thus, efficiency improves.

3. Permanent solutions to quality problems are achieved through solid corrective and preventive measures.

4. Employee morale is increased as they are asked to take control of their processes and document their work processes.

5. As the company transforms from a reactive organisation to a pro-active one, customer satisfaction and loyalty grows.

6. Better systematic inspection and testing, increased employee participation, involvement, awareness and systematic employee training leads to reduced problems.

7. Better design control leads to better products and services.

8. Encourages the understanding that quality is not limited to a quality department but is everyone's responsibility.

9. Improved profit levels resulting from improved productivity, reduced costs associated with failures and warranties.

10. Improved internal and external communications which proves quality, efficiency, on time delivery and customer/supplier relations.

Appendix 4[1]

ISO 14000 Series Standards

The environmental system standards, ISO 14001 and ISO 14004 are of central importance in the ISO 14000 series. They allow an organisation to take a systematic approach to the evaluation of how its activities, products and services interact with the environment. Moreover, they also control those activities to ensure that established environmental objectives and targets are met. The following are the environmental management series:

1. ISO 14001 - Requirements for an environmental management system (EMS)

ISO 14001 provides specification detailing the requirements an organisation must meet in order to achieve a third-party certification. The specification includes the following:

- Development of an environmental policy
- Identification of environmental aspects
- Establishment of relevant legal and regulatory requirements
- Development of environmental objectives and targets
- Establishment and maintenance of an environmental programme in order to achieve its objectives and targets
- Implementation of an EMS, including training, documentation, operational control and emergency preparedness and response
- Monitoring and measurement of operational activities, including record-keeping
- EMS audit procedures
- Management review of an EMS to determine its continuing suitability adequacy and effectiveness.

2. ISO 14004 - Design, development and maintenance of an EMS

While ISO 14001 is intended to provie the specification for an organisation's EMS, ISO 14004 acts as a stepping stone tot he specification for organisations who may require some additional guidance and information in relation to the development of an EMS. ISO 14004 includes the following:

- Internationally accepted principles of environmental management and how they can be applied to the design and development of all the components of an EMS.

[1] Appendix 4 Source: Sheldon, 1997.

- Practical examples of the issues an organisation will need to ensure they have addressed in the design of their EMS.
- Help sections to provide the organisation with assistance in the various stages of EMS design, development and implementation and maintenance.

3. ISO 14010 - Environmental Auditing Standard

ISO 14010 is the environmental auditing standard that provides the guidelines for principles involved in environmental auditing. It contains the following:

- Definitions of environmental audit and related terms
- General principles of environmental auditing
- Framework for the structure and format of an audit report

4. ISO 14011 - Environmental Auditing Standard

ISO 14011 provides guidance on the audit procedures that facilitate the planning and conduct of an EMS audit. It includes the following:

- Audit objectives
- Roles and responsibilities of those involved in the audit
- Development of the audit scope, plan and working documents
- Preparation and documentation of the audit report

5. ISO 14012 - Environmental Auditing Standard

ISO 14012 provides guidance on the minimum qualification criteria for environmental auditors and lead auditors. It provide information on the following requirements:

- Educational and professional qualifications
- Formal and on-the-job training
- Competencies and personal attributes and skills

The Benefits of ISO 14000:

Don Sayre (1996) stated the following benefits if an organisation implements an effective environmental management system:

1. Protect human health and the environment from the potential impacts of its activities, products, and services.
2. Assist in maintaining and improving the quality of the environment.
3. Meet customers' environmental expectations.
4. Maintain good public and community relations.
5. Satisfy investor criteria and improve access to capital.
6. Provide insurance at a reasonable cost.
7. Gain an enhanced image and market share.
8. Satisfy vendor certification criteria.
9. Improve cost control.
10. Limit liabilities.
11. Provide resource conservation.
12. Provide effective technology development and transfer.
13. Provide confidence to interested parties.

