TQM: An Optimum Model for Water Utilities Management?

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Abstract: New Zealand has abundant water resources that are generally of high quality. Although streams and rivers of New Zealand have some of the highest self-cleaning rates, they are still subject to faecal, sediment and nutrient run-off from pastures in their middle and lower reaches, especially in the North Island. This of course has an effect on the quality of the drinking water provided to the community. This paper examines managerial practices related to the supply of drinking water in the Waikato Region and the role of Total Quality Management (TQM) in that process. It reports on face to face interviews conducted with 21 Managers of nine councils of the Waikato Region to find themes and problems that face councils while applying the TQM models to the management of water utilities. The following themes were chosen as indicators for the best managerial practices in this model: (1) Training Personnel in Quality Systems; (2) Customer Satisfaction with Water Quality; (3) Purchasing Equipment/Chemicals; (4) Process Control; (5) Inspection; (6) Calibration; (7) Corrective and Preventive Action where drinking water is below standard (non-conformance); and (8) Control of Quality Records. How water utility managers deal with the above issues in their organizations is important as the sector seeks to effectively manage limited resources to achieve higher performance structure. The validity of the TQM Model for the management of water utilities is assessed.

Keywords: Water utilities managerial practices; TQM Model; Drinking water quality; Waikato Region

1. INTRODUCTION

The doctoral project, which underpins this paper, investigates and evaluates the use of QMS in New Zealand's water supply sector. The focus of the investigation is the organisational dynamics and results of the adoption, adaptation and use of QMS by the water supply organizations of nine Territorial Authorities in the Waikato Region. The research project has both qualitative and quantitative aspects including: (i) personal interviews with staff of the water departments; (ii) analysis of the data provided by the councils and their grading; (iii) comparison between the self assessment tool used in this model and the Ministry of Health water grading for the different councils in the Waikato Region. As shown in the methodology, this paper will only discuss the quantitative aspect of the research. Eight criteria that constitute the Model under investigation are chosen to assess optimum managerial practice for the water utilities in the Waikato Region. Finally the paper will present the key findings of the data analysis.

2. WAIKATO REGION

The Waikato Region covers 25,000 square kilometres in the central North Island of New Zealand. It contains a rich diversity of natural resources including snow-capped mountains, extensive rive and lake systems, forests, geothermal fields and productive farmland. A human population of 350,125 [Statistics New Zealand, 1996] live in the Waikato Region mostly urban areas. Within the Waikato region are the rohe, or tribal areas, of a number of iwi[1]. Waikato Iwi include Tainui, Tuwharetoa and Ngati Tahu [Waikato Regional Council, 1994 & 1998].

The Waikato Region is well endowed with water resources as shown on Table 1.

The Waikato Region is an area of New Zealand, which is highly dependent on surface water from rivers and lakes to supply its drinking water needs. Accordingly the Councils with the assistance of Environment Waikato gives great

[1] *Maori in New Zealand identify with and are identified through three levels of organization – Iwi – tribal level, hapu – clan and whanau – extended family.*

importance to the following issues [Waikato Regional Council, 1994 & 1998]:

- Maintaining and improving water quality,
- Maintaining and enhancing flow regimes,
- Efficient use of water, and
- Enhancing public access.

Table 1. Key Waikato Water Resources.

Rivers & Lakes	Description
Waikato River	The longest river in New Zealand and is considered an important natural resource for the Region
Waipa River	Contributes to extensive flood plains in the north
Piako River	Extensive flood plains in then orth
Waihou River	Extensive flood plains in the north
Lake Taupo	Exceptional water quality

3. RESEARCH METHOD

This study was conducted using structured questionnaires [with a mix of closed and open ended questions] in face-to-face interviews with district managers of the Waikato Region. The non-probabilistic sampling strategy [Merriam, 1998] or "purposive" as called by Chien [1981] and "purposeful" by Patton [1990] has been used by the research in this study. The researcher wants to discover, understand, gain insight of a specific issue [i.e. an optimum model for water management in the water utilities (refer to Figure 1)]; hence, needs to select a sample from which she can learn the most. Snowball, chain or network sampling [Patton , M.Q., 1990] is the form of purposeful sampling used in this research. The researcher identified the participants through contacting people in the different councils and asking about the most suitable and knowledgeable person in the area to be interviewed. An interview schedule was prepared for specific time of meeting the different council managers. Interviews were conducted through the months of September, October and November of the year 2000. A total of twenty one managers were interviewed from the nine district councils of the Waikato Region. The interviews were taped, transcribed and coded. The closed ended questions relate to the eight criteria chosen for this model (see Appendix A). 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.

