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THE USE OF IT TO SUPPORT TQM
IN THE MALAYSIAN PUBLIC SECTOR

by

Chooi-Leng Ang

A Doctoral Thesis

Submitted in partial fulfilment of the requirements
for the award of

The Degree of Doctor of Philosophy of
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The Use of IT to Support TQM in the Malaysian Public Sector

ABSTRACT

Both total quality management (TQM) and the use of information technology (IT) have been widely researched over recent years. However, there has been no well-founded empirical research on the two together - on how IT can support TQM practices. A scarcity of empirical studies on the role of IT in TQM, especially in the non-manufacturing sector, which can illustrate the importance or otherwise of IT for TQM, has prompted this study. Thus the study sought to provide such an empirical base.

This study investigated the extent to which IT has been used to support TQM among selected Malaysian public agencies. It also identified the external, organisational and technological factors that may influence the use of IT in TQM.

A framework based on the literature of TQM has been derived and used as the conceptual base for the creation of a questionnaire to determine the use of IT in TQM. The questionnaire was sent to 110 Malaysian public agencies that have implemented TQM. The results presented were based on the responses from 47 agencies.

The study reveals that IT is helpful for implementing TQM but its usage varies across the nine aspects of TQM processes. ‘Important Innovations’ exhibits the highest level of IT usage followed closely by ‘Information and Analysis’. ‘Supplier Quality Assurance’, on the other hand, shows the lowest level of IT usage.

Regression analysis showed that four independent variables have a significant effect on the use of IT. They are IT experience, top management support, public accountability and IT structure (in order of importance).

The responding agencies were then classified into three distinctive IT-usage groups (i.e. low, moderate, and high) according to their IT-usage level. Contextual influences (external, organisational and technological) were then explored using regression analysis. The results revealed that when the IT-usage level is high, technological factors play an important role. However, when the usage level is low, organisational factors become more influential. For the moderate group, both technological and organisational factors affect the usage level.
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CHAPTER 1 INTRODUCTION

1.1 Context of the Study

Computerisation started in the Malaysian public sector as early as 1965. The focus then was on computerising routine functions in the financial and administrative sectors. For the early half of the 1990s (1991-1995), 1.4 billion Ringgit Malaysia (RM) (around US$0.5 billion¹) was allocated for computerisation projects (Economic Planning Unit 1996, p. 456) in the public sector. The focus in the 1990s has been to integrate information technology (IT) into management processes, automating data collection so that accurate information can be generated for planning and control purposes, and for effective decision making.

Total Quality Management (TQM) is a continuous process that is customer-driven and involves the whole organisation to achieve total quality in all operational aspects (Chief Secretary to the Government 1992). The concept of TQM was formally introduced in the Malaysian public sector during the Sixth Malaysia Plan² (1991-1995). It aimed to cultivate a quality culture in public organisations. In 1992, the Development Administrative Circulars (series of 91-92) were issued by the Chief Secretary to the Government to guide public sector managers who were implementing TQM. Since then, the Malaysian public service has undergone significant changes. The 'outcome/customer orientation' model of public administration, which aims at satisfying customers and meeting their expectations, has superseded the traditional 'output/process' model where the emphasis is on the process and output of service delivery irrespective of customer requirements (Chiu 1997). Previous reports (Kyte 1991; English 1991; Atkinson 1991; Cho 1994; Kaplan 1996) strongly suggest that the application of TQM not only benefits the customers, in that they receive quality products and services, but also the organisation in terms of cost savings and enhanced operational efficiency. As TQM stresses management involvement, customer

¹ Using the exchange rate in mid 1997.
² The 5-year development strategies and programmes based on the National Development Policy.
satisfaction, and continuous improvement, measures have been taken by the
government to encourage government departments to implement TQM and eventually
make it a way of life. It is anticipated that, through TQM, the Malaysian public service
will become world-class.

Under the TQM Programme, Malaysian public officials are required to constantly
search for more efficient and effective methods for the delivery of public services that
satisfy customers. Ng Kam Chiu (1997), the Director-General of the Malaysian Public
Complaints Bureau, suggests that efforts be directed at upgrading both the capacity
and the reliability of administrative routines when improving work processes.
Adopting better technology and encouraging innovations are recommended for the
strengthening of work processes.

Anuar Maarof (1996) of the Malaysian Administrative Modernisation and
Management Planning Unit (MAMPU) stresses that a shift in management paradigm
is essential for the Malaysian public service at the threshold of the information age
with four main goals:

- increasing competitiveness in the delivery of public service
- greater entrepreneurship in government agencies
- greater focus on the customer
- increasing emphasis on results and performance

As IT has been singled out for achieving these goals, the government has taken on
various supportive roles on IT deployment. Among others mentioned by Maarof
(1996) are:

- formulation of policy directives and strategies
- encourage management support and user involvement
- proper information systems planning
- prioritisation of areas of computerisation

At the launch of the Seventh Malaysia Plan in May 1996, the government allocated a
sum of RM2.3 billion (around US$0.8 billion) for investing in IT-related programmes
and projects in the subsequent five years (Economic Planning Unit 1996, p. 467). The public sector is expected to utilise IT to increase productivity and efficiency as well as to enhance service quality. With billions of Ringgits allocated to satisfying service and other functional needs across various government departments, many challenges face public sector managers. These include: how IT can help and contribute in implementing TQM; the aspects of TQM in which IT is most likely to be useful, and thus be given priority in computerisation; and the factors that influence the contribution that IT can and does make to enhancing TQM in the public sector.

Within the above context, the term 'Information Technology (IT)' is defined as hardware and software that collects, transmits, processes, and disseminates information (Sethi & King 1994, p. 1604). Subsequently, the terms 'IT application' and 'IT use' are taken to mean the support of business activities through the use of IT. Throughout the discussion in this thesis, other terms including 'Information Systems (IS)', 'Computer Information Systems (CIS)', and 'Computer-Based Information Systems (CBIS)' that are used in the IT literature are taken to carry the same meaning as IT.

1.2 Statement of Purpose

The purpose of this study was to investigate the extent to which IT has been used to support TQM in Malaysian public agencies in order to ascertain the role of IT in TQM. The emphasis was on how IT supported TQM processes, i.e. how IT was actually used in TQM, rather than on the effect and influence of IT on TQM performance.

1.2.1 Differences between Public and Private IT Management

The use of IT in the public sector is pervasive. However, differences do exist between public and private sector management of IT. According to Mohan et al. (1990), public sector organisations operate with fixed budgets and have little leeway to shift funding from one category to another. In these circumstances, risky projects and those with
vague or not easily justifiable objectives are not likely to be high on the IT priority list.

To develop good IT in government, special attention must be paid to the information needs for the monitoring and assessment of service performance. Existing frameworks for IT in private sector organisations cannot automatically translate to government (Hendrick 1994). This is because the public sector differs from the private sector in that government processes, structures, functions, and products vary greatly. In addition, the objectives of government are less clear, clients and stakeholders are more diverse and numerous, and concepts such as quality are more complex.

Bretschneider (1990) conducted a study to test empirically if management of IT in public organisations differs from that carried out in private sector firms. In his work, a stratified sampling design was used to collect data from both public and private organisations, and the public organisation sample focused exclusively on state government agencies in the United States. This study provides two useful results. First, the environment of public management IT differs from that of its private sector counterpart. A public organisation's environment reflects greater interdependence and accountability, which leads in part to more red tape. Second, within these more constrained environments, the criteria used in private organisations for purchasing of hardware and software, planning of processes and the placement of the top data processing manager need to be adjusted to suit the public sector environments.

1.2.2 IT in TQM

The literature dealing with the organisational impact of IT highlights how IT is making possible fundamental changes and improvements in the way management work is carried out (Straub & Wetherbe 1989; Scott Morton 1994). However, the IT literature has not explicitly considered quality management or TQM. Although IT evaluation measures have been developed in the past (Bailey & Pearson 1983; Mahmood & Mann 1993; Sethi & King 1994), a new requirement has emerged. There
is a need to assess the role of IT in TQM (Kanji & Asher 1993; Mathieson & Wharton 1993; Wilcox et al., 1996).

IT has an important role in the TQM process (Pearson et al. 1995; Matta et al. 1998). It provides a comprehensive and integrated approach by which an organisation can achieve improved quality in the products and/or services it offers. Many quality-focused companies have achieved significant benefits from the integration of IT and TQM in the form of lowered manufacturing costs, improved profitability and improved customer satisfaction (Pearson et al. 1995; Matta et al. 1998).

For TQM to achieve its objectives, Hendrick (1994) argued, information must be available about the organisation’s operations and environment that is accurate, timely, accessible, comprehensive, and continuous. The empowered employees have a greater need for the right information to solve interdepartmental problems and to manage effectively the changes mandated in TQM implementation. This, in turn, requires an integrated and co-ordinated information system for collecting, organising, and sorting data, as well as creating and presenting meaningful information from the data in useful ways. Developing such a system is more than simply putting together computers, databases, and the associated personnel.

To ensure that TQM concepts and techniques are applied successfully, Zahedi (1998) suggests using quality IT to deal with ‘the right problems the right way’ (p. 447). Quality IT, according to Zahedi (1998), are designed to achieve the corporate vision, to serve quality efforts and has a dynamic nature in which continuous improvement is internalised to keep pace with the requirements of TQM. Like Hendrick (1994), Zahedi (1998) strongly believes that in developing quality IT, the technical approach and the behavioural approach must be synergised for the IT to be of any use.

TQM was originally introduced to the USA manufacturing sector during the 1920s and was widely implemented in the Japanese industry since 1950s to improve production performance (Milakovich 1991). As the concerns of productivity deepened and the realisation that quality is as important in service industries as in manufacturing firms, the eighties has seen TQM being widely adopted in corporations
and governments in the US (Bowman 1994). The strongest evidence of the value and benefits of TQM is seen as arising from the success of Japanese manufacturing companies. However, recent research on the advantages of TQM has presented mixed findings (Hill & Wilkinson 1995; Yong & Wilkinson 1999). As the government environment is distinctly different from that of the industrial sector, many are sceptical about the successful stories of TQM in public agencies. While academics like Milakovich (1991) and Bowman (1994), and practitioners such as Rago (1994) believe TQM can be successfully integrated into the government agencies, many have questioned the suitability of TQM in the same environment (Swiss 1992; Eastman & Fulop 1996).

In discussing the extent to which TQM 'fits' the public sector, Morgan and Murgatroyd (1994, pp. 57-59) believe this dispute is no longer valid. In their view, the changes in the public sector in recent years have made the attempt to distinguish between commercial and public sector service providers invalid. They conclude that TQM must be seen as a framework that can span all organisational settings with due recognition given to their differences. Hill and Wilkinson (1995) reckon that different sectors, different organisations with different sizes and market conditions, and at different stages of quality development require different manifestations of TQM.

Wilcox et al. (1996) point out that the exact nature of TQM and its relationship to other strategies such as IT and human resources is not clearly defined. Yet many companies pursue these in parallel and in isolation resulting in conflict and poor utilisation of resources. In addition, their study revealed that contradictions and conflicts resulting from the interactions between TQM and other policies are not addressed, and senior management tends to make decisions on the basis of short-term expediency. This phenomenon may be because many organisations have not recognised the important role that IT must have in TQM (Mathieson & Wharton 1993) or may be a lot of decisions are made in this way.

It is not the intention of this study to evaluate TQM interventions. Neither is it to measure TQM applicability in the public sector. This study accepts as a fact that TQM
is successfully in place in those public agencies that are to be studied and intends to explore the role of IT in this environment.

As implementation of TQM is a complex undertaking, Kanji and Asher (1993, pp. 82-84) called for research into every aspect of it so that a set of principles can be developed to help organisations to obtain the optimum benefit from TQM. One of the areas in which research is necessary for a wider and deeper understanding of TQM is technology. According to Kanji and Asher (1993, p. 83), although TQM deals with people and their commitment to quality, some quality problems need to be solved with the help of technology. They claimed that many companies have invested heavily in new technology yet some have also experienced quality problems. They urged researchers to investigate the technology solutions to enhance TQM in various areas including IT.

The literature on quality improvement efforts revealed that the role of IT in TQM has not been clarified. Barker (1991), Harding (1991), Cullen (1992), Woodruff (1995-96), Scully (1996), and Ward (1996) all highlighted the fact that information plays a critical role in quality improvement programs. However, when discussing the importance of information, they did not consider IT for quality as a specific dimension of quality management frameworks.

Murray (1991), Zadrozny and Ferrazzi (1992), Cortada (1995), Aiken et al. (1996), Goodman and Darr (1996), Khalil (1996), Kathuria and Igbaria (1997), Kock and McQueen (1997), and Matta et al. (1998) espoused the importance of IT in TQM. However, none of them provided empirical evidence for their claims, a few did only through examples and anecdotal evidence. Nevertheless, there are some notable exceptions. Forza (1995a) attempted to establish a link between quality management practices and the support given by IT. Even though his empirical work enabled him to propose a statistically tested valid-and-reliable reference model and associated measures to study the role of IT on quality management (Forza 1995a), he admitted that the 'IT for quality' dimension in his model could be improved. In addition, the study focused exclusively on the manufacturing environment.
Much of the research effort on quality initiatives in the public sector has been directed toward quality performance or outcomes and the role of IT in such environments was never addressed (e.g. Eastman & Fulop 1996; Mani 1996). To the knowledge of the author, there are no empirical studies on the role of IT in the management of government that can illustrate the importance or otherwise of IT for supporting TQM processes. This study is an attempt to provide such an empirical base.

1.3 Research Objective

The fundamental objective of this study is to understand how IT can most appropriately be used to support TQM in Malaysian public agencies. Specifically, it aims:

1) to broaden the knowledge of IT use in TQM by the current practice among high performing Malaysian public agencies³,

2) to derive guidelines in order to provide a framework for the successful application of IT in TQM in the public sector. In particular, to determine which organisational characteristics, external influences, and existing technology facilitate the applications.

This study is concerned with the impact of IT on TQM. It is not about TQM per se. It has not been the intention to investigate the impact and contribution of IT in the operational aspect of organisations. The study is of the IT impact on TQM, not TQ or Q itself.

1.4 Theoretical Framework

The variable of primary interest in this study is the dependent variable IT-use-in-TQM. As explained fully in Chapter 2, TQM can be decomposed into eight aspects, namely Leadership, Output Quality Assurance, Human Resource Utilisation, Strategic
Planning Process, Important Innovations, Information and Analysis, Customer Satisfaction, and Quality Results. The contribution of IT to various aspects of TQM is not likely to be equal. The use of IT on aspects which are information intensive such as Information and Analysis, and Strategic Planning Process is likely to be more extensive than in Leadership in quality (see e.g. Zadrozny & Ferrazzi 1992; Woodruff 1995-96). While IT has been found to be very useful in Output Quality Assurance in manufacturing environments (e.g. Burgess & Gules 1998; Matta et al. 1998), its role in the service sector may not be the same. This is because in delivering service to customers, the service provider himself or herself forms an important part of the service quality.

Three independent macro variables are used in an attempt to explain the variance in the IT use in TQM. This study builds on the work of Cahill et al. (1990). This work explored empirically the relative explanatory power offered by three constructs - the external, organisational and technological factors - on the impact of IT on managerial functions in American government agencies. In order to test the multiple alternative explanations of potential determinants of utilisation, a research model was constructed. The model conformed to and extended the conclusions of past research that the complex interrelationships among these three sets of factors explained and accounted for the successful use of IT, regardless of how 'utilisation' was defined. Cahill et al. (1990) found that the unique combination of these three categories of factors - external, organisational, and technological - gave a greater explanatory power for the impact of IT than any one single category alone. In order to elicit the underlying reasons that account for the variance in IT use in TQM, particularly in governmental settings, a list of factors has been identified from the literature. These three macro variables consist of external factors (economic climate, IT marketplace, legislation influence, public accountability and inter-organisational co-operation), organisational factors (organisational structure, organisational size, managerial IT knowledge, top management support, resources allocation, goal alignment, and budgeting method), and technological factors (IT experience, IT facilities, user support, IT integration, IT structure, and IT skills/competency). The technological

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3 High performing public agencies are defined as public agencies that have been short-listed for the Prime Minister's Quality Award in Malaysia.
factors considered in this study consist of existing IT practices adopted within the organisation. These IT factors are actually internal organisational factors, but are isolated as a separate category for two reasons. First, this study follows the variable-classification method used in the study of Cahill et al. (1990); and second, it makes sense to differentiate IT factors from other managerial-related organisational factors as past studies have showed that IT-related issues have a unique influence on IT adoption (King & Teo 1994; Nedovic-Budic & Godschalk 1996). The three categories of factors are fully discussed in Chapter 3.

The theoretical framework is depicted in Figure 1.1.

**Figure 1.1 Schematic Diagram of the Theoretical Framework**

**1.5 Research Questions**

From the theoretical framework discussed above, three research questions have been developed for this study relating to the Malaysian TQM implementing public agencies. They are:
Q1: What is the impact of IT on TQM; in particular, on Leadership, Strategic Planning Process, Output Quality Assurance, Important Innovations, Information and Analysis, Human Resource Utilisation, Customer Satisfaction, and Quality Results?

Q2: Which are the external, organisational, and technological factors that are associated with IT applications in TQM?

Q3: To what extent do external, organisational and technological factors account for the variance in the impact of IT on TQM?

1.6 Study Design

1.6.1 Nature of the study

As this research project attempts to analyse the relationship between the dependent and independent variables, this study is analytical in nature.

1.6.2 Study setting

This is a judgement study, according to McGrath's (1982) classification of research strategy, because it uses the candidates of the Malaysian Prime Minister's Quality Award as 'judges' to respond to the stimuli – the impact of IT on TQM.

1.6.3 Time horizon

The data for this study were collected over a two-month period in 1998. The study is cross-sectional in nature.
1.6.4 Unit of analysis

This study aims to ascertain the degree of impact of IT on TQM in all Malaysian public agencies that have been short-listed for the Prime Minister's Quality Award since its inception (1992). The unit of analysis for this study therefore is each individual public agency unit that has been a candidate for the quality award.

1.7 Assumptions

In undertaking the study, the following assumptions are made:

1. The quality award candidate agencies have implemented TQM successfully. These candidates have submitted documentation to substantiate their quality achievements to MAMPU. The documentation is prepared in accordance to the MAMPU guidelines that explicitly distinguish the eight aspects of TQM.

2. The respondents are regarded as key informants of the unit of analysis. The respondents include a) heads of organisation, b) administrative/executive officers, c) IT managers, or d) computer personnel who are responsible for the quality improvement programmes in their respective agencies.

1.8 Research Significance

This research is deemed significant for the following reasons:

Practitioners:

1. a) A description of IT use in the TQM implementing Malaysian public agencies will be useful for future national Strategic Planning of Information Resources (SPIR) because the IT implementation in these 'leader' agencies may serve as a 'blueprint' for their counterparts in realising the vision of Electronic Government (MAMPU 2000).
1. b) It will serve as a reference for other Malaysian public sector managers who are looking for support from IT to enhance TQM implementation.

1. c) A profile along the TQM dimensions will be useful to practitioners for demonstrating, or at least elucidating, the benefits of IT applications.

Researchers:

2. a) It provides a framework to link IT with TQM which is essential to further understand TQM implementation.

2. b) It operationalises the impact of IT on TQM. This will contribute to the MIS research in the construction of an index of IT effectiveness.

1.9 Organisation of the Thesis

The thesis consists of nine chapters. Following this introduction, Chapter 2 presents a review of the TQM literature with a view to develop a model for conducting an empirical study in public organisations. Chapter 3 covers the applications of IT, especially in the public sector, and reviews past research in the field of IT to determine factors that influence its use.

Chapter 4 outlines the research design, describing the method adopted in this study and the sample involved. This is followed by a chapter detailing the development of the questionnaire and a summary of the interviews with key TQM personnel. The implementation of the questionnaire is detailed in Chapter 6.

A rigorous examination of the measurement instrument is reported in Chapter 7. Chapter 8 focuses on data analysis undertaken. The analyses include descriptive statistics, multiple regression analysis and cluster analysis. Lastly, a summary of major findings, implications and recommendations for future work are provided in Chapter 9.
CHAPTER 2  THE TQM FRAMEWORK

2.1 Introduction

The review of the TQM literature reveals several TQM frameworks (e.g. the Malcolm Baldrige Quality Award, the European Quality Award, the British Quality Award and the Deming Prize). Different approaches have been put forward by its numerous contributors with disparate sets of concepts, management practices, tools and techniques developed. In an attempt to define TQM by examining the work of the original quality 'gurus', considering the view of leading institutions and also utilising evidence from surveys, Boaden (1997) concludes that the lack of agreement on a definition of TQM may be due to the confusion between principles and practices. Boaden (1997) argues that the motivation and rationale behind certain practices are more subject to changes in fashion and may be attributed to a variety of sources other than business activities. As TQM develops over time, with increasing adoption and experience, the relative importance of the principles will change.

The current study focuses on TQM as quality management - TQM in practice rather than TQM in theory or TQM as organisational change. The appropriate operational concept that best suit the purpose should therefore describe an organisation's TQM activities.

The following sections describe the TQM teachings of various quality gurus and the criteria of the Malcolm Baldrige Quality Award. After highlighting the important issues regarding the applicability of TQM to public organisations, the TQM model used in Malaysia is discussed. Finally, the framework adopted in the study is presented in detail.
2.2 The Definition of Quality and TQM

There are many definitions of quality; however, they all accept the notion that quality is defined by the customer and is concerned with meeting customer requirements. W. Edwards Deming, a leading quality thinker, defines it as 'a predictable degree of uniformity and dependability, at low cost and suited to the market'. Another expert, Joseph M. Juran, speaks of 'fitness for use in terms of design, conformance, availability, safety, and field use', while Philip Crosby uses the phrase 'conformance to requirements' (Omachonu & Ross 1994, pp. 7-11). The definition of quality chosen by the European Organisation for Quality Control (EOQC) and the American Society for Quality Control is 'the totality of features of a product or service that bears on its ability to satisfy given needs' (Morgan & Murgatroyd 1994, p. 8).

The above definitions do not take into account all the major features of TQM: the involvement of everyone in the organisation and the continuous nature of quality programmes in meeting customer needs. The definition used by the American Federal Quality Institute (cited in Morgan & Murgatroyd 1994, p. 7) captures the primary elements of TQM and can serve as a definition of TQM for the purpose of this study:

'A total organisational approach for meeting customer needs and expectations that involves all managers and employees in using quantitative methods to improve continuously the organisation’s process, products, and services.'

Having adopted this TQM definition, then quality within the context of this study would mean 'meeting and exceeding customer needs and expectations'.

2.3 TQM Teachings

In developing a TQM framework, there are many different approaches that can be used, which have arisen through the teachings of what are now commonly known as the TQM 'gurus'. It is therefore necessary to review these different approaches.
There are numerous quality gurus. To name a few, they include Philip Crosby, Bill Conway, W. Edwards Deming, Armand Feigenbaum, Joseph M. Juran, Kaoru Ishikawa and Genichi Taguchi. In his profile of the TQM gurus, Oakland (1993) includes only Deming, Crosby and Juran. Similarly, only the management insights of the same gurus are included in the discussion by Cortada (1995, pp. 9-10), Waldman (1994, p. 511) as well as Siegel and Seidler (1996, pp. 1782-1783). The following sub-sections summarise the quality programs of the three quality gurus.

### 2.3.1 Philip B. Crosby

Crosby's approach to quality improvement was popularised through his book *Quality is Free*, published in 1979. He defines quality as 'conformance to requirements' and it can only be measured by the cost of non-conformance. According to Crosby, there exists only one standard of performance - zero defects - which is achievable through prevention. He stresses motivation and planning and does not dwell on statistical process control.

Crosby points out that quality improvement is the responsibility of management. His four absolutes of quality are:

- Quality is **defined** as conformance to requirements,
- The **system** for achieving quality is prevention,
- The performance **standard** is zero defects,
- The **measurement** of quality is the price of non-conformance.

He offers management fourteen steps to quality improvement:

1. **Management commitment.** Make it clear that management is committed to quality;
2. **Quality improvement team.** Form quality improvement teams with representatives from each department, i.e. quality transcends functional disciplines;
3. Quality measurement. Determine where current and potential quality problems lie;
4. Cost of quality. Evaluate the cost of quality and explain its use as a management tool;
5. Quality awareness. Raise the quality awareness and personal concern of all employees;
6. Corrective action. Take actions to correct problems identified through previous steps;
7. Zero defects planning. Establish a committee for the zero defects programme;
8. Supervisor training. Train supervisors to actively carry out their part of the quality improvement programme;
9. Zero defects day. Hold a 'zero defects day' to let all employees realise that there has been a change;
10. Goal setting. Encourage individuals to establish improvement goals for themselves and their groups;
11. Error cause removal. Encourage employees to communicate to management the obstacles they face in attaining their improvement goals;
12. Recognition. Recognise and appreciate those who participate;
13. Quality councils. Establish quality councils to communicate on a regular basis;
14. Do it all over again. Do it all over again to emphasise that the quality improvement programme never ends.

2.3.2 W. Edwards Deming

Deming's (1986) basic philosophy is that quality and productivity increase as variability decreases. He advocates measurement of quality by direct statistical measures of manufacturing performance against specification. While all production processes exhibit variation, the goal of quality improvement is to reduce variation and statistical methods of quality control must be used.

In his view, quality management and improvement are the responsibility of all the firm's employees. However, management is responsible for the majority of quality
problems. In his book *Out of Crisis* (1986), Deming has laid down his fourteen points for management to achieve quality:

1. Create constancy of purpose towards improvement of product and service;
2. Adopt the new philosophy. We can no longer live with commonly accepted levels of delays, mistakes, defective workmanship;
3. Cease dependence on mass inspection. Require, instead, statistical evidence that quality is built in;
4. End the practice of awarding business on the basis of price tag;
5. Find problems. It is management's job to work continually on the system;
6. Institute modern methods of training on the job;
7. Institute modern methods of supervision of production workers. The responsibility of foremen must be changed from numbers to quality;
8. Drive out fear, so that everyone may work effectively for the company;
9. Break down barriers between departments;
10. Eliminate numerical goals, posters, and slogans for the workforce asking for new levels of productivity without providing methods;
11. Eliminate work standards that prescribe numerical quotas;
12. Remove barriers that stand between the hourly worker and his right to pride of workmanship;
13. Institute a vigorous program of education and retraining;
14. Create a structure in top management that will push every day on the above thirteen points.

2.3.3 Juran

Juran (1988) defines quality as fitness for use in terms of design, conformance, availability, safety, and field use. His concept closely incorporates the point of view of the customer. He emphasises increased conformance and decreased cost of quality. He introduced the managerial dimensions of planning, organising, and controlling, and focused on the responsibility of management to achieve quality as well as the need for setting specific annual goals to be worked on by project teams.
Like Deming, Juran recommends the use of statistical process control. However, he focuses on top-down management and technical methods rather than worker pride and satisfaction. Top management needs to be involved because ‘all major quality problems are interdepartmental’. The role of the workforce is mainly to be involved in quality improvement teams.

Juran’s ten steps to quality improvement are:

1. Build awareness of the need and opportunity for improvement;
2. Set goals for improvement;
3. Organise to reach the goals (establish a quality council, identify problems, select projects, appoint teams, designate facilitators);
4. Provide training;
5. Carry out projects to solve problems;
6. Report progress;
7. Give recognition (motivation);
8. Communicate results;
9. Keep score;
10. Maintain momentum by making annual improvement part of the regular systems and processes of the company.

The teachings of Crosby, Deming and Juran do provide common ideas to TQM (Waldman 1994):

1. A broad definition of quality as meeting customers’ expectations;
2. Senior management commitment to place quality as a top priority and to ‘walk the talk’;
3. Involvement and empowerment of all organisational members toward quality improvement with positive reinforcement and rewards;
4. The commitment continually to improve employees' capabilities through training and education;
5. The development of a quality culture - continuous improvement of processes;
6. An orientation toward managing-by-facts, including the prolific use of scientific and problem-solving techniques such as statistical process control.

The differences lie in the emphasis of their approach. Deming provides manufacturers with methods (Statistical Process Control or SPC) to measure the variations in a production process in order to determine the causes of poor quality. Juran emphasises setting specific annual goals and establishing teams to work on 'projects'. Crosby stresses a program of zero defects with company-wide motivation.

2.4 Malcolm Baldrige Quality Award

Many models have been developed on how to implement quality (Oakland 1991, Kanji & Asher 1993, p. 3; Silvestro 1995, p. 307), including those discussed in the previous section which form the basis of many models. Associated with these models is invariably an assessment function for measuring progress. The criteria used to quantify evidence of quality efforts and to measure performance provide a framework for quality improvement. The design that is becoming the standard of choice in the United States, which has also become the premise of many quality awards in other countries such as Malaysia, is the Baldrige approach. The recognition associated with the Baldrige approach is the most prestigious award in American industry: the Malcolm Baldrige Award. The award originated from the Malcolm Baldrige National Quality Improvement Act, signed by President Ronald Reagan on 20th August 1987 to honour the Secretary of Commerce in the Reagan administration who espoused the need for quality improvement in business to enhance US competitiveness (Garvin 1991). The award is administered by the National Institute of Standards and Technology and the American Society for Quality Control (ASQC) and is awarded annually (Cortada 1995, p. 11).

The Baldrige approach addresses all aspects of quality improvement effort using various criteria categorised under seven categories (Cortada 1995, p. 285):
1995 Examination Categories:

1. Leadership
   - senior executive leadership
   - leadership system and organisation
   - public responsibility and corporate citizenship

2. Information and Analysis
   - management of information and data
   - competitive comparisons and benchmarks
   - analysis and use of company-level data

3. Strategic Planning
   - strategic development
   - strategy deployment

4. Human Resource Development and Management
   - human resource planning and evaluation
   - high performance work systems
   - employee education, training, and development
   - employee well being and satisfaction

5. Process Management
   - design and introduction of products and services
   - process management: product and service production and delivery
   - process management support services
   - management of supplier performance

6. Business Results
   - product and service quality results
   - company operational and financial results
   - supplier performance results

7. Customer Focus and Satisfaction
   - customer and market knowledge
   - customer relationship management
   - customer satisfaction determination
   - customer satisfaction results
   - customer satisfaction comparison
The assessment of quality achievements involves the systematic analysis of the practices of the organisation in these seven categories. The points to be awarded vary with each category to reflect the relative importance of the categories. The criteria and point values by category continue to evolve each year (Wilson & Durant 1994).

The award has attracted the attention of many organisations, not so much for the award itself but because of the excellent framework it provides. Many organisations such as IBM do internal self-assessment each year using the Baldrige criteria without necessarily submitting a nomination for the award, but as an excellent basis to highlight areas for priority attention and to provide internal and external benchmarking. Besides private organisations, almost all of US state quality awards are modelled on the Baldrige award (Kaplan 1996). For example, the US Air Force uses Baldrige as the basis for its 'Unit Self-Assessment'. Oakland (1993, p. 148) claimed that the Baldrige framework 'is one of the closest things we have to an international standard for TQM'.

Dean and Bowen (cited in Silvestro 1995, p. 130) supported Oakland's view with the following justification:

‘There are several advantages to using the Baldrige criteria. First, the conceptual framework underlying the award addresses the principal domains of TQ. Second, it has been repeatedly updated by a team of experts to reflect current thinking on TQ. Third, the award framework is not limited to a single quality perspective (e.g. Deming’s or Juran’s), but rather it incorporates a diversity of viewpoints.’

2.5 TQM in the Public Sector

TQM has its roots in manufacturing, where statistical quality-control measures were first used to reduce product defects. It was perceived to be a powerful competitive weapon which had partly explained the success of Japanese manufacturers in
producing high volumes of defect-free products, at high speed and low cost (Morgan & Murgatroyd 1994, p. 35). Substantial improvements in work environments and remarkable gains in quality, productivity, and competitive position have been reported among manufacturing organisations that have implemented TQM. They include IBM (Kaplan 1996), Xerox (Kanji & Asher 1993, p. 88), British Steel (Kanji and Asher 1993, pp. 117-121), Ford and Rover Group Ltd (Morrison 1994, pp. 56-57). TQM has spread to include applications in service industries with equally impressive results, e.g. American Express (Cortada 1995, p. 18), Girobank (Rowe et al. 1994), and British Royal Mail (Morrison 1994, pp. 67-70).

The demonstrated success of TQM in market-driven organisations has prompted the extensive adoption of TQM in the public sector (Bowman 1994). In the US, TQM was designated the official management-improvement system for all federal executives by the issue of Executive Order 12637 (Milakovich 1991). Despite some reported barriers to achieving quality in the public sector, 'the federal government has acknowledged that TQM is the most effective way to continuously improve internal processes and raise the quality of customer service' (Milakovich 1991, p. 205).

The Clinton-Gore Administration started reinvention initiatives in 1993 to improve government services so as to restore the American people's faith in their own system of self-government (Gore 1996a). President Clinton told federal agencies to make customer service equal to the best in business. Under the leadership of the President and his Administration, cabinet secretaries and agency heads have committed to managing in accordance with the Malcolm Baldrige National Award criteria (Gore 1996b). Customer service standards were developed by asking customers what they wanted. To reflect a customer-driven government, agencies measure their results and report them to their customers (Gore 1996c). The results of these surveys of satisfaction are being used to improve both service and standards further.

To recognise outstanding efforts in quality improvement among American public agencies, the Federal Quality Improvement (FQI) Award was initiated. Premised directly on the Baldrige Award, the FQI Award uses eight categories of criteria to assess public agency nominees. The substantive FQI Award criteria deviate from
those of the Baldrige Award in only one respect, i.e. the human resource development and management criterion is split into two categories under the FQI Award: training/recognition and employee empowerment/teamwork (Wilson & Durant 1994).

The same endeavour was not lacking in the UK. In fact the British Quality Award scheme predated many other schemes including the Baldrige Award (Morrison 1994). This scheme was replaced in 1994 by the National Quality Award scheme that aimed at promoting TQM in all types of organisation in the UK. The judging panel worked closely with the Baldrige Award organisation and there is a commonality in the seven areas of judgement. However, the British counterpart seeks evidence of sustained improvement and progress over a four-year period instead of one year (Wedge 1991).

According to Milakovich (1991), the non-market character of the public sector is no longer true as 'once protected public agencies now face many of the same competitive challenges that American manufacturing industries confronted in the 1970s' (p. 203). He was optimistic about the adoption of TQM by the public sector to improve quality and to solve the problems that persisted under old systems. He made his point by outlining how Deming's fourteen points can be applied in that context. Furthermore, Milakovich proposed that TQM theories must also be customised to fit individual public agency cultures and its focus may vary in accordance to the nature of an agency.

English (1991) examined the potential for applying total quality in the UK public services and reported that 'the situation in the public service is ... similar to that of British manufacturers in 1984. ... there is a growing awareness amongst these public services that their customers are becoming more and more demanding' (p. 7). He believes that any public service organisation that gets serious about quality would gain tremendous benefits. The reason is that every organisation, whether manufacturing or service, profit-seeking or otherwise, encounters similar problems.

Swiss (1992), on the other hand, argues that TQM is not appropriate for the government environment due to four major problems: defining its customers (the broad general public with conflicting expectations), services vs. products (problem
with defining service quality due to the lack of uniformity in output of services as well as the delivery of services), focusing on inputs and processes (may cause the government service organisations to emphasise such factors as containing taxpayer cost and neglecting the customer needs), and government culture (the relatively high turnover in public top management and political manifestation may be significant quality obstacles). He believes modification of TQM is necessary if it is to be effective in the public sector.

Rago (1994) of the Texas Department of Mental Health and Mental Retardation agrees with Swiss that adaptation of TQM is necessary for government organisations but for different reasons. According to Rago, it is the government culture, the unmet needs of an unlimited supply of customers with inadequate revenues, and the unclear ultimate goal of TQM: the quality vs. quantity dilemma. Even in the presence of these problems, Rago does believe that TQM can be successfully integrated into the public organisation.

Eastman and Fulop (1996) report that TQM has not been enthusiastically adopted by the health care industry, especially public hospitals in Australia, for a number of complex reasons. They believed that implementation of TQM in health care would require different management and organisational approaches to the ones commonly found in the TQM literature.

As TQM was developed for use in the manufacturing environment, Vinzant and Vinzant (1996, p. 205) concluded that 'private sector models of TQM will work best in government areas which most closely resemble business enterprises. In other areas of the public sector, a modified TQM approach is more likely to be successful'. Hill and Wilkinson (1995) agreed that different manifestations of TQM were required in different sectors. In addition, they also argued that the appropriate TQM models might be contingent upon different market conditions in different organisations of different sizes and at different stages of quality development.

On discussing the extent to which TQM 'fits' the public sector, Morgan and Murgatroyd (1994, pp. 57-59) argued that it would be invalid to advocate either that
TQM is applicable or not applicable, or that exclusive models of TQM for manufacturing and service industries exist. It is also no longer valid for any attempt to exclusively distinguish between commercial and public sector service providers. They concluded that TQM must be seen as a framework that can span all organisational settings. However, they recognised that not all TQM concepts, tools and previous applications can be used in the public sector.

Millions of dollars have been saved and better quality service given at lower cost with substantial increase in quantity of service by three American navy commands (Ryan 1996). These three quality award recipients gave much credit of their success to the constant self-assessment against FQI award criteria.

Hart and Cooley (1996) suggested that TQM should be adopted to revitalise America's cities. To rebuild America and remould it into the economic and political giant it once was, they believed that a total quality system using the latest technology and focusing on the people must be developed.

However, in an attempt to measure and compare productivity between federal agencies that have implemented TQM and those that have not, Mani (1996) could not find any consistent noteworthy difference. Using data from the Federal Productivity Measurement Program as well as data reported by participating agencies in the US, the time-series analysis performed gave no statistically significant evidence to support the view that TQM affects productivity. Even then, Mani strongly believes that it may be inappropriate to conclude that TQM is not applicable to public agencies. The reason put forward was that many public-sector activities are difficult to quantify and this may affect the measurement of productivity. In addition, the quality aspect of output was not taken into account in the study. There was evidence of improved effectiveness and output quality in certain agencies that have adopted TQM despite the fact that their productivity was reported to stay constant.
2.6 ISO 9000 series

The International Standards Organisation (ISO) is a specialised international agency for standardisation. Its goal is to make the international exchange of goods and services easier, through the use of appropriate supplier certification. ISO 9000 was created to help manufacturing companies standardise quality assessment practices. It consists of guidelines for documenting activities implemented by companies (Cortada 1995, pp. 267-268).

Figure 2.1 illustrates the set of quality assurance standards published by ISO (Stevens & Williams 1991, p. 101).

**Figure 2.1 The ISO Standards on Quality**

![Diagram of ISO standards]

The ISO 9000 series is intended to judge quality assurance systems and has little to do with the quality of the total organisation or its strategy (Stevens & Williams 1991). The ISO places far less emphasis on examining the actual quality improvement.
process itself. It certifies the implementation of the quality standards and specifications as documented in an organisation's own quality handbook. It does not certify the adequacy of the quality handbook. Oakland (1993, p. 105) cautions that the quality manual can be a work of fiction and may not bear any relation to what actually happens. The manual becomes the 'end' in itself rather than a means of seeking improvement. It may be seen as legitimising quality to third parties (Yong & Wilkinson 1999).

When comparing the scope of ISO 9000 series with the Baldrige criteria, Stevens and Williams (1991) conclude that ISO covers only a part of the total quality field. Their view is readily supported by Oakland (1993, p. 129), Cortada (1995, p. 268), and Kaplan (1996).

Thiagarajan and Zairi (1997b) reviewed the comprehensive quality management literature and referred to about one hundred implementation case studies of best organisations, and concluded that many organisations regard registration with a quality management system such as ISO 9000 as a starting point and a vital element of the implementation process, as the registration process helped them to move on in developing the TQM process. Their conclusion is supported by the findings of an international empirical study on manufacturing companies which indicate that ISO 9000 registered companies exhibit higher levels of quality practices in all aspects of TQM than those that are planning to get registered or are not interested in the registration at all (Rao et al. 1997).

2.7 TQM in Malaysia

In Malaysia, quality implementation is modelled on the Baldrige approach. There are various quality awards, but the most prestigious one is the Prime Minister's Quality Award. It was launched on 9 November 1990. The awards are given annually as the highest honour and recognition to one agency/firm in each of the private, public, and social sectors.
The public sector Prime Minister’s Quality Award is administered by the Malaysian Administrative Modernisation and Management Planning Unit (MAMPU). The purposes of the award are:

a) to encourage and to increase awareness of quality;
b) to give formal recognition to government agencies that have shown a deep understanding about quality management and improvement as well as having achieved a unique quality leadership level;
c) to give publicity on successful quality strategies; and
d) to encourage healthy competition among government agencies toward better quality management implementation.