Appendix 5a
Register of Community Drinking-Water Supplies in Waikato Region – May 1998
Population Less than 500 (Water Grading)

CODE	NAME	POPLULATION	WATER GRADING
TAH001	Tahuna	120	Aa
MAT003	Matangi	500	Ad
TAM001	Tamahere	500	Ad
EUR001	Eureka	220	Au
GOR003	Gordonton	392	Au
ROT008	Rototuna	?	Au
TEP003	Te Poi	100	Ba
TIH001	Tihiroa	400	Bb
WHA014	Whatawhata Hill Country Research	105	Be
PIO001	Piopio	500	Ca
WAI047	Waipa	175	Cb
WAI049	Waitoa	200	Cc
HAH001	Hahei	100	Db
WAI012	Waitomo Caves	500	Db
MOK002	Mokau, Waitomo	200	Dc
OHU001	Ohura	300	Dc
TAU002	Taharoa	150	Dc
KAR001	Karangahake	140	Dd
MAT010	Matarangi	200	Dd
OWH001	Owhango	250	Dd
WAI043	Waikino	340	Dd
BEN002	Benneydale	280	De
MAC003	Mackaytown	140	De
ONE002	Onemana	150	De
THO002	Thornton Bay	100	De
HOR001	Horotiu	100	Eb
KAW001	Kawhia	500	Ec
TEP006	Te Puru - Unarei	100	Ee
WHA015	Whakapapa Village	200	Ee
ARA003	Arapuni	400	u
ARO001	Arohena	360	u
ATHOO2	Athol	50	u
ELS001	Elstow School	120	u
HIK002	Hikutaia	200	u
HIN002	Himuera	35	u
HIN005	Hinuera Primary School	149	u
HOE001	Hoe-O-Tainui School	149	u
HUN004	Huntly Power Station	260	u
ING003	Inghams Poultry	360	u
KAI024	Kaihere School	66	u
KAI013	Kaimanawa	100	u
KAK002	Kakahi	50	u
KEN003	Kennedy Bay School	35	u

SOURCE: Author's Table, Adapted from Ministry of Health, 1998.

Appendix 5a
Register of Community Drinking-Water Supplies in Waikato Region – May 1998
Population Less than 500 (Water Grading)

CODE	NAME	POPLULATION	WATER GRADING
KER003	Kereone School	62	u
KIN005	Kinohaku School	?	u
KIW006	Kiwitahi School	52	u
KOP003	Kopu Sawmill	220	u
LIC001	Lichfield	50	u
MAN035	Manawaru School	97	u
MAN034	Mangateparu School	44	u
MAT009	Matatoki	150	u
MOT015	Motumaoho School & Community	100	u
NAT001	National Park	220	u
NGA021	Ngarua Primary School	56	u
ONG001	Ognarue School	38	u
OPA003	Oparau School	36	u
PAC002	Pacific Aerospace Corp Hamilton	103	u
PAT006	Paterangi School	110	u
PIR001	Piriaka	100	u
PUR002	Pureora	30	u
PUR003	Puriri	150	u
RAN006	Ranginui	90	u
RAU001	Raurimu	30	u
RIC005	Richmond Downs Primary School	46	u
SPR006	Springdale School	59	u
TAT002	Tatua Co-op Dairy Co. Ltd.	120	u
TAT001	Tatuanui School	94	u
TAU017	Tauhei School	83	u
TEA005	Te Aroha West School & Com.	100	u
TEP004	Te Puninga School	35	u
TEP007	Te Puru - Aputa Ave	200	u
TUR005	Turanga-O-Moana Primary School	62	u
WAI062	Waihou School	105	u
WAI091	Waihou Township	105	u
WAI082	Waikato Regional Airport	110	u
WAI064	Waimiha School	43	u
WAI048	Waipapa Hydro Village, Waikato	100	u
WAL003	Walton Primary School	111	u
WAR005	Wardville Primary School	48	u

SOURCE: Author's Table, Adapted from Ministry of Health, 1998.

Appendix 5b
Register of Community Drinking-Water Supplies in Waikato Region – May 1998
Population 501 - 2000 (Water Grading)

CODE	NAME	POPULATION	WATER GRADING
KIH001	Kihikihi	2,000	Aa
NEW001	Newstead	800	Ad
TEK001	Te Kauwhata	1,700	Ad
TEM003	Templeview	1,200	Au
TOK006	Tokanui Hospital	550	Au
PAU001	Pauanui	1,020	b
TAU002	Taupiri - Hopu Hopu	660	Ba
WAH001	Waharoa	634	Ba
WAI013	Waikeria	972	Bc
TAI002	Tairua	1,233	Bd
TIR001	Tirau	700	Db
OHI001	Ohinemuri	1,000	Ed
COR001	Coromandel	1,393	Ee

SOURCE: Author's Table, Adapted from Ministry of Health, 1998.