As this study is in large manner qualitative, the quantitative part is applied to answer the following sub-questions related to the main research question of the doctorate study:

1)To what extent are TQM practices actually applied in the water utilities?
2)What relationship exists between the use of specific TQM procedures/models and water quality?

TQM Model

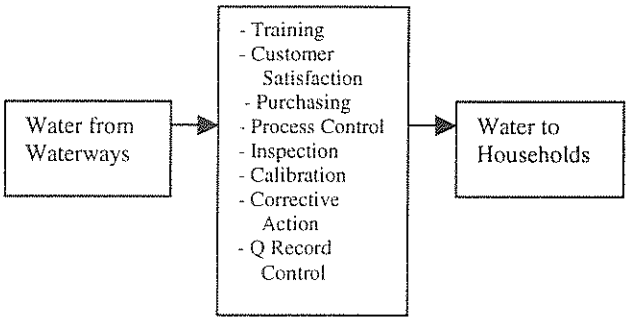

Figure 1. TQM Model.

4. DATA ANALYSIS OF THE WAIKATO DISTRICT COUNCILS

The questions related to the following quality management variables were coded and analysed on an excel spread sheet to get the mean of each criteria of the personal assessment tool for each of the nine Waikato District Councils:

- ***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 2 shows the mean score across all eight criteria on 5 point likert scale. It is worth mentioning here that although the criteria of analysis for this model was formulated by the researcher, the outcome is according to how each council scored themselves in relation to that model.

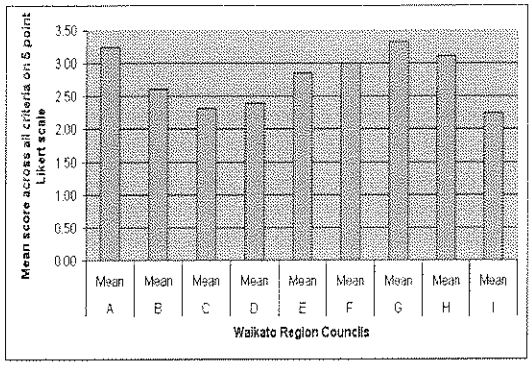

Figure 2. Mean Scores across all criteria in the Councils in the Waikato Region.

After calculating all the means of quality management variables across the councils the total score was 39.05 from 56 which is the total number of questions asked to the interviewed candidates. According to Figure 1 the following are the scores in descending order of the different councils:

1. Council G = 46.50
2. Council A = 45.45
3. Council H = 43.50
4. Council F = 42.00
5. Council E = 40.00
6. Council B = 36.50
7. Council D = 33.50
8. Council C = 32.50
9. Council I = 31.50

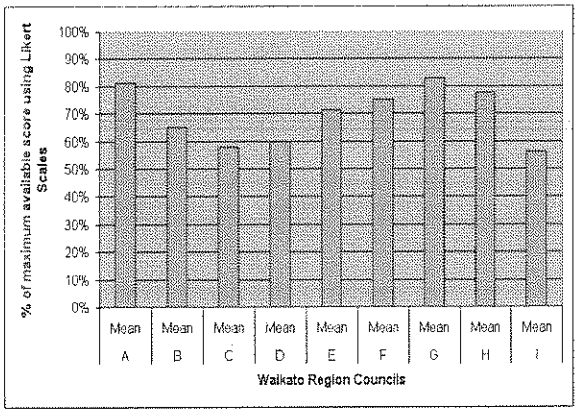

Figure 3. Percentage maximum score using likert scale.

Figure 3 not only illustrated the same data through presenting it in percentages of possible scores, but also confirmed the results of Figure 2 by giving the following scores in descending order:

1. Council G = 83%
2. Council A = 81%
3. Council H = 78%
4. Council F = 75%
5. Council E = 71%
6. Council B = 65%
7. Council D = 60%
8. Council C = 58%
9. Council I = 56%

The aim of using the percentages is to discriminate between the different councils who are adopting the model and the ones who are adopting it partially.

A further analysis of the scores of the eight criteria across all the nine councils was conducted to find out which quality criteria are more likely to be met by councils. Figure 4 shows the criteria 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 score that inspection and testing of equipment scores the highest among all the councils. On the other hand, training personnel in quality systems scores the lowest across councils.

Figure 4 shows to what extent TQM and its Models are actually applied in the water utilities which is in reply to the first sub-research question stated earlier.