MAMPU (1992) uses eight categories of evaluation criteria:

1. Leadership in quality management
   - management support
   - quality values
   - management systems
   - public accountability

2. Output quality assurance
   - output quality
   - process quality
   - output quality assessment
   - quality audit
   - supplier quality assurance
   - documentation

3. Human resource utilisation
   - management
   - employee involvement
   - training and education
   - employee recognition
   - quality environment at work place

4. Strategic planning process
• planning process

5. Important innovations

6. Use of information and analysis in quality effort
   • scope of data and information
   • data management
   • analysis and use of data in decision-making

7. Customer satisfaction
   • customer requirements and expectations knowledge
   • customer-agency relationship
   • customer satisfaction measurement

8. Quality results
   • output
   • quality improvement projects
   • customers’ recognition

The major criteria are very similar to those used in the Baldrige Award: the one major difference is that the criteria for Malaysian quality evaluation are categorised into eight categories instead of seven. The eighth category ‘Important Innovations’ stands by itself to give more emphasis on those innovations introduced by an agency to improve its work processes so as to provide quality services to customers. In the Baldrige evaluation, invention, innovation, and creativity are recognised as 'important aspects of delivering ever-improving value to customers and maximising productivity'. The importance of innovations is evaluated under the Process Management category (Cortada 1995, p. 282).

2.8 The TQM Framework Adopted in this Study

Some of the established TQM frameworks are procedural, like those contained in the Crosby (1979), Deming (1986) and Juran (1988) programs. Some are outcome or performance oriented like the criteria of the Malcolm Baldrige Quality Award, the British Quality Award, the Deming Prize, the European Quality Award, the ISO 9000
This study is concerned with the impact of IT on TQM in Malaysian public agencies. The primary unit of analysis is the public agency that has been a candidate for the Prime Minister's Quality Award since its inception. This award is based on MAMPU TQM guidelines. These guidelines form the basis of the framework adopted in this study.

Figure 1.1 presented the theoretical framework of the study and is reproduced as the top portion of Figure 2.2. The lower portion of Figure 2.2 depicts an overview of the framework representing a relationship between the eight categories. This framework is borrowed from the Baldrige framework (Oakland 1993, p. 150). The only modification made was to divide the scope of the Process Management category in the Baldrige framework into two: Output Quality Assurance and Important Innovations. This is more appropriate for the study as Output Quality Assurance emphasises the maintenance of product and service quality where prevention and control are the core activities, while Important Innovations focuses on improving product and service quality to exceed customer needs and expectations. Although design and introduction of new/improved end products as well as new processes are possible only in the existence of sound procedures, the applications of IT to the two aspects need not necessarily have the same priorities (Kathuria & Igbaria 1997).

The framework shown in Figure 2.2 includes the eight dimensions of TQM processes: the leadership of top management creates the vision, values, goals and systems to achieve customer satisfaction and the desired quality results; a set of well-defined and data-driven processes (output quality assurance, human resource utilisation, strategy planning process, important innovations, and information and analysis) for meeting the organisation's quality and performance requirements; and measures of progress and goal to seek hard evidence of data to provide a result-oriented basis for channelling actions to deliver ever-improving customer values and organisational performance (Oakland 1993, pp. 149-150).
Figure 2.2 Conceptual Framework of TQM of this Study

**Contextual Influences**
- External factors
- Organisational factors
- Technological factors

**Impact of IT on TQM**
- Strategic Planning Process
- Output Quality Assurance
- Important Innovations
- Human Resource Utilisation
- Information and Analysis

**Organisational Quality Achievement**
- Customer Satisfaction
- Quality Results
2.9 Description of the TQM Dimensions

The eight dimensions of TQM will be discussed with a description of key attributes. These attributes were derived through a process involving identification and synthesis of requirements for TQM that have been prescribed by quality practitioners and academics. The process included an extensive review of the TQM literature.

2.9.1 Leadership


Commitment

TQM must start at the top, where serious obsessional commitment to quality is demonstrated (Oakland 1993, pp. 22-25). Only when the top management has recognised and accepted the responsibility for initiation and operation of TQM will TQM then spread effectively throughout the organisation (Ruggieri & Merli 1998). The absence of top management commitment is the prime reason for many TQM failures (Tyrrell 1992; Morgan & Murgatroyd 1994, pp. 14-15; Yong & Wilkinson 1999). With reference to about one hundred best organisations in the world and a comprehensive review of the quality literature, Thiagarajan and Zairi (1997a) come to a conclusion that without a committed leader to make fundamental changes very little else is possible. In fact the significant influence of management on quality improvement is widely acknowledged (Adam et al. 1997).

However, it is not sufficient for management just to be committed. Top management should make a visible commitment to the task and show example through participation in quality improvement activities (Wythe 1991; Garvin 1991; Thiagarajan & Zairi 1997a). Spenley (1992, p. 40) added the attitude of top management to TQM be demonstrated whole-heartedly, everyday and in every action.
Cullen (1992) described it as 'personal leadership through example of 100 per cent commitment to quality' (p. 32).

**Vision and mission**

To manifest commitment, leaders must create a vivid vision for the organisation's future and develop broad but concrete goals (Bohan 1995; Terziovski et al. 1996). Senior management vision and a collective sense of purpose to achieve a common goal are equally vital in sustaining TQM (Dale et al. 1997). Oakland (1993, p. 31-32) argues that effective leadership starts with the top management's vision and continues through development of a strategy for implementation which eventually leads to business success. One of the requirements for effective leadership, according to Oakland, is to develop and publish clear documented corporate beliefs and objectives - a mission statement. The existence of a shared vision is emphasised by Captain Heilman of the Naval Aviation Depot, Alamela and Captain Holmes of SUPSHIP, Jacksonville, two of the US navy commands who have won the 1996 President's Quality Achievement Award (Ryan 1996).

**Creation of quality culture**

TQM is an approach to improving the competitiveness, effectiveness and flexibility of a whole organisation. It may require fundamental changes in organisational culture, changing the organisation itself, through new behaviours, values, roles, expectations, and relationship, to make them more responsive and customer focused. This requires careful planning and implementation by top management - the basis for driving organisational change (Lascelles & Dale 1992; Oakland 1993, pp. 28-29; Vinzant & Vinzant 1996).

**Total quality leadership**

'The first thing that anyone who aspires to be a leader must do is to make himself known to the people he wants to lead. They must recognise him, know his style of speech and action. They must learn to read his signals accurately, and interpret them correctly. It takes time. It calls for frankness and honesty' (Tyrrell 1992, p. 20). Effective leadership has been recognised as an important driving force in TQM interventions (Cullen 1992; Keck 1996; Thiagarajan & Zairi 1997a). Quality
leadership was found to have great effect on quality performance (Flynn et al. 1994). However, it cannot be done in an ivory tower.

**Communicating**

Effective and regular communication is essential for the development of awareness of, and commitment to, quality in an organisation and in aligning the workforce toward corporate expectations (Thiagarajan & Zairi 1997a).

The openness of leaders to explain basic work expectations and to listen is essential for getting to people to initiate change and sustain improvement (Oakland 1989, pp. 238-244; Jowett 1991; Wythe 1991; Garvin 1991; Cullen 1992; Woodruff 1995-96; Dale et al. 1997). Scully (1996) added that the old practice of controlling and carefully parcelling out of information to employees are barriers to TQM success.

**Supportive**

A leader who encourages employees to take thoughtful risks, supports and highly values innovation, as well as recognises achievement will enhance continuous quality improvement (Wythe 1991; Cullen 1992; Smyth 1992; Oakland 1993, pp. 43-44; Morgan & Murgatroyd 1994, pp. 15-17).

**Empowering**

People will act responsibly when given responsibility (Scully 1996). Encouraging effective employee participation will ensure commitment to constant improvement (Oakland 1993, pp. 33-34; Morgan & Murgatroyd 1994, pp. 15-16; Woodruff 1995-96).

2.9.2 **Strategic planning process**

Quality does not happen on its own, it has to be planned and managed. The achievement of the organisation's mission and objectives requires the development of clear, effective and agreed-by-all strategies and supporting plans (Oakland 1993, p. 33; Bohan 1995; Terziovski et al. 1996). The process of strategic planning itself
enables an organisation to identify its customers, prioritise their requirements and consequently determine the types of output as well as to make employees understand the objectives of the organisation, and how they will contribute to attaining the objectives (Thiagarajan & Zairi 1997a). Cantfil stressed the importance of strategic planning, saying that ‘our strategic plan bridges the gap between where we are and where we need to go’ (Ryan 1996, p. 49).

As successful implementing TQM in any organisation requires the alignment of every member’s efforts with the aim of the organisation, consensus quality plans are essential to ensure everyone understands and is committed to the plans (Thiagarajan & Zairi 1997a; Harrington 1997).

Oakland (1993, p. 33) recommends the analysis of critical success factors and identification of critical processes in developing strategies and plans. Others suggest the strengths weaknesses opportunities threats (SWOT) analysis (DAC 1991-1992). The strategies should incorporate all aspects of the business (Kanji & Asher 1993, pp. 86-88), from management down to employees, across to customers and suppliers. All the planning processes need to be integrated and fact-based in order to achieve the quality goals. Strategic quality plans are the glue holding together a company’s quality effort. The plans need not be elaborate documents but ideally be practically indistinguishable from the business plan (Garvin 1991).

2.9.3 Output quality assurance

The activity of checking to ensure the output is of desired quality is known as quality assurance. It is ‘the prevention of quality problems through planned and systematic activities (including documentation). These will include the establishment of a good quality management system and the assessment of its adequacy, the audit of the operation of the system, and the review of the system itself’ (Oakland 1993, p. 16).

Quality assurance is a framework that encapsulates four principles of control, i.e. setting standards, appraising conformance to these standards, acting to ensure
standards are met, and planning for improvement in standards, to provide an integrated system for managing all functions within an organisation (Lin 1991).

The techniques used for quality assurance and problem solving are secondary although such standard tools as statistical process control, Pareto charts, and cause-effect (fish-bone) diagrams are commonly employed among organisations implementing TQM (Garvin 1991). "These tools are not mandatory, and any other approach is acceptable, as long as it produces verifiable, repeatable, controllable results that meet customers' needs" (p. 82). Despite the different tools and techniques, implementation of a formal quality assurance system has been identified as a critical factor of success (Terziovski et al. 1996).

Quality characteristics and standards
Prior to the establishment of a good quality management system, it is essential to know what quality of output is expected. Understanding and measuring customer perceptions of quality are vital for continuous improvements and must be communicated throughout the organisation, particularly to employees who produce the goods or deliver the service (Terziovski et al. 1996).

Process control
To control the operation of any process requires some careful planning. This includes identifying what the process is, and what the inputs and outputs are suitable for the purpose. To prevent failure in any transformation, Oakland (1993, p. 245) emphasises the need for properly documented and agreed upon process definition, flow, inputs and outputs. The documentation of procedures allows reliable data about the process to be collected and analysed so that any case of variation in quality characteristics can be disclosed and actions can be taken to improve the process and prevent failure. Statistical process control methods provide objective means of controlling quality in any process.

A comprehensive quality control system has been strongly supported by quality gurus to aid the management of quality, ensuring achievement of high quality performance and overcoming process-related problems (Thiagarajan & Zairi 1997b).
Continuous improvement

According to Morgan and Murgatroyd (1994, p. 18), continuous improvement in quality of outcomes are achieved through improving each of many processes involved in delivering them. Processes can be improved only if they are monitored and brought under control by gathering and using data. The use of statistical process controls is to provide the feedback required for corrective action, where necessary, so that attention is focused on the process as a whole. Establishment of a formal structure for collecting, monitoring and reporting improvement initiatives is one of the best practice implementations of TQM (Terziovski et al. 1996).

A systematic approach to continuous improvement is possible if fact-based decisions are made using appropriate tools throughout the organisation (Woodruff 1995-96). The use of factual information, collected and presented using statistical techniques, opens a channel of communication not available through other problem solving techniques. As process control involves the need to manage real-time data, acting on information from the process not the product, Barker (1991) as well as Milakovich (1991) suggested that all managers must have an intimate knowledge and understanding of the capability of the statistical process control techniques.

Quality assessment

Constantly comparing actual performance against internal standards provides feedback on the impact of quality improvement efforts, forming an essential part of process control and continuous improvement (Oakland 1993, pp. 193-196).

Documentation

To operate under controlled conditions, documented work instructions must be available to staff. In the service sector, where staff skill is often the key factor influencing the process, documented procedures are a major requirement (Oakland 1993, p. 119). The documentation also lets customers know the firm is serious about quality (Woodruff 1995-96).
Supplier quality assurance

Supplier quality has a great effect on an organisation’s quality performance (Saraph et al. 1989; Flynn et al. 1994). World-class companies such as Toyota, Nissan and ICL Product Distribution UK view suppliers as an integral part of their organisation’s operations (Thiagarajan & Zairi 1997b). This is because they recognise that a major source of quality products/processes problems is due to defective in-coming suppliers. These companies have adopted various supplier management programmes in their pursuit of continuous quality improvement.

2.9.4 Important innovations

The quest for quality requires reduced variation in products or services, and adherence to pre-determined standards. However, there should be a balance between innovation and standardisation (Oakland 1993, p. 58) as TQM means continuous improvement. The improvement is characterised as both innovation (new ways of doing things) and maintenance (maintaining standards), and may be both incremental and transformational leading to major ‘breakthrough’ innovations (Hill & Wilkinson 1995). Deployment of new technology for strategic advantage is a critical success factor for TQM (Terziovski et al. 1996). Creativity and innovations are highly valued (Morgan & Murgatroyd 1994, p. 16) and accordingly rewarded (Varian 1992).

2.9.5 Information and analysis

Information has a vital role in TQM as all quality improvement activities are based on informed decision-making, not opinion or impression (Morgan & Murgatroyd 1994, p. 5). The approach of TQM to quality control is characterised by: ‘no process without data collection, no data without analysis, and no analysis without decision’ (p. 18). Lin (1991) argues that a quality strategy can be no better than the information from
which it is derived. The study of Flynn et al. (1994) showed that quality information has a significant effect on quality performance.

Data scope
Information is useful only if it meets the user's needs. As information comes from data that have been 'processed', a company's database must be comprehensive and cover all critical areas: customer, employee, supplier and project/process (Seddon & Jackson 1991; Kyte 1991; Wythe 1991; Garvin 1991; Atkinson 1991; Matta et al. 1998; and Zahedi 1998).

As managing quality generates a great deal of data, it is important to determine what data types are worth keeping and how to organise them into an easily accessible structure. The databases must be able to facilitate different data manipulation and in-depth analysis to fulfil information requirements of each level (strategic, tactical and operational) of decision-making activities and for each target group of customers (Lin 1991; Miller 1996).

Quality information systems
In order to be sure of continuously meeting customer requirements, a quality information system (QIS) is necessary for providing real-time computing and the handling of a sufficiently large database (Oakland 1993, pp. 133-134). The database should be an integrated resource that is made available to all those who need information in the organisation (Lin 1991; Kathuria & Igbaria 1997; Matta et al. 1998; Zahedi 1998)).

A well-planned QIS does more than make data collection and storage easy (Kern 1991). It maintains data accuracy, provides high-quality decision support tools for fast, detailed analysis of many alternatives. It also can provide access to many types of quality information from every function, and speed communications and decision-making among teams and people.
Information

Information quality is defined by the information's customer, and is constantly changing over time. The ten dimensions of information quality identified by Miller (1996) are: timely, relevant, accurate, accessible, coherent/consistent, complete/comprehensive, format, secure, valid, and compatible.

2.9.6 Human resource utilisation

Many of the problems occurring in organisations are to do with utilising fully the abilities of its employees to meet customer's requirements (English 1991). In TQM interventions, human resource management was identified as one of the critical success factors (Cho 1994; Flynn et al. 1994; Hill & Wilkinson 1995; Thiagarajan & Zairi 1997a).

Empowerment

The essence of cultural change in the TQM environment, according to Morgan and Murgatroyd (1994, pp. 15-16), is the change of 'control' values, where responsibility is decentralised so that 'every ounce of intelligence and ingenuity of the rank-and-file worker' can be fully utilised. Technology provides the tools but ultimate benefits can only be achieved in the hands of relevant human actors.

In TQM terminology, empowerment means people take part in continuous improvement activities in an unhindered manner where decision making is pushed to the lowest practical level (Thiagarajan & Zairi 1997a). People who have the ability to make quality improvements should be given the authority to make them (Wythe 1991; Scully 1996). They would feel responsible for the outcome of their actions and would ensure better output (Oakland 1993, p. 320).

Teamwork

Teamwork provides an environment in which people can grow and use all the resources effectively and efficiently to make continuous improvement. Scully (1996) believes people will act responsibly when given responsibility. However, he added
that empowerment alone is not sufficient because many people cannot manage everything on their own. As the whole truly becomes greater than the sum of its parts, a team will enable its members to supplement or complement the strengths of others and make up for their weaknesses.

Oakland (1993, pp. 318-320) highlights the advantages of using a team approach to tackle process improvement or problems:

- pooling of expertise and resources to tackle a greater variety of complex problems
- boosting employee morale and ownership through participation in problem solving and decision making
- improving problem solving process and producing results quickly and economically

This notion about teamwork is commonly shared (Atkinson 1991; Wythe 1991; Woodruff 1995-96). Morgan & Murgatroyd (1994, p. 20) claimed that teams are the building blocks of the TQM organisation. For TQM to achieve sustainable quality improvement over time, it has to be independent of any particular individual. Initiatives and innovations that are team-based and team-sustained are far less likely to die when any individual champions leave for other positions.

Two typical types of formal team system in TQM organisations are functional teams and cross-functional teams. These teams are set up to solve problems, improve quality and introduce new processes and products (Thiagarajan & Zairi 1997a). However, the practice of teamwork is not confined within an organisation. Joint company teams between Vesuvius UK Ltd, Newmilns and British Steel Sections, Plates and Commercial Steels, Teesside have extended the benefits of teamwork across organisations (McCafferty & Laight 1997).

**Involvement**
An organisation needs high levels of performance and involvement from each employee with respect to both the individual’s basic task and to his or her distinctive creativity in providing ideas for quality improvements. It also needs teams that are
highly supportive of the organisation's goals. In other words, to work as a team, people must get involved; employees have to get involved in more than their individual tasks and be more focused on the goals of the organisation (Terziovski et al 1996; Thompson 1998). This can be achieved by making employees responsible for producing individual improvement actions (Wythe 1991), through active encouragement in group activities. Operating employee suggestion schemes is a common practice among high performing organisations in the US to promote employee involvement (Thiagarajan & Zairi 1997a). Every employee can participate in decision-making and working as a team, and can get involved in quality improvement through proper training and education (Cullen 1992; Memmott 1992; Walley & O'Brien 1993).

Communication
Teamwork improves communications and develops interdependence that relies on a free exchange of ideas, knowledge, data and information (Oakland 1993, pp.318-319). In successful TQM environments, communication must be truly open. Scully (1996) stressed that all organisational information is of potential interest and use to others and should be made readily available as employees can select what they need to be productive. The old practice of controlling and carefully parcelling out of information to employees are barriers to team working, empowerment and communication.

Typically, best organisations tend to use a wide range of techniques to communicate, keeping everyone informed of quality activities. These organisations not only emphasise top-down communication, but also increase bottom-up and lateral communications (Thiagarajan & Zairi 1997b). A critical factor of success for TQM is to maintain open two-way communication as it helps foster good relationships between management and employees (Dale et al. 1997).

Oakland (1993, p.370) argues that communication can stimulate personal development at the workplace and achieve improvements for the organisation. Khalil (1996) agrees with him and suggests that this can be achieved by sharing task-relevant information. According to Goodman and Darr (1996), this can be best achieved through exchange of information on best practices. In addition, clear communication
can support the reward mechanism where employees are informed about what is expected of them, what it is that they are trying to achieve and why they are trying to achieve it (Thiagarajan & Zairi 1997a).

**Training and education**


When relating his experience in initiating a total quality culture in Mercury Personal Communications, Harding (1991) reaffirmed that the attitudes, values and competencies of people can be influenced through training and development. Scully (1996) added that people learn in groups, especially when changes in habits and deeply held beliefs are involved.

Cantfil of the Naval Station Mayport, Florida (Ryan 1996) believes quality training has to be made a job requirement. This is to ensure that all employees have the theory and tools they need to function as part of an organisation dedicated to quality principles.

Because a well-trained employee is more likely to contribute than one who lacks essential skills, organisations implementing TQM must view training as an element of its strategy (Siegel & Seidler 1996). Generally, the three types of training recommended are (Siegel & Seidler 1996; Thiagarajan & Zairi 1997a):

1. problem solving techniques, group processes, and group decision making and interpersonal skills which form the technical heart of TQM
2. worker technical skill training, mainly at the work site to support learning of multiple tasks
3. training in the organisation's culture of quality

Woodruff (1995-96) adds that training is essential for developing resources. He recommends a detailed training plan for each job within the organisation and every employee be periodically reviewed to identify needs/goals.

Recognition/Motivation

Reward systems and recognition are vital elements of a successful people management strategy (Terziovski et al. 1996). Rewards do not have to be monetary as employees are motivated by different things (Thiagarajan & Zairi 1997a). Wythe (1991) believes employees are motivated if they are allowed to own the problem, encouraged in the search for solutions, and recognised for application and achievement. Motivation is identified as one of the requirements for TQM teams to succeed (Keck 1996).

Girobank has found that the satisfaction of participating in improvement and of being recognised as a member of a successful team and organisation is the main motivational force for most people (Memmott 1992). Marcia Boyd of Baptist Memorial Hospital, one of the least expensive large hospitals in the US, fully concurs that recognition as a key ingredient for the drive of continuous improvement. 'The rewards are small in terms of monetary value. It is clearly the recognition that counts' (Varian 1992).

To evaluate an employee's individual performance and to recognise superior individual performance within a team-working environment, Thompson (1998) proposes three elements that need to be considered:
1. his or her specific job performance,
2. the productivity of the team of which the individual is part, and
3. how well that individual contributed to the team's collaborative efforts (process assessment)
2.9.7 Customer satisfaction

Quality is meeting and exceeding customer needs and expectations. Organisations 'delight' the customer by consistently meeting customer requirements, and then achieve a reputation for 'excellence' (Oakland 1993, p. 6). This phenomenon is common among the Baldrige award winners that often align their corporate strategies to their customers' requirements (Thiagarajan & Zairi 1997b). According to Garvin (1991), the winning companies' goal is to exceed customers' expectations and anticipate needs, even if customers have not articulated their needs.

Customer requirements determination

To satisfy customers, an organisation has to know its customers and be aware of customer requirements. Without understanding customers, there can be no true customer satisfaction (Thiagarajan & Zairi 1997b). There has to be an audit of satisfaction of customers (Wythe 1991; Kanji & Asher 1993, pp. 70-73). Information about the customer can also be collected from requests for information, letters of complaints etc. (Oakland 1993, p. 17), and through the employees' interactions with customers (Ryan 1996, p. 46). Empirical work has found that focusing on customers, constantly aware of their requirements is a critical factor of quality management (Terziovski et al. 1996; Adam et al. 1997).

Customer satisfaction evaluation

Measuring customer satisfaction is a cornerstone of TQM. With the constant focus on satisfying customers, quality-leading organisations use a variety of techniques to measure their satisfaction (Thiagarajan & Zairi 1997b).

Proactive means of measuring customer satisfaction beyond the measurement of complaints, returns, and warranty rates are common among the Baldrige award recipients (Evans 1991). In addition, continuous quantitative measures of customer satisfaction are developed and actively used to keep in touch with customers in order to anticipate their future quality requirements.
Relationship management

Knowing the current needs of the customer is important but not sufficient. Organisations need to keep in close contact with the customer in order to clearly understand their specific requirements and expectations for the future (Evans 1991; Ruggieri & Merli 1998). Service standards, determination and results are shared with customers and regularly updated in order to manage customer-agency relationships (Oakland 1993, p. 153).

2.9.8 Quality results

In an environment of never-ending improvement, measurement has an important role. To answer why measurement is needed, Oakland (1993, p. 165) gives the following reasons:

- to ensure customer requirements have been met;
- to be able to set reasonable objectives and comply with them;
- to provide visibility for people to monitor their own performance levels;
- to highlight quality problems and determine areas requiring priority attention;
- to give an indication of costs of poor quality;
- to justify the use of resources;
- to provide feedback for driving toward improvement.

Harding (1991) shares the view that all activities are processes and can be managed (defined, monitored and improved) according to the principles and practices of TQM. However, he found that determining what to measure, i.e. performance indicators, was the most problematic. His view is supported by Cantfil (Ryan 1996). Cantfil stressed the usefulness of measurement and emphasised that 'measurement ... must be tied to performance, to business-based results, and to the strategic plan' (p. 49). He points out that many organisations tend to measure what is easy to measure and readily available, which also are not always useful or meaningful.

Useful measures provide insight as a basis for action by supporting effective analysis and decision making. All activities performed by an organisation should be measured...
in order to sustain improvement. Ward (1996) espoused measurement and presented 'ten precepts of measurement':

- measure what the customer cares about;
- measure the process, not the person;
- set goals;
- know what to do with results;
- anticipate the results of your intervention;
- don't make measurement a burden;
- make objective measurements;
- provide feedback on the criteria and results;
- ensure comparability of measures;
- what you measure is what you get.

Winners of the Baldrige award do not stop after measuring their performance. They go a step further: using statistical methods, they correlate their objective quality results with measures of customer satisfaction. This enables them to predict changes in customer satisfaction from internal quality measures (Garvin 1991).

Ward (1996) cautioned that the usefulness of measures must be balanced against the cost and effort of obtaining them. 'Measurement is only a means to an end - the continuous improvement of processes - and never an end in itself.' (p. 61)

Woodruff (1995-96) suggests that key indicators of success need to be real time and that there should not be too many. Results that should be measured include (Oakland 1993, pp. 167-169; Woodruff 1995-96; Thiagarajan & Zairi 1997b):

- product and service quality;
- productivity;
  - increase in outputs and/or decrease in resources (cost, time, manpower)
- waste reduction or elimination;
  - categories of waste include: waiting, doing work over (rework), damaging goods and equipment, performance barriers, dissatisfied customers, and dissatisfied employees
2.10 Summary

While TQM is widely practised in both the private and the public sector, there is little agreement on what it actually means (Boaden 1997). Authors of TQM tend to adopt the definition that most suit to their purposes. The review of the TQM literature indicates that there is no one consensus TQM model for implementing quality in either the manufacturing or the service sector. It is argued that which TQM model is chosen is less important than the commitment of the entire organisation toward quality improvement effort (Kaplan 1996).

In this study TQM is defined as 'a total organisational approach for meeting customer needs and expectations that involves all managers and employees in using quantitative methods to improve continuously the organisation's process, products, and services'. Quality means 'meeting and exceeding customer needs and expectations'.

This study is concerned with the impact of IT on TQM in Malaysian high performing public agencies. High-performing public agencies are defined as those that have been short-listed for the Prime Minister's Quality Award in Malaysia. The MAMPU TQM model will therefore form the basis of the TQM framework for investigating the impact of IT on TQM. The eight dimensions in the MAMPU TQM model have been operationalised using key attributes prescribed in TQM literature.

To reiterate, the components of the TQM framework are:

1. Leadership
   1.1 commitment
   1.2 vision and mission
   1.3 creation of quality culture
1.4 total quality leadership
- communicating
- supportive
- empowering

2. Strategic planning process
- identification
- analysis
- formulation
- documentation

3. Output quality assurance
3.1 quality characteristics and standards
3.2 process control
3.3 continuous improvement
3.4 quality assessment
3.5 documentation
3.6 supplier quality assurance

4. Important innovations
- innovations
- implementation

5. Information and analysis
5.1 data scope
5.2 quality information systems
5.3 information quality

6. Human resource utilisation
6.1 empowerment
6.2 teamwork
6.3 involvement
6.4 communication
6.5 training and education
6.6 recognition/motivation

7. Customer satisfaction
   7.1 customer requirements determination
   7.2 customer satisfaction evaluation
   7.3 relationship management

8. Quality results
   8.1 product and service quality
   8.2 productivity
   8.3 waste reduction or elimination
   8.4 customer satisfaction
   8.5 employee satisfaction
CHAPTER 3 INFORMATION TECHNOLOGY

3.1 Introduction

Organisations have to engage in a deeper and more fundamental change process than before (Scott Morton 1994). To harness the inevitable change brought about by external environment change, Scott Morton (1994) described four enabling conditions for such change:

1. An organisation-wide, shared vision of the future which will be most effective when vigorously propagated by the CEO;
2. An IT infrastructure which involves an open system architecture and understood, shared, data standards;
3. A massive investment in education of employees as the widening competition constantly demands new skills in the way they work and with whom they work;
4. Creative human resource practices that encourage innovation and at the same time provide a safety net for those who take thoughtful risks in moving the organisation forward.

The advanced use of IT, proposed by Scott Morton (1994), requires continuous improvement and is characterised by leadership, vision and a sustained process of organisational empowerment. His concept is compatible with the TQM concept of continuous improvement.

The very same sources of change, the technology revolution and the globalisation of the marketplace, are also influencing governments, forcing the government to transform and reshape the relationship between governments and corporations (Gore 1997).

This chapter presents a review of the IT literature. First, issues of IT in the 1990s are covered as a backcloth to considerations of current IT issues. This is followed by a
description of IT applications in public organisations. Next, the role of IT in TQM environment is discussed. Lastly, factors affecting IT utilisation are summarised.

3.2 Issues of Information Technology

In a study using key informant interviews with 11 internationally known information management experts in the US to forecast those IT development which would have the greatest organisational impact during the 1990s, Straub and Wetherbe (1989) found that technologies that substantially improve the human-machine interface, technologies that greatly enhance data and person-to-person communications, and technologies that underwrite the development and maintenance of IS are going to be of greatest significance.

The major organisational impact in the 1990s was predicted to be the 'liberation' of information within organisations (Straub & Wetherbe 1989). The ability to 'move high volumes of information in multi-media forms, in varying sequences, back and forth between people and places where data is stored' would enable professionals and knowledge workers to access knowledge - both formal and informal information sources - directly and immediately at task level. They reported that IT would change the way an organisation operates and would better support teamwork as well as speed up decision-making processes.

In discussion with many IT executives from large corporations, Dixon and John (1989) discovered that in the 1990s a new hybrid concept of IT management has to be developed, where line management would manage the use of technology and must lead the management of the technology itself. The two aspects need to be separate but not isolated to avoid corporate resources becoming dispersed and less effective, with the direction and vision of the technology infrastructure diverging from that of the enterprise.

Senior IT executives in the 1990s would need to manage a network of technology resources, and support a network of uses determined by line management. The IT
function would be expected to become a knowledge function which integrates knowledge of both the business and technology. On the other hand, line management would determine the business use of technology and would be accountable for its business and operational impact. The impact would be measured and expressed in business terms. Technology planning and use need to be included in the strategic planning process of the company (Dixon & John 1989).

As decentralisation to the business unit level must be balanced with the need for centralised planning of information architecture and technology infrastructure, Dixon and John (1989) called for research and industry studies to better understand how the management of technology and the management of its use can be effective, and to determine if there is a 'technology infrastructure minimum' without which the partnership could not be workable and effective.

In a report on the third of a three-round Delphi survey of senior IS executives in the US to determine the most critical issues facing IS management in the early 1990s, Niederman et al. (1991) revealed that while traditional issues such as strategic planning and operational alignment remain important, technology infrastructure issues appeared to be demanding more attention. The issues dealing with concerns external to IS departments, focusing on managing the relationship between IS and the business, dominated the top ten throughout the 1980s and expected to remain so into the early 1990s.

The results of the Niederman et al. (1991) study also showed that the ranking of issues by IS executives in non-profit organisations differed from that of their counterparts in the commercial sector. The former tended to emphasise end-user computing and issues related to technology applications in general. Niederman et al. (1991) believed that this was accounted for by the different organisational environments, with the non-profit sector driven more by pressures to demonstrate efficient uses of and justification for specific technologies instead of by market forces.

Caudle et al. (1991) attempted to gauge American high-level public information resource managers' rating toward IS issues. The findings revealed that while most of
the top public sector issues also appeared on the top private sector issues list, the rankings showed a lag in public IS development as compared to the private sector. The public IS managers were more concerned with the internal issues of the IS function and related technologies than organisational issues external to the IS function such as linking IS plans with the organisation's plans. The difference in rankings reflected the public sector's characteristics. The findings of Caudle et al. (1991) are consistent with those of Niederman et al. (1991) for non-profit organisations. Technologies related and IS function issues are ranked higher than organisational and business issues. It might be deduced that deployment of IT to achieve public sector goals is a top issue facing the public IS managers in the 1990s.

An industry analysis conducted in the Republic of China to identify the key MIS issues of the 1990s revealed that public organisations placed more weight on IS strategic planning and technological issues than private organisations (Wang & Turban 1994). The finding agrees with the report of Caudle et al. (1991). Wang and Turban (1994) also found public organisations to be very different to other industry groups in their emphases on key MIS issues. The difference in management of information systems between public organisations and the private sector as claimed by Bretschneider (1990) and Hendrick (1994) is supported.

Many studies (Straub & Wetherbe 1989; Dixon & John 1989; Niederman et al. 1991 and Caudle et al. 1991) tried to generate lists of key IS issues as perceived by IS managers in an attempt to prepare organisations coping with changes that would impact on them by fast-growing IT. Watson (1990), on the other hand, sought to look behind the scenes to determine what factors influence an IS manager's perceptions of key issues. Based on self-report questionnaire responses of 43 IS managers drawn from the top 200 Australian organisations, Watson reported that IS managers with a close relationship to their CEO understood organisational goals better and tended to downplay the importance of IS planning. With the two-way communication channel, they were able to assert the potential role of IS and thus align IS planning with organisational strategic planning.
Local studies on IS key issues have been conducted separately in many countries (e.g. Watson 1990; Caudle et al. 1991; Wang & Turban 1994). In order to understand which concerns are global and which are regional in nature, and also to explain for differences in the causes of key issues among regions, Watson et al. (1997) examine the key concerns of IS executives in ten nations. They found that strategic planning, IS organisational alignment and competitive advantage were the top international issues in IS management. Their research also reveals that internationally, there are substantial differences on key issues. The analysis suggests that national culture and economic development can account for the differences. Nations with developed economies and similar culture such as Australia, the UK and the US are more concerned with strategic issues than developing countries such as India and Taiwan where they have more protected, hierarchical and masculine (i.e. unequal distribution of social gender roles, e.g. have few women in some occupations and high status positions) societies. The key concerns of the latter are more driven by operational needs as they have a less mature IT economy than the former group.

The 1990s have seen dramatical change in the concepts of IS resulting from changes that have occurred in both the underlying technologies and every aspect of business. In response to these changes and as a continuous effort to help IS practitioners perform their jobs more effectively, Kim and Kim (1999) conducted a survey of IS academics and practitioners to identify key IS issues. Their study found that major concerns revolved around the transition of IT platforms toward telecommunications and network environments. The development of a networked environment coupled with changes in business environment have resulted in network-related issues such as disaster recovery, information security and control, and client/server computing being highly ranked in importance. Kim and Kim (1999) also found that there were differences between the issues considered important by academics and practitioners. IS academics focused more on managerial issues, while practitioners were concerned more with technical issues.

The review of the IT literature revealed that the key IT issues in the last decade remained broadly the same with an emphasis on strategic issues. However, with the advancement in telecommunications and network technology, the networking-related
issues are becoming more significant. The following section briefly describes the recent IT applications in public organisations before the section focusing on the role of IT in TQM.

### 3.3 IT Applications in Public Organisations

The concept of 'one-stop shopping'\(^4\) for citizens was first put forward in 1989 (McDonough & Buckholtz 1992). It took about two years for American government leaders to consolidate the idea and since then the use of IT to serve citizens more effectively has been on the verge of becoming a major movement in the US.

As services provided by the public sector may be direct service delivery to a citizen or the provision of information about a service, Professor Jerry Mechling of Harvard University (cited in McDonough & Buckholtz 1992, p. 33) suggested the following:

1. try to emphasise citizen self service,
2. reduce the number of steps a citizen must take to obtain service,
3. provide service in the evenings and weekends at locations where the public normally gathers,
4. consolidate hot lines across agencies and integrate access to provide the convenience of one-stop shopping,
5. address the privacy and equity concerns,
6. build in mechanisms to provide citizen feedback,
7. acceptance of the concept must be mobilised through education of the public and the media.

The advice was well taken by the American government and many success stories of pilot efforts were reported, e.g. Social Security Administration, Utah Division of Corporations and Commercial Code, and US Department of Agriculture (McDonough & Buckholtz 1992).

\(^4\) The phrase 'one-stop shopping' is used to describe a situation where a citizen goes to a single location for multiple government services or information about the services, such as veterans benefits,
Corbin (1996a) reported that US government agencies were applying IT to deliver better services and to hasten the advent of electronic government. The Web has helped agencies overhaul the way they do business. Text, graphics, audio and video information is available to the public at all times. Agencies are using the Internet for procurement, issuing permits, processing grant application, to offer employment and training services, poll people for opinions on various issues, and automatically collect and disseminate information. The public can electronically file their taxes, check on the status of their social security benefits, order coins from the US mint, retrieve Supreme Court decisions and search postal service databases for ZIP codes. IT enables the government to provide categories of government services to computer users via single access points: one-stop shopping. The US local governments have also use IT to process social benefit claims, improve cash management and register contracts via electronic bid advertisements (Corbin 1996b).

Examples of other governments around the world using IT to deliver more convenient, accessible and efficient services are not lacking. The UK government has, for many years, made extensive use of IT to improve the efficiency of its services (Central IT Unit 1996a). The UK Government Information Service has been voted one of the world's top five percent of web sites by the US POINT Corporation, providing information about more than 300 public sector organisations. Electronic lodgement service to lodge self assessment tax returns, Automated First Registration and Licensing for motor dealers to register new cars and issue tax discs directly, an automatic system for handling trade declarations for faster clearance of goods and duty calculation are a few examples chosen from many reported in the Green Paper (Central IT Unit 1996a).

In Australia, examples of IT usage include touch screens for searching interactively all jobs in the national jobs database at Job Centres and the use of data comparison to check information given by individuals on different occasions when making claims to reveal discrepancies (Central IT Unit 1996b).

unemployment insurance, housing allowances and medical insurance reimbursement (McDonough and Buckholtz 1992, p. 32).
In Singapore, an extensive and well-established arrangement exists for the electronic delivery of government services to business (Central IT Unit 1996b). Individuals as well as business tax payers can pay taxes (Income Tax, Goods and Services Tax, and Custom Duties) via electronic funds transfer. Public can access the Electronic Valuation List for information on property ownership and tax assessment, as well as a wide range of government databases such as financial highlights and information about any company registered in Singapore. The success of TradeNet which handles import and export documents has led to the development of MediNet (healthcare), LawNet (legal services) and CORENet (construction and real estate). Information services have not only benefited the business community but also has extended to homes and schools (Ang & Soh 1995).

The remarkable achievement of the Singapore government in providing better services to the public through effective computerisation has been given recognition world-wide (Ang & Soh 1995). In 1993, Singapore was cited for its outstanding customer services through computerisation by CIO magazine, and was the only non-US government body to be included in the magazine’s list.

The Public Services Network of Malaysia has enabled government counter services (renewal of driving licences, road tax and business licences) to be delivered through post offices. The Standard Accounting System for Government Agencies provides effective management of financial activities. The public can also access information of government organisations via the Internet, besides various public access databases such as Civil Service Link, AGROLINK (agriculture), and INFO-FISH (fishery) (Maarof 1996).

The examples outlined above demonstrate that information technologies are changing the way public employees provide services. These examples are different from most traditional governmental applications of IT because they enhance or transform the nature of service provided to the public. The systems are oriented toward the citizen, involving direct citizen contact. By contrast, most past applications of IT have been focused on improving the flow of information inside an organisation, automating
Information Technology

routine operations such as payroll and providing management with summaries of internal operations. The internal, process-focused tradition in IT applications is being replaced by an external, mission-oriented approach (Anderson et al. 1994), providing effective services to citizens and bringing great convenience to customers.

3.4 The Role of IT in TQM

Technology plays a supporting rather than a leading role in TQM (Kern 1991). It is not the driver of change; instead, it supports the people in an organisation to become more efficient at TQM. Kern (1991) argues that TQM cannot be implemented with integrated, cross-functional technology alone as the successful implementation of TQM requires a strong organisational integration where the enterprise's commitment to quality improvement is demonstrated by extensive cross-functional teaming and a senior management that is directly involved in setting and driving toward customer-oriented quality goals. According to Kern (1991), many Japanese companies spent decades integrating their functional departments rather than seeking technical solutions when implementing TQM. These companies integrate IS technology into their operations only when they want the benefit of increased efficiency. To make best use of IT in a TQM context, Kern (1991) suggests there should be a balance between the ability of the organisation to work cross-functionally and the technology it uses in order to become more efficient at cross-functional teaming.