Appendix 5c
Register of Community Drinking-Water Supplies in Waikato Region – May 1998
Population 2001 - 5000 (Water Grading)

CODE	NAME	POPLULATION	WATER GRADING
RAG001	Raglan	2,400	Aa
MAT001	Mataouna/Manunui	3,000	Ad
PUK001	Pukerimu Rural	2,950	Au
TEA003	Te Aroha	3,465	Ba
TEK003	Te Kuiti	4,612	Ba
WAI003	Waihi	4,450	Ba
WHA003	Whangamata	4,000	Ba
PUT001	Putaruru	4,500	Bc
WHI001	Whitianga	3,600	Ca
PAE001	Paeroa	4,000	Cb
OTO001	Otorohanga	2,875	Cc
TAU003	Taumarunui	3,500	Ed

SOURCE: Author's Table, Adapted from Ministry of Health, 1998.

Appendix 5d
Register of Community Drinking-Water Supplies in Waikato Region – May 1998
Population Over 5000 (Water Grading)

CODE	NAME	POPLULATION	WATER GRADING
HAM001	Hamilton	100,000	Aa
THA001	Thames	6,950	Aa
CAM001	Cambridge	10,540	Ab
TEA001	Te Awamutu & Pirongia	9,105	Ab
HUN002	Huntly	7,410	Ba
MAT004	Matamata	5,600	Ba
MOR001	Morrinsville	5,600	Ba
NGA002	Ngaruawahia	5,420	Ba
TOK001	Tokoroa	17,400	Ca
HAU001	Hauraki Plains	5,158	Dc

SOURCE: Author's Table, Adapted from Ministry of Health, 1998.

Appendix 6[1]
THE UNIVERSITY OF WAIKATO
WAIKATO MANAGEMENT SCHOOL ETHICS COMMITTEE

TOTAL QUALITY MANAGEMENT MODELS AND DRINKING WATER QUALITY: THE WAIKATO EXPERIENCE

Organisation conducting/sponsoring research:
University of Waikato Management School

Purpose of Research:
It is part of research toward the fulfilment of requirements of a Doctoral Study at the University of Waikato.

How will the material be held and kept confidential:
The data and material collected (i.e. paper files, tapes and word processor data files) will be kept in a locked filling cabinet in a locked office.

CONSENT FORM FOR PARTICIPANTS

I have read the Outline of Research for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I understand that I am free to withdraw from the study at any time, or to decline to answer particular questions in the study. I agree to provide information to the researchers under the conditions of confidentiality set out on the information sheet.
I wish to participate in this study under the conditions set out in the Outline of Research Project form.

Signed: ______________________________

Name: ______________________________

Date: ______________________________

Researcher's Name and contact information:
Ms. Siham Omer El-Kafafi
Environment and Management Programme
University of Waikato Management School
Private Bag 3105
Hamilton, New Zealand
Telephone: 0064 7 838 4466 Ext: 6318
Mobile: 0064 25 233 9224
Facsimile: 0064 7 838 4260
Email: elkafafi@mngt.waikato.ac.nz
S.O.ElKafafi@xtra.co.nz

[1] Appendix 6 Source: The Researcher

Appendix 7[1]

Ms. Siham Omer El Kafafi
University of Waikato Management School
Private Bag 3105
Hamilton
New Zealand
E-mail: S.O.ElKafafi@xtra.co.nz

Date:

Mr/Ms
Manager – Water, Drainage & Refuse
Title
Address
New Zealand

Subject: Invitation for Participation in Research Project

Dear Mr/Ms ,

My name is Siham Omer El Kafafi, a Ph.D. student at the Waikato Management School, Waikato University, Hamilton. I am investigating environmental and managerial determinants of drinking water quality in New Zealand and in the Waikato.

The reason for this letter is to introduce the researcher, and the research conducted, and to invite you to participate in the research project entitled: "Total Quality Management Models and drinking water quality: The Waikato Experience."

The research will involve a structured questionnaire for face-to-face interviews to be conducted with the relevant council managers. The aim of these interviews is to report and analyse managers' views on the following issues:

1. Management perceptions of quality management systems?

2. The impact of Chief Executive philosophy and organisational architecture on the development and operation of TQM systems?

3. How water utility managers perceive the link between ISO 9000 Standards and TQM?

4. What are the benefits of implementing ISO 9000 Standards as a model of quality management in the Water Utilities in New Zealand?

[1] Appendix 7 Source: The Researcher

5. How far have water utilities implemented TQM models as a means of quality assurance?

6. What are the challenges confronting the Water Utilities in maintaining ISO 9000 Standards?

7. What is the motivation for water utilities implementing ISO 9000 Standards and obtaining the certification?

8. Have water utilities received any national awards like The Business Development Quality Award or The New Zealand Business Excellence Award? Are these awards of any relevance for the drinking water quality?