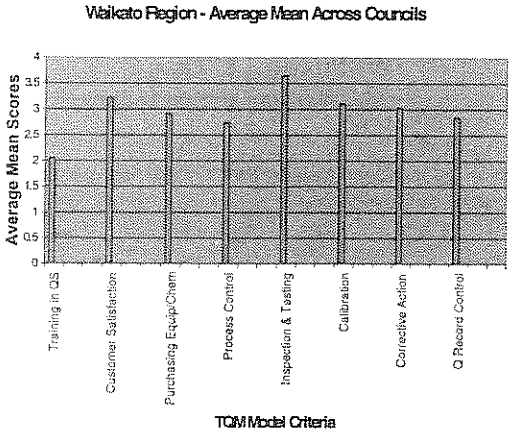

Figure 4. Waikato Region – Average mean of all quality criteria across Councils.

Table 2 aims at illustrating the application of quality systems in the Waikato Region District Councils.

Table 2. Quality Systems across Water Supply Utilities in the Waikato Region.

Coun-cil	Drinking Water Standards	Quality System (TQM)	ISO 9000	ISO 14000
G	Yes – 1995 Standards	Yes	Yes	No
A	Yes – 1995 Standards	Yes	Yes	No
H	Yes – 1995 Standards	Yes	No	No
F	Yes – 1995 Standards	No	Yes *	Yes *
B	Yes – 1995 Standards	Yes	No	No
D	Yes – 2000 Standards	No	No	No
C	Yes – 1984 Standards	No	No	No
I	Yes – 1995 Standards	No	No	No

*Treatment Plant Contractor is ISO 9000/ISO 14000 Certified.

Table 2 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 & b]. Moreover, none of the water supply departments within councils have any quality awards apart from Council A who are preparing application for a quality award for the whole organization. If we compare between the mean scores illustrated earlier in Figure 1 and this table, we would find out 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'. Appendix B provides further details concerning the Ministry of Health water grading scales.

The results show that there is a relationship between the adoption and adaptation of TQM and its models to the quality of water.

5. FINDINGS

The Model and the survey are effective in disentangling the components of TQM and their relevance for water utility management. Particularly important are the following results:

- Not all the Councils have fully adopted the quality management approach within their structures.
- A diversity of formal QMS approaches are in use amongst the nine Councils 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 Experience."
- Economic factors, especially cost play an important factor in the adoption, adaptation and use of QMS approaches by the Councils.
- Inspection and testing of equipment seems to be of high priority to all

councils which is quite relevant to the issue to water grading.

- Training in quality systems seems to be somewhat ignored by most of the councils which is an area that needs to be targeted for future improvement.

6. CONCLUSION

The significant differences in the grading of drinking water quality (as awarded by the Ministry of Health) may have a relationship with the use or non-use of QMS approaches. This is an early stage of adoption of QMS e.g. Council A is considered the oldest council of the nine in adopting the TQM Model i.e. has been ISO 9000 certified for 6 years. Hence, it is an early stage to give clear cut answers in this case.

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8. APPENDIX A: WAIKATO DISTRICT MANAGERS SURVEY QUESTIONS

1. Training Personnel in Quality Systems
   1.1 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

   1.2 What training is funded in your budget
      i) Attend short courses
      ii) Attend course at the Polytech or University
      iii) Attend overseas conferences
      iv) Other – Please specify
      v) None

   1.3 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

2. Customer satisfaction with water
   2.1 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

3. Purchasing equipment/chemicals
   3.1 Is demonstrating 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
   3.2 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

4. Process Control

4.1 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

5. Inspection and Testing
   5.1 Are all the phases of monitoring and testing the drinking water quality controlled and conducted by qualified personnel?
      i) All the phases
      ii) Most of the phases
      iii) Some of the phases
      iv) None of the phases

6. Calibration
   6.1 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

7. Corrective/preventive action
   1.1 Are you sure the rot cause of the problems are investigated?
      i) Very sure
      ii) Sure
      iii) Somewhat sure
      iv) A little sure
      v) Not sure at all
   1.2 How effective is the corrective/preventive action?
      i) Very effective
      ii) Effective
      iii) Somewhat effective
      iv) A little effective
      v) Not effective at all

8. Control of Quality Records
   8.1 How well do you monitor your records?
      i) Very well
      ii) Well
      iii) Moderately
      iv) Poorly
      v) Very poorly
   8.2 How easily can you retrieve accurate information?
      i) Very easily
      ii) Easily
      iii) Moderately easy
      iv) With some difficulty
      v) Very difficult
   8.3 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

9. APPENDIX B: REGISTER OF COMMUNITY DRINKING WATER SUPPLIES AND WATER GRADING SYSTEM IN NEW ZEALAND

Source and Treatment Grading:

A1 Completely satisfactory, negligible level of risk, demonstrating 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, demonstrating 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.