Spenley (1992, p. 12), on the other hand, viewed TQM as a management methodology to harness appropriate technology with business strategy. As technology can be a competitive advantage when utilised fully and focused to support business objectives, TQM, according to Spenley (1992, p. 15), links people and technology to achieve the business strategy for competitive advantage.

3.4.1 Theory-deduced IT practice and application examples

According to Zadrozny and Ferrazzi (1992), many companies implementing TQM lack synergy between the firm's IT goals and TQM goals. To support TQM, the right
information must travel up to management for decision making and down to employees, empowering them to appropriate action. This information includes the operation data and feedback from the internal functions and the external customers. Berkley and Gupta (1994) support the notion that TQM goals must be aligned with the firm's corporate-wide and IT goals.

Based on the analysis of the diffusion of IT integration in health care organisations, Tan (1998) proposes a total quality management-information technology model to help health care organisations pursuing TQM to realise an appropriate, efficient and cost-effective health information infrastructure. The connectivity supported by IT enables various departments within a health care provider to integrate and re-engineer business processes and create effective computer-based services. However, Tan (1998) emphasises that the customer-focused, future-oriented services can be achieved only if the health care IT strategy is aligned with the business strategy and both the short-term and long-term objectives of IT delivery are clearly stated.

Cortada (1995, pp. 14-19) claims that the role of IT is an important factor in quality process work. The primary strategy for quality improvement involves several problem-solving techniques using statistical data to make decisions.

To elaborate on the IT's role in quality improvement, Cortada (1995, pp. 93-98) classified the benefits derived from applying IT to TQM into:

- reduced processing time
- precise management of a process
- accurate movement of data
- in-process measurements and cost accounting
- linked organisations
- IT-based decision making

To substantiate the claim of the benefits of IT applications, Cortada (1995, pp. 136-144) presents the characteristics of IT applications and explains how they can be used to bring about the desire results in TQM (Table 3.1). He also gives specific examples
of IT as a facilitator of TQM and the effect on quality processes in Table 3.2 to support his claim.

Table 3.1 Characteristics of IT that Facilitate Quality Management

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>What IT does</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transactional</td>
<td>Converts unstructured activities into routine ones</td>
<td>Drives down costs, errors, and waste</td>
</tr>
<tr>
<td>Geographical</td>
<td>Moves data fast to wherever it is needed</td>
<td>Improves effectiveness, lowers costs, speeds response to situations</td>
</tr>
<tr>
<td>Automational</td>
<td>Reduces labour content</td>
<td>Lowers costs, increases consistency, reliability</td>
</tr>
<tr>
<td>Analytical</td>
<td>Provides tools to facilitate fact-based decision making</td>
<td>Improves productivity, quality of decision making</td>
</tr>
<tr>
<td>Informational</td>
<td>Provides vast quantities of data in usable formats</td>
<td>Improves knowledge of teams, enhances fact-based management</td>
</tr>
<tr>
<td>Flexible</td>
<td>Can cause rapid changes in how tasks are performed</td>
<td>Mass customisation allows more effective response to customers</td>
</tr>
<tr>
<td>Linking</td>
<td>Connects together various people and organisations</td>
<td>Improves effectiveness, improves customer retention, drives down costs</td>
</tr>
<tr>
<td>Tracking</td>
<td>Will monitor and measure performance of processes, people, and resources</td>
<td>Improves performance, increases productivity of resources</td>
</tr>
</tbody>
</table>

Table 3.2 Examples of Exploiting IT as a Facilitator of Quality Management

<table>
<thead>
<tr>
<th>IT effort</th>
<th>Effect on quality processes</th>
<th>Anticipated benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laptops in sales</td>
<td>Makes work mobile</td>
<td>Faster response to customers</td>
</tr>
<tr>
<td>Modelling tools</td>
<td>Identify what processes to change</td>
<td>Lower costs, more effective processes</td>
</tr>
<tr>
<td>IT effort</td>
<td>Effect on quality processes</td>
<td>Anticipated benefits</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Automation</td>
<td>Reduced steps, reduced or augmented human labour</td>
<td>Accuracy, productivity</td>
</tr>
<tr>
<td>Networking</td>
<td>Teamwork, communications</td>
<td>More effective results, employees</td>
</tr>
<tr>
<td>Databases</td>
<td>Fact-based decision making</td>
<td>Confidence, accuracy</td>
</tr>
<tr>
<td>Competitive/</td>
<td>More knowledge of rivals and customer needs</td>
<td>Become more competitive, improve decision making</td>
</tr>
<tr>
<td>Customer records</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision analysis</td>
<td>Improves &quot;what if&quot; and &quot;what happens&quot; analysis</td>
<td>Less risk of big mistakes, better quality decisions</td>
</tr>
<tr>
<td>Data gathering</td>
<td>Performance monitoring, measurements</td>
<td>Accurate, fact-based, improved decision making</td>
</tr>
</tbody>
</table>

The core of IT support for TQM is the development and implementation of process improvement and monitoring systems such as statistical process control systems, real-time collection of customer satisfaction data, critical business systems, and other measurement systems (Zadrozny & Ferrazzi 1992). As many quality techniques are graphical in nature or require graphics (e.g. statistical process control), IT makes these techniques easily accessible for users to contribute to quality efforts in an organisation (Zahedi 1998). IT can improve external service quality by focusing on systems that improve the response time to the customer. Citibank, Singapore’s Changi Airport, McDonald’s, and American Express are examples that have used IT to monitor service quality elements such as waiting times and service times on a real-time basis (Berkley & Gupta 1994). Those companies often supplement employee training and empowerment with IT training to augment the ability of the customer service representatives to resolve problems effectively.

To gain better insights into the issue of returns from IT investment, Quinn and Baily (1994) interviewed over 100 executives from top performing companies in all major service industries that were heavy users of IT. They reported improved quality is a most common and important output of IT systems even though appraising the impacts of IT on service quality is problematic. Many of the respondent companies had on-line
IT systems to ensure that crucial elements of quality were delivered at the point of customer contact.

Information is the critical enabler of TQM. IT and IS serve as keys to quality success (Zadrozny & Ferrazzi 1992; Omachonu & Ross 1994, pp. 41-42). 'IT systems can be designed to either empower or control employees. By making real-time data available to employees at the lower levels of the organisation, IT can provide information that permits empowered employees to make well-informed decisions. ..., IT can also be used to disseminate orders, create controls, and monitor employee behaviour.' (Zadrozny & Ferrazzi 1992, p. 16).

Since TQM is a fact-driven system, database systems play an important role in managing quality (Zahedi 1998). The role of database systems, according to Zahedi (1998), is to determine what data types are worth keeping and organise them into an easily accessible structure.

Sobkowiak and LeBleu (1996) acknowledge the critical role of information and IT in quality success, and add that better informed customers or employees are more involved, connected, and productive. Employees have become increasingly connected to their companies through the information they receive and the systems they use. They proposed to reposition the human resource information systems to be an enterprise-wide system that serves employees and makes each individual employee more effective, motivated through information self-sufficiency.

Teams are a major factor in TQM and good communication is the key to a successful team. Any technology that improves team performance facilitates the TQM process. Aiken et al. (1996) strongly believed that a group decision support system (GDSS) is one technology that can be used to enhance communication and decision making in these quality groups.

Kock and McQueen (1997) added that groupware technology has enormous potential to support quality management procedures, especially to improve group work and process documentation. From their experiences in implementing quality management
and groupware applications at multinational auto and truck part manufacturers in Brazil, Knock and McQueen found that the four most useful groupware applications were e-mail, computer conferencing, workflow control and group decision support systems. On top of that, asynchronous groupware systems were more likely to improve efficiency and effectiveness of quality management.

Computer-aided systems for learning provide three benefits: fast and efficient communication, a memory shared by all organisation members, and a mechanism whereby multiple members can dynamically exchange solutions and updated solutions to problems (Goodman & Darr 1996). Such systems can facilitate the exchange of best practices, i.e. exchanging and sharing of information and expertise among organisational units. Despite those benefits mentioned, four real dilemmas represent inherent problems in using computer-aided systems for learning were highlighted:

- motivation for best practice sharing
- matching computer-aided systems to the distribution of problems and solutions in the organisation
- alternative mechanisms for transferring best practice
- assessing effectiveness of sharing

To overcome the obstacles that impair knowledge sharing and to tap the potential of computer-aided systems for enhancing the speed of sharing, Goodman and Darr (1996) suggested that a company’s culture, particularly of learning and rewards, must be aligned with the desired values and norms. In the end, the operationalisation of best practice exchange has to be actively supported by senior management.

Organisations that properly plan and implement IT could establish a work environment conducive to innovation. A conducive environment, according to Khalil (1996), is one that provides employees with intrinsic motivation, access to relevant information, continuous reminders and hints, and enables them to transfer problem-solving experiences to new problems, and risk being wrong.

Khalil (1996) believed IT tools have a big role to play in establishing an innovation conducive environment. The aspects of IT support could be in terms of sharing of
task-relevant information via hypertext applications, e-mail and chat systems for discussion among interest groups; applying creativity techniques via GDSS; promoting intellectual diversity by using databases and a common graphical user interface; and encouraging risk taking and experimentation via modelling, prototyping, DSS and CAD (computer-aided design systems).

Kaplan (1996), CEO of a consulting company serving IBM, believed team-based quality assessments were probably the most important element of IBM's successful TQM effort. He claimed that computerised team-based assessments are highly cost-effective and provide a more accurate view than a single assessor. By averaging scores and merging comments from many assessors, team-based software increases the validity of a self-assessment while increasing involvement and understanding. He recommended that periodic team-based assessments should be part of a long-term committed effort to improve quality. They not only help the organisation focus its improvement efforts but also provide the in-process feedback that gives people confidence to continue the quality-improvement journey as financial results may take several years to appear.

The use of IT to support TQM is claimed to account for the success of Bethesda Hospital, Cincinnati (Collins 1994). Besides using IT to support daily control/process management, systems have been developed to help in decision making and strategic quality planning. With IT, data are collected and made readily available for use by process improvement teams to investigate current processes, identify opportunities for improvement, modify the process and evaluate the results of the process improvement activities. As TQM effort continues, data trends are used to track TQM progress throughout the Hospital. IT has also been used to measure quality results and customer satisfaction. Another innovative use of IT at Bethesda is simulation modelling. This process improvement tool is found valuable in supporting and facilitating the design or redesign of major processes, providing a visual method to anticipate the effect of proposed process changes.

Pearson and Hagmann (1996) reaffirm that the success of quality improvement strategies depends heavily on the organisation's IS, which provide the tools necessary
to perform precise analysis and give direct access to important organisational information. In the quest for world class status, many organisations are pursuing total quality improvements programs. Murray (1991) argued that these programs will be fruitful only if the organisation's IT department is itself world class. The reason being that IT has a more substantial role to measure, understand, and, most importantly, improve the organisation's sustainable quality.

In order to ascertain the status of IT departments and to develop business-driven IT metrics regarding world class capabilities, Murray (1991) proposed four analysis components to benchmarking IT resources with key business processes:

1. identifying key business metrics to understand how they are affected by IT;
2. evaluating IT expenditures to know the level of funding on IT resource, IT activity, and applications supporting the key business processes;
3. evaluating IT results using portfolio analysis technique which surveys functional quality and technical quality, to focus on tasks IT can do best;
4. evaluating IT management variables to identify practices that impact on IT success. These less tangible characteristics include the extent to which IT planning is linked with business planning; level of IT funding (relative to other companies); business self-sufficiency (managers access information directly); quality and quantity of IT resources associated with supporting business processes (skill and experience, technology and tools, management practices, and IT leverage to business); and backlog of IT work.

In an attempt to understand the 'right type' of IT applications for a given company pursuing a particular competitive priority, a conceptual framework has been proposed to match competitive priorities and IT applications in manufacturing firms (Kathuria & Igbaria 1997). Using the theoretic-deductive approach to match the key managerial tasks specific to competitive priorities with the characteristics of IT applications, the framework proposed that for companies pursuing a 'quality of conformance and quality of design' competitive strategy, IT is suitable for quality planning, especially to discover customer needs and to determine quality standards, quality control to
ensure minimal product variation, and quality engineering to optimise product design and manufacturing processes.

Kathuria and Igbaria (1997) suggest that the framework can be extended to service organisations to choose the 'right type' of IT application to give a competitive edge. The importance of IT is indisputable, but the extent of its impact on pursuing a competitive priority has yet to be established empirically.

Based on the anecdotal evidence from organisations at the forefront of TQM practice, Matta et al. (1998) argue that information is critical to the success of TQM activities, and IT is a vital component in the implementation process. As TQM involves information-intensive management, its implementation necessitates substantial reliance on integration of information both from within and outside the organisation. Matta et al. (1998) illustrate their claims by citing successful IT applications in major organisational activities such as product design and testing, process control and improvement, and customer service among the Malcolm Baldrige Quality Award winners. Apart from being the primary tool for enabling multi-disciplinary team interaction, collecting customer requirements, and transforming data into useful quality information, IT plays an important role in training and education, process control as well as being used as a quality assurance tool. Subsequently, Matta et al. (1998) modelled the design of an IS that is responsive to requirements of TQM. The IS integrates information on customer needs, organisational performance and systems capabilities, making the information available at the lower organisational level more sophisticated, yet facilitating simple queries and simple responses for individual and group decision support.

To date, much of the focus of the literature has been on describing, rather than systematically investigating, how IT enhances quality improvement activities. The empirical reports investigating the role of IT in quality improvements are summarised in the following section.
3.4.2 Empirical studies and evidence

On analysing the application of IT to TQM processes in administrative and business operations in four institutions of higher education, Hughes (1994) found that the use of IT in TQM required significant changes in organisational culture by a highly committed top management leadership. Although the use of IT among those institutions did not correlate to the level of TQM implementation, IT was perceived to be a tool to facilitate quality management and appeared to influence future planning. A mutually supportive but not exclusive relationship between IT and TQM was evident from the data. Organisational culture as well as vision and leadership of top management were identified as important factors influencing the approaches to the use of IT in such an environment. In addition, the size and structure of the organisation, budget restraints, existence of IT policy, structure of IT (centralisation vs. decentralisation) were also found to affect IT use.

Hughes (1994) employed a qualitative case study methodology to investigate the role of IT in TQM processes with the emphasis on formulating a conceptual framework and planning model of TQM implementation that facilitates IT applications. His study did not attempt to answer how and where IT was used in TQM processes. Hughes recommended a future quantitative study on the relative contributions and effects of IT on TQM implementation and quality outcomes to dispel the scepticism of some people on the role of IT.

Cho (1994) studied the impact of TQM on organisational performance in three types of industries in the United States: large manufacturing companies, small firms, and service organisations. Using stepwise multiple regression analysis to predict TQM success, his results identified three critical success factors: 1) human resource management, 2) IT, and 3) the management of process quality.

Cho (1994) considered the role of IT only in the production of quality data and information, and also in benchmarking. The role of IT in TQM was not examined extensively.
Based on the reference model of Forza (1995a) to investigate the role of IT on quality management, Forza's (1995b) study of 34 manufacturing plants in Italy was an attempt to seek answers for the following questions:

1. What is the relationship between quality management practices and quality information flows?
2. What is the role of information technologies in obtaining better quality performance?

The IT-for-quality variables included in the study were:

1. Computerisation of seven tools: flow charts, Pareto charts, run (trend) charts, histograms, control charts, cause-effect (fish-bone) diagrams and scatter diagrams;
2. On-line quality control.

The population was stratified by industry (auto-suppliers, machinery and electronics) and quality reputation. Data obtained via questionnaires from a total of 34 plants and 646 respondents was treated through correlation analysis. The results showed that quality management practices are closely linked to supporting quality information flows (particularly the information from suppliers on quality control, the information exchange with customers on quality, the internal information for quality and the document on production procedures). However, the correlation between the IT variable and the performance variable, and between the IT variable and the information flows variable is significant only in a limited number of cases. Forza (1995b) concluded that the IT variables considered were not suitable for all quality information flows. The IT variables were rather narrow in scope and very specific to the output quality assurance aspect of quality management. Therefore, the claim that IT contributes to the achievement of high quality performance cannot be established with any significant confidence. Forza proposed that IT's contribution should be further investigated by developing adequate measures especially with reference to its use.

Motivated by a scarcity of empirical research on the linkage between IT and performance, Rogers, Daugherty and Ellinger (1996) examined the relationship...
between utilisation of IT and firm performance in the warehouse industry. Using mail survey, a total of 1,189 questionnaires were sent to all American Warehouse Association members, of which about 27 per cent useful returns was secured. A list of 15 warehousing technologies was employed as the independent variable. The dependent variable consisted of self-reports of executives' perceptions of firm performance on eight warehousing-related goals. The t-test results revealed a linkage between IT usage and warehousing performance. Firms using more warehousing IT had significantly high/better perceived performance in the areas of quality improvement, cycle time reduction, and productivity improvements.

In a study to investigate the buyer-supplier relationships in the manufacturing sector, empirical evidence was collected from 83 firms in the top tier of the Turkish automotive industry (Burgess & Gules 1998). The findings support that success with TQM and IT-utilisation are positively associated.

Rogers et al. (1996) and Burgess and Gules (1998) did not try to investigate the role of IT in quality management. However, their work contributed to the empirical evidence of IT in quality improvement. Like Forza (1995b), Rogers et al. used numbers and types of available IT hardware/ peripherals and specific applications to operationalise the extent of IT use. In their study, Burgess and Gules (1998) focused only on firms that have adopted advanced manufacturing technology. Hence types of IT such as computer-aided design, flexible manufacturing systems and robots were used to measure the extent of IT use. The operationalisation of the IT dimension of the two studies is restricted to a particular research population.

Lloyd-Walker and Cheung (1998) conducted a study to examine which factors influence IT planning and purchasing in the Australian banking industry. The study found that quality customer service and product issues most strongly influenced IT investment. The study also found that IT for innovation per se did not impact positively on bank performance. When the innovation was customer-focused the benefits were achieved. Although the work did not investigate the role of IT in TQM directly, it provided evidence to support the positive link between IT and TQM in the service sector.
In a questionnaire survey to examine the usage of IT to support quality management among service and manufacturing organisations in Hong Kong, Cheng and Ngai (1998) found that the usage level was low. It was reported that the most of the respondents perceived 'no advantages at all' in using computers to support quality and there was a lack of suitable software to support such applications. Although the majority of the respondents (about 90 per cent) claimed to use office computers in the daily operations of their organisations, the low usage level of IT for quality management came as no surprise at all. First, the sample included companies that have not practised quality management. Thus the question about using IT to support quality management became irrelevant. Second, the IT to support quality were categorised as decision support systems, group support systems, executive information systems, expert systems and artificial neural networks. This generic categorisation of IT may appeal to IT personnel but could be inappropriate for the survey as their functions and definitions may not be obvious to quality practitioners. In addition, the use of IT to communicate quality activities or to keep track of employees' quality training needs does not necessarily come under any of the categories.

The link between IT and TQM is mostly demonstrated by quoting particular application examples or deduced practice from theory as detailed in section 3.4.1. Among the handful of empirical studies reported, five (Hughes 1994; Cho 1994; Rogers et al. 1994; Cheng & Ngai 1998; Lloyd-Walker & Cheung 1998) investigated the relationship at the macro level, i.e. TQM as a whole, whereas the remaining two studies (Forza 1995b; Burgess & Gules 1998) focused on the quality assurance aspect of TQM alone. Past work on the role of IT in TQM processes is summarised in Table 3.3.

**Table 3.3 Summary of the Literature on the Role of IT in TQM**

<table>
<thead>
<tr>
<th>Dimension</th>
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<tr>
<td>Leadership</td>
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<td>Strategic planning process</td>
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<td>Dimension</td>
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<td></td>
<td>Mahmoud &amp; Rice 1998</td>
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<tr>
<td>Output quality assurance</td>
<td>Zadrozny &amp; Ferrazzi 1992</td>
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<td>Collins 1994</td>
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<td>Quinn &amp; Baily 1994</td>
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### Dimension Source

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<td>Zahedi 1998</td>
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<td>Mahmoud &amp; Rice 1998</td>
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</table>

### 3.5 Factors Influencing IT Applications

A significant amount of effort has been directed toward identifying the factors and processes that contribute to IT use and success. In particular, user involvement in the systems development process and top management support toward IT have received considerable research attention (Cheney & Dickson 1982; Reich & Benbasat 1990; Cragg & King 1993). Other factors thought to influence system success are individual differences (Lucas 1978; Zmud 1979) and technical system quality (Stevens & LaPlante 1986; Thompson et al. 1991). Investigators have also looked at the impact of power distribution (Kim & Michelman 1990), organisational structure (Ein-Dor & Segev 1978; Sanders & Courtney 1985), and culture (Cooper 1994; Grover & Segars 1996) as well as business objectives (Zviran 1990; Grover & Segars 1996) on systems
success. Besides organisational and personal factors, external influences (Stevens & Cahill 1992; King & Teo 1994) on IT use have also been examined.

Table 3.4 summarises findings of past studies on factors affecting IT use.
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<tr>
<th>Author</th>
<th>Research objective</th>
<th>Methodology</th>
<th>Sample</th>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>Data analysis</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ein-Dor &amp; Seggey (1978)</td>
<td>To identify organisational variables affecting MIS success &amp; failure</td>
<td>Literature survey</td>
<td>158 papers from scientific, professional &amp; trade literature on construction &amp; use of MIS</td>
<td>MIS success: widespread use</td>
<td>Uncontrollable organisational factors: size, structure, time frame, extra-organisational situation, organisational resources</td>
<td>Simple regression</td>
<td>MIS projects are more likely to succeed in a larger organisation with centralised structure and sufficient external resources. Positive attitudes towards higher rank IS executive and steering committee.</td>
</tr>
<tr>
<td>Lucas (1978)</td>
<td>To examine factors associated with computerised library system success</td>
<td>Questionnaire &amp; on-line measure of use (no. of inquiries)</td>
<td>180 (of 203) staff of a major pharmaceutical manufacturing &amp; marketing firm</td>
<td>Implementation success: no. of successful or unsuccessful systems</td>
<td>Controllable factors: rank &amp; location of responsible IS executive &amp; steering committee</td>
<td>Pearson's correlation &amp; factor analysis</td>
<td>Favourable attitudes &amp; leadership are related to direct system use. Leaders influence attitudes and use.</td>
</tr>
<tr>
<td>Robey &amp; Zeller (1978)</td>
<td>To determine factors associated with IS success</td>
<td>Case study</td>
<td>2 separate departments at 2 very large US organisations</td>
<td>Organisational, human and process factors</td>
<td>Non-parametric: Mann-Whitney U test</td>
<td></td>
<td>Favourable attitudes toward the effect of QIS on job performance &amp; perceived urgency/important, less centralised authority &amp; higher formalisation.</td>
</tr>
<tr>
<td>Author</td>
<td>Research objective</td>
<td>Methodology</td>
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<td>Dependent variable</td>
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</tbody>
</table>
| Kraemer et al. (1981) | To analyse the impacts of alternative policies for the management of CBIS           | Case study & questionnaire | 42 (of 403) US cities with populations over 50,000                      | Performance of local government information-processing tasks | Technological development, structural arrangement, socio-technical design, organisational context | Correlation & multivariate analysis | Higher performance is associated with:  
• high levels of automation & utilisation, more sophisticated applications  
• user involvement, decentralised control & participatory strategies for nonroutine tasks  
• human-relations strategy  
• professional management practices  
Management strategies are more important than environmental variables |
| Cheney & Dickson (1982) | To investigate relationship bet. managerial & technical expertise in MIS department, & CIS success | Questionnaire & interview | 79 users in 8 large firms in Minneapolis/ St. Paul areas                | User satisfaction & system utilisation             | Technical sophistication  
• system characteristics  
• IT structure  
• use of decision models  
Organisational  
• top management support  
• user participation  
• evolutionary approach to system development | F-test                      | Well-managed MIS department influences user’s satisfaction.  
MIS organisational variables are significantly related to MIS success but not technological factors |
| Laudon, (1985)    | To explore the power of environmental & institutional                              | Survey               | 48 senior members of state criminal record systems                      | Adoption, utilisation & management of computerised criminal history systems | Environmental  
• uncertainty  
• opportunity Institutional | T-tests and correlation         | Environmental factors are dominant in system adoption  
Institutional factors are dominant in system |
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<th>Author</th>
<th>Research objective</th>
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<th>Data analysis</th>
<th>Results</th>
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</thead>
<tbody>
<tr>
<td>Sanders &amp; Courtney (1985)</td>
<td>To ascertain influence of user's task environment on DSS success</td>
<td>Mail questionnaire</td>
<td>378 (of 496) DSS users from 124 organisations (DSS vendors' client base)</td>
<td>DSS success: user satisfaction</td>
<td>Task environment (decision context) Task interdependence (task constraints) Length of DSS use Top management support User training</td>
<td>Correlation analysis, multicollinearity test of independent variables</td>
<td>Task environment, length of use, top management support &amp; training have significant influence on DSS success</td>
</tr>
<tr>
<td>Stevens &amp; LaPlante (1986)</td>
<td>To examine factors influencing use of computerised information systems (CIS) in state financial &amp; budgeting decision-making</td>
<td>Mail questionnaire</td>
<td>38 (of 50) states budget &amp; financial management offices in the executive branch, US</td>
<td>Impact on decision support system factors</td>
<td>Contextual/environmental • statutory constraints • legislative influence • political influence • fiscal scarcity • accountability Managerial/organisational • structure • no. of professionals • top management support • centralised CIS CIS • CIS experience • no. of computers owned • timely information</td>
<td>Correlation analysis</td>
<td>Computer &amp; decision support use are influenced by key factors in those three categories</td>
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<td>Author</td>
<td>Research objective</td>
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<td>Henderson &amp; Sifonis</td>
<td>To explore what influences good IS planning</td>
<td>Literature</td>
<td>Strategic IS planning</td>
<td>complexity of CIS</td>
<td></td>
<td></td>
<td>Key market (within the firm) for IS products &amp; services; consistency bet. strategic business plan &amp; strategic IS plan; validity checks bet. the 2 plans are essential</td>
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<td>(1988)</td>
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<td>research &amp; case example</td>
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<tr>
<td>Ahituv et al. (1989)</td>
<td>To analyse relationship between organisational characteristics &amp; deployment of hardware resources</td>
<td>Mail questionnaire</td>
<td>303 (of 1360) top IS managers of organisations in Israel</td>
<td>Hardware distribution: centralised, distributed, decentralised</td>
<td>Organisational characteristics: size, structure, sector classification, distribution of decision-making process</td>
<td>Chi-square test, Lambda measurement, Kendall’s Tau B</td>
<td>Distribution policy is not affected by size, structure &amp; sector classification of organisation except decision-making process</td>
</tr>
<tr>
<td>Kim &amp; Michelman</td>
<td>To identify factors to be dealt with prior to strategic use of IS in healthcare industry</td>
<td>Literature</td>
<td>Strategic use of IS</td>
<td></td>
<td></td>
<td></td>
<td>Overcome political barriers to achieve integration Integrate isolated TPS/IRS Strategic use of integrated TPS/IRS</td>
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<tr>
<td>(1990)</td>
<td></td>
<td>survey &amp; case examples</td>
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<tr>
<td>Reich &amp; Benbasat</td>
<td>To investigate factors influencing success of customer-oriented strategic systems (C OSS)</td>
<td>Case study</td>
<td>System success: timely development, high adoption, improved competitive position</td>
<td>Sponsoring company characteristics Customer Industry Product COSS itself</td>
<td>Simple inspection of data</td>
<td></td>
<td>Proactive IS function with high level of competence, CEO support, high level of resources for COSS project &amp; champion continuity</td>
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<tr>
<td>(1990)</td>
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<tr>
<td>Cahill et al. (1990)</td>
<td>To explore complex inter-</td>
<td>Mail questionnaire</td>
<td>Impact of on managerial functions</td>
<td>Environmental Organisational</td>
<td>3-step hierarchical</td>
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<td>Unique combinations of 3 types of factors give greater</td>
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<td>parent case study</td>
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<tr>
<td>Zviran (1990)</td>
<td>To examine relationship between organisational &amp; IS objectives</td>
<td>Questionnaire-based interview</td>
<td>Senior executive &amp; IS executive of 131 (of 1360) organisations in Israel</td>
<td>IS objectives</td>
<td>Organisational objectives</td>
<td>Chi-square test, scalar-to-profile approach to find specific correspondence</td>
<td>IS objectives are associated with organisational objectives and correspondence exists between each respective objective</td>
</tr>
<tr>
<td>Thompson et al. (1991)</td>
<td>To investigate factors influencing PC use</td>
<td>DISKQ interactive questionnaire</td>
<td>212 (of 455) knowledge workers of a large Canadian firm</td>
<td>Optional PC use (intensity, frequency &amp; diversity of use)</td>
<td>Social factors Facilitating conditions Affect Complexity of PC use Job fit Long-term consequences</td>
<td>Partial least squares analysis</td>
<td>Social factors, complexity of PC use, job fit &amp; long-term consequences have strong influence on utilisation</td>
</tr>
<tr>
<td>Stevens &amp; Cahill (1992)</td>
<td>To examine factors associated with effective CIS use in financial management decision-making</td>
<td>Mail questionnaire</td>
<td>45 state budgeting offices in US</td>
<td>Impact on financial management decision-making</td>
<td>Environmental Managerial/organisational Technical</td>
<td>Correlation analysis</td>
<td>Environmental: accountability demand, political pressures, fiscal scarcity; Organisational: top management support, effective organisational structure; and Technological: years of computer use, no. of computers owned, information quality, IS staff support, complexity of CIS do have effect on CIS use in decision making</td>
</tr>
<tr>
<td>Cragg &amp; King (1993)</td>
<td>To identify factors that motivate or inhibit IT</td>
<td>Case study</td>
<td>6 manufacturing firms with less than 50 employees</td>
<td>No. of IT applications</td>
<td></td>
<td>Descriptive analysis</td>
<td>Motivators • managerial support • improved efficiency</td>
</tr>
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<td>Methodology</td>
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<td>Kraemer et al. (1993)</td>
<td>To explore factors influencing perceived usefulness of CBI for finance &amp; operation tasks</td>
<td>Mail questionnaire</td>
<td>260 department heads of local governments in 46 US cities</td>
<td>Perceived usefulness of CBI for financial &amp; operation management</td>
<td>CBI characteristics</td>
<td>Correlation analysis &amp; stepwise regression</td>
<td>New, precise, timely &amp; accessible information, indirect use through information broker, financial tasks have significant influence on perceived usefulness</td>
</tr>
<tr>
<td>Stevens et al. (1994)</td>
<td>To examine combined influence of environmental, organisational &amp; technological contingencies in explaining CIS use in public sector</td>
<td>Mail questionnaire</td>
<td>566 (of 1106) US state managers</td>
<td>Impact on productivity improvement factors</td>
<td>Environmental Managerial/organisational Technological</td>
<td>Multivariate analysis (primary regression)</td>
<td>Managerial factors are most significant in influencing CIS use Effects of environmental &amp; technological factors are moderate</td>
</tr>
<tr>
<td>Chen &amp; Klay (1994)</td>
<td>To explore relationships between managerial motives &amp;</td>
<td>Mail questionnaire</td>
<td>742 (of 1231) employees of 11 state agencies in capitol city of Florida</td>
<td>Computer use (degree of use in various applications)</td>
<td>Management motivations</td>
<td>Pearson's r correlation</td>
<td>Managerial motivations &amp; behaviours are significantly related to individual motivation &amp; computer impact</td>
</tr>
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<td>Author</td>
<td>Research objective</td>
<td>Methodology</td>
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<td>King &amp; Teo (1994)</td>
<td>To determine differences in perceptions toward facilitating &amp; inhibiting factors bet. companies that have adopted strategic IT use (SIS and those that have not (non-SIS))</td>
<td>Mail questionnaire</td>
<td>121 (of 419) former Executive MBA students of a US university</td>
<td>Internal factors&lt;br&gt;External factors&lt;br&gt;Perceived needs</td>
<td>Management behaviours&lt;br&gt;- electronic monitor&lt;br&gt;- listen to employees&lt;br&gt;- work as a team&lt;br&gt;- give on-job training time&lt;br&gt;- expect more reports&lt;br&gt;- prior notice given&lt;br&gt;- smoothness of change</td>
<td>Wilcoxon test</td>
<td>Internal factors &amp; perceived needs play a stronger facilitating role for both groups, but SIS group emphasises on IT-related issues &amp; non-SIS group on management related factors as important facilitators</td>
</tr>
<tr>
<td>Hughes (1994)</td>
<td>To analyse application of IT to TQM processes</td>
<td>Case study</td>
<td>4 institutions of higher education</td>
<td>IT use</td>
<td>Descriptive analysis</td>
<td></td>
<td>Organisational culture, structure, size, leadership, budget constraints, &amp; IT deployment affect IT use</td>
</tr>
<tr>
<td>Boynton et al. (1994)</td>
<td>To explain factors affecting IT use</td>
<td>Mail questionnaire</td>
<td>132 (of 365) senior IT executive in firms using large IBM systems</td>
<td>IT use in&lt;br&gt;- cost reduction&lt;br&gt;- management support&lt;br&gt;- strategic planning&lt;br&gt;- competitive thrust</td>
<td>Managerial IT knowledge&lt;br&gt;- IS-manager's business knowledge&lt;br&gt;- line-manager's IT knowledge&lt;br&gt;IT-management-process effectiveness</td>
<td>Factor analysis</td>
<td>Managerial IT knowledge is critical for high level of IT use;&lt;br&gt;IT-management climate influences managerial IT knowledge &amp; IT-management-process effectiveness</td>
</tr>
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<td>Author</td>
<td>Research objective</td>
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<tr>
<td>Bergeron et al. (1995)</td>
<td>To ascertain determinants of EIS use</td>
<td>Mail questionnaire</td>
<td>38 executives in 9 organisations in Quebec, Canada</td>
<td>EIS use: frequency of use &amp; internalisation of use</td>
<td>EIS experience</td>
<td>Pearson's r correlation &amp; stepwise regression</td>
<td>EIS use is influenced by perceived consequences, affect, social factors, EIS experience &amp; facilitating conditions (in order of importance)</td>
</tr>
<tr>
<td>Hasan &amp; Lampitsi (1995)</td>
<td>To examine factors affecting executive use of CBI in public organisations</td>
<td>Multiple case study</td>
<td>4 Australian public organisations</td>
<td>Executive use of CBI</td>
<td></td>
<td></td>
<td>Quality information; alignment of organisational IS with strategic goals; top management involvement</td>
</tr>
<tr>
<td>Babcock et al. (1995)</td>
<td>To examine the executive use of IT &amp; its impact on organisations' level of IT adoption</td>
<td>Mail questionnaire</td>
<td>165 (of 400) public managers 97 (of 250) public IS managers</td>
<td>Departmental technology use (perceived usage)</td>
<td>Personal characteristics</td>
<td>Regression analysis</td>
<td>Attitude toward IT, funding &amp; size are related to level of departmental IT use Formal education &amp; training are correlated with attitudes but not personal use of IT</td>
</tr>
<tr>
<td>Gibson &amp; Mc-Donough (1996)</td>
<td>To examine the use of IT by government administrators</td>
<td>Literature study</td>
<td>5 developed countries in Europe</td>
<td></td>
<td></td>
<td></td>
<td>Application of IT is successful if it is adapted to the structure of the organisation</td>
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<tr>
<td>Nedovic-Budic &amp;</td>
<td>To identify factors</td>
<td>Multiple-case study</td>
<td>4 agencies within a North</td>
<td>GIS adoption</td>
<td>Human factors</td>
<td>Qualitative analysis: pattern</td>
<td>• perceived relative advantage, previous</td>
</tr>
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<td>Research objective</td>
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<td>Godschalk (1996)</td>
<td>affecting the adoption of Geographic Information Systems (GIS)</td>
<td>Carolina county government</td>
<td></td>
<td>Environmental factors</td>
<td>IT management factors</td>
<td>matching</td>
<td>computer experience, exposure to technology, &amp; networking are significant determinants of GIS use</td>
</tr>
<tr>
<td>Grover &amp; Segars (1996)</td>
<td>To explore relationship between organisational characteristics &amp; hardware deployment To explore if various combinations of organisational characteristics &amp; hardware configurations affect IS success</td>
<td>Mail questionnaire</td>
<td>155 (of 500), 68 (of 240), &amp; 121 (of 500) corporate IS executive in US, Korea &amp; France respectively</td>
<td>IS success</td>
<td>• profit contribution</td>
<td>Organisational</td>
<td>Kendall's rank correlation, Lambda measurement, chi-square test, f-test</td>
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<td></td>
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<td>• service improvement</td>
<td>• user satisfaction</td>
<td>characteristic</td>
<td>Distribution of decision-making &amp; role of IT are related to hardware deployment IS success is related to role of IT only</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>• frequency of use</td>
<td>• diffusion of technology</td>
<td>• economic sector</td>
<td>Hardware is more distributed as role of IT becomes a more integral part of corporate strategy</td>
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<td></td>
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<td>• perceived success</td>
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<td>• co-ordinating structure</td>
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<td>• distribution of decision-making</td>
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<td>• role of IT</td>
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<td>Distribution of hardware</td>
<td></td>
</tr>
<tr>
<td>Sohal &amp; Ng (1998)</td>
<td>To identify critical success</td>
<td>Mail questionnaire</td>
<td>81 (of 530) heads of IT</td>
<td>Extent of computerisation in</td>
<td>External, organisational &amp; technological success</td>
<td>Descriptive statistics</td>
<td>Causes of misused IT:</td>
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<td>Author</td>
<td>Research objective</td>
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<td>Dependent variable</td>
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<td>Foong (1999)</td>
<td>To investigate the effect of personal characteristics &amp; IS attributes on IS success in Malaysian SMEs</td>
<td>Mail questionnaire</td>
<td>49 (of 200) SMEs around Kuala Lumpur</td>
<td>IS success • user satisfaction • systems usage • perceived systems effectiveness in goal achievement</td>
<td>End-user personal characteristics • age • education • job responsibility • IT literacy Systems attributes • IS sophistication • Accessibility • Extent of computation • IT experience • User involvement • Top management support</td>
<td>Correlation analysis</td>
<td>IS success is related to user educational level, top management support, IT sophistication, IT accessibility and extent of computation</td>
</tr>
</tbody>
</table>
3.6 Factors to be Examined in this Study

The effect of organisational phenomena can be evaluated at two levels: the effect on organisational performance (macro level), and the effect on individual welfare (micro level) (Sanders 1984). Based on the criteria of MIS success identified by Ein-Dor and Segev, Sanders (1984) categorises the measures, namely widespread use and application to major problems of the organisation, to reflect their use in the organisational performance (macro) evaluation of system success.

This study aims to investigate the impact of IT on TQM by measuring the extent of IT use at the organisational level. Factors to be integrated into the study would therefore include those that may associate with the use of IT at the organisational level.

Many factors have previously been found to influence the use of IT in disparate settings (see Table 3.4). These factors have been classified into four categories, namely user, external, organisational, and technological. As this study is to measure the extent of IT use at the organisational level, it is appropriate to exclude factors such as user educational level, age, job responsibility and IT literacy under the user category. The omission of the user category is also sensible to restrict the size of the questionnaire so as not to jeopardise the response rate. Laudon (1985) explored the power of external and organisational factors to explain the pattern of adoption, utilisation, and management of information system technology in criminal justice and concludes that external and organisational factors taken together provide more powerful explanations than either of them taken separately. Kraemer et al. (1981) agree that external factors are of some significance to several information-processing tasks of the US local government. However, in their study on the impact of alternative policies for the management of IT, they have found management strategies for shaping technology, structure, socio-technical design, and organisational context of computing operations are more important in explaining performance variations than is the external environment. The finding of King and Teo (1994) is also in agreement with
Laudon (1985) and Kraemer et al. (1981) who found that internal factors play a stronger facilitating/inhibiting role than external factors.

In a study aimed to operationalise and empirically examine 'utilisation' as the impact of IT on managerial functions, and to empirically explore the complex interrelationships among the three sets of explanatory factors identified in the literature (external, organisational, and technological) which potentially influence the impact of IT on organisational decision support functions, Cahill et al. (1990) found that the unique combination of these three categories of factors - external, organisational, and technological - would give greater explanatory power for the successful use of IT in various government settings than any one category of factors.

Cahill et al. (1990) call for more empirical studies to examine the interdependence of multiple sets of factors as influences on the impact of IT at all level of government, paying particular attention to those factors that contribute to the utilisation. They argue that the attempt to outline determinants of utilisation is less critical than to elicit the underlying reasons that account for successful implementation of technology.