In accordance with University research ethics requirements, you will be required to sign a consent form participation in the research. This consent form explains the conditions and rights that you are entitled to. A copy of the interview transcript will be given to you for your checking before being finalised. Also a copy of a research paper derived from this research will be forwarded to you upon completion of the study.

Shortly, I will be contacting you by phone to arrange for a convenient time to meet with you if it is possible for you to participate in the research project.

In case you require any further details in relation to the research project, please feel free to contact me on the following numbers (07) 838 4466 Ext: 6318 or 025 233 9224 or e-mail me on elkafafi@mngt.waikato.ac.nz or S.O.ElKafafi@xtra.co.nz.

Your help and assistance by participating in this research is of great importance. Looking forward to meeting with you in the near future.

Sincerely yours,

Siham Omer El-Kafafi

Appendix 8[1]

Waikato Water Utilities Managers Survey Questions

Waikato Region TLAs:

1. Hamilton City Council
2. South Waikato District Council
3. Otorohanga District Council
4. Waitomo District Council
5. Waipa District Council
6. Thames Coromandel District Council
7. Matamata Piako District Council
8. Waikato District Council
9. Hauraki District Council

Specify Council: --

Name of Person Interviewed: --

Title of Person Interviewed: --

Department: --

Date: --

[1] Appendix 8 Source: The Researcher

PART I: Questions related to TQM

1. What department manages the provision of drinking water?

   ----

2. What water supply systems are your department responsible for?

   ----

3. Who does the department manager report to?

   ----

4. What is your definition of "quality"?

   ----

5. What quality management system is used in your department?

   ----

6. Do all "quality systems" apply to all water delivery systems?

   ----

7. Are you developing any techniques for quality improvement?

   Examples:
   a) team based problem solving techniques:

      ----

   b) statistical process control of drinking water quality:

      ----

   c) other:

      ----

8. Have you read any literature on quality management systems?

   a) A very large amount
   b) Many references
   c) A modest amount of references
   d) A few references
   e) None

9. Identify any quality management ideas you have read about that you have incorporated in your department's management system?

   ----

10. Have you applied any of the quality management models e.g. ISO 9000 Standards, ISO 14000 Standards, New Zealand Business Excellence Award (Baldrige Award)?

    ----

11. If Yes! How long has your department been certified for ISO 9001/ISO 9002/ISO 14000?

    ----

12. If No! Why haven't you applied?

    ----

13. Has their been any difference in quality since the certification of ISO 9001/ISO 9002/ISO 14000?

    ----

14. Why did you apply for the certification?

    ----

15. Are you aware of the updated versions of ISO 9000-2000/ISO 14000-2000?

    ----

16. Have you made any preparation for the new version? If Yes! What are they?

----

17. Have you applied the principles of the New Zealand Excellence Award?

----

18. If Yes! Have you noticed any significant measurable improvement in water quality system?

PART II: Questions related to implementation

1. Senior Management Responsibility:

a) What Quality Policy exists that show your organisation's attitude to quality?

----

b) How is that policy communicated throughout the organisation?

----

c) What financial resources are allocated for training personnel to perform the work of the Quality System?

i) None
ii) \$1 – \$1000
iii) \$1000 – \$2000
iv) \$ 2000 - \$5000
v) Over \$5000

d) What training is funded in your budget?

i) Attend short courses
ii) Attend course at the Polytech or the University
iii) Attend overseas conferences
iv) Other – Please specify

e) Who is the management representative who monitors the Quality System?

----

f) Do senior management conduct regular management reviews to ensure the health of the quality system?

----

2. Quality System:

a) Is the Quality System fully documented within the framework of ISO 9001/ISO 9002/ISO 14000?

----

b) How well does the Quality System satisfy customer's requirements and specifications? (In this case we are referring to the community people and their satisfaction with the drinking water quality provided to them. The specification would be in accordance with the NZ Drinking Water Quality Standards.)

vi) Very well
vii) Well
viii) Moderate
ix) Poorly
x) Very poorly

c) Please explain how the Quality System is adapted to your organisation?

----

d) Please define how quality requirements are met?

----

3. Review of Customer Satisfaction:

a) How often do you review the requirements of your customers?

i) Never
ii) 6 - 12 months
iii) 1 – 3 years
iv) 3 – 5 years
v) More than 5 years

b) Are changes in customer requirements documented and incorporated in revised performance targets?