3.6.1 External factors

External factors represent the facilitating conditions and uncertainties outside the control and influence of the organisation that may influence the organisation's effort to use IT (Cahill et al. 1990).

Economic climate

In a series of studies to examine factors influencing the use of IT by the US public managers in financial and budgeting decision making, Stevens and Laplante (1986), Stevens and Cahill (1992) and Stevens et al. (1994) found that fiscal scarcity does have an effect on IT use. Favourable economic growth facilitates and promotes the use of strategic IT applications (King & Teo 1994).
IT marketplace
The extent to which technology is perceived to be available in the external environment (the IT marketplace) where critical technological functionality can be obtained, has a positive effect on IT use (Ein-Dor & Segev 1978; Cahill et al. 1990).

Legislation influence
Studies of Stevens and Cahill (1992), King and Teo (1994), and Nedovic-Budic and Godschalk (1996) indicate that favourable government policies and legislation may be a facilitating factor for enhancing IT use.

Public accountability
Accountability demands may have positive effects on IT use, forcing improved performance and productivity of public agencies (Stevens & Cahill 1992; Chen & Klay 1994).

Other public agencies
Pressure and influence from other public agencies affect the use of IT positively (Cahill et al. 1990; King & Teo 1994).

3.6.2 Organisational factors
Organisational context affects MIS success (Mason & Mitroff 1973). Organisational variables consist of factors within the organisation that may be powerful influences on technology use. They include direct influences such as management attitudes and indirect influences such as organisational characteristics (King & Teo 1994).

Organisational structure
The application of IT can only be successful if it is adapted to the structure of the organisation (Stevens & Cahill 1992; Stevens et al. 1994; Hughes 1994; Gibson & McDonough 1996). Robey and Zeller (1978) and Ein-Dor and Segev (1978) found that a centralised authority and high formalisation structure could be a strong factor for IT adoption.

Organisational size
Although some studies (e.g. Ahituv et al. 1989; Grover & Segars 1996) find IT distribution policy is not affected by organisational size, Ein-Dor and Segev (1978), Hughes (1994) and Babcock et al. (1995) suggest that it may have a positive association with IT use.

Managerial IT knowledge
The current trend in IT management would see line management as responsible for determining the business use of IT and be accountable for its operational impact (Dixon & John 1989). On the other hand, the IT function would be expected to become a knowledge function integrating knowledge of business and technology. Cragg and King (1993), Boynton et al. (1994) and Sohal and Ng (1998) confirm that managerial IT knowledge is critical for high levels of IT use.

Top management support
Top management plays a significant role in determining the success of any organisational undertaking and a committed management encourages IT use (Cheney & Dickson 1982; Sanders & Courtney 1985; Reich & Benbasat 1990; Stevens & Cahill 1992; Cragg & King 1993).

Financial resources
Limited financial resources affect the use of IT and inhibit IT growth (Ein-Dor & Segev 1978; Cragg & King 1993; King & Teo 1994; Babcock et al. 1995; Sohal & Ng 1998).
Goal alignment
Consistency between business and IT goals promotes the use of IT (Henderson & Sifonis 1988; Zviran 1990; King & Teo 1994; Hasan & Lampitsi 1995; Sohal & Ng 1998).

Budgeting method
Unlike private sector organisations, public organisations have to operate within fixed budgets and have little freedom to shift money from one category to another (Mohan et al. 1990). The budgeting of sufficient resources increases the likelihood of IT success and its usage (Ein-Dor & Segev 1978; Hughes 1994; Babcock et al. 1995).

IT champion
A strong supporter of IT within the user group who lobbies for support, and oversees its deployment is important for IT success (Robey & Zeller 1978; Reich & Benbasat 1990).

Steering committee
The establishment of a high level steering committee to guide the IT effort increases the likelihood of IT success (Ein-Dor & Segev 1978).

3.6.3 Technological factors
This category of variables 'refers to the strong and pervasive positive influence which technology-in-use has on further use within an organisation; it is the need to adopt technology caused by the obvious benefits which the technology itself presents' (Cahill et al. 1990, p. 59).

IT experience
The experience of IT use has been identified as one of the determinants of new/further IT deployment (Sanders & Courtney 1985; Stevens & Cahill 1992; King & Teo 1994; Bergeron et al. 1995).

**IT facilities**
The existence of extensive IT facilities within an organisation significantly contribute to the effective use of IT (Kraemer et al. 1981; Stevens & Cahill 1992; King & Teo 1994).

**User support**
The availability of user support is an essential facilitating condition to ensure pervasive IT use (Stevens & Cahill 1992; Cragg & King 1993; King & Teo 1994; Bergeron et al. 1995).

**Systems compatibility**
Incompatible systems hamper IT use (Stevens et al. 1994) and hinder effort to integrate isolated systems for strategic applications (Kim & Michelman 1990).

**IT structure**
IS success is related to the role of IT within an organisation (Hughes 1994; Grover & Segars 1996). Grover and Segars (1996) find that hardware is more distributed as the role of IT becomes a more integral part of corporate strategy. The trend in the public sector has been reported whereby in many countries authority and responsibility for IT are being decentralised to allow users to define and develop the applications systems (Kraemer et al. 1981; Gibson & McDonough 1996).

**IT competency**
Lack of IT skills and a lack of strong technical support staff hinder IT growth (Cragg & King 1993; King & Teo 1994). An IS function with a high level of competence ensures success of a system (Reich & Benbasat 1990).

**Computer-based information characteristics**
Characteristics of computer-based information which influence IT use are similar to those set out in Section 2.9.5, which include accuracy, timeliness, completeness, relevance, accessibility, and cost-effectiveness (Kraemer et al. 1993, Stevens et al. 1994).

3.7 Summary

IT has been identified as a major force bringing about organisational change (Scott Morton 1994). To play its part as an enabler of change, the organisation's IT personnel must be prepared to take up the challenge. However, key MIS issues of the 1990s faced by IS managers from the public and the private sectors differ significantly (Niederman et al. 1991; Caudle et al. 1991; Wang & Turban 1994). IS strategic planning and technological issues are emphasised in public organisations. This is because IT is being developed to improve services provided to the public (Corbin 1996a; 1996b; Central IT Unit 1996a; 1996b). The internal, process-focused tradition in IT applications is giving way to an external, citizen-oriented approach (Anderson et al. 1994).

This study aims to investigate the impact of IT on TQM. An understanding of the organisation's internal and external environments will help to explain how IT plays its part. The huge number of factors influencing IT use investigated by past studies are listed in Table 3.4. This study seeks to account for IT use at the macro level among the Malaysian public agencies. In order to ensure that this study is reasonable and manageable within a fixed timeframe, factors that are relatively unimportant in this context have to be excluded. They include those that are not applicable to the public sector and those with cultural implications. The external, organisational and technological factors that have been considered as significant in previous research on the use of IT are set in Table 3.5.
Table 3.5 Factors Affecting IT Use in Public Agencies

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<tr>
<th>External factors</th>
<th>Organisational factors</th>
<th>Technological factors</th>
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<td>economic climate</td>
<td>organisational structure</td>
<td>IT experience</td>
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<td>IT marketplace</td>
<td>organisational size</td>
<td>IT facilities</td>
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<td>legislation influence</td>
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CHAPTER 4 RESEARCH DESIGN

4.1 Introduction

'The research process can be viewed as a series of interlocking choices, in which we try simultaneously to maximise several conflicting desiderata' (McGrath 1982, p. 69). When embarking on research, one faces a series of logically ordered choices right from problem formulation, through study design and execution, to results analysis and interpretation. At each stage of the research process, there is a set of dilemmas and a related set of choices. These choices are interconnected across stages. Viewed in this way, when designing a study, one has to compromise among generalisability of findings, precision of measurement of behaviours and the realism of context as the three aspects are mutually exclusive. There is no one correct or perfect set of methodological choices for a given problem, setting, and available set of resources that will guarantee success; there is no flawless research. To handle the dilemmas, according to McGrath (1982), multiple approaches are required. This is because multiple methods not only serve the purposes of replication and convergence; more importantly they serve the crucial purpose of compensating for inherent limitations that any one method, strategy, or design would have if used alone.

This chapter focuses on the ways adopted to tackle the research question, discussing the measurement of variables, and identifying the population of the study.

4.2 Methods Employed in Previous Research on IT Use

The use an individual, group, or organisation makes of IT is a key variable in management information systems (MIS) research. A review of several studies on IT applications (Table 3.4) reveals that the earlier researchers have often used IT-use as
either an independent or a dependent variable (e.g. Sanders & Courtney 1985; Boynton et al. 1994; Sethi & King 1994; and Rogers et al. 1996). The data collection approaches employed have generally been case studies or mailed questionnaire surveys (e.g. Reich & Benbasat 1990; Cragg & King 1993; Bergeron et al. 1995; Rogers et al. 1996).

Trice and Treacy (1988) caution that deciding what aspect of use to measure should be guided by the purpose which the measures are to serve. Sparrow (1990) argues that to assess the impact of IT, case-study approaches 'yield a high degree of specificity of information, from which subsequent analyses across cases may identify general factors; they effectively only generate hypotheses for subsequent empirical research to validate' (p. 322). As the generalisation of case-study findings is questionable due to contextual differences, Sparrow (1990) suggests that the approach used should be 1) exhaustive, generating all items that describe such a particular dimensions or categories of IT use as information handling processes and competitive advantage, 2) independent of the size of unit being assessed (e.g. departments, organisations, industries), 3) independent of an organisation's specific equipment (e.g. PC, mainframe), 4) able to provide adequate reliability, validity and discriminability, and 5) able to minimise overlap or redundancy between items.

4.3 Methods Employed in Past Research on the Role of IT in TQM

According to McGrath (1982), there are eight distinguishable research strategies for gaining knowledge about a research problem (Figure 4.1). These generic classes of research settings differ in terms of the population used, subject behaviour and context. When undertaking research, it is always desirable to maximise generalisability with respect to population, precision in the control and measurement of variables related to the behaviours of interest, and the realism for the participants of the context within which those behaviours are observed. However, as shown in Figure 4.1, the three are mutually exclusive. To gain knowledge about a research problem, McGrath argues that there is no one best methodological strategy. The use of a combination of multiple strategies (not
within one study, but over studies within a program) to gain information about a given problem through multiple means that do not share the same weaknesses is highly recommended.

Figure 4.1 Research Strategies

I. Settings in natural systems.
II. Contrived and created settings.
III. Behavior not setting dependent.
IV. No observation of behavior required.

A. Point of maximum concern with generality over actors.
B. Point of maximum concern with precision of measurement of behavior.
C. Point of maximum concern with system character of context.


Past work on the role of IT in supporting TQM is summarised in Table 4.1. It shows that the link between IT and TQM is mostly demonstrated by quoting particular application examples or deduced practice from theory. All the attempts are to model a universal
system of IT in TQM theoretically without empirical measurement of the actual role of IT. The strategy involved either maximises population generalisability (A) or realistic context (C) but compromises on precision of behaviour measurement (B) (see Figure 4.1).

Table 4.1 Summary of the Literature on the Role of IT in TQM

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<th>Dimension</th>
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<td>Kock &amp; McQueen 1997</td>
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<td>Strategic planning process</td>
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<td>Mahmoud &amp; Rice 1998</td>
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<td>Output quality assurance</td>
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<td>Quinn &amp; Baily 1994</td>
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<td>Forza 1995b</td>
<td>Survey</td>
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<td>Kathuria &amp; Igbaria 1997</td>
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<td>Matta et al. 1998</td>
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<td>Zahedi 1998</td>
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<td>Mahmoud &amp; Rice 1998</td>
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<td>Supplier quality assurance</td>
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<th>Dimension</th>
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4.4 **Research Method Adopted in this Study**

One objective of the study is to determine the impact of IT on TQM in the Malaysian public sector. A second objective is to identify the aspects of TQM to which IT priority should be given. In other words, the study aims to gauge the impact of IT on the various aspects of TQM by assessing the view of Malaysian high performing public agencies. It also hopes to identify factors that increase or decrease the impact, establishing a relationship between IT-impact and these factors.

There are several approaches to acquiring information about an organisation's IT-impact. According to Yin (1994, pp. 3-9), if research questions focus mainly on 'what' questions, and the type of 'what' question is actually a form of a 'how many', 'how much', or 'where' line of inquiry (i.e. quantification is sensible), identifying such phenomena is likely to favour survey techniques. Examining the extent of IT-impact falls into this category of research questions, and as such the survey approach may be advantageous. However, identifying factors affecting IT-impact addresses the type of 'what' questions that is exploratory. Yin suggests that this type of 'what' questions is a justifiable rationale for conducting an exploratory study, and any major research approaches such as case study, experiment, survey, history, and archival analysis can be used.

When many approaches appear to be equally attractive, two other conditions may help to make the choice (Yin 1994, pp. 3-9): the extent of control over behavioural events, and the degree of focus on contemporary as opposed to historical events. In the context of this study, the natural settings of the public agencies do not allow manipulation of variables under controlled conditions to examine the effects on outcomes (IT-impact). Also, this study's focus is not on historic events. Thus the experiment and history (archives) approaches will not be used. Based upon Yin's guidelines, the case study and survey approaches are considered equally relevant for exploring factors affecting IT-impact in TQM.
This study's purpose is to find out which aspect of TQM activities is most affected by IT applications, rather than simply to describe the present usage of IT in TQM environments. The case study or qualitative research is an advantageous empirical form of inquiry that allows a researcher to investigate a contemporary phenomenon within its real-life context, offers the opportunity to establish rapport with the interviewees, and helps to explore and understand complex issues (Sekaran 1992, p. 220). On the downside, this intensive research methodology has the potential for introducing social desirability, interviewer distortion and subversion, and can be expensive as well as time consuming to administer if the sample is not small (Dillman 1978, pp. 74-75). To ensure that the IT-impact of interest will be adequately represented to allow for meaningful generalisations, the sample is likely to be quite large. However, a manageable sample for a case study, undertaken by a single researcher with time constraints in particular, is unlikely to be big.

Telephone interviews and face-to-face interviews (including personally administrated questionnaires) are not considered appropriate in this study even though both techniques might overcome the limitations of mail questionnaires such as inability of researchers to probe for more information and restriction in the kinds of questions used (for example contingency questions and open-ended questions). It is noted that telephone interviews can quickly be conducted with many people across long distances, but the relatively high cost and limited interview length are disadvantages. Besides having the advantages of the telephone interview, face-to-face interviews permit long, complex questions and visual observations. On the negative side, the face-to-face approach is the most costly and time consuming among the three techniques discussed (Neuman 1994, pp. 242-245).

Sample surveys can be used to deal with phenomenon and context: however, their ability to investigate the context is extremely limited as the number of variables to be covered in a survey usually is bounded by the size of a measuring instrument. This is particularly true for mailed questionnaires. Although this approach often has a low response rate and one cannot be sure if the data obtained are biased because the non-respondents may be different from those who do respond, the mailed questionnaire survey appears to be the
best option for obtaining a substantial amount of information through structured questions, at minimal costs, from subjects that are widely dispersed geographically (Sekaran 1992, p. 220).

Having considered the pros and cons of these techniques and trade-offs among accuracy, time and cost, it was decided that a mail questionnaire would be the most appropriate for this study.

Ideally, for this study, a quantitative approach would be used to assess the extent of IT use in TQM and qualitative techniques to explore how the use of IT is affected by contextual variables. Due to resource constraints, a mail questionnaire strategy was adopted.

Factors influencing IT use in disparate environments were identified through literature research to formulate the initial questionnaire. Interviews were then conducted during the pre-test stage to ensure that the factors selected were relevant and adequate to explain the phenomenon, and also to refine the indicators used for measuring the phenomenon.

This study attempts to measure the impact of IT on TQM (behaviour) so as to determine the role of IT in all TQM implementing organisations (generalisability). However, according to McGrath (1982), this can be achieved only if the generic setting i.e. public agencies (context) does not play a part in the behaviour of concern. In other words, using McGrath's (1982) expression, this study compromises between precision of measurement of behaviour (the impact of IT on TQM) and generalisability with regard to populations (TQM implementing organisations) with realism of context at a minimum. The research strategy adopted is the judgement task according to McGrath's classification (see Figure 4.1). The difference between a judgement task and a sample survey lies in the sampling of the population units to be studied. While the sample survey maximises concern with representative sampling of the respondents, the judgement task uses small but appropriate population units assumed to be 'generic' judges. This study also takes the suggestion of
Straub and Carlson (1989) to tackle the problem quantitatively, undertaking rigorous instrument validation as well as quantitative analysis to establish greater confidence in the research and its findings.

4.4.1 Benchmarking

The ultimate goal of the Malaysian government is to be a world-class public service provider. One way of achieving this goal is by adopting and adapting best practice of its counterpart organisations from all over the world, i.e. by benchmarking - an integral part of a total quality process. According to Thiagarajan and Zairi (1997b), benchmarking is a tool for obtaining the information to be used in the continuous improvement process, and to determine business and work processes that represent best practices as well as to establish rational performance goals in order to achieve high standards of competitiveness. To attain one of the benefits of this study, i.e. to understand how IT can most appropriately be used in the Malaysian public sector to support TQM, and parallel to the practice of TQM, the current IT applications in Malaysian public agencies should be benchmarked against those practised by their counterparts in other countries.

In reviewing TQM in practice, Thiagarajan and Zairi (1997b) highlight four essential types of benchmarking:

1. Competitive benchmarking in which comparisons are made with primary competitors
2. Functional benchmarking which compares with similar functions within same-industry leaders
3. Generic benchmarking which compares with similar functions regardless of type of industry
4. Internal benchmarking in which comparisons are made within the organisation itself.

The present study recognises that benchmarking against other public agencies from the developed countries is not a simple task. Many contextual aspects such as political, economical and cultural influences have to be carefully handled. According to Madsen
(1995), there are principles that unavoidably have to be respected when managing an organisation of a political system. These include traditional economic control, political powers and group influences as well as organisational culture. Public administrators are subject to obedience to public power and administrative law (Gibson & McDonough 1996). In addition, most of what government does is not defined by market forces. Public agencies often offer monopoly services where the government's customers have only a take-it-or-leave-it kind of choice. Political rationality underlies most decisions (Anderson et al. 1994).

The approach adopted in this study may be regarded as conducting the internal benchmarking stressed by Thiagarajan and Zairi (1997b). The internal benchmarking has been practised by Rank Xerox with great success even though it is generally played down as unimportant by TQM writers (Thiagarajan & Zairi 1997b). Their view is consistent with Murray's (1991). Murray argues that in the quest for world class IT capability, IT managers must first obtain an understanding of their organisation’s current IT position. They have to develop internal benchmarks to ensure their improvement goals are achievable. He believes internal benchmarking should precede the benchmarking of target companies.

4.5 Measurement of Variables

4.5.1 The dependent variable

The study recognises various measures of IT use as dependent variables in MIS research. The utilisation constructs operationalised by the researchers vary according to the research objective addressed (see Table 3.4). Generally, the past research in the utilisation area implicitly defines IT use as either the amount of effort expended by individuals interacting with an information system (e.g. frequency, intensity, and diversity of use), or the diffusion of the technology (e.g. number of pieces of IT equipment and the number of applications), or the extent of effect on certain activities by reports or other information
products generated by the information system (e.g. effect on decision making, productivity, and business performance).

The current study intends to assess the impact of IT on TQM. The first two measures of utilisation mentioned above are deemed unsuitable for the following reasons:

1. **Amount of direct interaction.**
   a) The study is interested in the impact of IT at the organisational level, not in individual effectiveness. Due to resource constraints, it is not feasible to solicit data about the multiple individual efforts expended interacting with IT in order to measure an organisational level of IT impact.
   
b) This study recognises the use of IT by an individual can be either direct or indirect. Studies have shown that IT has an important role in the managerial function but the majority of management are indirect users who use the IT output produced by some intermediary (Abdullah et al. 1996). Reporting the amount of interaction is not a valid measure of IT use for these indirect users. Furthermore, frequency or diversity of use is not an appropriate measure for a manager who uses IT occasionally for making decisions of strategic importance.

2. **Number of pieces of IT equipment.**
   The main business activity of public agencies is to provide services to their customers. Like most service providing organisations, IT is used to furnish the appropriate information upon which to base a wide range of operational decisions. It is also increasingly being used in identifying and analysing strategic issues as well as other information handling processes. The amount of hardware and the number of applications an organisation has installed cannot give a true picture of IT diffusion in business as the use of IT at the management level is often voluntary (Thompson et al. 1991) and the use is not transactional in nature. In addition, the size and power of hardware will further complicate the measurement. It is difficult
to compare the IT of an organisation with a 8-megabytes-RAM computer with another organisation which has ten machines with only 256K RAM each. Sparrow’s (1990) suggestion that the measure of utilisation should be independent of an organisation’s specific equipment is observed.

In view of the above discussion, the study adopted the approach taken by Kraemer et al. (1981), Sparrow (1990), Stevens et al. (1994), and Sethi and King (1994) in the design of the IT utilisation constructs. The impact of IT on TQM is to be operationalised by measuring the extent to which IT is used to support TQM activities within an organisation.

4.5.1.1 Operationalisation of the IT-impact

The operationalisation of the IT-impact was underpinned by the rationale proposed by McGrath (1982). Suppose that a relation has been postulated – derived either from the literature, from general observation, from thoughts or from a combination of these methods. An example of such a relation is that intelligence is a predictor of intellectual attainment. In general terms, this relation can be considered to be the relation between X and Y: i.e. the construct intelligence is denoted by X, the construct intellectual attainment is denoted by Y, and the relation is denoted by X-Y. The setting up of an instrument to measure the relation X-Y is often not easy, since often neither X nor Y can be measured directly: there needs to be surrogates for them. The surrogates are denoted by x and y respectively. An instrument is needed to measure x and an instrument to measure y. In the intelligence-intellectual attainment relation, the surrogate measure for intelligence could be numeracy, whilst a surrogate measure for intellectual attainment could be the knowledge of some subject – such as physics. The surrogate relations are denoted by X-x and Y-y.

Thus four relations are involved as Figure 4.2 illustrates. It can be seen that the relation x-y does not directly reveal the X-Y relation: what it does is reveal in the combination of
the X-x, Y-y and X-Y relations. What is thus required is to validate X-x and Y-y so that x-y does reveal the X-Y relation as well as possible.

Figure 4.2 The Rationale for the Operationalisation of the Constructs

The appropriateness of the surrogate measures and thus the relations (X-x and Y-y) need to be tested – both that the surrogates adequately represent the two constructs and that they can be measured. The surrogates must be measurable since, if they adequately represent the constructs, the empirical relation between them will be taken to be the same as the relation between the constructs. Thus the relation x-y can be taken to be the same as the relation X-Y.

As described earlier and shown in Figure 4.2, relation 1 is a conceptual relation. Relations 2 and 3 are definitional relations – they are defined to be so (e.g. intelligence is defined as being adequately represented by numeracy). Relation 4 is an empirical relation that is determined through measurement. However, as McGrath (1982) points out, which relation to test empirically and which to define is entirely arbitrary. With the intelligence-intellectual attainment relation for example, the relation that might be empirically tested might be that between intelligence and numeracy, with that between numeracy and attainment in physics taken as known.
Figures 1.1 and 2.2 presented the overall model of the impact of IT on TQM, and this model is reproduced as the top portion of Figure 4.3. The lower portion of Figure 4.3 illustrates the rationale for measurement operationalisation.

**Figure 4.3 The Rationale for Measurement Operationalisation**

- **Contextual Influences**
  - External factors
  - Organisational factors
  - Technological factors

- **Impact of IT on TQM**

- **Organisational Quality Achievement**

**A** Extent of IT use in TQM

**B** Impact of IT on TQM

**C** IT use in 8 aspects of TQM processes:
- leadership
- strategic planning process
- quality output assurance
- important innovations
- information and analysis
- human resource utilisation
- customer satisfaction
- quality results

**D** Impact of IT on:
- service quality
- quality management
- service productivity
As depicted in Figure 4.3, IT will have an impact on TQM if and only if it is used to support TQM. In other words, the impact of IT can be inferred from the extent to which it is used to perform TQM processes. In order to draw an inference about the extent of IT use in relation to the impact of IT on TQM (relation 1 of Figure 4.3), the extent of IT use in TQM environments is operationalised through how it is used along the eight dimensions of TQM processes. Relation 2 in Figure 4.3 will be an appropriate relation if the IT-use measurement instrument (C) truly measures the concept of the extent of IT use in TQM (A), i.e. it has high content and construct validity. If the impact of IT on TQM (B) and its operationalisation in terms of service quality, quality management and service productivity (D) are also strongly related (relation 3), then relation 4 can be used to test for relation 1 empirically because relations 2 and 3 are soundly based. This means that if the IT-use measurement instrument (C) and the impact of IT on the organisational service quality, quality management and service productivity (D) are correlated (relation 4), then it may be interpreted as evidence for the existence of relation 1. The IT-use measurement instrument (C) will then be a valid measure of the impact of IT on TQM (B). The validation of the measurement is discussed in Chapter 7.

As no suitable instrument was readily available, an instrument had to be developed. To determine the domain of TQM, an extensive review of the theoretical, empirical and practitioner literature was undertaken. A framework based on the literature of TQM (e.g. Saraph et al. 1989; Flynn et al. 1994; Oakland 1993 and Kanji & Asher 1993) has been derived and used as the basis for the fieldwork content agenda to determine the use of IT in TQM.

The components of the TQM framework (discussed in Chapter 2) that can be structured into a construct to measure the use of IT to support TQM in the expert rating questionnaire are listed in Table 5.1 of Chapter 5 and are discussed in detail in that chapter.
4.5.2 The independent variables

The factors that have been identified from published works have been listed in Table 3.5. The table is reproduced as Table 4.2.

The study has decided to drop the variables 'steering committee' and 'IT champion' categorised under organisational factors as they can be subsumed under 'top management support'. Ein-Dor and Segev (1981, pp. 77-78) argue that steering committees are composed of senior executives and the appointment of a steering committee is a good method of demonstrating management support (pp. 139-140) as well as a way of attaining user involvement (pp. 77-78). Studies have also implicitly indicated that top management support and IT champion/leadership are related (Reich & Benbasat 1990; King & Teo 1994).

Table 4.2 Factors Affecting IT Use in Public Agencies

<table>
<thead>
<tr>
<th>External factors</th>
<th>Organisational factors</th>
<th>Technological factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>economic climate</td>
<td>organisational structure</td>
<td>IT experience</td>
</tr>
<tr>
<td>IT marketplace</td>
<td>organisational size</td>
<td>IT facilities</td>
</tr>
<tr>
<td>legislation influence</td>
<td>managerial IT knowledge</td>
<td>user support</td>
</tr>
<tr>
<td>public accountability</td>
<td>top management support</td>
<td>IT integration</td>
</tr>
<tr>
<td>inter-organisational co-operation</td>
<td>financial resources</td>
<td>IT structure</td>
</tr>
<tr>
<td></td>
<td>goal alignment</td>
<td>IT competency</td>
</tr>
<tr>
<td></td>
<td>budgeting method</td>
<td>CBI characteristics</td>
</tr>
<tr>
<td></td>
<td>IT champion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>steering committee</td>
<td></td>
</tr>
</tbody>
</table>

Lastly, 'computer-based information (CBI) characteristics' in the technological category has been dropped because it is evaluated indirectly in the construct for IT use in TQM under the 'information and analysis' dimension.
After dropping the variables that appear to be overlapping, the study has 18 independent variables grouped under three categories of factors to explain the contribution that IT can make to enhance TQM. The list of the factors is shown in Table 4.3.

Table 4.3 Factors Affecting IT Use Examined in the Present Study

<table>
<thead>
<tr>
<th>External factors</th>
<th>Organisational factors</th>
<th>Technological factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>economic climate</td>
<td>organisational structure</td>
<td>IT experience</td>
</tr>
<tr>
<td>IT marketplace</td>
<td>organisational size</td>
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<td>financial resources</td>
<td>IT structure</td>
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<tr>
<td></td>
<td>goal alignment</td>
<td>IT competency</td>
</tr>
<tr>
<td></td>
<td>budgeting method</td>
<td></td>
</tr>
</tbody>
</table>

4.5.3 Pre-testing of the instrument

The various aspects of TQM and the factors that influence the use of IT were established via the extensive literature review discussed in Chapters 2 and 3. This, according to Straub and Carlson (1989), strengthens instrument development by permitting the researcher to pre-specify the makeup and structure of the constructs and reducing the threat of misspecification. Once the instrument was developed, pre-tests were run to ensure completeness and precision.

Pre-testing a questionnaire by interviewing permits a greater determination of problems in that an interviewer can detect confusion and probe into the nature of that confusion on the spot (Babbie 1973, pp. 206-207). As the goal of pre-testing is to refine the research instrument rather than to provide descriptions of the population, Babbie (1973) suggests that little concern should be given to strict representativeness; rather the attempt should be made to achieve the broadest range of respondent types. The current study takes note of his recommendation for the selection of subjects that they should be reasonably appropriate respondents for the questions under consideration. Thus many respondent
types were consulted in pre-testing the questionnaire, rather than only using a sample of the proposed 'targets'.

The participants involved in the pre-test include two IT and two TQM academics from the UK, three TQM practitioners and two technical managers from Malaysia. The selection of participants was designed to get maximum feedback from academic and practitioner experts in TQM and IT, both from the UK and Malaysia. The instrument was continuously re-edited for the successive interviews.

Personal interviews were conducted with the nine participants in order to improve the questionnaire instrument progressively in terms of both content validity and construct validity. The points discussed in the interviews include:

1. The various aspects of TQM practice.
2. Factors affecting IT use in TQM.
3. The legibility of the questionnaire especially with regard to the spacing, the structure and the general appearance of the questionnaire.
4. The clarity of the instructions given on the cover page and in each section of the questionnaire.
5. The ambiguity of any questions, scales and answers. This includes vague, unfamiliar phrases and difficult questions.

4.6 The Study Population

The purpose of this study is to investigate the extent to which IT impacts on TQM in order to ascertain the role of IT in TQM. As the research strategy adopted is the judgement study, particular attention has to be paid to sample public agencies that can be regarded as 'generic judges'. Thus the population of the study should consist of all public agencies in Malaysia that have implemented TQM successfully.
In order to fulfil the above requirement, this study has decided to use the public agencies that have been short-listed for the Prime Minister’s Quality Award in Malaysia. The selection criteria are outlined by MAMPU (1992) and are very similar to the Baldrige criteria to measure quality achievements (detailed in Chapter 2). These agencies can be assured to have implemented TQM successfully, as they have provided extensive documentation to substantiate the implementation of TQM within their organisations.

The list of quality award candidate agencies (since its inception, i.e. 1992-1997) was obtained from MAMPU, which is responsible for administering the public sector Prime Minister’s Quality Award in Malaysia. There are a total of 110 agencies. It could be confidently assumed that only the agencies that have implemented TQM were included in the study because the list revealed that many of the candidate agencies are actually a subunit or division of the larger organisations. They include the Medical Faculty of National University of Malaysia (UKM), the School Division of Ministry of Education, the Economy Planning Unit of Prime Minister Department, and the Blood Service Centre of Kuala Lumpur General Hospital. This allows us to deduce that a sub-unit of the larger organisation would be considered for the award instead of the whole organisation if TQM is not fully implemented in the entire organisation.

4.7 The Data Analytic Scheme

The scheme for data analysis in the study can be divided into two stages. The two stages are:

Stage 1: Identification of the level of IT use in various aspects of TQM,
Stage 2: Analysis of the relationships between IT use in TQM and the factors impinging on the applications.

In stage 1 of the data analysis process, univariate analysis was conducted to describe the perceived use of IT along the eight aspects of TQM. Repeated measures of ANOVA were
then performed to test whether there were any significant differences in the perceived use of IT among the eight aspects of TQM. This comparison analysis allowed for determining the area(s) of IT use that would be most appropriately be given priority if it is to support TQM in the Malaysia public sector.

In stage 2, the study uses correlation and multiple regression to answer the research questions. Correlation analysis was performed to test for any relationships between the variables that describe the external, organisational, and technological factors and the use of IT in TQM. The relationships between variables mentioned were evaluated by the correlation coefficient between the variables and the significance level of the correlation coefficient. Correlation analysis enables the study to determine factors that facilitate/inhibit IT applications.

The study also adopted multiple regression analysis to assess the strength of environmental, organisational, and technological factors to explain the use of IT in public TQM settings. This allowed for modelling TQM supported by IT as a function of the agency’s external, organisational, and technological factors.

4.8 Summary

‘The choice of data-collection methods depends on the facilities available from the organisation, the accuracy required, the time span of the study, and other costs and resources associated with and available for data gathering’ (Sekaran 1992, p. 190).

The present study focuses on the Malaysian high performing public agencies rather than the randomly selected public agencies to investigate the use of IT in TQM. This research design gives the study the most logical influence regarding the phenomenon and contextual variables. Excluding non-candidates of the quality award limits the scope of the research question, so the resulting information (findings) is constrained. This is a trade-off between scope (the amount of potential information in the study) and precision.
(the amount of reduction in noise) (McGrath 1982). In adopting the research design, it is hope that more would be learned about less, i.e. more about the role of IT in TQM but confined to high performing public agencies in Malaysia.

This chapter has outlined the research design and research activities undertaken by the study. A diagrammatic description of the activities for the research process is shown in Figure 4.4. The remainder of the thesis will discuss those activities undertaken in step 4 (measurements construction) and the rest of the steps in Figure 4.4.
Figure 4.4 Research Process of the Study

1. Literature Review
2. Identification of independent variables
3. Establishment of TQM framework
4. Operationalisation of variables
5. Construction of initial measurement items
6. Pre-test of measurement items by expert rating interview
7. Refinement of items
8. Second phase questionnaire pre-test
9. Finalisation of questionnaire
10. Data collection by mail survey
11. Assessment of reliability & validity
12. Data analysis
   - Univariate analysis & ANOVA test
   - Multivariate analysis & regression analysis
13. Interpretation of results & discussion
14. Deduction & report writing
CHAPTER 5  THE QUESTIONNAIRE DESIGN

5.1 Introduction

The benefits of using any research instrument will only be fruitful if the instrument is carefully developed to serve its purpose. The focus of this chapter is on the design of the questionnaire. After identifying the respondents of the mail survey, the design of the construct for the use of IT in TQM is described in detail. Next, the formation of the measures of the contextual influences is discussed, followed by the structure of the questionnaire. Lastly, the pre-testing process is presented.

5.2 The Respondents of the Judgement Study

As defined by Phillips (1981), the key informant method, i.e. interviewing one or more respondents chosen because they have special qualifications, is an effective means for collecting information about a social system. This data-gathering technique, according to Phillips (1981), may be employed in survey contexts to obtain quantifiable responses rather than qualitative information. Campbell (1955) identifies two criteria for choosing the informant: the respondents should occupy roles that make them knowledgeable about the issues being research; and they should be able and willing to communicate with the researchers.

The present study agrees with Saraph et al. (1989) that the senior quality managers of a business unit are likely to be the ‘thought leaders’ with respect to quality management in their business unit. The target respondents, therefore, were the senior quality managers. They were the senior managers responsible for quality programmes from agencies that applied for the Malaysian Prime Minister’s Quality Awards (Public Sector). A mail
survey technique is appropriate to this group: they are literate and knowledgeable thus should have no difficulty in responding to the questionnaire (Sekaran 1992, p. 201).

To overcome the shortcomings of the single-respondent approach and to take note of McGrath’s (1982) suggestion to combine multiple research strategies, the Prime Minister’s Quality Award administrator (MAMPU), senior quality managers, and IT managers of the public agencies were contacted via e-mail for interview.

The Director of the Financial and Quality Management Division of MAMPU granted full support to the study. However, only two senior quality managers and one technical manager of the agencies agreed to be interviewed. Questionnaires were also sent to ten IT managers of the public agencies to solicit different points of view on the use of IT in TQM. Questionnaires could not be sent to IT managers of all the agencies for the following reasons:
1. Many of the candidate agencies do not have an IT manager or IT personnel.
2. TQM and IT are in the portfolio of a same manager/officer in many of the agencies such as the Economy Planning Unit and many local authorities.
3. The IT facility of a number of the agencies is supported by one common unit. For example, the IS Division of the Ministry of Education is responsible for the IT facility of the three candidate agencies from the same ministry: the Technical and Vocational Education Division, the School Division, and the Technology Education Division.

5.3 Considerations in the Design of the Questionnaire

The questionnaire was designed to elicit information on the four main areas of concern: the use of IT in the agency’s TQM processes, the external influences that impinge on the agency, the organisational factors affecting the use of IT in the agency, and the existing technological implementation that affects the agency’s IT adoption.
In designing the questionnaire, meticulous attention was given to constructing items that were precise and concise. This was achieved by keeping the respondents’ perspective in mind when formulating the items.

There is a large body of literature in which ways to increase response rates for mail questionnaires are discussed (Dillman 1978, pp. 160-165; Heberlein & Baumgartner 1978; Sekaran 1992, pp. 209-214; Neuman 1994, pp. 238-242). The present study followed closely the Total Design Method developed by Dillman (1978, pp. 12-16) in particular. Besides good question wording and questionnaire design, the co-operation of respondents could be sought by granting the following rewards:

1. Show a high regard to their agencies and make them feel important to the study.
2. Use simple questions and avoid formidable questions to minimise the mental effort, personal costs, and time required to complete the questionnaire.
3. Build a feeling of trust through a professional-looking questionnaire with a stamped returned envelope, evidence of a legitimate sponsor, and a promise of a copy of the survey results.

Measures taken to improve the responses of the mail survey are discussed in detail later in this and next chapters: the structure of the questionnaire is described in Section 5.6 and its implementation covered in Section 6.3.

5.4 Designing the IT-Use-in-TQM Construct

The main purpose of designing the IT-use-in-TQM construct was to relate the items in the questionnaire with the following research question that has been discussed in Chapter 1:

Q1: What is the impact of IT on TQM; in particular, on Leadership, Output Quality Assurance, Human Resource Utilisation, Strategic Planning Process, Important Innovations, Information and Analysis, Customer Satisfaction, and Quality Results?
The present study recognises that organisations operating in TQM environments may choose to address the environment differently (Flynn et al. 1994; Boaden 1997). This study defined TQM as a total organisational approach for meeting customer needs and expectations that involves all managers and employees in using quantitative methods to improve continuously the organisation's process, products, and services. This study followed the approach taken by Saraph et al. (1989) and Flynn et al. (1994) to capture the practices of TQM. In their studies, Saraph et al. (1989) and Flynn et al. (1994) focused on the development of a means for measuring the extent of use of specific quality management practices, rather than assessing quality performance, conceptualising quality management in various dimensions.

A similar approach was also taken by Sethi and King (1994) to assess the extent to which an IT application provides competitive advantage. According to Sethi and King (1994), the outcome measures are very aggregated and thus insensitive to the effects of an IT application. In addition, they are of little help in understanding 'how' IT affects competitive advantage and have limited applicability in contexts other than the one studied. Sethi and King (1994) adopted the trait approach in their study that identified key attributes that characterise competitive advantage. They argue the main advantage of this approach is that it provides insights into how and why IT affects competitive advantage, showing in detail competitive advantage components and subcomponents as well as describing the interrelationships among them. This knowledge is indispensable for building theories regarding the impact of IT on competitive advantage.

However, it is acknowledged that neither the process approach nor the performance approach for measuring IT use is superior to the other. The process approach was chosen in this study simply because this approach would provide insights into how IT was used in TQM, showing in detail these TQM components that benefit most from IT applications.
Each of the eight major dimensions were operationalised using the attributes described in Table 5.1. As the study aimed at investigating the effect of IT on TQM processes, questions about the attributes were phrased by asking respondents the extent to which IT has been used by their agencies to perform those processes.

Table 5.1 The Eight Dimensions of TQM

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Attribute</th>
<th>No. of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Vision &amp; mission</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Commitment</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Creation of quality culture</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Total quality leadership</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- communication</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>- empowering</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- supportive</td>
<td>1</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>Identification</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Analysis</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Formulation</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>1</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>Quality characteristics &amp; standards</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Process control</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Continuous improvement</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Quality assessment</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Documentation</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Supplier quality assurance</td>
<td>2</td>
</tr>
<tr>
<td>Important innovations</td>
<td>Innovations</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Implementation</td>
<td>1</td>
</tr>
<tr>
<td>Information &amp; analysis</td>
<td>Data scope</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quality information systems</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Information quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- timely</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- relevant</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- comprehensive</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- accessible</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- accurate</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>- coherent/consistent</td>
<td>1</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>Empowerment</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Teamwork</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Involvement</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Communication</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Training &amp; education</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Recognition/motivation</td>
<td>2</td>
</tr>
</tbody>
</table>
5.4.1 The format of the IT-use-in-TQM construct

The attributes in Table 5.1 were linked to a seven-point scale, ranging from 1 (not at all) to 7 (maximum feasible amount). Past research on the effect of the number of scale points on the quality of measures found contradicting results. It has been reported that an increase from five to seven, or even nine points on a rating scale does not improve the reliability of the ratings (Sekaran 1992, p. 168). Other findings indicate that the reliability of the measure increases as the number of scale points increase (Churchill 1995, pp. 483-484). Since there is a lack of consensus regarding the optimum number of points to be used in a rating scale, in this study a seven-point scale was chosen in an attempt to make respondents differentiate their perceptions. This is to minimise the tendency of neutral/moderate answers that would not strictly reflect a respondent’s true feelings/attitudes.

This study deliberately excluded a ‘Don’t Know’ response option as the survey questions were not factual but asked about perception. In addition, for self-administered questionnaire, a ‘Don’t Know’ option was not advisable because the inclusion of a ‘Don’t Know’ option reduced the rate of usable responses for many items and increased the potential for introducing error into data set due to missing responses (Poe et al. 1988). In a study to evaluate the effect of ‘Don’t Know’ options, Poe et al. (1988) found that the absence of such options did not affect the overall questionnaire return rate, and there was no appreciable difference in the response error rate if the options were excluded.
Finally, this study acknowledged that response scales serve informative functions and this might affect respondents' behavioural reports as well as related judgements (Schwarz et al. 1985). The endpoint labels chosen (1: not at all and 7: maximum feasible amount) were considered most appropriate. This study realised the problem of the upper endpoint label as there was no established standard for the respondents to compare or benchmark their extent of IT use. 'Maximum feasible amount' was chosen simply because it was felt at least the respondents could use their current IT capabilities as a yard-stick to describe the use of IT in TQM. An explanation of the response scales was included in the preface to the IT-use-in-TQM questions.

Table 5.2 summarises the number of items developed to capture the impact of IT for each dimension of TQM. The number of items for each dimension does not reflect the importance of any particular aspect of TQM. Rather, they are the attributes of the respective dimensions that have been found significant in the literature. The 'important innovations' dimension carries only two items as many of its features have been subsumed in the 'output quality assurance' dimension in the TQM literature.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>No. of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>7</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>5</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>8</td>
</tr>
<tr>
<td>Important innovations</td>
<td>2</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>11</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>12</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>4</td>
</tr>
<tr>
<td>Quality results</td>
<td>5</td>
</tr>
</tbody>
</table>
A section with an open-ended question was included to solicit any plans to increase the extent of IT use in quality management in the near future. The final format of the measures on the use of IT in TQM is given in Appendix A.

5.5 **Formulating the Constructs for Contextual Influences**

The objective of formulating the items that could elicit information on contextual influences was to seek answers to the following research questions:

Q2: Which are the external, organisational, and technological factors that are associated with IT applications in TQM?

Q3: To what extent do external, organisational and technological factors account for the variance in the impact of IT on TQM?

The list of the contextual factors identified at Table 4.3 of Chapter 4 is reproduced as Table 5.3. Their format will now be discussed.

<table>
<thead>
<tr>
<th>External factors</th>
<th>Organisational factors</th>
<th>Technological factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>economic climate</td>
<td>organisational structure</td>
<td>IT experience</td>
</tr>
<tr>
<td>IT marketplace</td>
<td>organisational size</td>
<td>IT facilities</td>
</tr>
<tr>
<td>legislation influence</td>
<td>managerial IT knowledge</td>
<td>user support</td>
</tr>
<tr>
<td>public accountability</td>
<td>top management support</td>
<td>IT integration</td>
</tr>
<tr>
<td>inter-organisational co-operation</td>
<td>financial resources</td>
<td>IT structure</td>
</tr>
<tr>
<td></td>
<td>goal alignment</td>
<td>IT competency</td>
</tr>
<tr>
<td></td>
<td>budgeting method</td>
<td></td>
</tr>
</tbody>
</table>
5.5.1 The format of the constructs for contextual influences

Questions regarding all the factors affecting the use of IT (Table 5.3) were formulated as semantic differential scales except for two factors: organisational size and IT experience. In each item a pair of bipolar attributes were anchored at the extremes of a seven-point scale. Respondents were to indicate the position of their agency on the scale between the two adjectives that best describes their agency along external, organisational and technological characteristics. The chosen adjectives were based on the work of past MIS studies (see Table 3.4).

The semantic differential scale was chosen here rather than the Likert scale because it was felt that in items using the Likert scale, the respondents might indicate the extent to which they agree or disagree to a particular statement per se, and might not interpret it as the degree to which it described the actual situation/practice. Also, a response of 'strongly disagree' might not automatically imply that the actual situation/practice was the opposite, and vice versa. The interpretation is potentially confusing.

The semantic differential scale, on the other hand, made the description of the actual situation/practice explicit. As the pair of adjectives was selected to describe two extremes, it was hoped the respondents, when indicating their response would actually describe the situation but not the degree to which they agree or disagree with a statement.

The organisational-size factor was operationalised using a ratio scale to capture the number of staff employed in an agency. The use of staff size was considered a more appropriate operational measure in this context than annual sales or market share because a public agency is not profit-driven and its market share is irrelevant. A five-point scale was used to categorise organisational size using the definition of small and medium enterprises (SMEs) by the Malaysian Ministry of International Trade and Industry (MITI). According to MITI, firms that employ fewer than 50 employees are classified as small, while those with 50 or more employees but less than 150 belong to the medium category.
The IT experience of an organisation was operationalised as stages of technological growth. This enabled the IT experience to be categorised into one of the six stages (Table 5.4) based on the 'stages of growth' model developed by Galliers (1991). The movement through the stages is primarily a shift in the types of applications with the accumulated wisdom of the earlier stages; a transition from principally clerical and transaction processing systems to interactive information systems concerned with strategy and long term planning. The actual number of years an agency has been involved in using IT was not used here. This was to minimise effort and time from respondents when answering this question, particularly if an agency has had IT long before the respondent joined the agency. Furthermore, an agency with ten years of transaction processing systems may not necessarily have more effective IT experience than another agency which has had IT applications later but used them with strategic intent.

An open-ended-question was included to solicit other influential factors.

Table 5.4 Stages of IT Growth

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Few unconnected and uncoordinated systems which focus on accounting and finance.</td>
</tr>
<tr>
<td>Stage II</td>
<td>Many applications on centralised systems mainly to meet operational and financial needs.</td>
</tr>
<tr>
<td>Stage III</td>
<td>Still mostly centralised systems and most major business activities are covered.</td>
</tr>
<tr>
<td>Stage IV</td>
<td>Decentralised integrated office technology systems with some controls but mostly lacking co-ordination. Some decision support applications.</td>
</tr>
<tr>
<td>Stage V</td>
<td>Decentralised systems but with central control and co-ordination. More decision support applications and some strategic systems using external data.</td>
</tr>
<tr>
<td>Stage VI</td>
<td>Comprehensive, centrally co-ordinated internal systems with inter-organisational systems which link the agency with other organisations, e.g. suppliers, customers, and government.</td>
</tr>
</tbody>
</table>
5.6 The Structure of the Questionnaire

In order to achieve a good return and to minimise biases from the respondents, attention was focused on the wording, measurement and general appearance of the questionnaire. To fulfil the objectives, the guidelines for the construction of an effective questionnaire suggested by Dillman (1978, p. 95-117), Sekaran (1992, pp. 202-214), and Neuman (1994, pp. 225-242) have been followed.

According to Sekaran (1992, p. 209), not only is it important to address issues of wording and measurement when designing a questionnaire, it is also necessary to pay attention to how the questionnaire looks in order to minimise biases and measurement errors. The appearance of a questionnaire may even affect the recipient’s decision to respond (Dillman 1978, p. 120).

In sequencing the order of the questions in the questionnaire, the study subscribed to the four ordering principles under the Total Design Method (Dillman 1978, pp. 123-125). The principles are derived on the basis of increasing respondents’ motivation and building their confidence in completing the questionnaire. The four ordering principles are:

1. Sequence the questions in descending order of usefulness and importance.
2. Group the questions that are similar in content or question type together.
3. Build a sense of flow and continuity throughout the questionnaire by taking advantage of the cognitive ties that respondents are likely to make among groups of questions.
4. Position the questions that are most likely to be difficult to answer after those that are less likely to be difficult.

Recognising that certain compromises must be made when applying Dillman’s (1978) four ordering principles as well as taking into consideration his suggestions in formulating the pages of the questionnaire (pp. 133-153), the questionnaire was structured
with seven sections. It was printed as a booklet with dimensions 6"x8 1/2". The main
sections of the questionnaire are as follows:

1. Section A consists of three ordered-choice questions. The first question is in the item-
in-a-series format to elicit information on the overall use of IT in the agency's quality
management as well as the perceived influences from the three independent variables,
namely external, organisational and technological factors. The second question aims
at measuring the agency's 'stage-of-growth' in IT applications. The third question is
to gauge the size of the agency.

This is chosen as the first section because it is clearly related to the survey topic. It
also gives the respondent a feel for the entire questionnaire as communicated to them
by the cover letter and the cover page of the questionnaire. It is an effort to capture the
interest of the respondents so that they will continue answering the questions that

2. Section B of the questionnaire is designed to probe the use of IT in TQM along the
eight dimensions. It is placed second due to its importance to the study. Also, it is put
after Section A as it is likely to be more difficult to answer.

The ordering of the eight dimensions of TQM is sequenced in a logical order with
considerations given to the flow and continuity of the questions to take advantage of
their cognitive ties.

3. Section C consists of an open-ended question to solicit information on future plans to
increase the extent of IT use in TQM. It is put immediately after Section B because it
seems to be more formidable than the preceding section. It is also closely tied to
Section B cognitively.
4. Section D is formatted as items-in-a-series questions. It is constructed to measure the external influences on the use of IT in the agency.

Section E and F are composed of questions in the same format as Section D. Section E is designed to measure the organisational context while Section F aims to capture the technological practices that affect the use of IT in the agency.

The three sections are placed after Section B and C as they are less related to the survey topic. They are grouped next to each other as they consist of questions that are similar in type. The sequence of the sections follows the flow of external influences to internal factors, first on general organisational characteristics and then focus on the technological attributes.

5. Section G comprises two open-ended questions regarding the respondent. They are placed at the end of the questionnaire as the two questions are the least important and interesting. They are to help interpret the responses.

6. The back cover of the questionnaire booklet is constructed to solicit other influencing factors on IT use that may add richness to the study and also to seek additional comments pertaining to the study. The design is based on an exchange principle, trying to reward the respondents by asking for their advice in a consulting manner and with the expression of appreciation as well as a promise of a summary of results (Dillman 1978, pp. 153-154).

5.7 Pre-Testing Interview

After developing an initial measurement instrument, pre-testing was carried out to ensure completeness and precision. Informal interviews were first conducted with four academics in order to improve the instrument progressively in terms of both content and construct validity (Nunnally 1978; Churchill 1979; Straub & Carlson, 1989). The
selection of the participants was designed to get maximum feedback from academic experts in the fields of TQM and IT. The instrument was continuously modified for the successive interviews. Next, three Malaysian practitioner experts were contacted to pre-test the questionnaire as well as to be interviewed to gain some insight into the actual implementation of TQM in the Malaysian context.

5.7.1 The Interview with the Director of the Financial and Quality Management Division, MAMPU

The Director of MAMPU was initially contacted via e-mail to seek support for the study and also to invite for pre-testing the questionnaire. Upon agreement, the pre-tested questionnaire was mailed to him and two weeks later, he was contacted to fix a date for the interview. The points highlighted in the interview include:

1. Practicality and comprehensiveness of the construct of IT-use-in-TQM;
2. The quality award selection criteria and procedure;
3. The identification of quality managers or their equivalents of the candidate agencies;
4. The data-collection sponsorship.

The interview took place at the MAMPU headquarters in Kuala Lumpur on 4th June 1998. The following information was gathered during the interview:

1. The Director and his assistant agreed that the construct of IT-use-in-TQM was very comprehensive and covered the various aspects of TQM sufficiently. The Director expressed keen interest on the study as MAMPU has never evaluated the impact of IT on TQM. Computers have become common and essential equipment in the operation of the Malaysian public sector, the Director felt that it is desirable to integrate IT use into TQM activities to enhance TQM implementation.

2. The Director confirmed that all the candidate agencies had fulfilled the eight aspects of TQM requirement outlined by MAMPU. However, there may be variation in the extent of implementation among these agencies as some of the agencies, e.g. the Palm
Oil Research Institute of Malaysia (PORIM) and the Standard and Industrial Research Institute of Malaysia (SIRIM), have had TQM implemented since early 1990s. They are the quality leaders in the Malaysian public sector. On the other hand, agencies like Hospital Jitra and Jabatan Kastam dan Eksais DiRaja Kedah have only been introduced to TQM in the recent years.

3. It was confirmed that top management plays a vital role in promoting a quality culture. Very often they also assume the role of quality managers. Although the award application documentation of those agencies was not accessible to the researcher due to confidentiality, MAMPU has provided a complete list of past candidates as well as addresses of the main public agencies in Malaysia. The Director advised that the candidates should be contacted directly by telephone to secure participation in the study.

4. MAMPU turned down the data-collection sponsorship request as it is against its policy to undertake collaborative research directly with an individual. Any such proposal has to be done between organisations via heads of organisations.

5.7.2 The Interview with the Deputy Director General of the Forest Research Institute of Malaysia (FRIM)

The Deputy Director General of FRIM is himself responsible for the quality programmes in his organisation. He was contacted via e-mail and agreed to be interviewed. The interview was fixed two weeks after the pre-tested questionnaire has been mailed out to him. The points discussed in the interview include:

1. Comprehensibility of the construct of IT-use-in-TQM;
2. Thoroughness of the factors affecting IT use;
3. The role of IT in the management of FRIM;
4. Future plans for IT and TQM.
The interview was conducted at the FRIM Deputy Director General’s office in Kepong on 10th June 1998. The feedback generated is as follows:

1. The IT-use-in-TQM construct was found to be satisfactory and comprehensible. He felt that in general Malaysian senior public managers should be able to understand the questionnaire even though it was in English.

It was decided not to translate the questionnaire into the Malaysian national language.

2. The list of factors affecting IT use was found to have covered all the major influencing issues. However, FRIM emphasises staff IT skills. In-house IT training on basic skills such as word-processing and e-mailing is provided to all staff.

In the present study, it was decided that the IT-training factor should not be isolated as a single item but should be subsumed under the item ‘Help available to staff using IT applications’.

3. As a research institution, FRIM has formulated a strategic plan and policies that aim to optimise IT capability. It also serves as a broad framework for IT development at FRIM to keep abreast of the national IT agenda. The three major aspects addressed are: infrastructure development, on-line databases and IT-based applications, and manpower training.

There is extensive IT usage among research and management staff. At the time of the interview, FRIM has already used IT substantially to support quality management, especially in the Human Resource Utilisation and Information and Analysis aspects. The computer to knowledge worker ratio is expected to reduce from current 1:1.3 to 1:1 when the intranet facilities are in place. This will further boost the use of data and other resources for research as well as management purposes.
4. FRIM does not take quality lightly and will not compromise quality during the current economy setback. By the year 2000, all major functions at FRIM will go for the ISO 9000 certification. The quality culture is clearly spelt out by the Deputy Director General who strongly believes in leadership by example. On top of that, quality concerns are made known to all new staff the day they join FRIM. This is emphasised in the induction course.

5.7.3 The Interview with the General Manager of the Engineering Department of the Standard and Industrial Research Institute of Malaysia (SIRIM)

The General Manager of the Engineering Department of SIRIM is a qualified ISO lead assessor. Although he is not directly responsible for SIRIM’s quality programmes, he has served in and headed many technical departments/centres and has involved in many quality projects in SIRIM for the last 25 years. His department has a team of artificial intelligence (AI) experts which is responsible for all AI projects.

The interview was conducted two weeks after the questionnaire has been sent to him. The interview took place at his office in Shah Alam on 8th July 1998. With input from the IT Department, the information gathered included:

1. The IT needs of each department are discussed and negotiated at the executive business meeting attended by top management and all department heads. The IT Department then follows-up with a proposal and plan for any approved IT projects. This process ensures that IS planning and business planning are aligned to support the business objectives of the organisation.

2. The IT acquisition process also reflects the situation that the current provision of IT facilities and support is highly centralised. IT at SIRIM has changed from centralised to decentralised practice and now back to centralisation. The current emphasis is on
overcoming the integration problems among IT applications. However, decentralisation of information resources is being emphasised.

3. The IT platform at SIRIM includes mainframe, mini and micro-computers. The current IT facilities to staff ratio is about 1:2. Software applications are mostly developed internally by IT Department with input from end-users. Even though the IT budget is affected by the slowdown in the economy, it still gets priority.

4. IT for TQM is increasingly being emphasised. Besides on-line IT help and support, work-flow tracking systems as well as project management applications, SIRIM has also identified several critical applications: Decision Support Systems, Executive Information Systems, Human Resource Information Systems, and Small and Medium Industries Project Monitoring Systems.

5. It is felt that top management support is an important factor to promote the use of IT. At SIRIM strong leadership is demonstrated for both quality management and IT use. The SIRIM president and the most of its vice presidents are direct IT users.

5.8 Second-Phase Pre-Testing of the Questionnaire

The purpose of the second-phase pre-testing was to determine the acceptability of the questionnaire to the target respondents. It provided an opportunity to identify any errors and omissions as well as to test the level of difficulty of each of the questions. Although the purpose is similar to that of a pilot test, it was decided that ‘second-phase pre-testing’ is a more appropriate term than pilot test here. This is because the number of the responses is too small for any proper pilot-test data analysis to determine construct validity and reliability. The refined questionnaire (i.e. after first-phase pre-testing by interview) was tested with six participants: one administrative officer from UUM (Universiti Utara Malaysia), and five administrative officers from USM (Universiti Sains Malaysia) who are actively involved in quality programmes. These respondents were
chosen for testing the questionnaire because they were from the public sector and resembled the target respondents in terms of their quality responsibility within their agencies. However, the two samples were different in that the agencies of the pre-test group had never been nominated for the Quality Award. As the number of the candidates for the Award was small, it was decided not to involve the target respondents of the study at this stage.

Each respondent completed the questionnaire in the presence of the researcher and provided feedback regarding the wording of items, their understandability, and overall organisation of the questionnaire. The respondents faced no apparent difficulty in gauging the use of IT in their organisations as well as identifying factors affecting its use. They also reassured that the use of English would not pose any problem for understanding the questionnaire.

Table 5.5 summarises the feedback received from the second-phase pre-testing and the subsequent action taken. The final version of the questionnaire was formed and used as the research instrument for the study (Appendix A).

Table 5.5 Feedback and Action Taken After Second-phase Pre-testing

<table>
<thead>
<tr>
<th>Item</th>
<th>Feedback</th>
<th>Action taken</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section B Human Resource Utilisation (HRU) items no. 13-24</td>
<td>One of the respondents pointed out that the targeted respondents might overlook the question that intends to measure the extent of IT use on various aspects of human resource management in TQM rather than TQM per se. As they have had many TQM surveys in the past, they might regard the present study as similar to one of those and</td>
<td>As the use of IT in Information and Analysis, and Important Innovations are more obvious, the sequence of HRU items is reordered. It is felt by putting HRU items after Information and Analysis and Important Innovations, respondents will internalise the purpose of the survey, i.e. to evaluate the extent</td>
</tr>
<tr>
<td>Item</td>
<td>Feedback</td>
<td>Action taken</td>
</tr>
<tr>
<td>------</td>
<td>----------</td>
<td>--------------</td>
</tr>
<tr>
<td></td>
<td>might respond to the items as checking the extent of quality management practices instead of the extent of IT use in carrying out those practices.</td>
<td>of IT use in TQM. Thus the numbering of HRU items is changed from 13-24 to 34-45.</td>
</tr>
</tbody>
</table>
CHAPTER 6 IMPLEMENTATION OF THE QUESTIONNAIRE

6.1 Introduction

This chapter details how the questionnaire was implemented. After reporting on how the addresses and the targeting respondents were identified, the approach adopted to encourage the rate of response as well as the survey implementation process are explained. Lastly, the outcomes of the mail survey and the non-response bias check are given.

6.2 Development of the Survey Mailing List

The first step toward the implementation of the mail survey was to develop a subject mailing list. The list of the Prime Minister’s Quality Award candidates was obtained from MAMPU. The names of the candidate agency were keyed into a database and then sorted by name. This ‘tidying-up’ process ensured that each candidate agency appeared only once in the mailing list.

After the ‘tidying-up’ process, a list of 110 public agencies was generated. Next, the homepage on the web-site of the agencies was accessed, where available, to identify the name, designation, postal address, e-mail address, and telephone number of the person to whom the questionnaire would be sent. When the designation is not clearly stated on the homepage, the head of the agency was e-mailed to request the name of the responsible quality manager. As not all of the targeting agencies owned a homepage, the telephone directory was consulted in order to contact the agencies requesting for the names of the quality managers. Information of agencies obtained from their homepages was also reconfirmed via telephone to ensure up-to-date data.

This mailing list was then cross-referenced with the MAMPU’s quality application records (confidential) to produce a final listing. The list of subjects was then
computerised into a mail-database of name, position and address of the targeted respondents. The mail-database was then used to produce personalised cover letters accompanying the questionnaires as well as the mail label for the envelopes.

6.3 The Measure Taken to Encourage the Rate of Response

Believing that a good response rate partly lies in the approach adopted, this study has taken the following measures recommended by Neuman (1994, p. 241):

1. Addressing the questionnaire to a specific person, not an occupant, and send it first class.
2. Enclosing a post-paid, addressed return envelope.
3. Including a carefully written, dated cover letter on letterhead stationary. In it, respondent is requested co-operation and guaranteed confidentiality. The purpose of the survey is explained and the name and phone number of the researcher given.
4. Printing of the questionnaire is professionally done with neat and attractive layout to ensure that it is easy to read, and with clear instructions.
5. Associating the questionnaire with legitimate sponsorship to enhance the importance of the survey.
6. Follow-up to remind those who have not returned the completed questionnaire.

6.4 Mail Survey Administration

The questionnaire was mailed out on 27th June 1998 to all 110 agencies. They were given five weeks to return the questionnaires, i.e. by 1st August 1998. Each of the mail-out packages contained a cover letter, a letter from the sponsor, the questionnaire and a post-paid return envelope.

The cover letter (Appendix B) served to introduce the issue being studied, the importance of the study to the Malaysian public sector, especially the Electronic Government initiatives, and to the responding agencies themselves. The cover letter also explained why they were chosen to participate in the study and requested their co-
operation in completing and returning the questionnaire. In return, a copy of the survey results was offered.

The Vice Chancellor of Universiti Utara Malaysia (UUM) wrote a letter to explain the importance of the study, urging full support from the agencies. The letter of the sponsor was prepared using the Vice Chancellor’s letterhead (Appendix C).

Besides the cover letter, the questionnaire also carried a cover page (Appendix A) which conveyed brief and concise information on the aim of the study, the logo of the Prime Minister’s Quality Award, the return deadline and address for the questionnaire, and a thank you message.

To ensure that the subjects would not miss the deadline for returning the completed questionnaire, a follow-up in the form of reminder was e-mailed. The reminder was sent three weeks after the mail-out of questionnaires to subjects who had not responded and had e-mail addresses. Telephone follow-ups were conducted with those without an e-mail facility from the fourth week onwards.

As a result of the follow-ups, a substantial increase in the number of completed questionnaires was received (see Table 6.1). A few respondents requested fresh questionnaires to be forwarded to them. However, the majority of the non-replying respondents preferred not to respond to the reminders.

6.5 Results of the Mail Survey

A total of 110 questionnaires were mailed out to the respondents and 48 replies were received. Since one of the respondents declined to complete the questionnaire, 47 usable responses were obtained - an effective response rate of 43 per cent. Table 6.1 reveals the weekly number of questionnaires returned after the mail-out.
Table 6.1 The Weekly Questionnaire Return Rate

<table>
<thead>
<tr>
<th>Duration</th>
<th>No. of Replies</th>
<th>Percentage of the 110 agencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>One week after mail-out</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Two weeks after mail-out</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Three weeks after mail-out</td>
<td>9</td>
<td>8</td>
</tr>
<tr>
<td>Four weeks after mail-out</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Five weeks after mail-out</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Six weeks after mail-out</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Seven weeks after mail-out</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>43</td>
</tr>
</tbody>
</table>

6.5.1 Profile of respondents

The questionnaires were sent to the senior managers in charge of quality programmes. However, in the majority of the agencies, it was found that many of the heads of organisations or their deputy have quality management in their portfolio. When the questionnaires were sent to these responding agencies, about 30 per cent of them redirected the questionnaires to their IT managers or the equivalent. One director of the responding agencies explained when approached over the telephone that the IT manager/personnel would give a correct picture of the IT usage in his agency and would be a more appropriate person to respond to the questionnaire than himself.

A profile of the respondents is shown in Table 6.2. More than half of the respondents came from the senior management group (about 66%) and about 40 per cent of them have worked in their agencies for more than ten years.
6.5.2 Comparing multiple-source responses

In order to detect any biases and inaccuracies which may arise from single-source-single-method reports (Phillips 1981), questionnaires were sent separately to both quality and IT managers of ten public agencies (see Section 5.2 in Chapter 5). However, only four pairs of questionnaires were returned; these were subsequently used to see if any differences exist between responses from the quality and IT managers. As the questionnaires were returned separately and on different dates, it was likely that the responses were independent. T-tests for the two independent samples were performed on each item of the dependent and independent variables. The results revealed that there were no significant differences between the two groups. Levene’s test for equality of variance showed that there was insufficient evidence to suspect that the variances were unequal for most of the items (95%) at the 0.05 significance level. Accordingly, t-tests for equality of means were found to be insignificant at the 95 per cent confidence interval for the items. In the case where

<table>
<thead>
<tr>
<th>Job Title</th>
<th>Frequency</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head of organisation or deputy</td>
<td>23</td>
<td>49</td>
</tr>
<tr>
<td>Administrative or executive officer</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>IT manager or deputy</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Other IT personnel</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>No information</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length of Service</th>
<th>Frequency</th>
<th>Percentage of Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 3 years</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>3 - 5 years</td>
<td>13</td>
<td>28</td>
</tr>
<tr>
<td>6 - 10 years</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>11 - 15 years</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>More than 15 years</td>
<td>11</td>
<td>23</td>
</tr>
<tr>
<td>No information</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
Levene’s test revealed that the variances were unequal, the corresponding t-tests gave insignificant results.

Although the four organisations represented only about 4 per cent of the population, the information has helped to eliminate some of the doubts on biases resulting from the key informant method. Furthermore, many of the responding organisations either felt that the views of their IT manager/personnel were representative of their organisations (slightly over a quarter of them) or IT and quality were the responsibility of the head of organisations (detailed in Chapter 5). It is thus deduced that the responses received in the present study could be regarded as representative of these organisations.

Analysis was also conducted to test if there was any variation between responses of young and old respondents in terms of working experience. The two-tail t-test for equality of means showed that about 90 per cent of the items were found to be not significantly different at 0.05 level between responses of those with working experience less than three years in their present organisations and those who have worked more than 15 years in their present organisations. There was not enough evidence to identify differences between the two groups.

6.6 Non-response Bias

Non-response bias should be of concern to researchers who employed mail questionnaire (Armstrong & Overton 1977; Lambert & Harrington 1990). Its existence can greatly reduce the generalisability of the results of the respondent sample to the entire population.

Armstrong and Overton (1977) reviewed the literature on non-response bias and offered three methods to deal with the potential problem of non-response bias: comparisons with known values for the population, subjective estimates, and extrapolation.
Recognising the potential problem of non-response bias, the present study has adopted the extrapolation method described and tested by Armstrong and Overton (1977). This method is based on the assumption that subjects who respond less readily are more like non-respondents. ‘Less readily’ has been defined as answering later, or as requiring more prodding to reply.

In order to test for non-response bias, the last quartile of the respondent base (returns received after seven weeks' mail-out) was compared to earlier responses (returns received in the first three weeks after mail-out, before any follow-ups). The two-tail t-test for equality of means was found to be insignificant at the 0.05 level for 74 out of 75 items. Therefore, because late respondents can be considered similar to non-respondents, non-response bias is unlikely to be an issue in this study (Armstrong & Overton 1977; Lambert & Harrington 1990).

In addition, during the telephone follow-up exercise, a number of the subjects have given ‘no time’ as an excuse for not being able to respond to the questionnaire. It appeared that time constraints may be the reason for non-response instead of content issues.

Although the Armstrong and Overton’s (1977) method has suggested that non-response bias was not present, other possible reasons for not returning the questionnaire have been explored. It was felt that those who did not reply might be because 1) they did not use or had little use of IT, or 2) they have abandoned the practice of TQM and hence found the survey irrelevant. The likely explanation for the first issue may be either they are small organisations with little budget allocation from the government and have limited IT facilities, or these organisations are far from the heart of IT development in Malaysia (away from the Multimedia Super Corridor) and have limited external support for IT applications.

Those who did not return the questionnaire as TQM was no longer a concern to them actually helped to eliminate biases because they should not be included in the population of the study. They may be the pioneers of TQM but could not sustain the continuous process due to internal issues such as change of leadership.
To account for the above possibilities, the known characteristics of the population were explored to enable comparison to be made between the numbers of respondent and non-respondent.

Table 6.3 Cross-tabulation of Status of Response by Organisational Size

<table>
<thead>
<tr>
<th>Size</th>
<th>&lt; 150 staff</th>
<th>≥ 150 staff</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>12</td>
<td>35</td>
<td>47</td>
</tr>
<tr>
<td>No</td>
<td>27</td>
<td>36</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>71</td>
<td>110</td>
</tr>
</tbody>
</table>

Since chi-square tests showed no evidence to suggest that real differences exist between the numbers of respondent and non-respondent in terms of organisational size (Table 6.3, Pearson chi-square value = 3.53, degree of freedom = 1, p = 0.06), location (Table 6.4, Pearson chi-square value = 0.47, degree of freedom = 1, p = 0.49), and current TQM practice (Table 6.5, Pearson chi-square value = 0.09, degree of freedom = 1, p = 0.76), it could be deduced that the responses received was representative of the population. Thus non-response bias was not considered a significant issue in this study.

Table 6.4 Cross-tabulation of Status of Response by Location

<table>
<thead>
<tr>
<th>Location</th>
<th>MSC</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>24</td>
<td>23</td>
<td>47</td>
</tr>
<tr>
<td>No</td>
<td>28</td>
<td>35</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>52</td>
<td>58</td>
<td>110</td>
</tr>
</tbody>
</table>
Since great care has been taken to check for non-response bias, and no significant evidence was found to suggest its existence, it was decided that no adjustment was required for the findings in later chapters. However, bearing in mind that the sample size of this study is only 47, the results of analysis have to be interpreted with caution.

Table 6.5 Cross-tabulation of Status of Response by TQM Practice

<table>
<thead>
<tr>
<th>TQM Responded</th>
<th>Before 1995</th>
<th>After 1995</th>
<th>Total</th>
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</thead>
<tbody>
<tr>
<td>Yes</td>
<td>20</td>
<td>27</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(43%)</td>
</tr>
<tr>
<td>No</td>
<td>25</td>
<td>38</td>
<td>63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(57%)</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>65</td>
<td>110</td>
</tr>
<tr>
<td></td>
<td>(41%)</td>
<td>(59%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>
CHAPTER 7 ASSESSMENT OF THE MEASUREMENT INSTRUMENT

7.1 Introduction

At the end of the 1980s instrument assessment had been found to be inadequately addressed in MIS research (Straub & Carlson 1989). MIS researchers were urged to validate their research instrument to help substantiating their findings. More importantly, Straub and Carlson (1989) contend that sound instrumentation promotes co-operative research efforts by permitting confirmatory, follow-up research to utilise a tested instrument. Triangulation of results are supported when the tested instrument is used across heterogeneous settings and times.

The assessment of the measurement properties of the present research instrument was underpinned by the rationale proposed by McGrath (1982) which has been discussed in Section 4.5.1.1. The measurement assessment is the focus of this chapter.

7.2 Rationale for Instrument Assessment

Figure 4.3 is reproduced as Figure 7.1 to illustrate the rationale for instrument assessment. As depicted in Figure 7.1, if the use of IT in the eight aspects of TQM processes (C) is an appropriate surrogate measure for the use of IT in TQM (A), and the impact of IT on service quality, quality management and service productivity (D) is appropriate for the impact of IT on TQM (B), then the appropriateness of the surrogate measures, C and D, need to be validated. This requires for C and D to demonstrate content validity and construct validity. An inference about the relation of IT-use (A) and IT-impact (B), i.e. relation 1, can then be drawn if relation 4, the relation between C and D can be tested empirically. This requires predictive validity. The measure C will then be a valid measure of B, the impact of IT on TQM.
The contextual elements affecting the use of IT within an organisation were measured directly. These influencing factors were operationalised via three separate constructs namely external, organisational and technological factors. Testing for the construct validity of each of these constructs was considered sufficient in this study.

Before a construct could be tested for its validity, the quality of the construct should be ascertained (Churchill 1979). Quality in this context refers to how well all the
items within a construct are intercorrelated; the internal consistency of the set of items or the reliability is a necessary condition for validity (Churchill 1979).

The remainder of this chapter focuses on the assessment of the measurements. First, reliability analysis is discussed in Section 7.3. This is followed in Section 7.4 by item-measure correlations to ascertain the appropriateness of each item within the IT-use-in-TQM and the three contextual constructs. Then in Section 7.5 the content validity is briefly described in Section 7.5.1 as it has been discussed in Chapter 2 (TQM literature review), Chapter 3 (IT literature review) and Chapter 5 (instrument pre-test by IT and TQM experts). Next, the construct validity for the IT-use-in-TQM construct and the contextual constructs are presented in Section 7.5.2. Finally, reliability analysis and construct validity for the surrogate measure of the IT-impact (D) are discussed in Section 7.5.3 to establish the predictive validity.

7.3 Reliability Analysis

The reliability analysis of a measurement instrument determines the consistency with which the instrument is measuring the concept (Nunnally 1978, p. 191).

Four methods could be used to assess reliability of empirical measurements: 1) the test-retest method, 2) the parallel-form or alternative-form method, 3) the split-half method, and 4) the inter-item or internal consistency method (Nunnally 1978, pp. 229-236; Churchill 1979; Sekaran 1992, pp. 173-174). For field studies, the first three methods have major limitations such as requiring two independent administrations of an identical instrument on the same group of people, or requiring two comparable sets of the measuring instrument. Churchill (1979) suggested that researchers should avoid test-retest reliability as well as split-half reliability because the former would have the problem associated with respondents' memories which would influence responses in the second test whereas the latter would give different coefficients depending on how the items were split to form the two halves. In contrast, the internal consistency method is popular in field studies because it needs only one administration of a single
Measurement Assessment

measuring instrument. Furthermore, it is the most basic form of reliability estimation (Nunnally 1978, pp. 229-236).

In the present study, reliability is taken to be internal consistency, which is the degree of intercorrelation among items that measure the same concept (Sekaran 1992, p. 174). The recommended measure of the internal consistency of a set of items is provided by coefficient alpha (Nunnally 1978, p. 230; Churchill 1979). Cronbach's alpha can be considered a perfectly adequate indication of the internal consistency - and thus of reliability (Sekaran 1992, p. 174).

Before assessing the internal consistency of the measures, an item intercorrelation matrix was constructed for each measure to examine the extent to which some common trait was present in the items. Low inter-item correlations indicate that the associated items are likely to have been inappropriately selected (Nunnally 1978, pp. 206-209; Churchill 1979). Hence items having a relatively low correlation (≤ 0.30) with the other items within a measure should be deleted prior to reliability analysis in accordance with recommendation of Flynn et al. (1994). All the inter-item correlations for each measure of the IT-use-in-TQM were above 0.35. However, one item in the organisational factors (A. 3 Organisational size) was found to have a low correlation (≤ 0.30) with the other six items within the organisational measure. It was subsequently removed from further analysis.

Next, using the SPSS reliability program, an internal consistency analysis was performed separately for the items of each of the measures of the IT-use-in-TQM construct and the three categories of independent variables - the external, organisational and technological factors.

A satisfactory level of reliability depends on the purpose of the research (Nunnally 1978, p. 287). Permissible Cronbach's alpha values can be somewhat lower for new measures, suggesting that reliabilities of 0.70 or higher will suffice. As the measurements used in the present study were developed by the researcher and therefore may be deemed new, a criterion alpha value of 0.70 was considered adequate for these new measures.
After having calculated Cronbach's alpha, two possibilities might exist. First, measures with high alpha values (at least 0.70) and consistent item intercorrelations were accepted without any changes. Second, measures with alpha values below 0.70 were further analysed after deleting some items. The item intercorrelation matrix was used to determine which items contributed least, and were accordingly removed. For measures not achieved the minimum criterion alpha value after removal of such items, the entire scale would be discarded.

Tables 7.1 and 7.2 summarise of the reliability analysis. The reliability coefficients range from 0.80 to 0.97 for the IT-use-in-TQM construct (Table 7.1), indicating a strong reliability. None of the items was removed. The measures developed for contextual influences were also judged to be reliable according to the criterion value. Table 7.2 shows that the alpha values ranged from 0.72 (External Factors) after removing one item (D.1 Economic climate) to 0.82 (Organisational Factors).

Table 7.1 Reliability Analysis for the Measures of the IT-Use-in-TQM

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Original item number</th>
<th>Number of items</th>
<th>Items deleted (by number)</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>1-7</td>
<td>7</td>
<td>none</td>
<td>0.9247</td>
</tr>
<tr>
<td>Strategic planning Process</td>
<td>8-12</td>
<td>5</td>
<td>none</td>
<td>0.9587</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>13-20</td>
<td>8</td>
<td>none</td>
<td>0.8000</td>
</tr>
<tr>
<td>Important innovations</td>
<td>21-22</td>
<td>2</td>
<td>none</td>
<td>0.9419</td>
</tr>
<tr>
<td>Information &amp; analysis</td>
<td>23-33</td>
<td>11</td>
<td>none</td>
<td>0.9445</td>
</tr>
<tr>
<td>Human resource Utilisation</td>
<td>34-45</td>
<td>12</td>
<td>none</td>
<td>0.9625</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>46-49</td>
<td>4</td>
<td>none</td>
<td>0.9697</td>
</tr>
<tr>
<td>Quality results</td>
<td>49-54</td>
<td>5</td>
<td>none</td>
<td>0.9377</td>
</tr>
</tbody>
</table>

Table 7.2 Reliability Analysis for the Measures of Contextual Influences

<table>
<thead>
<tr>
<th>Factor</th>
<th>Original item number</th>
<th>Number of items</th>
<th>Item deleted (by number)</th>
<th>Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>D. 1-5</td>
<td>5</td>
<td>D. 1</td>
<td>0.7219</td>
</tr>
<tr>
<td>Organisational</td>
<td>E. 1-6</td>
<td>6</td>
<td>none</td>
<td>0.8205</td>
</tr>
<tr>
<td>Technological</td>
<td>A. 2, F. 1-5</td>
<td>6</td>
<td>none</td>
<td>0.8031</td>
</tr>
</tbody>
</table>
7.4  **Item-Measure Correlations**

Nunnally (1978, pp. 279-287) developed a method to evaluate the appropriateness of each item in each measure. The method examines the correlation of each item to each measure. The item-measure correlations are used to determine if an item belongs to the measure as assigned. Compared to items of other measures with relatively low correlations with a measure-score, those that have higher correlations with the measure-score have more variance relating to the common factor among the items, and so contribute more to the measure of reliability.