----

4. Document and Data Control:

a) How often are documents reviewed and re-authorised?

i) Never
ii) 1 - 6 months
iii) 6 – 12 months
iv) 1 – 3 years
v) More than 3 years

b) Are obsolete documents removed from circulation and latest issues located at appropriate areas throughout the facility and available at the workplace?

----

c) Are changes recorded and released in a controlled manner?

----

d) Is all data produced checked and approved?

----

5. Purchasing:

a) What information do you keep about your purchasing?

i) Suppliers name and details
ii) Contracts with suppliers and goods delivered

iii) Equipments and chemicals purchased
iv) General information
v) Others – please specify

b) Is demonstrated quality the main criteria for selecting your suppliers (or subcontractors)?

i) The main important criteria
ii) A secondary important criteria
iii) A third important criteria
iv) A somewhat important criteria
v) Not important at all

c) How often are suppliers/subcontractors monitored?

i) Never
ii) 6 - 12 months
iii) 1 – 2 years
iv) 2 - 3 years
v) 3 years or more

6. Customer Control of Product:

(In this case it would be the drinking water quality supplied to the community.)

a) Are there any actions that consumers make which influence the quality of drinking water they receive?

----

b) If yes! What are they?

----

c) Describe any existing procedures for monitoring those actions?

----

7. Identification and Traceability:

Please specify testing of drinking water quality at each and every stage until it reaches the consumer?

----

8. Process Control:

How well documented are the procedures related to performance and monitoring of the water treatment plant?

i) Very well
ii) Well
iii) Moderately
iv) Poorly
v) Very poorly

9. Inspection:

a) Are all the phases of monitoring and testing the drinking water quality controlled and conducted by qualified personnel?

i) All of the phases
ii) Most of the phases
iii) Some of the phases
iv) Very few phases
v) None of the phases

b) Have you got a documented verification process for all the following stages of your control process?

i) Receiving of raw material (i.e. water for testing).

----

ii) Water leaving the treatment plant.

----

iii) Final inspection - at customer.

----

10. Calibration:

a) Do you check the accuracy of all inspection and measuring equipment (i.e. thermometers, scales, test software etc…) in your department?

----

b) If No! do you contract out the testing?

----

c) How often is all the equipment accurate?

i) All the times
ii) Most of the times
iii) Some of the times
iv) Few of the times
v) None of the times

d) How do you protect and maintain the equipment to ensure continuing accuracy?

----

11. Inspection and Test Status:

a) How do you identify water quality at all phases of production (i.e. drinking water testing and treatment) that does not meet quality standards?

----

b) To whom do you report the inspection results? (Internal & External)

----

12. Control of Nonconforming Product:

What are the measures taken in cases of non-conforming product (i.e. drinking water is not up to the required standard)? Please cite examples.

----

13. Corrective and Preventive Action:

a) What formal processes are there to correct and prevent problems from occurring?

----

b) Are you sure the root cause of the problems are investigated?

i) Very sure
ii) Sure
iii) Somewhat sure
iv) A little sure
v) Not sure at all

c) How effective is the corrective/preventive action?

i) Very effective
ii) Effective
iii) Somewhat effective
iv) A little effective
v) Not effective at all

14. Control of Quality Records:

a) How well do you monitor your records (i.e. log books, computer, or what)?

i) Very well
ii) Well
iii) Moderately
iv) Poorly
v) Very poorly

b) How easily can you retrieve accurate information?

i) Very easily
ii) Easily
iii) Moderately easy
iv) With some difficulty
v) Very difficult

c) For how long are those quality records retained?

i) Never
ii) 6 - 12 months
iii) 1 – 3 years
iv) 3 – 5 years
v) More than 5 years

15. Internal Quality Audits:

a) Are you conducting formal internal audits to examine all activities affecting quality?

----

b) Have you got documented procedures for these internal audits?

----

c) Are those internal audits in accordance with ISO 9000 (or whatever TQM Model being used) requirements?

----

16. Training:

a) How often are you providing appropriate training to people carrying out activities affecting product quality?

i) Never
ii) 6 - 12 months
iii) 1 – 3 years
iv) 3 – 5 years
v) More than 5 years

b) How do you identify the need for Training?

----

c) Are the training activities documented?

----

17. Statistical Techniques:

a) What statistical techniques are used for water testing, data analysis and sampling methods?

----

b) How long have you been using these techniques?

i) 1 - 6 months
ii) 6 - 12 months
iii) 1 – 3 years
iv) 3 – 5 years
v) More than 5 years

c) Are they reliable and precise? If yes! Please illustrate with examples.