The items presented in Table 7.1 were evaluated according to the procedures developed by Nunnally (1978). Table 7.3 shows the correlation matrix for the eight measures of the IT-use-in-TQM (labelled q₁, q₂, q₀, q₁₁, q₁, q₇, q₉, and q₉₉) and the measurement items. For example, item 1 (Vision and mission) has correlations of 0.79, 0.67, 0.63, 0.52, 0.65, 0.69, 0.44, and 0.60 with the eight measures respectively. Since the q₁ (Leadership) measure-score refers to the mean of items 1 to 7, the correlation of item 1 with the q₁ measure-score was expected to be the highest among all possible measure-scores. Item 1 showed relatively lower correlations with the other measure-scores, so it was concluded that item 1 had been assigned appropriately to the q₁ measure. Likewise, item 2 (Commitment) had a correlation of 0.90 with the q₁ measure-score but lower correlations with other measure-scores (ranging from 0.78 to 0.57). Thus item 2 was appropriate for the q₁ measure. All other items were similarly examined.
Table 7.3 Item-Measure Correlation Matrix for the Eight Measures of the IT-use-in-TQM

<table>
<thead>
<tr>
<th>Measure</th>
<th>Items no.</th>
<th>q1</th>
<th>q2</th>
<th>q3</th>
<th>q4</th>
<th>q5</th>
<th>q6</th>
<th>q7</th>
<th>q8</th>
<th>q9</th>
<th>q10</th>
<th>q11</th>
<th>q12</th>
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</thead>
<tbody>
<tr>
<td><strong>Leadership</strong></td>
<td></td>
<td></td>
<td></td>
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<td>Leadership (ql)</td>
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</tr>
<tr>
<td>Vision &amp; mission</td>
<td>1</td>
<td>.79</td>
<td>.67</td>
<td>.63</td>
<td>.52</td>
<td>.65</td>
<td>.69</td>
<td>.44</td>
<td>.61</td>
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<td>.78</td>
<td>.74</td>
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<td>.70</td>
<td>.57</td>
<td>.71</td>
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</tr>
<tr>
<td>Creation of quality culture</td>
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<td>.91</td>
<td>.75</td>
<td>.70</td>
<td>.72</td>
<td>.67</td>
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<td>Communicate quality values</td>
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<td>Facilitate communication</td>
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<td>.12</td>
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<td>.07</td>
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<td>.13</td>
<td>.22</td>
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<td><strong>Important innovations</strong> (qii)</td>
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<td>Innovations</td>
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<td>.67</td>
<td>.83</td>
<td>.97</td>
<td>.74</td>
<td>.71</td>
<td>.55</td>
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<td>Implementation</td>
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<td>.70</td>
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<td>.67</td>
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<tr>
<td><strong>Information &amp; analysis</strong> (qi)</td>
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<td>Staff, customer, supplier data</td>
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<td>.57</td>
<td>.54</td>
<td>.62</td>
<td>.58</td>
<td>.81</td>
<td>.58</td>
<td>.52</td>
<td>.43</td>
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<td>.70</td>
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<td>.84</td>
<td>.57</td>
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<td>Decision tools</td>
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<td>.65</td>
<td>.72</td>
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<tr>
<td>Information timeliness</td>
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<td>.64</td>
<td>.73</td>
<td>.71</td>
<td>.58</td>
<td>.86</td>
<td>.68</td>
<td>.57</td>
<td>.63</td>
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</tr>
<tr>
<td>Information relevancy</td>
<td>29</td>
<td>.66</td>
<td>.77</td>
<td>.60</td>
<td>.55</td>
<td>.83</td>
<td>.67</td>
<td>.62</td>
<td>.67</td>
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</tr>
</tbody>
</table>
As shown in Table 7.3 with one exception, all items had the highest correlations with the measures to which they were originally assigned relative to all other measures. The single exception was item 31 (Information accessibility). Accordingly, it was concluded that all items except item 31 had been appropriately assigned to their respective measures. Item 31 was found to correlate equally highly to two measures:
qc (Customer satisfaction) and qi (Information and analysis). Since the iteration of reliability analysis with the removal of item 31 reduced the alpha value from 0.9445 to 0.9430 for the qi measure, likewise the addition of item 31 to the qc measure lowered its alpha value, it was decided to retain item 31. The items reported in Table 7.3 are the final items of measurement for the IT-use-in-TQM construct.

Similar item-measure correlations were also calculated for the three sets of independent variables. The corresponding correlation matrix is shown in Table 7.4. Again the items reported in Table 7.4 are the final items of measurement.

Table 7.4 Item-Measure Correlation Matrix for the Independent Variables

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item</th>
<th>Measure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>external</td>
<td>organisational</td>
</tr>
<tr>
<td>External</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT market-place</td>
<td>D. 2</td>
<td>.69</td>
<td>.32</td>
</tr>
<tr>
<td>Legislation influence</td>
<td>D. 3</td>
<td>.65</td>
<td>.37</td>
</tr>
<tr>
<td>Public accountability</td>
<td>D. 4</td>
<td>.67</td>
<td>.59</td>
</tr>
<tr>
<td>Inter-agency co-operation</td>
<td>D. 5</td>
<td>.80</td>
<td>.73</td>
</tr>
<tr>
<td>Organisational structure</td>
<td>E. 1</td>
<td>.19</td>
<td>.37</td>
</tr>
<tr>
<td>Managerial IT knowledge</td>
<td>E. 2</td>
<td>.51</td>
<td>.63</td>
</tr>
<tr>
<td>Top management support</td>
<td>E. 3</td>
<td>.56</td>
<td>.80</td>
</tr>
<tr>
<td>Resource allocation</td>
<td>E. 4</td>
<td>.38</td>
<td>.82</td>
</tr>
<tr>
<td>IT-business alignment</td>
<td>E. 5</td>
<td>.66</td>
<td>.81</td>
</tr>
<tr>
<td>IT justification</td>
<td>E. 6</td>
<td>.53</td>
<td>.85</td>
</tr>
<tr>
<td>Technological</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IT experience</td>
<td>A. 2</td>
<td>.29</td>
<td>.25</td>
</tr>
<tr>
<td>IT facilities</td>
<td>F. 1</td>
<td>.35</td>
<td>.55</td>
</tr>
<tr>
<td>IT help</td>
<td>F. 2</td>
<td>.43</td>
<td>.62</td>
</tr>
<tr>
<td>IT integration</td>
<td>F. 3</td>
<td>.49</td>
<td>.66</td>
</tr>
<tr>
<td>IT structure</td>
<td>F. 4</td>
<td>.28</td>
<td>.47</td>
</tr>
<tr>
<td>IT skills</td>
<td>F. 5</td>
<td>.37</td>
<td>.53</td>
</tr>
</tbody>
</table>

7.5 **Validity Analysis**

Having established the reliability of the measures, their validity needs to be ascertained. A measuring instrument is valid if it measures what it is intended to measure (Nunnally 1978, p. 86).
Measuring instruments in the social sciences usually serve three major functions: 1) representation of a specified universe of content, 2) establishment of a statistical relationship with a particular variable, and 3) measurement of traits. Corresponding to these are three types of validity: 1) content validity, 2) construct validity, and 3) predictive validity (Nunnally 1978, p. 87).

7.5.1 Content Validity

Content validity represents the adequacy with which a specified domain of content is sampled (Nunnally 1978, p. 91); the instrument has measurement items that cover all aspects of the variables being measured. Content validity cannot be determined numerically; its determination is subjective and judgmental (Nunnally 1978, pp. 91-94). According to Nunnally, content validity primarily depends on an appeal to the correctness of content and the way it is presented.

The instrument developed in this study demonstrates the content validity of the IT-use-in-TQM construct and the contextual factors influencing its use. The selection of measurement items was based on both an exhaustive review of the literature and detailed evaluations by academics and practising managers during pre-testing interviews. Further, the administrator of the Malaysian Prime Minister's Quality Award agreed that each dimension of the IT-use-in-TQM was well represented by the measurement items employed.

7.5.2 Construct Validity

Construct validity refers to the degree to which a measure assesses the construct it is purported to assess (Peter 1981). A measure is construct valid to the degree that it assesses the magnitude and direction of a representative sample of the characteristics of the construct and to the degree that the measure is not contaminated with elements from the domain of other constructs or errors.
Measurement Assessment

Factor analysis was used to verify the number of dimensions conceptualised (Churchill 1979). Prior to performing factor analysis, the data matrix was examined to ensure that it had sufficient correlations to justify the application of factor analysis. One of the measures to quantify the degree of intercorrelation among the variables and the appropriateness of factor analysis is the Kaiser-Meyer-Olkin measure of sampling adequacy (MSA). A small value of MSA means each variable cannot be predicted/explained by the other variables without error, and hence factor analysis may not be appropriate. As a guideline, MSA values in the 0.90s are marvellous; 0.80s are meritorious; 0.70s are middling; 0.60s are mediocre; 0.50s are miserable; and below 0.50s are unacceptable (Hair et al. 1995, p. 374). Individual variables that have MSA values in the unacceptable range (below 0.50) were excluded (only item E. 1: Organisational structure indicated in Table 7.6). The MSA for the eight measures of the IT-use-in-TQM and the influencing factors are above 0.70 (Tables 7.5 and 7.6) except for the important innovations (0.50) and the output quality assurance (0.65) dimensions.

### Table 7.5 Measure of Sampling Adequacy for the IT-use-in-TQM

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Number of items (after reliability analysis)</th>
<th>Items deleted (by number)</th>
<th>MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>7</td>
<td>none</td>
<td>0.86</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>5</td>
<td>none</td>
<td>0.87</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>6</td>
<td>none</td>
<td>0.83</td>
</tr>
<tr>
<td>Supplier quality assurance</td>
<td>2</td>
<td>none</td>
<td>0.50</td>
</tr>
<tr>
<td>Important innovations</td>
<td>2</td>
<td>none</td>
<td>0.50</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>11</td>
<td>none</td>
<td>0.85</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>12</td>
<td>none</td>
<td>0.89</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>4</td>
<td>none</td>
<td>0.76</td>
</tr>
<tr>
<td>Quality results</td>
<td>5</td>
<td>none</td>
<td>0.86</td>
</tr>
</tbody>
</table>

### Table 7.6 Measure of Sampling Adequacy for the Influencing Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of items (after reliability analysis)</th>
<th>Items deleted (by number)</th>
<th>MSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>4</td>
<td>none</td>
<td>0.70</td>
</tr>
<tr>
<td>Organisational</td>
<td>6</td>
<td>E. 1</td>
<td>0.76</td>
</tr>
<tr>
<td>Technological</td>
<td>6</td>
<td>none</td>
<td>0.81</td>
</tr>
</tbody>
</table>
A close inspection on the output quality assurance items revealed that two items (out of eight) showed individual MSA scores below the acceptable lower limit (0.50). These two items were not eliminated but separated from the output quality assurance dimension as a new dimension as they were significantly correlated (p < 0.05). By doing so, the alpha value for the now 6-item output quality assurance dimension increased from 0.80 to 0.97, and the new dimension (2-item supplier quality assurance) showed alpha value of 0.76. The MSA values were found to be 0.83 and 0.50 respectively. The small value of 0.50 was due to having only two measuring items in the dimension. Overall the measures of the IT-use-in-TQM indicated that factor analysis was appropriate. The results of factor analysis (Table 7.7) clearly supported that both the output quality assurance and supplier quality assurance dimensions were unifactorial. The reduced set of contextual variables also indicated that factor analysis was appropriate. The Cronbach's alpha was recalculated for the organisational factors after the removal of one item (E. 1 Organisational structure). Its value of alpha increased from 0.82 to 0.87.

Table 7.7 Factor Matrix for the IT-use-in-TQM

<table>
<thead>
<tr>
<th>Measure</th>
<th>Eigenvalue</th>
<th>Factor loading of item for Factor 1 (order as in questionnaire)</th>
<th>% variance*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>4.95</td>
<td>.77 .90 .92 .86 .71 .86 .93</td>
<td>70.7</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>4.29</td>
<td>.97 .95 .77 .96 .97</td>
<td>85.9</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>4.06</td>
<td>.83 .89 .85 .86 .61</td>
<td>67.7</td>
</tr>
<tr>
<td>Supplier quality assurance</td>
<td>1.61</td>
<td>.90 .90</td>
<td>80.4</td>
</tr>
<tr>
<td>Important innovations</td>
<td>1.89</td>
<td>.97 .97</td>
<td>94.5</td>
</tr>
<tr>
<td>Information &amp; analysis</td>
<td>7.20</td>
<td>.81 .81 .82 .84 .79 .86 .82 .79 .73 .80 .81</td>
<td>65.5</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>8.38</td>
<td>.68 .83 .92 .89 .86 .90 .82 .84 .84 .86 .85</td>
<td>71.5</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>3.68</td>
<td>.97 .97 .94 .95</td>
<td>91.9</td>
</tr>
<tr>
<td>Quality results</td>
<td>4.03</td>
<td>.93 .88 .90 .88 .90</td>
<td>80.7</td>
</tr>
</tbody>
</table>

* Percentage of variance explained by Factor 1
Table 7.8 Factor Matrix for the Influencing Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Eigenvalue</th>
<th>Factor loading of item for Factor 1</th>
<th>% variance explained by Factor 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>External</td>
<td>2.19</td>
<td>D.2 D.3 D.4 D.5</td>
<td>54.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.62 .72 .80 .80</td>
<td></td>
</tr>
<tr>
<td>Organisational</td>
<td>3.34</td>
<td>E.2 E.3 E.4 E.5 E.6</td>
<td>66.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.76 .87 .82 .81 .81</td>
<td></td>
</tr>
<tr>
<td>Technological</td>
<td>3.20</td>
<td>E.1 E.2 E.3 F.4 F.5 A.3</td>
<td>53.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.72 .80 .91 .52 .78 .59</td>
<td></td>
</tr>
</tbody>
</table>

The construct validity for each of the now nine measures of the IT-use-in-TQM construct as well as the three sets of contextual factors were evaluated by factor analysing the measurement items. In this analysis (shown in Tables 7.7 and 7.8), each measure was assumed to be a separate construct. Following the most commonly used technique to decide on the number of factors to extract, the factors with eigenvalues\(^5\) greater than one were considered significant (Hair et al. 1995, p. 377). The factor matrices showed that they were unifactorial except for the information and analysis items.

In the case of the information and analysis measure, two factors emerged. However, the unrotated factor solution was considered adequate after inspecting factor loadings of the items involved. Since the loadings ranged from 0.73 to 0.86 which could be considered significant for the sample size of this study (Hair et al. 1995, p. 385), it was decided not to carry out a rotation. In addition, factor 1 accounted for 65 per cent of the total variance and was regarded as a satisfactory solution. The findings indicate that the measures of the IT-use-in-TQM construct contained in the instrument have construct validity. Similar results were achieved for the contextual factors after eliminating those items that fell short of the MSA criterion (less that 0.50).

\(^5\) Measures of importance/value of the linear combination of variables (i.e. items within a measure).
### 7.5.3 Predictive Validity

Predictive validity, also known as criterion-related validity or external validity, is concerned with the extent to which a measuring instrument is related to an independent measure of the relevant criterion (Nunnally 1978, pp. 87-91). The validity is determined by, and only by, the degree of correspondence between the predictor test and the criterion variable (Nunnally 1978, pp. 88-89). A predictor test cannot be predictively valid unless it has a significant correlation with the criterion. In this study, the predictor test is the extent of IT use in TQM processes and the criterion variable is the impact of IT on service quality, quality management, and service productivity (see Figure 7.1).

Ideally the establishment of predictive validity is accomplished via a comparison to another ‘established’ measure of the same attribute, for example IQ test and school grades. However, in reality finding an independent established measure often presents a difficulty (Nunnally 1978, p. 90). As a well-developed assessment of IT-impact is still lacking (Powell 1992; Willcocks & Lester 1997), in order to examine the predictive validity, this study followed other previous work (Bailey & Pearson 1983; Sethi & King 1994) by asking the respondents to self-assess three criterion items about the impact of IT on service quality, quality management, and service productivity. It was done via a separate mail questionnaire about ten months later. Twenty-eight responses were received from the earlier 47 respondents (60%) and were used to examine predictive validity of the IT-use-in-TQM construct.

**Criterion Variable Survey**

In order to test for predictive validity, a mail questionnaire was developed to gauge information on the impact of IT on service quality, quality management, and service productivity. The three items were formulated using a 7-point Likert scale. A fourth item (an item from the previous questionnaire: the overall use of IT in TQM) was also included as a control item in this second survey (Appendix D). Together with a cover letter to explain the purpose of this survey, a pre-paid envelope and an executive
summary (Appendix E) for the first survey, the predictive-criterion questionnaire was sent to the 47 respondents (from the first survey) on 24\textsuperscript{th} April 1999.

As only slightly less than two-thirds of the responses were received, several tests for non-response bias were conducted. First, the level of IT use in TQM of the second survey respondents ($n = 28$, mean IT use $= 4.7$, std dev $= 0.9$) was compared to that of the non-respondent group ($n = 19$, mean $= 4.5$, std dev $= 1.2$). The two-tailed t-test for equality of means was found to be insignificant at the 0.05 level ($t = 0.81$, df $= 45$, $p = 0.42$). There was not enough evidence to identify differences between the IT-use level of the two groups.

Next, using the known characteristics of the two groups, the numbers of respondent and non-respondent in the second survey were compared. Again, there was no significant relationship between the two groups in terms of organisational size (Fisher exact probability $= 0.51$, two-tailed test), IT experience (chi-square $= 0.61$, df $= 1$, $p = 0.43$) and IT-level clusters (chi-square $= 1.29$, df $= 2$, $p = 0.53$). Therefore, non-response bias was not considered a significant issue in the second survey.

In addition, to ensure consistency in the responses of the two sets of questionnaire, responses to the control item (the overall IT use in TQM) in the first and second questionnaires were compared. The t-test for paired samples showed that the mean scores for the control item (first-questionnaire mean $= 4.8$, second-questionnaire mean $= 5.1$) were not different at 0.05 significance level. This indicated that the respondents were not inconsistent in their responses even after a lapse of nearly ten months.

Having established the consistency in responses of the two surveys and ruled out the presence of any non-response bias, the measurement properties of the second questionnaire were assessed. Table 7.9 shows that the criterion variable – the impact of IT on service quality, quality management, and service productivity, a measure comprising three items, satisfies the criteria for reliability and construct validity.
Table 7.9 Assessment of Criterion Variable Measurement

<table>
<thead>
<tr>
<th>Measure of the impact of IT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Overall impact of IT on service quality</td>
</tr>
<tr>
<td>2. Overall impact of IT on quality management</td>
</tr>
<tr>
<td>3. Overall impact of IT on service productivity</td>
</tr>
</tbody>
</table>

Reliability and validity results:
- Alpha: 0.8346
- Correlation coefficient: 0.7194
- Eigenvalue: 2.2591 Percentage of variance explained: 75.3
- Range of factor loading: 0.8439 - 0.8797

The predictive validity of each measure of the IT-use-in-TQM was assessed by its correlation to the criterion variable. Table 7.10 reports the results of the eight tests carried out to relate each measure of the IT-use-in-TQM to the IT-impact measure. The positive coefficient of all the dimensions provides evidence for predictive validity. This was enhanced by the results of the two-tailed t-test for difference of means between the combined set of eight measures of the IT-use-in-TQM and the IT-impact measure, which indicated no significant difference at 0.05 level. In addition, taken as a set, the IT-use-in-TQM has a correlation of 0.54 with the measure of IT-impact on the service quality, quality management, and service productivity. It was concluded that the eight measures have predictive validity when taken together.

Predictive validity of the three sets of independent variables was not evaluated as good criteria for the influencing factors were not available. There was no single measure to describe a good or desirable context. It is the intention of this study to identify those influencing factors that support the use of IT in TQM environments.
Table 7.10 Assessment of Predictive Validity with Extent of IT Use

<table>
<thead>
<tr>
<th>IT use in TQM Dimension</th>
<th>Correlation coefficient</th>
<th>2-tail significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>0.3748</td>
<td>0.059</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>0.3353</td>
<td>0.094</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>0.6932</td>
<td>0.000</td>
</tr>
<tr>
<td>Important innovations</td>
<td>0.4114</td>
<td>0.037</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>0.3905</td>
<td>0.049</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>0.6347</td>
<td>0.000</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>0.4605</td>
<td>0.018</td>
</tr>
<tr>
<td>Quality results</td>
<td>0.5091</td>
<td>0.008</td>
</tr>
<tr>
<td>Overall IT-use-in-TQM</td>
<td>0.5411*</td>
<td>0.004</td>
</tr>
</tbody>
</table>

* 2-tailed t-test for difference of means insignificant at $\alpha = 0.05$

7.6 Summary

Analysis of the literature suggested eight dimensions of TQM, namely leadership, strategic planning process, output quality assurance, important innovations, information and analysis, human resource utilisation, customer satisfaction, and quality results. The research findings supported this and suggested a ninth dimension, supplier quality assurance. The assessment of the instrument indicated that the IT-use-in-TQM construct demonstrated key measurement properties including reliability, construct validity, and predictive validity. The nine dimensions of the IT-use-in-TQM form the basis of a multidimensional measure of the impact of IT on TQM. The contextual influences were measured via the three categories of factors: external, organisational and technological.

The final variables to be used in subsequent analysis are summarised in Tables 7.11 and 7.12.
<table>
<thead>
<tr>
<th>Dimension 1: Leadership</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Formulate vision and mission</td>
</tr>
<tr>
<td>2. Make their commitment to quality visible to staff</td>
</tr>
<tr>
<td>3. Create quality as a way of life within your agency</td>
</tr>
<tr>
<td>4. Communicate quality values to staff</td>
</tr>
<tr>
<td>5. Facilitate communication between top management and other staff</td>
</tr>
<tr>
<td>6. Encourage staff involvement to improve work processes</td>
</tr>
<tr>
<td>7. Empower staff for continuous improvement</td>
</tr>
<tr>
<td>Dimension 2: Strategic Planning Process</td>
</tr>
<tr>
<td>8. Identify strategic issues</td>
</tr>
<tr>
<td>9. Analyse strategic issues</td>
</tr>
<tr>
<td>10. Make strategic decisions</td>
</tr>
<tr>
<td>11. Formulate strategic plans</td>
</tr>
<tr>
<td>12. Document strategic planning</td>
</tr>
<tr>
<td>Dimension 3: Output Quality Assurance</td>
</tr>
<tr>
<td>13. Set up service quality standards</td>
</tr>
<tr>
<td>14. Control work processes in the delivery of services</td>
</tr>
<tr>
<td>15. Use quality tools such as flow charts, histograms and Pareto charts for quality control (Statistical Process Control)</td>
</tr>
<tr>
<td>16. Improve services continuously</td>
</tr>
<tr>
<td>17. Assess actual performance against established quality standards</td>
</tr>
<tr>
<td>18. Document work procedures/processes</td>
</tr>
<tr>
<td>Dimension 4: Supplier Quality Assurance</td>
</tr>
<tr>
<td>19. Determine supplier quality</td>
</tr>
<tr>
<td>20. Facilitate inter-organisational co-operation for service quality</td>
</tr>
<tr>
<td>Dimension 5: Important Innovations</td>
</tr>
<tr>
<td>21. Create innovative work processes</td>
</tr>
<tr>
<td>22. Implement innovations to improve service quality</td>
</tr>
<tr>
<td>Dimension 6: Information and Analysis</td>
</tr>
<tr>
<td>23. Collect data about staff, customers, and suppliers</td>
</tr>
<tr>
<td>24. Collect data about work processes</td>
</tr>
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<td>25.</td>
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<td>27.</td>
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<td>30.</td>
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<td>31.</td>
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<td>32.</td>
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<tr>
<td>33.</td>
</tr>
<tr>
<td><strong>Dimension 7: Human Resource Utilisation</strong></td>
</tr>
<tr>
<td>34.</td>
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<tr>
<td>35.</td>
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<tr>
<td>36.</td>
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<td>37.</td>
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<td>38.</td>
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<td>39.</td>
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<td>40.</td>
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<td>41.</td>
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<td>42.</td>
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<td>43.</td>
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<td>44.</td>
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<tr>
<td>45.</td>
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<tr>
<td><strong>Dimension 8: Customer Satisfaction</strong></td>
</tr>
<tr>
<td>46.</td>
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<tr>
<td>47.</td>
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<tr>
<td>48.</td>
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<tr>
<td>49.</td>
</tr>
<tr>
<td><strong>Dimension 9: Quality Results</strong></td>
</tr>
<tr>
<td>50.</td>
</tr>
<tr>
<td>51.</td>
</tr>
<tr>
<td>52.</td>
</tr>
<tr>
<td>53.</td>
</tr>
</tbody>
</table>
Table 7.12 Three Contextual Factors that Satisfy the Reliability & Validity Criteria

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Organisational factors</th>
<th>Technological factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT marketplace</td>
<td>managerial IT knowledge</td>
<td>IT experience</td>
</tr>
<tr>
<td>legislation influence</td>
<td>top management support</td>
<td>IT facilities</td>
</tr>
<tr>
<td>public accountability</td>
<td>financial resources</td>
<td>user support</td>
</tr>
<tr>
<td>inter-organisational cooperation</td>
<td>goal alignment</td>
<td>IT integration</td>
</tr>
<tr>
<td></td>
<td>budgeting method</td>
<td>IT structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IT competency</td>
</tr>
</tbody>
</table>
CHAPTER 8 ANALYSIS AND DISCUSSION

8.1 Introduction

This chapter focuses on the statistical analyses performed on the returned questionnaires. The analyses used in this study include descriptive analysis, repeated measures ANOVA, one-way ANOVA, cluster analysis, correlation analysis, and multiple regression analysis. All the analyses were undertaken using the SPSS package.

The aim of the statistical analyses was to answer three questions regarding the use of IT to support TQM in the Malaysian public sector. The research questions addressed are as follows:

Q1: What is the impact of IT on TQM; in particular, on Leadership, Strategic Planning Process, Output Quality Assurance, Important Innovations, Information and Analysis, Human Resource Utilisation, Customer Satisfaction, and Quality Results?

Q2: Which are the external, organisational, and technological factors that are associated with IT applications in TQM?

Q3: To what extent do external, organisational and technological factors account for the variance in the impact of IT on TQM?

First, the results for the use of IT in TQM along the nine dimensions are discussed. Next the results of repeated measure ANOVA, undertaken to determine the significant differences in the extent of IT use among the nine dimensions of TQM are presented. This is followed by the discussion of a descriptive analysis of each of the contextual variables before a detail assessment of their effect on the use of IT in TQM is presented. Next, the results of multiple regression for the IT-use-in-TQM and the
contextual factors, undertaken to determine predictive factors for the use of IT in TQM, are detailed. This is followed by a classification of the respondents into three 'usage groups' according to their level of IT use derived from cluster analysis. This is conducted as a prelude to a close examination of the relationships between different levels of IT usage in TQM and contextual factors. One-way ANOVA is then used to determine the significant differences in the relationships among the usage groups. Lastly, multiple regression analyses are carried out, repeated for each of the usage groups in order to estimate the relationships between independent factors and each of the three levels of IT usage.

8.2 The Use of IT in TQM

8.2.1 Findings

On the whole, the use of IT in TQM along the nine dimensions were all above the moderate level, i.e. above 4 on a 7-point scale anchored at 1 = not at all and 7 = maximum feasible amount (Table 8.1). Over 85 per cent of the organisations reported that they have used a moderate to the maximum feasible amount of IT to support Important Innovations' (number of respondents = 41) and 'Information and Analysis' (40). Only about 20 per cent of them indicated that they have used IT less than the moderate level to perform 'Leadership' (9), 'Human Resource Utilisation' (10), and 'Output Quality Assurance' (11) aspects of quality management. As for both 'Customer Satisfaction' (33) and 'Strategic Planning Process' (33), about 70 per cent of the organisations said that the measure of IT use was 4 or above. Only about a half of the responding organisations used IT more than the middle of the scale in 'Quality Results' (23) and about 30 per cent in 'Supplier Quality Assurance' (8). 'Important Innovations' has the highest level of IT use (5.09) followed closely by 'Information and Analysis' (5.06). 'Supplier Quality Assurance' has the lowest mean of IT use (4.09). Table 8.1 summarises the extent of IT use on all the nine dimensions of TQM.

6 There were only 28 valid observations for the 'Supplier Quality Assurance'.

166
Table 8.1 The Use of IT along the Nine Dimensions of TQM

<table>
<thead>
<tr>
<th>Dimension*</th>
<th>Mean</th>
<th>Std. dev.</th>
<th>Min.</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Important innovations</td>
<td>5.09</td>
<td>1.27</td>
<td>1.50</td>
<td>7.00</td>
</tr>
<tr>
<td>Information &amp; analysis</td>
<td>5.06</td>
<td>1.03</td>
<td>2.45</td>
<td>7.00</td>
</tr>
<tr>
<td>Leadership</td>
<td>4.88</td>
<td>1.10</td>
<td>2.00</td>
<td>6.86</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>4.82</td>
<td>1.08</td>
<td>1.17</td>
<td>6.67</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>4.80</td>
<td>1.10</td>
<td>2.00</td>
<td>6.86</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>4.40</td>
<td>1.43</td>
<td>1.60</td>
<td>7.00</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>4.35</td>
<td>1.45</td>
<td>1.00</td>
<td>7.00</td>
</tr>
<tr>
<td>Quality results</td>
<td>4.28</td>
<td>1.31</td>
<td>1.80</td>
<td>6.60</td>
</tr>
<tr>
<td>Supplier quality assurance</td>
<td>4.09</td>
<td>1.17</td>
<td>1.00</td>
<td>6.50</td>
</tr>
<tr>
<td>Overall IT use in TQM</td>
<td>4.66</td>
<td>1.02</td>
<td>1.74</td>
<td>6.78</td>
</tr>
</tbody>
</table>

* measured on a 7-point scale

The normality test suggested that the distribution of the use of IT for each of the nine dimensions was approximately normal with Kolmogorov-Smirnov (Lilliefors) statistics ranging from 0.05 to 0.11. Their observed significance levels are above a lower bound of the true significance, i.e. p > 0.20 (Norusis 1997, p. 224).

Table 8.1 also shows that taken as a whole the use of IT in TQM is 4.66. Its distribution was found to have a kurtosis of 0.32 and a slight negative skew (-0.27). The Kolmogorov-Smirnov (Lilliefors) statistic is 0.05 with the significance level big enough to assume a normal distribution (p > 0.20).

Repeated measures ANOVA showed a significant difference in the use of IT among the nine dimensions of TQM (Table 8.2, F_{8,216} = 7.893, p < 0.01). Duncan’s range test found that the use of IT on ‘Information and Analysis’ and ‘Important Innovations’ differed from ‘Strategic Planning Process’, ‘Customer Satisfaction’, ‘Quality Results’, and ‘Supplier Quality Assurance’. Differences were also found between ‘Leadership’ and ‘Quality Results’ as well as between ‘Supplier Quality Assurance’ and ‘Leadership’, ‘Output Quality Assurance’ and ‘Human Resource Utilisation’ at the 0.05 significance level.
Table 8.2 Summary of Analysis of Variance

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>Sum of squares</th>
<th>Degrees of freedom</th>
<th>Mean square</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT use</td>
<td>30.69</td>
<td>8</td>
<td>3.84</td>
<td>7.89*</td>
</tr>
<tr>
<td>Residual error</td>
<td>105.00</td>
<td>216</td>
<td>0.49</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.01

8.2.2 Discussion

The results in Tables 8.1 and 8.2 indicate that the use of IT in TQM among the high performing public agencies in Malaysia is just slightly above a moderate level. The present study provided empirical findings to supplement anecdotal and case evidence on the role of IT in TQM environments (Zadrozny & Ferrazzi 1992; Cortada 1995; Matta et al. 1998; Zahedi 1998). Although Ngai and Cheng (1998) found a weak linkage between IT and quality management in Hong Kong, their results should be interpreted with caution because the findings may be due to the limitations imposed by the sampling frame. As the exact number of organisations in Hong Kong practising quality management was not known, Ngai and Cheng (1998) adopted a random approach to mail their questionnaire. Since the general IT usage in offices was reported as being high, the low IT usage level in support of quality could be due to responding organisations not having TQM in place. Consequently, responses from these organisations became hypothetical in comparison with the TQM implementing agencies in this study.

This study clearly shows that the use of IT on various aspects of TQM is not the same. In general, the organisations use more IT on ‘Important Innovations’ and ‘Information and Analysis’. As expected, as IT has been singled out to help improving service quality and productivity in the Malaysian public sector (Maarof 1996), the innovative use of IT has been encouraged, especially to improve efficiency by creating effective work processes and to realise ‘one-stop shopping’ for citizens (MAMPU 2000). The extensive use of IT in ‘Information and Analysis’ is consistent with the literature. The results lend support to the views of Matta et al. (1998) and Zahedi (1998) that TQM is
Analysis & Discussion

an information-intensive management system and the critical information needs of TQM necessitates the deployment of IT to implement and sustain TQM activities. The high level of IT use in providing quality information and analysis also supported Forza’s (1995b) work which found that flows of information strongly and positively influenced the achievement of quality performance.

The results of the study also shows that the level of IT use is significantly lower on ‘Quality Results’ and ‘Customer Satisfaction’ than on ‘Important Innovations’ and ‘Information and Analysis’. This finding is inconsistent with the work of Lloyd-Walker and Cheung (1998) which found quality customer services and product issues strongly influence IT planning in the Australian banking industry, but not IT applications that support innovations. One possible explanation for the difference in the results is that the banking industry, being profit-oriented, emphasises customer-focused technologies to ensure a return on investment, whereas the public agencies in Malaysia concentrate more on innovative applications to improve efficiency and effectiveness of service delivery.

8.2.3 Other Findings

In an open-ended question about their next three-year plan to increase the extent of IT use in TQM, about 43 per cent of the agencies indicated that their emphasis would be on ‘Information and Analysis’, about 32 per cent would focus on ‘Output Quality Assurance’ and about 19 per cent planned to increase IT use in ‘Human Resource Utilisation’. Apparently, IT for quality service delivery is at the top of their IT portfolio. Hardly two per cent of the agencies have a future plan to increase IT use in measuring service quality and monitoring quality costs. Using IT to measure customer satisfaction and to facilitate communication with customer or supplier are not in the immediate plan of any of the agencies. This findings reinforce the results presented in Table 8.1.
8.3 Contextual Influences on IT Use

8.3.1 External factors

As shown in Table 8.3, the high mean and median indicate that the majority of the respondents found it quite easy in obtaining the hardware and software required for their IT applications from the IT market-place. This may imply that in-house IT expertise may not be a necessary condition for ensuring extensive IT use since the software supporting the applications is easily obtainable from the IT market-place where vendor support is readily available.

Table 8.3 Summary of the External Influences on the IT-Use-in-TQM

<table>
<thead>
<tr>
<th>Factor*</th>
<th>Pearson's r</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT availability in market-place (difficult - easy)</td>
<td>0.2618</td>
<td>6.0</td>
<td>5.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Legislation influence (weak - strong)</td>
<td>0.2460</td>
<td>6.0</td>
<td>5.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Public accountability (minimal - extensive)</td>
<td>0.5340**</td>
<td>5.0</td>
<td>4.9</td>
<td>1.3</td>
</tr>
<tr>
<td>Inter-organisational co-operation (poor - good)</td>
<td>0.6381**</td>
<td>4.5</td>
<td>4.3</td>
<td>1.5</td>
</tr>
</tbody>
</table>

* measured on a 7-point scale
** p < 0.001

Three quarters of the responding organisations (77 %, 36) felt that government policies have a strong influence on their IT use. This is expected because when reporting to the central government, public agencies are mandated to use the standard systems such as Standard Accounting Systems for Government Agencies (Maarof 1996). However, these two factors: 'IT availability in market-place' and 'legislation influence' were found to have no significant correlation with the extent of IT use in TQM (Table 8.3, p > 0.05). This is expected as the organisations are under a similar external influence.

'Public accountability' and 'inter-organisational co-operation' were found to correlate significantly with the extent of IT use in TQM (Table 8.3, p < 0.001). In other words,
only two of the four external factors examined influence the use of IT in TQM in this sample.

Table 8.3 shows that the use of IT to ensure public accountability is above a moderate level (mean = 4.9). About 65 per cent of the responding organisations indicated that they used an above average amount of IT to ensure public accountability. On the whole, the co-operation required for IT intervention was slightly skewed toward good (mean = 4.3). However, about 20 per cent of the organisations were indifferent to the co-operation they received from other public agencies in implementing their IT applications.

When asked how they could possibly increase the use of IT, about ten per cent of the responding organisations expressed the view that the central government should exert more legislation influence, especially in providing guidance and advice concerning systems acquisition. This is to ensure system compatibility for inter-organisational co-operation.

8.3.2 Organisational Factors

Table 8.4 reveals that a high proportion of the managers recognised the potential of IT to enhance quality output (median = 6.0, mean = 5.5). Their organisations (83%) received encouraging support from top management for their IT applications (mean = 5.7). However, generally they felt that resource allocation for IT was marginal (mean = 4.4) with only 34 per cent of these organisations feeling that resources allocated to IT projects could be regarded as sufficient. About one third claimed that their IT projects were hampered by insufficient funding. When asked about the alignment of their IT planning and business objectives, more than half (28) reported that alignment between IT and business strategies exist within their organisations (mean ≥ 5). As a whole, these responding organisations used both cost and quality issues to justify IT investment. Although about 50 per cent of the organisations (24) have used more quality issues for IT investment justification than cost issues, 20 per cent of the agencies (10) still limited the criteria for IT investment to cost and productivity issues.
Table 8.4 Summary of the Organisational Influences on the IT-Use-in-TQM

<table>
<thead>
<tr>
<th>Factor*</th>
<th>Pearson's r</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managerial IT knowledge (low - high)</td>
<td>0.4230**</td>
<td>6.0</td>
<td>5.5</td>
<td>1.2</td>
</tr>
<tr>
<td>Top management support (weak - strong)</td>
<td>0.6723**</td>
<td>6.0</td>
<td>5.7</td>
<td>1.4</td>
</tr>
<tr>
<td>Resources allocation (insufficient - sufficient)</td>
<td>0.4353**</td>
<td>5.0</td>
<td>4.4</td>
<td>1.7</td>
</tr>
<tr>
<td>IT and business objectives (isolated - aligned)</td>
<td>0.6751**</td>
<td>5.0</td>
<td>4.8</td>
<td>1.6</td>
</tr>
<tr>
<td>IT justification (cost - quality)</td>
<td>0.5140**</td>
<td>5.0</td>
<td>4.3</td>
<td>1.8</td>
</tr>
</tbody>
</table>

* measured on a 7-point scale
** p < 0.005

Table 8.4 also summarises the results of the correlation of the five organisational factors with the use of IT in TQM. All the factors were found to be positively and significantly correlated to the extent of IT use (p < 0.005). The findings suggest that high managerial IT knowledge, strong top management support and a sufficient allocation of resources as well as closely aligned IT and business objectives may promote the use of IT in TQM. When these conditions are met, the criteria for IT investment may no longer be confined to productivity and efficiency issues. A wide range of criteria such as quality and effectiveness may be used.

In an open-ended question about the factors that were regarded as important in affecting IT use, about 15 per cent of the respondents stressed that it was not sufficient for the managers to be IT-literate and know about the potential of IT: it was equally important for the IT personnel to be aware of the business requirements so that IT could be deployed to meet those needs.

8.3.3 Technological Factors

Table 8.5 presents the results of the technological influences that exist within the organisations. These technological factors were found to have significant correlations with the extent of IT use (p < 0.005). Hardly surprising, good IT facilities with extensive user help and highly integrated systems appear to enhance IT use in TQM.
Also, a distributed IT structure as well as highly skilled IT staff seem to promote extensive use of IT in TQM.

On the whole, the respondents agreed that the IT facilities for their business operations were at an acceptable level (Table 8.5, mean = 4.7) with sufficient help available to staff using IT applications, and a slightly above moderate level of integration among IT applications. These organisations adopted a mix of centralised and distributed IT provision. About a quarter of the organisations reported that their provision of IT facilities and support was distributed throughout the organisations. However, around 20 per cent of them have a highly centralised IT provision. Overall, the technical skills of IT staff were slightly above average (mean = 4.5): 58 per cent of the organisations claimed to be better than average.

Table 8.5 Summary of the Technological Influences on the IT-Use-in-TQM

<table>
<thead>
<tr>
<th>Factor*</th>
<th>Pearson’s r</th>
<th>Median</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT facilities (bad - good)</td>
<td>0.4748**</td>
<td>5.0</td>
<td>4.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Help availability (limited - extensive)</td>
<td>0.5361**</td>
<td>5.0</td>
<td>4.8</td>
<td>1.4</td>
</tr>
<tr>
<td>IT integration (low - high)</td>
<td>0.6757**</td>
<td>5.0</td>
<td>4.6</td>
<td>1.4</td>
</tr>
<tr>
<td>IT structure (highly centralised - distributed )</td>
<td>0.4830**</td>
<td>5.0</td>
<td>4.2</td>
<td>1.6</td>
</tr>
<tr>
<td>IT skills (low - high)</td>
<td>0.5372**</td>
<td>5.0</td>
<td>4.5</td>
<td>1.4</td>
</tr>
<tr>
<td>IT experience (operational - strategic)</td>
<td>0.6082**</td>
<td>4.0</td>
<td>3.6</td>
<td>1.7</td>
</tr>
</tbody>
</table>

* all measured on a 7-point scale except IT experience where a 6-point scale was used
** p < 0.005

There appeared to be a fairly equal distribution of organisations with various stages of IT experience. About 35 per cent of the organisations (16) described their present IT applications as mainly to meet operational and financial needs characterised by uncoordinated systems. Thirty seven per cent of the organisations (17) claimed that their IT applications have evolved toward a sophisticated stage where co-ordinated systems were in place to support strategic applications as well as some extent of inter-organisational linkages.
The questionnaire did not single out staff IT training as a factor but subsumed in the IT help availability. However, about a quarter of the respondents (12) felt that staff training was the most important factor if the IT-usage level was to increase. Another interesting factor put forward by about ten per cent of the respondents that would widen the use of IT was IT exposure. In order to improve the IT knowledge of public managers and to update them on IT developments, demonstrations of new applications and potentialities were considered essential.

8.4 Multiple Regression Estimations for IT-Use-in-TQM

The three categories of contextual variables discussed in the early sections were candidates as predictors of the extent to which IT is used in TQM. The technique to test this view was multiple linear regression analysis. This technique was deemed appropriate as the scatter-plot matrices of the use of IT in TQM versus the three sets of contextual variables (Appendix F) suggested linear associations. Although other technique such as LISREL (Linear Structural Relationships) is becoming popular in recent years, it is not suitable for this study which involves only one dependent variable.

Out of 47 responses, only 44 were valid for all variables included in the regression analyses. Arguably, the sample size is small, which reduces the likelihood of finding any significant relationships (Speed 1994, p. 91): ‘only very strong relationships can be detected with any degree of certainty’ (Hair 1995, p. 103). With this in mind and due to the exploratory nature of the analysis, the significance level was set at 0.10.

Following the rule recommended by Hair et al. (1995, p. 105) and Speed (1994), three regression analyses were initially run separately, one for each of the three categories of contextual variables, keeping the ratio of the number of observations to the number of independent variables above five, the minimum recommended ratio. Using the results of the three regression analyses, only significant independent variables were retained as predictors in the subsequent regression for model estimation. By doing so, it was hoped meaningful relationships between dependent and independent variables would
be detected despite the small sample size. For this study the observation-to-variable ratios range from 1:7.0 to 1:10.5.

Another issue highlighted by Speed (1994) which could exacerbate the problem of small sample size is multicollinearity, i.e. the correlations among independent variables. Multicollinearity can have a substantial effects on the results of a regression analysis as the contribution of each independent variable may be wrongly estimated due to the correlation with other independent variables (Hair et al. 1995, p. 126; Speed 1994).

Hair et al. (1995, p. 127) recommend two commonly used measures for assessing multicollinearity: the tolerance value and its inverse - the variance inflation factor (VIF). These measures indicate the degree to which each independent variable is explained by the other independent variables. A variable with a small tolerance (high VIF) denotes high collinearity, i.e. it is almost a linear combination of the other independent variables (Norusis 1993, p. 355).

In order to reduce the problems of error correlation and collinearity, careful selection of variables for inclusion in the analysis was done following the common cut-off threshold of tolerance suggested by Hair et al. (1995, p. 127): variables with tolerance values below 0.1, which correspond to VIF values above 10, would be excluded. A careful inspection of the tolerance values revealed no multicollinearity problem for the four regression equations. Thus, the four predictor sets (one for each of the three categories of contextual and one combined-predictor set) were considered suitable for the analyses.

A method developed specifically to diagnose the amount of multicollinearity present and the variables exhibiting the high multicollinearity was also used to identify multicollinearity (Norusis 1993, pp. 356-357; Hair et al. 1995, p. 153). The method has two components: the condition index and the decomposition of regression coefficient variance. According to this method, all condition indices above 30 would be identified and the variance proportions of the variables examined. Collinearity would be a problem when the identified condition index (30 or above) accounts for a
high proportion of variance (0.90 or above) for two or more coefficients (Hair et al. 1995, p. 153). Again, this procedure confirmed that multicollinearity was absent as the condition indices of all the four variable sets were well below 30 and no two variables had a proportion of the variance above 0.90 even for a condition index smaller than 30.

In estimating the regression equations, an initial ‘dry run’ was performed for each of the three contextual-variable regression analyses to check for outliers and assumptions as recommended in the literature (Speed 1994; Hair et al. 1995, pp. 110-124; Norusis 1997, pp. 398-399, 421-438). All the independent variables were entered simultaneously as they had been selected on the basis of theoretical considerations (detailed in Chapter 3). After eliminating any outliers, each of the three regression analyses were repeated to determine significant links within each of them. Finally the analysis was run again for the combined-predictor set to estimate a single regression model. A ‘dry run’ was also performed for the fourth regression model to determine the presence of any outliers and the violation of assumptions.

To check for outliers and influential observations, three methods were used (Hair et al. 1995, pp. 120-124, 154-165; Norusis 1997, pp. 482-487). Hair et al. (1995, p.195) claim that the studentised residual is the primary indicator of an observation which is an outlier on the dependent variable. To ensure that no mistakes would be made, Norusis (1997, p. 437) recommends the use of the studentised deleted residual as it makes any unusual results of residual analysis easier to spot. It has been used successfully with small samples (Speed 1994). This study used the studentised deleted residual for all the residual analyses to detect outliers and the violation of assumptions. Throughout the rest of the regression discussion, studentised deleted residuals will be referred simply as residuals.

Outliers can readily be spotted on a residual plot as they are observations with very large positive or negative residuals. In general, residual values exceeding an absolute

---

7 The studentised deleted residual, also known as the jack-knifed residual, is the studentised residual for an observation when the observation is excluded from the computation of the regression statistics.
value of 3 are considered outliers (Norusis 1993, p. 330). For the four regression
equations, no outliers were detected.

The second method involves checking leverage. Leverage measures how far the
values for an observation are from the means of all the independent variables (Norusis
1997, p. 485). Leverage points are observations with unusual combinations of values
of the independent variables (Norusis 1997, p. 485). Computed leverage values range
from 0 to close to 1. Observations with high leverage values may have a large impact
on the estimates of the regression coefficients. Hair et al. (1995, p. 124) encourage
analysts to delete truly exceptional observations to make the data set more
representative of the actual population. This helps to ensure generalisability of the
results.

For a sample size less than 50, it is recommended that observations are considered
unusual when a leverage value greater than 3p + n is obtained, where p is the number
of independent variables plus one and n is the sample size (Hair et al. 1995, p. 156).
Following the recommendation of Hair et al. (1995), the calculated values for
independent variable sets corresponding to the external, organisational, technological
factors and the combined set are 0.34, 0.41, 0.45 and 0.50 respectively. Using these
threshold limits, two observations were identified as leverage points for all the four
regression equations. A close examination of the raw data of the two observations
revealed that they had some independent variables with unusual combination of
values. For example, one organisation reported having a highly centralised IT
provision but with isolated IT-business planning, good IT facilities and extensive help
availability and with low internal IT competency with difficulty in getting outside
support.

A third method known as single-case diagnostics was used as a further check on the
presence of any influential points. With this method, one or more observations that
have a large impact on a regression model would be determined. This is particularly
important for small sample sizes as exclusion of such a point would bring about
substantial change in the slope of the regression line or the coefficient of the
independent variable (Norusis 1997, pp. 435-436). In SPSS, the impact of a single
observation on each regression coefficient is shown by the DFBETA\(^8\). The guidelines for identifying particularly high values suggest that a lower threshold of 1.0 be applied to small and medium size samples (Hair et al. 1995, pp. 156-157). When this procedure was used no influential observations were detected.

In the processes of detecting outliers and influential observations, only two observations were identified. Responses of these questionnaires were consequently removed from further analysis, reducing the number of usable questionnaires down to 42.

8.4.1 Assumptions in multiple regression analysis

Possible violations of the linear regression assumptions were explored. The assumptions that were examined are: 1) the observations are independent, 2) the relationship between the dependent and independent variables is linear, and 3) for each combination of values of the independent variables, the distribution of the values of the dependent variable is normal with a constant variance (Norusis 1997, pp. 398-399).

Independence of observations means that the value of one observation is not related to the value of another observation (Norusis 1997, p. 433). As the present study involved collecting one-time, cross sectional data from single informants, it was not likely that the respondents consulted each other when answering the questionnaires. Therefore, it could be assumed that the observations were independent.

In order to evaluate the linearity assumption, a scatter-plot of residuals against predicted values for each of the three regression equations was performed (Hair et al 1995, pp. 111-112; Norusis 1997, pp. 430-431). The residual plots (Appendix F) did not show any specific patterns indicating the existence of linear relationships for the four regressions. It was concluded that the linearity assumption was observed.

\(^8\) The difference between the results with and without the observation. It is the relative effect of an observation on each coefficient.
A histogram of residuals is the simplest diagnostic for a predictor set in a regression equation (Hair et al. 1995, p. 114). However, a visual inspection for a normal distribution may be difficult with small samples. An easier method to assess normality is the normal probability plot of residuals (Hair et al. 1995, p. 114; Norusis 1997, pp. 223-224, 426-427). If the data are a sample from a normal distribution, the residual points are expected to fall on or close to a straight diagonal line.

In this study, the histogram and normal probability plots (Appendix F) did not provide a basis for rejecting the normality assumption for all the regression equations. The results were confirmed by the statistical tests of normality in Table 8.6.

Table 8.6 Tests of Normality of Residuals

<table>
<thead>
<tr>
<th>Residual</th>
<th>Kolmogorov-Smirnov (Lilliefors)</th>
<th>df</th>
<th>2-tail p</th>
</tr>
</thead>
<tbody>
<tr>
<td>External-predictor</td>
<td>0.06</td>
<td>42</td>
<td>&gt; 0.20*</td>
</tr>
<tr>
<td>Organisational-predictor</td>
<td>0.08</td>
<td>42</td>
<td>&gt; 0.20</td>
</tr>
<tr>
<td>Technological-predictor</td>
<td>0.11</td>
<td>42</td>
<td>&gt; 0.20</td>
</tr>
<tr>
<td>Combined-predictor</td>
<td>0.090</td>
<td>42</td>
<td>&gt; 0.20</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance (Norusis 1997, p. 224)

Finally, to determine if the variance of the dependent variables was constant for all values of the independent variables, diagnosis was made by plotting the residuals against the predicted values. The absence of any pattern in the data points indicates a constant variance (Hair et al. 1995, p. 113; Norusis 1997, pp. 428-429). The residual plots (Appendix F) for all the regression equations showed that the residuals appeared to be randomly scattered around a horizontal line through 0. The constant variance assumption should not be suspected. This conclusion was supported by applying the Levene test for homogeneity of variances (p > 0.10 for all regression equations).

Analyses of residuals have confirmed the appropriateness of the regression models. Violations of the regression assumptions were not encountered.
8.4.2 Model estimation

The regression results for each of the three independent variable sets as well as the combined-predictor set (after removing the insignificant linkages, i.e. $p > 0.10$) entered simultaneously are presented in Table 8.7.

### Table 8.7 Summary Statistic of the Regression Equations

<table>
<thead>
<tr>
<th>Predictor set</th>
<th>$R^2$</th>
<th>Adj $R^2$</th>
<th>Std error</th>
<th>F-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>External factors</td>
<td>0.39</td>
<td>0.33</td>
<td>0.79</td>
<td>5.98</td>
<td>0.0008</td>
</tr>
<tr>
<td>IT-use = 0.24(public accountability) + 0.24(inter-organisational co-operation) + 2.78</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organisational factors</td>
<td>0.49</td>
<td>0.42</td>
<td>0.74</td>
<td>6.96</td>
<td>0.0001</td>
</tr>
<tr>
<td>IT-use = 0.38 (top management support) + 0.25 (IT-business alignment) + 2.20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technological factors</td>
<td>0.64</td>
<td>0.58</td>
<td>0.63</td>
<td>10.43</td>
<td>0.0000</td>
</tr>
<tr>
<td>IT-use = 0.23 (IT experience) + 0.13 (IT structure) + 1.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combined-predictor set*</td>
<td>0.68</td>
<td>0.63</td>
<td>0.59</td>
<td>12.65</td>
<td>0.0000</td>
</tr>
<tr>
<td>IT-use = 0.27 (IT experience) + 0.22 (top management support) + 0.17 (public accountability) + 0.14 (IT structure) + 1.02</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* after removing insignificant links

8.4.2.1 External factors

The results of regressing the four external factors as independent variables against the extent of IT-use-in-TQM can be seen in Table 8.7. About 35 per cent of the variance in the use of IT were explained by the four external factors. Only two factors showed significant effects at the 0.10 level. They were ‘public accountability’ (beta = 0.31) and ‘inter-organisational co-operation’ (beta = 0.37). As expected, the use of IT increases as IT was regarded by the public agencies as a tool to ensure public accountability. The use was extensive when they have good co-operation with their counterparts to implement such IT applications.
8.4.2.2 Organisational factors

The organisational factors explained 42 per cent of the variance of the IT-use-in-TQM (Table 8.7). Two out of the five independent variables showed a significant linear relationship. The strongest influence on an organisation’s IT use is the positive support given by top management (beta = 0.51) for IT applications followed by alignment of IT-business planning (beta = 0.40). An organisation’s IT usage level increases when there is a proper, coherent planning for IT strategy and business objectives, and when the backing of top management is strong.

Surprisingly, the recognition by managers of the potential of IT to enhance quality output (beta = -0.20) is the least important predictor and has no significant influence on the use of IT (p = 0.41). This result would appear to be at variance with the findings of Boynton et al. (1994) which indicated clearly that ‘managerial IT knowledge is crucial for bringing about high levels of IT use within business units’ (p. 313).

8.4.2.3 Technological factors

As shown in Table 8.7, the six technological factors explained about 60 per cent of the variation in the extent of IT-use-in-TQM, of which only two factors have positive significant effects (p < 0.10). Organisations with a distributed structure of IT facilities and support (beta = 0.19) as well as sophisticated IT experience (beta = 0.39) promote IT use. As expected, the use of IT is extensive when an organisation has comprehensive, centrally co-ordinated internal systems for decision making and strategic applications as well as some extent of inter-organisational systems. No significant influence could be observed for the remaining four predictor variables. The technical skills of IT staff (beta = 2.04E-4) was the least important predictor followed by the IT facilities for business operations (beta = 0.03).
8.4.2.4 Combined-predictor set

The six independent variables that showed a significant effect on the use of IT in TQM in the previous three regressions (i.e. two external, two organisational and two technological factors with \( p \leq 0.10 \)), were entered simultaneously in the fourth regression. Four out of the six independent variables yield a significant relationship \( (p \leq 0.10) \) with the use of IT (adjusted \( R^2 = 0.63 \)). They are IT experience (beta = 0.46), IT structure (beta = 0.21), top management support (beta = 0.30) and public accountability (beta = 0.22). It may be concluded that organisations with sophisticated IT experience as well as distributed IT facilities and support, and are fully supported by top management in using IT extensively to ensure public accountability are likely to use IT substantially to support TQM. Given the four conditions, probably it may be explained that the extent of resources allocation and IT-business objectives alignment as well as criteria for justifying IT investment are mainly dependent on top management’s commitment to IT applications, and thus they become insignificant. Similarly, with sophisticated internal and inter-organisational IS in place, co-operation with other organisations to implement IT applications no longer surface as important.

Table 8.7 also reveals that among the three predictor sets, the two internal factors, technological and organisational, have more influence on the IT-usage level than the external factors. Of the two internal factors, the technological factors were found to influence the use of IT more strongly than the organisational factors. This finding is consistent with the results of past studies (Kraemer et al. 1981; Laudon 1985; King & Teo 1994) that internal factors play a stronger facilitating role than external factors. In addition, the present study also confirmed the work of Cahill et al. (1990) that the combination of these three categories of factors offers greater explanatory power for the extensive use of IT than any one category of factors singly.

8.4.3 Model evaluation and validation
As a regression equation with a large number of independent variables does not necessarily describe the situation better than another equation with fewer variables (Norusis 1993, pp. 345-346; Hair et al. 1995, p. 129), an attempt was made to identify a concise model that would be a good predictor of IT use in TQM.

Three commonly used procedures for constructing regression models are: forward selection, backward elimination and stepwise selection of variables (Norusis 1993, pp. 346-350; Hair et al. 1995, pp. 115-118). The three procedures may not result in the same equations with the same number of corresponding variables and no one procedure is necessarily superior. To compare the regression models, the most common standard used is overall predictive fit provided by the coefficient of determination (R^2). However, R^2 never decreases as additional independent variables are added. The more appropriate method for comparing models with different numbers of predictors is the adjusted R^2 as it is not subject to the inflationary bias of unadjusted R^2 (Norusis 1993, p. 346) and helps to avoid 'over fitting' of the model due to a small sample size.

The three regression procedures produced almost identical equations (Table 8.8). The equation with the largest adjusted R^2 was selected (i.e. Y_3 or Y_4 by the backward or stepwise procedure).

**Table 8.8 Summary of the Regression Models Using Different Variable Selection Procedures**

<table>
<thead>
<tr>
<th>Model</th>
<th>Procedure</th>
<th>R</th>
<th>R^2</th>
<th>Adj R^2</th>
<th>Std error</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y_1</td>
<td>Enter</td>
<td>.83</td>
<td>.68</td>
<td>.63</td>
<td>.59</td>
<td>12.65*</td>
</tr>
<tr>
<td>Y_2</td>
<td>Forward (criteria: prob-of-F-to-enter ≤ .05)</td>
<td>.81</td>
<td>.66</td>
<td>.62</td>
<td>.59</td>
<td>17.83*</td>
</tr>
<tr>
<td>Y_3</td>
<td>Backward (criteria: prob-of-F-to-remove ≥ .10)</td>
<td>.82</td>
<td>.68</td>
<td>.64</td>
<td>.58</td>
<td>19.61*</td>
</tr>
<tr>
<td>Y_4</td>
<td>Stepwise (criteria: combination of forward and backward procedure)</td>
<td>.82</td>
<td>.68</td>
<td>.64</td>
<td>.58</td>
<td>19.61*</td>
</tr>
</tbody>
</table>

* significance = 0.00

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised coeff</th>
<th>Std error</th>
<th>Std coeff</th>
<th>t</th>
<th>Signif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y_1</td>
<td>IT provision structure</td>
<td>.14</td>
<td>.07</td>
<td>.21</td>
<td>2.06</td>
</tr>
</tbody>
</table>

183
<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardised coef</th>
<th>Std coef</th>
<th>t</th>
<th>Signif</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>IT experience</td>
<td>.27</td>
<td>.06</td>
<td>.46</td>
<td>4.25</td>
</tr>
<tr>
<td>public accountability</td>
<td>.17</td>
<td>.10</td>
<td>.22</td>
<td>1.70</td>
</tr>
<tr>
<td>top management support</td>
<td>.22</td>
<td>.10</td>
<td>.30</td>
<td>2.16</td>
</tr>
<tr>
<td>inter-organisational co-operation</td>
<td>-.05</td>
<td>.10</td>
<td>-.08</td>
<td>-.52</td>
</tr>
<tr>
<td>IT-business objectives alignment</td>
<td>.06</td>
<td>.10</td>
<td>.10</td>
<td>.64</td>
</tr>
<tr>
<td>constant</td>
<td>1.02</td>
<td>.51</td>
<td>2.01</td>
<td>.05</td>
</tr>
</tbody>
</table>

Y₂: IT-use-in-TQM, where i = 1, 2, 3 or 4.

Next, to ensure no violation of the assumptions and the absence of outliers for the selected equation, the process to examine the assumptions and outliers was repeated. The problem of multicollinearity was ruled out as the variables in the final equation have tolerance values above 0.71 (VIF < 1.50) and the condition index less than 15. Outliers were not detected: all residual values were well below the absolute value of 3. Furthermore, the leverage of all observations was below the threshold limit, i.e. 0.36.

The results of residual analysis revealed that none of the assumptions was violated (Appendix F). The normality test (Lilliefors = 0.09, p > 0.20) and the Levene test for homogeneity of variances (statistic = 0.58, p = 0.68) both confirmed that the regression assumptions were observed.
The estimated regression relationship for the use of IT in TQM is: IT use = 1.00 + 0.27 (IT experience) + 0.23 (top management support) + 0.18 (public accountability) + 0.14 (IT structure). As shown in Table 8.8, 64 per cent of the variance in the extent of IT use in TQM was explained by this equation.

The variable with the greatest impact on IT use is IT experience (beta = 0.45) followed by top management support (beta = 0.31), public accountability (beta = 0.23) and IT structure (beta = 0.22). Of the three groups of independent factors employed - external, organisational and technological - the technological variables were the most important in explaining the variability in the use of IT in TQM. Together, the two technological variables and the single organisational variable explained about 61 per cent of the variance of IT use in this study. This findings support previous work by Kraemer et al. (1981), Laudon (1985) and King and Teo (1994).

The findings suggest that IT experience of an organisation, measured not by the length of using IT or the quantity of computers and the peripherals but rather by the purpose of its applications, has a positive effect on the use of IT in TQM, thus further suggesting that appropriate attention should be given to the development of innovative and strategic applications of IT projects. While top management support and involvement has a positive impact on IT usage, the centralised control over IT provision has a negative effect. Aligned with the advancement of technology, the favourable IT provision that promotes its use is the distributed structure where controls are established to maximise centrally co-ordinated coalitions, encourage resource sharing but to minimise isolated applications (Galliers 1991; Fiedler et al. 1996).

In estimating a model for the use of IT in TQM, fifteen independent variables have been identified and used in multiple regression analyses. However, after removing all those insignificant links, only four variables could significantly explain about 65 per cent of variance in IT use. Other predictors are needed to try to account for the 35 per cent non-explained variance. When determining factors that might affect the success of IT adoption in Malaysian small and medium-size enterprises, Foong (1999) found that user's IT literacy had a significant association with the extent of IT use. This
finding is supported by about a quarter of the respondents in the present study. They believed in the importance of staff IT training. Another potential predictor for the model is the business knowledge and awareness of IT personnel as highlighted by about 15 per cent of the respondents and also in the study of Boynton et al. (1994).

8.5 Cluster Analysis for Level of IT Use

Cluster analysis is a technique that can be used to sort items or individuals into a small number of homogeneous groups. Clustering techniques may be used to search for natural groupings in the data, to simplify the description of a large data set, and to generate hypotheses to be tested on future samples (Everitt 1980, pp. 6-7; Hair et al. 1995, p. 424). In this study, cluster analysis was used to divide the organisations into groups based on the use of IT in the nine dimensions of TQM. Using these groups, the relationships between the level of IT use and contextual influences can then be explored more fully.

The use of IT in the nine dimensions of TQM are deemed appropriate to be used as clustering variables for partitioning the organisations as they are validated measures (discussed in Chapter 7). They also conform to the common practice suggested by Saunders (1994) that factor analysis applied prior to cluster analysis helps to reduce the number of variables to be used in cluster analysis and also to interpret the clusters.

In order to group the organisations according to their extent of IT use, this study decided to use the distance measure of alikeness which seeks items/individuals that are close together on all dimensions. This measure is more meaningful in this context than matching or similarity measures (Saunders 1994; Hair et al. 1995, pp. 430-432). Using the most widely used method of clustering algorithm: hierarchical cluster analysis and the best approach to measure the distance between organisations suggested by Saunders (1994) and Hair et al. (1995, p. 432) for efficient computations and also to minimise the within-cluster differences, the Ward's or minimum variance approach was chosen to allocate organisations into groups. As the same scales were
used for the clustering variables (all were on a 7-point scale), no standardisation of data was undertaken.

The dendrogram obtained (Figure 8.1) indicated that organisations could be classified into three clusters by noting when the stress of combining two clusters becomes particularly large (Saunders 1994). To ascertain the number of clusters, the best stopping rule is that of using the Calinski and Harabasz index identified by Milligan and Cooper (1985) and computed using the formula:

\[
Pseudo.F - statistic = \frac{Between\:cluster\:heterogeneity/(k-1)}{Within\:cluster\:heterogeneity/(n-k)}
\]

where  
- \( k \) = number of clusters
- \( n \) = number of cases
- \( n - k \) = stage in agglomeration schedule using Ward’s method.

As revealed in Table 8.9, the number of clusters in the data is three where the pseudo F-statistic is the largest. The outcome is consistent with the visual approach of determining the appropriate number of clusters based on its dendrogram.

<table>
<thead>
<tr>
<th>No. of cluster</th>
<th>Pseudo F-statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>31.03</td>
</tr>
<tr>
<td>3</td>
<td>39.62</td>
</tr>
<tr>
<td>2</td>
<td>34.06</td>
</tr>
</tbody>
</table>

The dendrogram (Figure 8.1) also provides a means of identifying outliers in the sample. A visual inspection for outliers (featured by ‘long’ branches that did not join until very late) confirmed that the data set has no potential outlier problem. Thus the selection of three clusters is appropriate.
Figure 8.1 Dendrogram Using Ward’s Method

Rescaled Distance Cluster Combine

<table>
<thead>
<tr>
<th>CASE</th>
<th>0</th>
<th>5</th>
<th>10</th>
<th>15</th>
<th>20</th>
<th>25</th>
</tr>
</thead>
<tbody>
<tr>
<td>Label Num +--</td>
<td>--</td>
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<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Case 10 10 -</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 11 11 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 36 36 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 12 12 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 18 18 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Case 24 24 -</td>
<td></td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Case 34 34 -</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Case 35 35 -</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case 39 39 -</td>
<td></td>
<td></td>
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<td>Case 2 2 -</td>
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<td>Case 4 4 -</td>
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<td>Case 14 14 -</td>
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<td>Case 45 45 -</td>
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<td>Case 5 5 -</td>
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<td>Case 23 23 -</td>
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<td>Case 44 44 -</td>
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</tbody>
</table>
However, before the cluster solution was accepted as an appropriate description of the data, it was validated by comparing the centroids (means for each of the nine dimension of IT-use-in-TQM) of the three clusters. The results of the one-way ANOVA in Table 8.10 reveal that all the centroids of the three clusters along various TQM dimensions except the ‘Supplier Quality Assurance’ are significantly different at 0.01%. The membership of the clusters also reflects a normal distribution of the responding population.

Table 8.10 Comparison of Centroids and Significance Levels for the Three Cluster Solution

<table>
<thead>
<tr>
<th>Variables</th>
<th>Usage Cluster</th>
<th>F ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Leadership</td>
<td>3.51</td>
<td>4.78</td>
</tr>
<tr>
<td>Strategic planning process</td>
<td>2.58</td>
<td>4.28</td>
</tr>
<tr>
<td>Output quality assurance</td>
<td>3.62</td>
<td>4.67</td>
</tr>
<tr>
<td>Supplier quality assurance</td>
<td>4.00</td>
<td>3.96</td>
</tr>
<tr>
<td>Important innovations</td>
<td>3.30</td>
<td>5.20</td>
</tr>
<tr>
<td>Information &amp; analysis</td>
<td>3.85</td>
<td>4.95</td>
</tr>
<tr>
<td>Human resource utilisation</td>
<td>3.58</td>
<td>4.71</td>
</tr>
<tr>
<td>Customer satisfaction</td>
<td>2.50</td>
<td>4.33</td>
</tr>
<tr>
<td>Quality results</td>
<td>2.64</td>
<td>4.13</td>
</tr>
<tr>
<td>Number of members</td>
<td>10</td>
<td>23</td>
</tr>
</tbody>
</table>

* p < 0.0001

Another method for validating a cluster solution, i.e. to use a different clustering routine, was also employed in this study. The non-hierarchical clustering: K-Means cluster analysis, was used to examine the results from Ward’s hierarchical cluster analysis (Hair et al. 1995, p. 442). Using the output of Ward’s method as the input for the K-Means method, 46 cases (98 %) were classified consistently (Table 8.11). The results of clustering for the two methods are almost identical.

---

9 The number of members in cluster 1, 2 and 3 are 5, 13 and 10 respectively.
Table 8.11 Cluster Membership of the Ward’s and K-Means Routine

<table>
<thead>
<tr>
<th>Method</th>
<th>Number of cases in cluster:</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Ward’s</td>
<td>10</td>
<td>23</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>K-Means</td>
<td>10</td>
<td>22</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Supported by these results, it was concluded that the data collected from the 47 organisations could validly be partitioned into three groups that differ in terms of the extent of IT-use-in-TQM.

8.5.1 Characteristics of the three IT-usage clusters

Having identified the three distinct IT-usage groups, their characteristics were examined. Table 8.12 shows that the three groups are not significantly different in terms of organisational structure and size. Regardless of their level of IT usage, the three groups tend to adopt the conventional organisational structure where decision making is centralised. Most of them are also large organisations according to the SME definition of the Malaysian Ministry of International Trade and Industry (MITI) with 150 or more employees.

Table 8.12 Characteristics of the IT-Usage Clustering Groups

<table>
<thead>
<tr>
<th>Organisational structure:</th>
<th>Usage Cluster</th>
<th></th>
<th></th>
<th>Pearson Chi-square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>centralised</td>
<td>8</td>
<td>12</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>decentralised</td>
<td>0</td>
<td>5</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Organisational size:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 150 staff</td>
<td>1</td>
<td>7</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>≥ 150 staff</td>
<td>9</td>
<td>16</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>IT experience:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uncoordinated functional IS</td>
<td>6</td>
<td>12</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>integrated IS</td>
<td>3</td>
<td>11</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

* 2-tail exact p < 0.01
However, the chi-square exact test revealed that the groups are different in IT experience at the 1% significance level (Table 8.12). While there were about equal number of organisations in the moderate group with low and high IT experience, the majority of the high IT-usage group had a high level of IT experience with integrated information systems (Table 8.12). However, the situation is the other way round for the low IT-usage group. Two thirds of the low IT-usage members have less IT experience where most of their information systems are focused on meeting functional needs and are typically uncoordinated.

8.5.2 Contextual influences on the three IT-usage groups

8.5.2.1 External factors

One-way ANOVA revealed that the degree of influence on the three IT-usage groups was significantly different at the 0.01 level for public accountability and inter-organisational co-operation (Table 8.13). The low IT-usage group reported receiving poor co-operation from other public agencies when implementing IT applications. As expected, this group used less IT to ensure public accountability than the high IT-usage group who also enjoyed better inter-organisational co-operation.

Table 8.13 Summary of the External Influences on IT Groups

<table>
<thead>
<tr>
<th>Factor*</th>
<th>IT-usage group</th>
<th></th>
<th></th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>IT availability in market-place</td>
<td>Low</td>
<td>5.00</td>
<td>5.52</td>
<td>6.14</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td>5.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>6.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Legislation influence</td>
<td>Low</td>
<td>5.40</td>
<td>5.41</td>
<td>6.29</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public accountability</td>
<td>Low</td>
<td>4.00</td>
<td>4.82</td>
<td>5.79</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inter-organisational co-operation</td>
<td>Low</td>
<td>3.00</td>
<td>4.18</td>
<td>5.57</td>
</tr>
<tr>
<td></td>
<td>Moderate</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High</td>
<td></td>
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</tr>
</tbody>
</table>

* measured on a 7-point scale  
** p < 0.01

The effect of IT availability and legislation influence on the three groups, however, exhibited no significant difference (p > 0.05). In all cases, ease of obtaining hardware and software as well as government legislation strongly affect the use of IT and in the same way as expected.
The results of correlation analysis (Table 8.14) revealed that Pearson’s r for the three groups with all the external factors was not significant at the 0.05 level except for the correlation of public accountability with the low IT-usage group. This indicates that the external factors generally do not affect the level of IT usage among these Malaysian public agencies. The use of IT to ensure public accountability becomes an important facilitating factor only for low IT-usage organisations.

Table 8.14 Correlations of the IT-Use-in TQM with the External Influences for Three IT Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>Pearson’s r for IT-usage group:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>IT availability in market-place</td>
<td>-0.5760</td>
</tr>
<tr>
<td>Legislation influence</td>
<td>0.1164</td>
</tr>
<tr>
<td>Public accountability</td>
<td>0.6795*</td>
</tr>
<tr>
<td>Inter-organisational co-operation</td>
<td>0.3965</td>
</tr>
</tbody>
</table>

*p < 0.05

8.5.2.2 Organisational factors

The results of one-way ANOVA in Table 8.15 showed that the influences of all the organisational factors on the three IT-usage groups are significantly different at the 0.05 level except for the resource allocation factor. Although the members of the high IT-usage group indicated that they received sufficient resources for their IT projects, this was not so for the members of the low IT-usage group. However, statistically the difference was not significant (p > 0.05).

Overall, members of the high IT-usage group have higher managerial IT knowledge, stronger top management support and more aligned IT-business objectives than their counterparts in the low IT-usage group. They also use quality issues to justify their IT investment as compared to the low IT-usage group where cost and productivity issues are commonly used.
Table 8.15 Summary of the Organisational Influences on IT Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>IT-usage group</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td>F-ratio</td>
</tr>
<tr>
<td>Managerial IT knowledge</td>
<td>4.60</td>
<td>5.52</td>
<td>6.07</td>
<td>4.89**</td>
</tr>
<tr>
<td>Top management support</td>
<td>4.40</td>
<td>5.74</td>
<td>6.64</td>
<td>10.76***</td>
</tr>
<tr>
<td>Resources allocation</td>
<td>3.70</td>
<td>4.17</td>
<td>5.21</td>
<td>2.77</td>
</tr>
<tr>
<td>IT and business objectives</td>
<td>3.10</td>
<td>4.78</td>
<td>6.00</td>
<td>15.27***</td>
</tr>
<tr>
<td>IT justification</td>
<td>3.00</td>
<td>4.22</td>
<td>5.29</td>
<td>5.32***</td>
</tr>
</tbody>
</table>

* measured on a 7-point scale
** p < 0.05
*** p < 0.01

Although all the organisational factors investigated were found to correlate significantly with the use of IT for the overall sample (Table 8.4), a closer look at the relationships between the influences and the IT-usage groups revealed a different phenomenon. Table 8.16 shows that the high and moderate IT-usage groups did not have any significant correlations with any of the organisational influences at the 0.05 level. However, top management support and resource allocation were found to correlate with the low IT-usage group at the 0.05 and the 0.10 significance levels respectively. This indicates that for the low IT-usage group, top management support and resource allocation are the two major influential factors which affect IT use. For those with high IT-usage level, the role of organisational factors is no longer significant.

Table 8.16 Correlations of the IT-Use-in-TQM with the Organisational Influences for Three IT Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>IT-usage group</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Managerial IT knowledge</td>
<td>-0.1221</td>
<td>0.2249</td>
<td>0.2497</td>
<td></td>
</tr>
<tr>
<td>Top management support</td>
<td>0.6466**</td>
<td>0.3924*</td>
<td>0.2914</td>
<td></td>
</tr>
<tr>
<td>Resources allocation</td>
<td>0.5827*</td>
<td>0.3368</td>
<td>0.2774</td>
<td></td>
</tr>
<tr>
<td>IT and business objectives</td>
<td>0.3221</td>
<td>0.3502</td>
<td>0.1529</td>
<td></td>
</tr>
<tr>
<td>IT justification</td>
<td>0.4503</td>
<td>0.3273</td>
<td>0.2433</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.10
** p < 0.05
8.5.2.3 Technological factors

Table 8.17 reveals that the influences of all the six technological factors on the three groups are significantly different (p < 0.05). As expected, good IT facilities, highly skilled IT staff, extensive IT help for users using systems with high level of integration and distributed IT provision encourage high level of IT use. Organisations with these technological characteristics usually have accumulated enough past IT experience and have evolved from the IT initiation stage characterised by uncoordinated functional systems (Galliers 1991). The use of IT is therefore pervasive in these organisations.

<table>
<thead>
<tr>
<th>Factor*</th>
<th>IT-usage group</th>
<th>F-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>IT facilities</td>
<td>4.20</td>
<td>4.57</td>
</tr>
<tr>
<td>Help availability</td>
<td>3.70</td>
<td>4.65</td>
</tr>
<tr>
<td>IT integration</td>
<td>3.20</td>
<td>4.61</td>
</tr>
<tr>
<td>IT structure</td>
<td>3.10</td>
<td>4.39</td>
</tr>
<tr>
<td>IT skills</td>
<td>3.40</td>
<td>4.52</td>
</tr>
<tr>
<td>IT experience</td>
<td>2.33</td>
<td>3.26</td>
</tr>
</tbody>
</table>

* all measured on a 7-point scale except IT experience where a 6-point scale was used
** p < 0.05
*** p < 0.01

Table 8.18 shows that Pearson's r is significant at the 0.05 level for IT facilities, IT integration and IT structure for the high IT-usage group. The three factors were found to affect high level of IT use. As for the moderate group, IT skills of technical staff appeared to have significant correlation with the level of IT use instead. However, at the same significance level, all the technological factors failed to account for IT use among the members of the low IT-usage group.
Analysis & Discussion

Table 8.18 Correlations of the IT-Use-in-TQM with the Technological Influences for Three IT Groups

<table>
<thead>
<tr>
<th>Factor</th>
<th>IT-usage group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>IT facilities</td>
<td>0.5857*</td>
</tr>
<tr>
<td>Help availability</td>
<td>-0.0811</td>
</tr>
<tr>
<td>IT integration</td>
<td>0.4228</td>
</tr>
<tr>
<td>IT structure</td>
<td>0.3303</td>
</tr>
<tr>
<td>IT skills</td>
<td>-0.0960</td>
</tr>
<tr>
<td>IT experience</td>
<td>0.2375</td>
</tr>
</tbody>
</table>

* p < 0.10
** p < 0.05

The results in Tables 8.14, 8.16 and 8.18 indicate that external and organisational factors have more influence on IT use when the IT-usage level is low. However, as the usage level increases, the influence of external and organisational factors become less prominent. The use of IT is enhanced mainly by technological factors for the moderate and high IT-usage groups.

8.5.3 Multiple regression estimations for the three IT-usage groups

Although a regression model has been developed which explains about 65 per cent of variance of the overall IT-use-in-TQM (Section 8.4), an attempt was made to formulate three separate models of IT use, one for each of the three IT-usage groups. This is because the contextual factors were found to have significantly different degrees of influence on the level of IT usage (detailed in section 8.5.1). However, due to the constraint of sample size which has a direct impact on the statistical power of multiple regression and generalisability of the results (Hair et al. 1995, pp. 103-105), only variables with significant correlations (p < 0.10) identified in the previous section were used to estimate the use of IT in TQM.

Variables which did not show significant linear relationships with the IT-usage level were examined for curvilinearity using the curve estimation function. Appropriate data transformation would then be undertaken. However, this was exercised with

In the regression analysis for the three models, the backward elimination of variables was chosen instead of the enter method even though only significantly correlated variables would be used. This was to keep the ratio of observations to independent variables as high as possible for a small sample size.

The significance level was set at 0.10. This is considered appropriate because, according to Speed (1994), for the small sample size, it is more likely to not find significant results than significant results that are wrong.

The three regression models developed are presented in Table 8.19. Out of the 14 (high IT-usage group), 23 (moderate) and 10 (low) usable responses in each group, only 13, 23 and 9 in the respective groups were valid for all variables included in the models.

Initially, a 'dry run' was performed for each regression model to check for outliers and for multicollinearity as well as regression assumptions as recommended in the literature (Norusis 1993; Speed 1994; Hair et al. 1995). The procedure led to the exclusion of only one case in the moderate group, bringing the number of usable cases down to 22. There were no such 'problem' cases detected for high and low IT-usage groups. The observation-to-variable ratios for the three regression analyses were above 6.0.

In the sections that follow, the regression results for the three IT-usage levels are presented; a summary is provided in Table 8.19. As the sample sizes are small, the results should be used with caution.
8.5.3.1 **High IT-use-in-TQM**

The regression analysis results with high IT-use as the dependent variable are shown in Table 8.19. The regression equation explains 53 per cent of the variation in the dependent variable ($F = 7.90, p = 0.01$). Only two variables show significant effects at the 10% level. These are ‘IT integration level’ and ‘IT structure’ variables. The positive impact of both variables on IT-use indicates that integrated IT applications and distributed IT structures promote IT-use as compared to isolated applications with highly centralised IT management.

<table>
<thead>
<tr>
<th>IT usage</th>
<th>$R^2$</th>
<th>Adj $R^2$</th>
<th>Std error</th>
<th>F-value</th>
<th>Signif</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>0.61</td>
<td>0.53</td>
<td>0.28</td>
<td>7.90</td>
<td>0.01</td>
</tr>
<tr>
<td>Moderate</td>
<td>0.33</td>
<td>0.26</td>
<td>0.33</td>
<td>4.71</td>
<td>0.21</td>
</tr>
<tr>
<td>Low</td>
<td>0.76</td>
<td>0.72</td>
<td>0.09</td>
<td>21.86</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**High IT-use** = 0.28 (IT integration) + 0.15 (IT structure) + 3.69

**Moderate IT-use** = 0.14 (Top management support) + 0.10 (IT structure) + 3.36

**Low IT-use** = 0.09 (Resource allocation) + 3.02

8.5.3.2 **Moderate IT-use-in-TQM**

Only slightly over 25 per cent of the variation in the moderate IT usage level was accounted for by two significant variables ($p < 0.10$). Organisations which have stronger top management support with less centralised IT structure are likely to have higher IT usage level.

8.5.3.3 **Low IT-use-in-TQM**

Only one independent variable, the ‘resource allocation’, showed a significant linear relationship with low IT use and explained 72 per cent of its variation. An organisation’s low IT-usage level is mainly caused by insufficient resource allocation.
Therefore, in order to increase the use of IT in this low IT group, obviously more resources should be allocated to develop IT applications.

8.6 Summary

Regardless of the IT usage level, the regression analysis shows that IT experience, top management support, public accountability, and IT structure significantly affect the use of IT in TQM. However, when the different IT-usage levels are taken into consideration, the significance of the factors changes.

The results of the regression analyses reveal that when the IT usage level is high, technological factors, particularly ‘IT integration level’ and ‘IT structure’, play an important role in enhancing IT use. However, when a low-usage level is observed, organisational factors, specifically ‘resource allocation’, become more influential. For the moderate group, both technological and organisational factors, especially ‘IT structure’ and ‘top management support’, affect the usage level.

The results indicate that a low IT-usage organisation should allocate more resources to IT projects if it wishes to increase the IT-usage level. After attaining a moderate level, it should adopt a distributed IT structure to manage its IT provision. At the same time, top management should give full support to all IT applications in order to further ensure the success of IT use. After which, a high usage level can be attained if all the IT applications are compatible to achieve one integrated system.
CHAPTER 9 CONCLUSION AND RESEARCH IMPLICATION

9.1 Introduction

Both TQM and the use of IT have been widely researched over recent years. The literature of TQM tends to indicate that IT plays a critical role in the success of TQM (Zadrozny & Ferrazzi 1992; Cortada 1995; Sobkowiak & LeBleu 1996; Pearson & Hagmann 1996). The integration of IT into TQM enables an organisation to achieve improved quality in the products and/or services it offers (Hendrick 1994; Pearson et al. 1995; Matta et al. 1998; Zahedi 1998). However, there has been no well-founded empirical research on the two together - on how IT has and can support TQM practices. A scarcity of empirical studies on the role of IT in TQM, which can illustrate the importance or otherwise of IT for TQM, especially in the non-manufacturing sector, has prompted this study. Thus the study sought to provide such an empirical base.

9.2 Major Findings

The current study has two major findings. The first, which corresponds to research question 1, is concerned with the appropriate aspects of IT applications for organisations implementing TQM and the second, which corresponds to research questions 2 and 3, is about the factors that are associated with the organisations’ use of IT in TQM.

9.2.1 Research Question 1

What is the impact of IT on TQM; in particular, on Leadership, Strategic Planning Process, Output Quality Assurance, Important Innovations, Information and Analysis, Human Resource Utilisation, Customer Satisfaction, and Quality Results?
Conclusion & Implication

The study provided empirical findings to supplement anecdotal and case evidence on the role of IT in TQM environments. The survey results supported the claims of the authors detailed in Chapter 3 (e.g., Zadrozny & Ferrazzi 1992; Quinn & Baily 1994; Kathuria & Igbaria 1997; Matta et al. 1998) that IT benefits TQM implementation in ‘Important Innovations’, ‘Information and Analysis’, ‘Output Quality Assurance’ and ‘Human Resource Utilisation’. Although past work has given examples to demonstrate how IT can be deployed to support ‘Customer Satisfaction’ and ‘Quality Results’, this study found that the IT usage level of these two dimensions was only moderate.

When comparing the findings of this study to the few empirical results reported in Chapter 3, the high level of IT usage in providing quality information and analysis supported Forza’s (1995b) work which found that flows of information strongly and positively influenced the achievement of quality performance. However, this study did not fully support the findings of Burgess and Gules (1998) on the significant use of IT in the supplier quality assurance aspect of TQM. The difference in the context of the study may account for the variation in the results. The study of Burgess and Gules (1998) was conducted in an automobile manufacturing sector where the quality of assembly parts is tangible and therefore more easily measurable. In the case of the service sector, particularly the public sector in this study, the quality of the input from external agencies is usually intangible and difficult to measure. The use of IT to monitor such supplier quality is largely dependent on the stage of computerisation of the supplying agencies and their IT priority. This is especially true in the Malaysian public sector where the focus is still very much on the computerisation of internal operational processes as revealed in the findings on IT experience of this study and the immediate future plans for IT applications discussed in Section 8.2.3. It is therefore not surprising that the use of IT in ‘Supplier Quality Assurance’ was significantly lower than in any other aspects of TQM.

The finding of the study was not consistent with the work of Lloyd-Walker and Cheung (1998) in the Australian banking industry who found quality customer services and product issues most strongly influence IT planning, but not IT applications that support innovations. One possible explanation for the difference in
the results is that the banking industry, being profit-oriented, emphasises customer-focused technologies to ensure a return on investment with potential shareholder pressure, whereas the public agencies in Malaysia concentrate more on innovative applications to improve efficiency and effectiveness of service delivery (Maarof 1996; MAMPU 2000). Thus it would appear that findings are contingent upon the type of industry studied that might reflect the kinds of objectives prioritised according to their strength and opportunities as well as stages of IT development.

9.2.2 Research Question 2

Which are the external, organisational, and technological factors that are associated with IT applications in TQM?

When regressing the external, organisational and technological factors separately as independent variables against the extent of IT use in TQM, the results suggested that the following variables have a significant association with IT use:

External factors
Public accountability: the use of IT increases when IT is regarded by the public agencies as a tool to ensure public accountability. This reflects the effort of the Malaysian government for making the government more accountable and transparent via IT with the implementation of Electronic Government (MAMPU 2000).

Inter-organisational co-operation: the use of IT is extensive when the agencies have good co-operation with their counterparts to implement such IT applications. This is especially true in this study as the Malaysian government is in the process of upgrading the level of connectivity between agencies. This will speed up communication between agencies and allow for information sharing through IT to improve inter-agency and intra-agency services (MAMPU 2000).
Organisational factors

Top management support: strong top management backing for IT applications promotes IT use. This finding is well supported by many other studies (e.g. Robey & Zeller 1978; Reich & Benbasat 1990; Hughes 1994; Hasan & Lampitsi 1995) that top management plays an important role for backing new ideas and bringing in changes in an organisation.

IT-business planning alignment: an organisation’s IT usage level increases when there is a proper, coherent planning for IT strategy and business objectives. This is because a coherent strategy and planning is essential for a good utilisation of resources within an organisation (Wilcox et al. 1996).

Technological factors

IT structure: organisations with the distributed structure of IT facilities and support promote IT use. As the role of IT becomes a more integral part of the corporate strategy, a more distributed hardware promotes technology diffusion, increases usage and satisfaction (Grover & Segars 1996).

IT experience: the use of IT increases when an organisation has accumulated sophisticated IT experience with comprehensive, centrally co-ordinated internal systems for decision making and strategic applications as well as some extent of inter-organisational systems (Galliers 1991).

However, when combining the six significant variables in a regression analysis, only four out of the six independent variables yield a significant relationship with the use of IT. They are IT experience, top management support, public accountability and IT structure (in order of importance). It may be concluded that organisations with sophisticated IT experience as well as distributed IT facilities and support, and are fully supported by top management in using IT extensively to ensure public accountability are likely to use IT substantially to support TQM. Given the four conditions, one may conclude that the extent of resources allocation and IT-business
objectives alignment as well as criteria for justifying IT investment are mainly
dependent on top management’s commitment to IT applications. Similarly, with
sophisticated internal and inter-organisational IS in-place, co-operation with other
organisations to implement IT applications no longer surfaces as an important issue
but has become part of the IT infrastructure.

9.2.3 Research Question 3

To what extent do external, organisational and technological factors account
for the variance in the impact of IT on TQM?

Regression analyses show that external, organisational and technological factors
separately explain about 33 per cent, 42 per cent and 58 per cent of the variance in the
use of IT. When the three are combined, the explanatory power increases to 63 per
cent. The results reveal that among the three predictor-sets, the two internal factors,
technological and organisational, have more influence on the IT-usage level than the
external factors. Of the two internal factors, technological factors were found to
influence the use of IT more strongly than organisational factors. This finding is
consistent with the results of past studies (Kraemer et al. 1981; Laudon 1985; King &
Teo 1994) that internal factors play a stronger facilitating role than external factors. In
addition, the present study also confirmed the work of Cahill et al. (1990) that the
combination of these three categories of factors offers greater explanatory power for
the extensive use of IT than any one category of factors singly.

However, when the respondents were grouped into three IT-usage levels, further
analysis produced the following findings:

1. When the IT-usage level is low, organisational factors, particularly resource
   allocation, play an important role in enhancing the use of IT to support TQM. The
   factors explain about 72 per cent of the variance. Naturally, an organisation’s low
   IT-usage level is mainly caused by insufficient resource allocation. Therefore, to
   increase IT use, more resources should be allocated to develop IT applications.
2. For the moderate IT-usage organisations, both organisational and technological factors affect the usage level. Specifically, after attaining a moderate level, organisations that have strong top management support with a less centralised IT structure are likely to improve IT-usage level. However, only 26 per cent of the variance in IT use is explained by these factors.

3. Technological factors are most influential on high IT-usage organisations than the other two categories of contextual factors. Slightly more than half of the variance is explained. For these organisations, integrated IT applications and distributed structure promote IT use.

These findings are summarised in Figure 9.1. The external factors appear to have no influence on any of the IT-usage groups because the organisations have a very similar environment.

Figure 9.1 Contextual Influences on the IT-Usage Levels

9.2.4 Other Findings

Analysis of the literature suggested eight dimensions of TQM, namely leadership, strategic planning process, output quality assurance, important innovations,
information and analysis, human resource utilisation, customer satisfaction, and quality results. The research findings supported this and suggested a ninth dimension, supplier quality assurance.

9.3 Implication of the Findings

The findings of this study suggest that Malaysian public sector managers seeking IT to support TQM implementation may best concentrate on developing innovative applications that improve efficiency and effectiveness of service delivery. The capability of IT could be exploited to simplify work processes as well as to make the public services more readily available. Applications that support the information need of the service providers should also be given priority. This is because information strongly influenced the achievement of quality performance (Forza 1995b). In order to make accurate information readily accessible at all times by those who need it to carry out their responsibilities, IT could also be used to maintain a comprehensive database of customer, supplier, employee and process/project. These up-to-date databases would enable the use of analytical and decision support tools to analyse complex problems, facilitating better decisions and assisting in formulation of realistic public policies. The electronic databases would form the groundwork for the Electronic Government projects and enable linkages among public agencies to realise ‘one-stop shopping’ for Malaysian citizens. Eventually, the quality of service delivery would be improved and the effectiveness and efficiency of the government would be increased, fulfilling the ultimate goal of TQM.

In the mid-term review of the Seventh Malaysia Plan 1996-2000, the allocation for IT projects has been doubled from 2 billions Ringgit to 4 billions Ringgit (“Allocation for IT projects doubled to RM4b” 1999). The extra allocation of about one billion Ringgit Malaysia was aimed for the implementation of Electronic Government projects. With the development and usage of IT that is expected to increase, Malaysian public sector managers need to be aware of those aspects of IT applications that should be given priority and how best to prepare their organisations for the increasing use of IT so that the target of the government will be met.
Conclusion & Implication

As suitable software to support TQM has been reported lacking (Ngai & Cheng 1998), this study helps to provide directions to software developers to focus their attention on developing software applications along these dimensions such as ‘Important Innovations’ and ‘Information and Analysis’ to cater for the immediate demand. The discrepancy between past work and this study on the use of IT to support ‘Customer Satisfaction’ and ‘Quality Results’ may indicate a potential of IT exploitation. If the relatively low IT-usage in ‘Supplier Quality Assurance’, ‘Quality Results’, ‘Customer Satisfaction’ and ‘Strategic Planning Process’ has been due to the lack of suitable software, then it will be beneficial for software developers to focus their software development in these areas.

To harvest the benefits of using IT in TQM, organisations need to be aware of their present IT-usage level and the contextual factors that may impede IT use. The regression results indicate that a low IT-usage organisation should allocate more resources to IT projects if it wishes to increase the IT-usage level. After attaining a moderate level, it should adopt a distributed IT structure to manage its IT provision for enhancing IT deployment. At the same time, top management should grant full support to all IT applications in order to further ensure the success of IT use. After which, a high usage level can be attained if all the IT applications are compatible to achieve one integrated information system.

Lastly, this study focused on the use of IT to support TQM processes in the Malaysian public agencies that have been candidates for the Prime Minister’s Quality Award. These ‘highly regarded’ agencies may not be considered representative of all TQM implementing organisations. The difference in sample selection may itself account for the contradicting findings reported by Ngai and Cheng (1998). As this present study was undertaken in a rather narrow field (i.e. public services), there may be concern as to the generalisability of the findings, especially to a wider profit-oriented community. This very much depends on how TQM is viewed. Garvin (1991) has pointed out that TQM does not guarantee instant financial success, but rather the long-term survival and future profitability of an organisation in the competitive and vulnerable market. It is possible that in the private sector, the quality programs are viewed very differently. The pressures in the profit-making sector may depend upon achieving results in the
short term, shifting the emphasis from the public at large to shareholders. Similarly, if IT is regarded as a tool to generate short-term return on investment, its usage in supporting quality programs may not be prioritised. If so, then the level of IT usage in supporting TQM would be difficult to establish.

9.4 Suggestions for Future Work

In presenting the findings and conclusions of this study, it should be noted that there are a number of limitations (addressed in Chapter 1). It is hoped that the following suggestions may help to overcome them.

1. In estimating a model for the use of IT in TQM, fifteen independent variables were used initially in the multiple regression analyses. However, after removing all those insignificant links, four variables remained that explained 65 per cent of the variance in the use of IT in TQM. Other predictors are needed to account for the 35 per cent non-explained variance. Future study may consider staff IT training a likely variable as about a quarter of the respondents in the present study as well as Foong’s (1999) study indicate that user’s IT literacy had a significant association with the extent of IT use. Another potential predictor for the model is the business knowledge and awareness of IT personnel as highlighted by about 15 per cent of the respondents and also in the study of Boynton et al. (1994). Another factor which may have an indirect but powerful relationship to IT use is the size of the ‘customers’ an organisation serves. As IT has been seen as a tool to ensure public accountability, it is likely that a demand for greater efficiency may lead to an increase in IT use.

2. Further to suggestion 1, in order to improve the explanatory power of the model, future study may expand the three contextual factors to include the fourth factor: user factors such as user characteristics (age, educational level, job responsibility and IT literacy) and their attitudes toward IT adoption. The present study has purposely excluded this category of factor because it was set to investigate IT use at the organisational level besides being restricted by the size of the measuring
Conclusion & Implication

instrument. However, past studies (e.g. Allingham & O'Connor 1992; Foong 1999; Martisons & Chong 1999) have shown that users significantly affect IT success. Further study is required to confirm if there are significant linkages.

3. Further to suggestion 1, in order to identify potential predictors for the IT-use-in-TQM model, future study may consider focus groups to complement the literature approach used in this study. This is because in group interviews, members tend to stimulate one another and this results in spontaneous responses and synergy among the group (Johns & Lee-Ross 1998, pp. 126-127).

4. Due to resources constraints, this study has used 'convenience' sampling to identify TQM implementing organisations: the Malaysian quality award candidate agencies as the 'generic' judges in the judgement study. These 'highly-regarded' public agencies may have well-developed IT facilities which would impact on any management approach/philosophy and thus may have biased the results in favour of IT usage. To rule out any such a possibility, future study should develop a measure to evaluate and identify all TQM implementing organisations. Results can then be compared between the award-nominees group and the non-nominees group.

5. There is a need to replicate this study in the same sector but in other cultural settings, such as Europe, the US and the East Asia, in order to examine cross-cultural similarities and differences. This will help to understand the potential moderating effects of geographic region and socio-political culture on the relationship between IT use and the influencing factors.

6. This study was limited to public agencies. In order to have a complete picture on the role of IT in TQM, further empirical work in the profit-oriented sector should be explored. This is because the IT priority and management in the public and profit-oriented sectors are not the same (Bretschneider 1990). Findings from different sectors will help to explain a more complete pattern of the actual contributions of IT in TQM.
7. This study has successfully used regression to determine the relationships between the use of IT in TQM and the various contextual variables. However, it cannot explain causality. In order to understand the nature of the relationships, future work should examine a smaller portion of the research situation in greater depth and detail. It is desirable to conduct case study research or action research to explain the causal links between the IT-use-in-TQM and the contextual variables, which are too complex to be determined from a questionnaire survey. The case study approach will contain a longitudinal component to allow the dynamics of IT development to be explored.

Further work is needed in order to better understand the role of IT in TQM and how it affects quality performance. In addition, many of the contextual factors that have significant relationships with the use of IT in TQM may be interconnected and potentially mutually reinforcing. Organisations should explicitly incorporate these factors in their day-to-day practice. They would eventually become part of the culture of managing organisational and technical change. It is also clear that many of the factors identified in this study are not restricted to IT deployment. One can argue that a study of this kind, focused on the deployment of IT in supporting TQM, provides an insight into managerial and organisational behaviour and learning more generally. It is hoped the findings of this study and suggestions put forward will help both researchers and practitioners in this area.
REFERENCES


References


References


References


References


APPENDICES
Appendix A

Questionnaire
HOW DOES INFORMATION TECHNOLOGY
SUPPORT QUALITY MANAGEMENT
IN HIGH PERFORMING PUBLIC AGENCIES?

We are undertaking a study to understand how IT can most appropriately be used to support Quality Management in the Malaysian public sector. Specifically, this questionnaire is to examine the use of IT in the agencies which have been candidates for the Prime Minister’s Quality Award. Please indicate your responses about your agency, not the whole organisation, if it is only your unit/division which has been a candidate for the Award. Please try to answer all the questions.

Thank you for your help.

Please return this questionnaire by 1 August 1998 to:

Sekolah SiswaZah
Universiti Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman
Information technology (IT) is defined as hardware and software that collect, process, transmit, and/or disseminate information.

We would like to ask about the use of IT applications in your agency and to learn more about the factors influencing its use.

### A. Background Information

1. Please circle the appropriate number, on the scale below, which best describes IT in your agency.

<table>
<thead>
<tr>
<th>a. Overall, the use of IT applications on the delivery of our agency's services has been</th>
<th>very little</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very much</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>b. Overall, the extent to which IT has been used to support quality management in our agency is</th>
<th>very little</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>very much</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>c. Overall, the external influences on our use of IT are</th>
<th>weak</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>strong</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>d. Overall, our agency's support for IT use is</th>
<th>weak</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>strong</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>e. Overall, our current IT facilities and practices are</th>
<th>poor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>excellent</th>
</tr>
</thead>
</table>

2. Please tick (✓) the statement which best describes your agency's present IT applications. Tick only ONE box.

- Few unconnected and uncoordinated systems which focus on accounting and finance. □
- Many applications on centralised systems mainly to meet operational and financial needs. □
- Still mostly centralised systems and most major business activities are covered. □
- Decentralised integrated office technology systems with some controls but mostly lacking co-ordination. Some decision support applications. □
- Decentralised systems but with central control and co-ordination. More decision support applications and some strategic systems using external data. □
- Comprehensive, centrally co-ordinated internal systems with inter-organisational systems linking with other organisations, e.g. suppliers, customers, and government. □

3. Please tick (✓) the category which best fits the number of staff employed in your agency.

- less than 50 □
- 50-149 □
- 150-299 □
- 300-500 □
- over 500 □

---

1 Agency is used to refer to Ministry, Department, Statutory Body, Local Authority, either at the federal or state level, as well as Unit or Division under these organisations. It is the unit to which all your subsequent responses should apply.
### B. Use of IT in Quality Management

The following questions aim to assess the use of IT in the eight aspects of quality management outlined by MAMPU. Please indicate the extent to which IT has affected the ability of your agency to perform the following activities by circling the appropriate number ranging from 1 (not at all) to 7 (maximum feasible amount).

**Example:** How much has IT helped to improve your work?

<table>
<thead>
<tr>
<th>aspect</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

This example indicates that you have rated highly the use of IT to improve your work, but you feel it would have been possible to achieve a little bit more within your current IT capabilities.

#### Leadership

<table>
<thead>
<tr>
<th>How much has IT helped your agency’s leadership to:</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Formulate vision and mission</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2. Make their commitment to quality visible to staff</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3. Create quality as a way of life within your agency</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4. Communicate quality values to staff</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Facilitate communication between top management and other staff</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Encourage staff involvement to improve work processes</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. Empower staff for continuous improvement</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

#### Strategic Planning Process

<table>
<thead>
<tr>
<th>How much has IT been used by your agency’s management to:</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>8. Identify strategic issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. Analyse strategic issues</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10. Make strategic decisions</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11. Formulate strategic plans</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. Document strategic planning</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
### Output Quality Assurance

**How much has IT helped your agency to:**

<table>
<thead>
<tr>
<th></th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Set up service quality standards</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Control work processes in the delivery of services</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Use quality tools such as flow charts, histograms and Pareto charts for quality control (Statistical Process Control)</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Improve services continuously</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Assess actual performance against established quality standards</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Document work procedures/processes</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Determine supplier quality</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Facilitate inter-organisational co-operation for service quality</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Important Innovations

**How much has IT impacted your agency’s effort to:**

<table>
<thead>
<tr>
<th></th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Create innovative work processes</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. Implement innovations to improve service quality</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Information and Analysis

**How much has IT been used by your agency to:**

<table>
<thead>
<tr>
<th></th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>23. Collect data about staff, customers, and suppliers</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24. Collect data about work processes</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25. Maintain databases</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26. Maintain quality information systems</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27. Provide professional staff with decision support tools such as statistical techniques and cause-effect diagrams</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28. Provide timely information to staff for decision making</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29. Provide relevant information that meets staff requirements</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30. Produce comprehensive information for different levels of need</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31. Allow staff to access information for decision making</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32. Improve information accuracy</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>33. Improve information consistency</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Human Resource Utilisation

**To what extent has IT affected the ability of your agency to:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>34. Make information available to staff for carrying out their responsibilities</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>35. Form work teams or quality improving groups</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. Facilitate team-working to solve problems</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37. Involve staff in quality improvement</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>38. Solicit suggestions from staff for quality improvement</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>39. Provide feedback to staff on quality performance</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40. Enable staff to share task-related information</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>41. Plan staff training needs</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42. Train staff on quality-related skills</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>43. Provide work-related skills</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>44. Recognise staff for their contribution to quality improvement</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>45. Appraise staff participation in quality improvement programmes</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Customer Satisfaction

**How much has IT helped your agency to:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>46. Identify customer needs</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47. Assess customer needs</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48. Measure customer satisfaction</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49. Improve communication between your agency and customers</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Quality Results

**To what extent has your agency used IT to:**

<table>
<thead>
<tr>
<th>Activity</th>
<th>not at all</th>
<th>moderate</th>
<th>maximum feasible amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>50. Measure service quality</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>51. Measure productivity</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52. Measure reductions in operational costs</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53. Monitor waste such as waiting, re-do work, and damage to equipment</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54. Evaluate employee satisfaction</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
C. Future Plans

*Does your agency plan to increase the extent of IT use in quality improvement programmes in the next three years? If yes, please briefly describe the plans.*

---

D. External Influences

*Please rate your agency, on the scales below, by circling the number that best describes your agency in recent years. Each statement is concerned with the external influences on the use of IT in your agency.*

<table>
<thead>
<tr>
<th>1. The effect of the economic climate on our IT projects is</th>
<th>weak 1 2 3 4 5 6 7 strong</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. The hardware and software required for our IT applications can be obtained in the IT marketplace</td>
<td>with difficulty 1 2 3 4 5 6 7 easily</td>
</tr>
<tr>
<td>3. The influence of government policies on our IT use is</td>
<td>weak 1 2 3 4 5 6 7 strong</td>
</tr>
<tr>
<td>4. The use of IT to ensure public accountability or responsibility is</td>
<td>minimal 1 2 3 4 5 6 7 extensive</td>
</tr>
<tr>
<td>5. Co-operation with other public agencies to implement our IT applications is</td>
<td>poor 1 2 3 4 5 6 7 good</td>
</tr>
</tbody>
</table>
E. Organisational Factors

Please rate your agency, on the scales below, by circling the number that best describes your agency in recent years. Each statement is concerned with the organisational context affecting the use of IT in your agency.

1. Strategic decision making is highly centralised
   - centralised 1 2 3 4 5 6 7 decentralised

2. The recognition by our managers on the potential of IT to enhance quality output is low
   - low 1 2 3 4 5 6 7 high

3. Support given by top management for IT applications is weak
   - weak 1 2 3 4 5 6 7 strong

4. Resources allocated to IT projects are insufficient
   - insufficient 1 2 3 4 5 6 7 sufficient

5. Our IT strategy and business objectives are isolated
   - isolated 1 2 3 4 5 6 7 aligned

6. The justification for IT investment is mostly cost issues
   - cost issues 1 2 3 4 5 6 7 quality issues

F. Existing Technological Implementation

Please rate your agency, on the scales below, by circling the number that best describes the present IT circumstances in your agency.

1. The IT facilities for our business operations are bad
   - bad 1 2 3 4 5 6 7 good

2. The help available to staff using IT applications is limited
   - limited 1 2 3 4 5 6 7 extensive

3. The level of integration among IT applications is low
   - low 1 2 3 4 5 6 7 high

4. The provision of IT facilities and support is highly centralised
   - highly centralised 1 2 3 4 5 6 7 distributed

5. The technical skills of the IT staff are low
   - low 1 2 3 4 5 6 7 high

G. Respondent

Finally, we would like to ask a few questions about yourself for statistical purposes.

1. Your job title: ____________________________________________

2. How many years have you worked in your present agency? ________ years
Is there anything else you would like to tell us about the factors influencing the use of IT, or what your agency has done to encourage the use of IT? If so, please use this space to share with us.

Also, any comments you wish to make that you think may help us in future efforts to understand how IT can support quality management will be appreciated, either here or in a separate sheet of paper.

Would you like a summary of the results? Yes □ 1  No □ 2

Date: ________________

We sincerely appreciate your time and co-operation. Please check to make sure that you have not skipped any questions, and then return the questionnaire in the post-paid envelope provided.

Thank you very much for your contribution.
Appendix B

Survey Cover Letter
Penambahbaikan kualiti dan produktiviti Perkhidmatan Awam sentiasa menjadi matlamat utama kerajaan. Dengan pelancaran program reformasi khasnya Kerajaan Elektronik, Perkhidmatan Awam dijangka akan mempertingkatkan lagi penggunaan Teknologi Maklumat (IT) dalam operasi sehari-hari, khususnya dalam pengurusan untuk kualiti.

Soalselidik ini adalah sebahagian daripada satu penyelidikan yang bertujuan untuk mengkaji kesan IT ke atas pengurusan kualiti di kalangan agensi awam Malaysia yang berprestasi tinggi. Oleh kerana agensi tuan/puan dikenali pasti sebagai salah satu daripada agensi sektor awam yang telah mencapai tahap kepimpinan kualiti yang tinggi, kami memohon kerjasama tuan/puan untuk mengisikan borang soalselidik yang terkepil.

Kajian ini dianggap penting kerana ia akan dapat menjanakan laporan tentang penggunaan IT dalam pengurusan kualiti di kalangan agensi awam yang berprestasi tinggi. Maklumat ini akan dapat membantu dalam perancangan dan pelaksanaan program reformasi selain menjadi rujukan bagi pengurusan awam yang bercadang untuk memperkenalkan komputer ke dalam agensi mereka. Agensi berprestasi tinggi seperti agensi tuan/puan akan dapat menggunakan keputusan kajian ini untuk mengukur tantat penggunaan IT.

Sukacita kami mengesahkan bahawa segala maklumat yang tuan/puan kemukakan akan dikekalkan sulit. Tiada kes individu akan dilaporkan. Nombor pengenal pasti yang tertera pada muka hadapan borang soalselidik hanya untuk tujuan mengenalpasti agensi yang telah mengembalikan borang tersebut.

Sekiranya tuan/puan ingin menerima satu salinan laporan kajian tersebut, sila nyatakan di belakang borang soalselidik itu.

Kami amat menghargai bantuan tuan/puan untuk menjayakan penyelidikan ini. Sesungguhnya sumbangan tuan/puan akan membantu agensi awam lain dalam usaha mereka untuk melaksanakan pengurusan kualiti. Adalah diharap bersama-sama kita dapat mempergiatkan lagi usaha untuk mewujudkan Perkhidmatan Awam yang cemerlang.

Jika tuan/puan mempunyai sebarang pertanyaan, sila hubungi nombor telefon: 04-7005103.

Terima kasih.

Yang benar

Ang Chooi Leng
Penyelidik/Pensyarah
Print Text

Translation

Dear ------

Improving the quality and productivity of the Public Service has always been the goal of the government. With the launch of the Electronic Government initiatives, the Public Service is expected to maximise the capabilities of IT in its operations, especially in the management for quality.

This questionnaire is part of a study aimed at determining the impact of IT on quality management among the Malaysian high performing public agencies. Your organisation has been recognised as one of the leaders in the Malaysian public sector; hence we would be pleased if you could respond to the questionnaire enclosed.

This study is deemed important, as it will help to generate a profile of IT applications in quality management of the leading public agencies and enhance the planning and implementation of the reformation programmes. It will also serve as a reference for public managers who plan to introduce computers into their agencies. Organisations like yours will be able to use the results of this study to benchmark current IT applications.

Please be assured that all responses will remain confidential to the research team. No individual cases will ever be reported. The questionnaire has an identification number for mailing purposes only. This is so that we may check off your agency when your questionnaire is returned.

If you would like a summary of the results, please indicate accordingly at the end of the questionnaire.

We greatly appreciate your help in furthering this research endeavour. More importantly, we are sure that your contribution to this study will help other public agencies in their pursuit of quality management and together we can gear our effort toward improving the Malaysian public sector as an excellent service provider.

We would be most happy to answer any questions you might have. Please call. The telephone number is 04-7005103.

Thank you.

Yours sincerely

Ang Chooi Leng
Researcher
Appendix C

Letter of the Survey Sponsor
PUAN ANG CHOOI LENG - PENYELIDIKAN IJAZAH DOKTOR FALSAFAH: THE USE OF INFORMATION TECHNOLOGY (IT) TO SUPPORT QUALITY MANAGEMENT IN THE MALAYSIAN PUBLIC AGENCIES

Sukacita dimaklumkan bahawa Puan'Ang Chooi Leng, seorang pensyarah di Universiti ini sedang menjalankan satu projek penyelidikan seperti di atas dan perlu mengutip maklumat daripada organisasi yang mempunyai tahap pencapaian pengurusan kualiti yang tinggi.

Projek ini merupakan satu kajian yang penting yang dijangka akan dapat membantu agensi kerajaan membuat perancangan yang lebih teliti terhadap keperluan IT di negara ini menjelang abad ke-21.

Sehubungan ini, besarlah harapan saya sekiranya tuan/puan dapat memberi kerjasama dan bantuan seperti yang diperlukan demi memantapkan hasil penemuannya serta memberi hasil yang bernas terhadap peningkatan berterusan dalam bidang teknologi maklumat dan pengurusan untuk kualiti.

Di atas segala bantuan yang diberikan, saya mengucapkan terima kasih.

Sekian dan salam hormat.

Yang benar,

(DATO' PROF. IR. DR. MOHAMMAD NOOR B. HJ. SALLEH)
Naib Canselor
Appendix D

Predictive Criteria Questionnaire
The Impact of IT on TQM among Malaysian Public Agencies

Information technology (IT) is defined as hardware and software that is used to collect, process, transmit, and disseminate information.

1. Please circle the appropriate number, on the scale below, which best describes the impact of IT on your agency.

<table>
<thead>
<tr>
<th></th>
<th>very little</th>
<th>very great</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Overall, the impact of IT on our agency’s service quality has been</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>b. Overall, the impact of IT on our agency’s quality management has been</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>c. Overall, the impact of IT on our agency’s service productivity has been</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
<tr>
<td>d. Overall, the extent to which IT has been used to support quality management in our agency is</td>
<td>1 2 3 4 5 6 7</td>
<td></td>
</tr>
</tbody>
</table>

Please return the questionnaire today using the pre-paid envelope enclosed.

Thank you very much
Appendix E

Executive Summary
Executive Summary: The Use of IT to Support TQM among the Malaysian Public Agencies

I am writing to thank you for participating in a study on “The Use of IT to Support TQM among the Malaysian Public Agencies” under the sponsorship of the Universiti Utara Malaysia. As promised, I hereby enclosed a copy of the executive summary for your reference. Should your agency require further information regarding the findings, please do not hesitate to contact me.

Together with this letter I also enclose a one-page questionnaire aimed to supplement the previous study. I sincerely hope that you will continue to extend your support to the study. May I ask you to answer the 4 questions in the questionnaire and return it immediately using the pre-paid envelope provided. Your prompt reply is very much needed to further enhance the quality of the study.

Once again, I would like to take this opportunity to thank you for responding to the questionnaire. Your participation has contributed to a study that will be very useful to the Malaysian public agencies.

Many thanks in anticipation and best regards.

Ang Chooi Leng
Lecturer
UUM
Executive Summary

The Use of IT to Support TQM in Malaysian Public Agencies

Ang Chooi Leng
email: C.L.Ang@lboro.ac.uk  fax: 44 1509 223960

Research Objective

This study investigated the extent to which IT has been used to support TQM among the selected Malaysian public agencies. It also identified external, organisational and technological factors which may influence its use to support TQM in order to guide the deployment of IT in Malaysian public agencies.

A schematic diagram of the research framework is illustrated in Figure 1. The contextual influences that may impinge on the extent of IT use in supporting TQM include external factors (IT availability in marketplace, legislation influence, public accountability and inter-agency co-operation), organisational factors (managerial IT knowledge, top management support, resources allocation, IT-business goal alignment, and budgeting method), and technological factors (IT facilities, help availability, IT integration, IT structure, IT skills and IT experience).

Figure 1. Schematic Diagram of the Research Framework

Contextual Influences

- External factors
- Organisational factors
- Technological factors

TQM Supported by IT

Use of IT in TQM Processes:
- leadership
- output quality assurance
- human resource utilisation
- strategic planning process
- important innovations
- information and analysis
- customer satisfaction
- quality results

Organisational Performance
- customer satisfaction
- quality results
Data Sources

A survey questionnaire was sent to 110 Malaysian public agencies that have applied for the Malaysian Prime Minister’s Quality Award since its inception. The list of agencies was obtained from the Malaysian Administrative Modernisation and Management Planning Unit (MAMPU).

The results presented were based on the responses from 47 agencies, representing an effective response rate of about 43%.

Findings

1. Usage

The extent of IT use was significantly different along the eight dimensions of TQM, namely leadership, output quality assurance, human resource utilisation, strategic planning process, important innovations, information and analysis, customer satisfaction, and quality results (Figure 2). The ‘important innovations’ has the highest level of IT use followed closely by the ‘information and analysis’. On the other hand, the agencies reported to have used the least of IT in the ‘quality results’ followed by the ‘customer satisfaction’ and the ‘strategic planning process’.

Figure 2. Extent of IT Use along the Eight Dimensions of TQM

2. External Factors

The responding agencies were classified into three distinct IT-usage groups (low, moderate, and high) according to their level of IT usage along the eight dimensions of TQM. The contextual influences on the three IT-usage groups were explored. Figure 3 shows the influence of the external factors on the three IT-usage groups (measured on a 7-point scale). Out of the four external factors investigated, only ‘public accountability’ was found to affect the use of IT among the members of the low group. Apparently these external factors did not have any effect on the extent of IT use for the moderate and high groups.
3. Organizational Factors

The effect of organizational factors on IT-usage level is shown in Figure 4. Although the high group reported to receive a more positive influence from these factors than the other groups, the organizational factors were found to have insignificant influence on the extent of IT use. The only factor which affect the moderate group is top management support. As for the low group, strong top management support and sufficient resources allocation were found to enhance IT use.

Figure 4. Organizational Influences on IT-Usage Groups
4. Technological Factors

Finally, technological factors were not found to influence IT use for the low group. However, for the high group, these factors especially ‘IT facilities’, ‘IT integration/compatibility’ and ‘IT structure’ affected the usage significantly. The competency of IT staff, IT structure and IT integration/compatibility issues were found to affect the moderate group. The influence of these technological factors on the usage levels is shown in Figure 5.

Figure 5. Technological Influences on IT-Usage Groups

5. Overall Results

Interestingly, the findings of this study indicate that in order to increase the low IT-usage level, an agency should provide strong top management support for IT applications and focus its use to ensuring public accountability. More resources should also be allocated to improve IT facilities for business operations. When the IT usage level has increased, top management should continue to give the positive support. In addition, the agency should concentrate on improving the competency of its IT staff. IT integration and system compatibility should then be emphasised, with IT management be shifted toward distributed structure. When an agency has attained a high IT-usage level, external factors and organizational factors become less important in influencing its use. Instead the agency should focus on technological factors to further enhance IT use. At this stage, high level of IT integration and good IT facilities with distributed IT structure should be the ultimate goals.
Appendix F

Scatter-plot Matrices and Residual Plots

for Regression Equations
### TQMSIT vs External Factors

<table>
<thead>
<tr>
<th></th>
<th>1 IT availability; 2 Legislation influence; 3 Public accountability; 4 Inter-agencies co-operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

**NB:** TQMSIT is used to mean 'IT-use-in-TQM'.

### TQMSIT vs Organisational Factors

<table>
<thead>
<tr>
<th></th>
<th>1 IT knowledge; 2 Top management support; 3 Resources allocation; 4 IT-business plans; 5 IT justification</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

**NB:** TQMSIT is used to mean 'IT-use-in-TQM'.

---

*Appendix F*
Appendix F

TQMSIT vs Technological Factors

1 IT facilities; 2 Help availability; 3 IT integration
4 IT structure; 5 IT skills; 6 IT experience

Histogram of Residuals

External Factors

Studentized Deleted (Press) Residual

Std. Dev = .99
Mean = .06
N = 42.00

NB: TQMSIT is used to mean 'IT-use-in-TQM'.

2
Appendix F

Histogram of Residuals
Organisational Factors

Studentized Deleted (Press) Residual

Normal P-P Plot of Residual
Organisational Factors

Std. Dev = 1.06
Mean = .00
N = 42.00

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Appendix F

Normal P-P Plot of Residual External Factors

Residuals vs Predicted Values External Factors

NB: TQMSIT is used to mean 'IT-use-in-TQM'. 
Residuals vs Predicted Values

Organisational Factors

Studentized Deleted Residual

Predicted Value

Histogram of Residuals

Technological Factors

Studentized Deleted (Press) Residual

Std. Dev = 1.02
Mean = .05
N = 42.00

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Normal P-P Plot of Residual
Technological Factors

Residuals vs Predicted Values
Technological Factors

NB: TQMSIT is used to mean ‘IT-use-in-TQM’.
Histogram of Residuals

Combined Predictors - Method: Enter

Studentized Deleted (Press) Residual

Normal P-P Plot of Residual

Combined Predictors - Method: Enter

NB: TQMSIT is used to mean 'TT-use-in-TQM'.
Residuals vs Predicted Values

Combined Predictors - Method: Enter

Histogram of Residuals

Combined Predictors - Method: Backward

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Normal P-P Plot of Residual
Combined Predictors - Backward

Residuals vs Predicted Values
Combined Predictors - Method: Backward

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Appendix F

Histogram of Residuals
Combined Predictors - Method: Forward

Studentized Deleted (Press) Residual

Normal P-P Plot of Residual
Combined Predictors - Forward

NB: TQMSIT is used to mean "IT-use-in-TQM".
Residuals vs Predicted Values

Combined Predictors - Method: Forward

Histogram of Residuals

Combined Predictors - Method: Stepwise

Studentized Deleted (Press) Residual

Std. Dev = 1.05
Mean = -.01
N = 42.00

NB: TQMSIT is used to mean ‘IT-use-in-TQM’.
Normal P-P Plot of Residual

Combined Predictors - Stepwise

Residuals vs Predicted Values

Combined Predictors - Method: Stepwise

NB: TQMSIT is used to mean ‘IT-use-in-TQM’.
Appendix F

Histogram of Residuals

High TQMSIT

Studentized Deleted Residual

Normal P-P Plot of Residual

High TQMSIT

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Residuals vs Predicted Values

High TQMSIT

Histogram of Residuals

Moderate TQMSIT

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Normal P-P Plot of Residual

Moderate TQMSIT

Residuals vs Predicted Values

Moderate TQMSIT

NB: TQMSIT is used to mean 'IT-use-in-TQM'.
Appendix F

Histogram of Residuals

Low TQMSIT

Studentized Deleted (Press) Residual

Normal P-P Plot of Residual

Low TQMSIT

NB: TQMSIT is used to mean 'IT-use-in-TQM'.

Residuals vs Predicted Values

Low TQMSIT

NB: TQMSIT is used to mean 'IT-use-in-TQM'.

Appendix F