**Division of Manufacturing
Engineering and Operations Management**

Development of A Framework for the Transfer of Quality Management to Thai Industry

**By
Montalee Nagswasdi
BS. , MS.**

**Thesis submitted for the degree of Doctor of Philosophy
December 1998**

TO:

My parents

Table of Contents

Findings
Discussions

List of Figures

List of Tables

Acknowledgment

I would like to express my sincere gratitude to my supervisor and mentor Professor Christopher O'Brien for his patience and understanding throughout the course of this work. His untiring support and continuous interest throughout the project has been an inspiration to me.

I am also very grateful to my co-supervisor Prof. Dr. Pakorn Adulphan for his suggestions and managerial support in Thailand.

I would also like to express my appreciation to Prof. F. Nishikawa, Dr. K. Nakamura, Dr. M. Hasegawa from Nagaoka University of Technology, Japan for their generous helps during my visit to Japan.

I am also grateful to all the staff and friends of the Department of Manufacturing Engineering and Operations Management especially, Mrs. Ann Wright, for their support.

I would also like to thank Prof. Dr. Naksitte Coovatanachai, and all my colleagues and friends at the Faculty of Engineering, Thammasat University, particularly Dr. S. Praparntanatorn, Dr. J. Jaroenpantarak, and Dr. B. Tulyathan, for their kind encouragement.

This work could not have been accomplished without the financial support of Thammasat University to which I am indebted. I am also grateful to the Japan International Cooperation Agency (JICA) for providing generous support during my plant visits in Japan. My appreciation also goes to those who provided valuable information for the case studies, unfortunately, whose names cannot be revealed due to the confidentiality agreement.

Finally, my greatest thanks go to all the members of my family: Mom and Dad - thanks for your love and for always being there, Pop- thanks for being a special sister, Setta- thanks for being a friend and a good husband. Most of all, I would like to thank my parents again for their moral support and inspiration. Without their love, I would not have been where I am today; therefore, I dedicate this work to them: Mr. Chalermsag and Mrs. Tida Nagswasdi.

Abstract

Due to the rapid changes in manufacturing environment, management innovation has been of heightened interest for industrial practitioners. All over the world, organizations are searching for the best approaches that allow them to sustain growth and competitiveness. Of equal importance is the adoption and transfer of management practices that have been successfully applied in various environments.

This research is primarily concerned with the adoption of management practices to Thai industry. The questions of interest are: what impedes or enhances the adoption of management practices, what kinds of applications are more difficult to adopt, and what are the critical success factors in the adoption process.

This study involves an empirical study of 53 Thai companies that are interested in adopting, or are adopting quality management. Of particular interest is the implementation of total quality management (TQM) and ISO 9000 as they are widely recognized among Thai practitioners. The findings lead to greater understanding in the issues of quality management evolution of Thai industries.

The research also deals with in-depth case studies of seven companies in Thailand and Japan, whose results validate the findings from the empirical studies and offer further insights into the critical success factors in the adoption process. The overall conclusions have been drawn from a combination of the quantitative analyses and the case studies.

Important contributions of this work are as follows.

1. It provides greater insights into the various stages of development of Thai manufacturing industries toward quality management by investigating the characteristics of organization and technology. The findings are useful in that they recommend the approaches appropriate for each stage of organizational and technological development.

2. Based on the systematic studies of Thai and Japanese manufacturing industries, the findings add to existing management theories by pointing out the critical success factors in the adoption of management practices. The investigation also leads to a framework for the transfer of quality management to the Thai industry. The framework serves as a general guideline for those wishing to successfully adopt management practices.

Chapter 1

Introduction

1.1 Introduction

This Chapter provides an overview of the research by describing the aims, its background, the targeted end users, the benefits of the research, and the plan of the study.

1.2 Aims of the Research

The general aim of this research is to investigate the development of Thai manufacturing industries toward quality management and to formulate a framework for the transfer of quality management to Thai manufacturing industry. It builds on existing theories of best management practices, and offers further insights into the key issues facing organizations in their efforts to adopt quality practices.

To achieve the overall aim, preliminary research that is described in Chapter 2 reveals that the following areas need to be explored.

1. The impacts of quality practices on performance.
2. The evolution of quality management in the Thai industry.
3. The relationship between the levels of quality development and performance.
4. The characteristics of Thai organizations that successfully adopt quality management practices.

It is expected that the findings would benefit those wishing to gain a greater understanding of the development of Thai manufacturing industries toward quality management. For individuals responsible for planning and instigating change within organizations, the framework should provide helpful guidelines for the transfer of quality practices.

1.3 Background to the Research

With the emergence of free-trade areas in Europe, North America, and elsewhere in the world, it is increasingly difficult to sustain competitiveness by protecting markets. This, together with the growth of international trade, means that companies are now competing on a worldwide scale (Pfeffer, 1994).

Global competition is healthy for industry and for each country's economy (Schonberger, 1986). It is also the main reason that stimulates manufacturers to search for the approaches that guarantee competitive advantages. The industrialized nations have struggled for decades to find the best practices. Through their struggling, various management practices have been developed.

The emerging nations have the advantage of not having to repeat the mistakes that were made by the industrialized countries (Crosby, 1991). They can progress through a much shorter path to success if they take time to study the approaches. An important issue that emerges is the transfer of these practices which has become the major theme of this research.

1.4 Plan of the study

To accomplish the research aims, it is necessary to conduct preliminary research in order to identify the areas to be explored. This is presented in detail in Chapter 2, which contains a review of the pertinent studies together with an analysis and critique of their findings.

Chapter 3 states the research problems and presents the details of the adopted methodology. This involves the research methods for both quantitative and qualitative studies. including hypotheses development, survey instrument, data collection methods, and identification of study sites.

Chapter 4 presents the results of the quantitative analyses that involve surveying thirty-five Thai companies that are currently adopting, or interested in adopting quality management practices. The findings disclose the pattern of organizational and technological development of the Thai manufacturing industries, and justify the hypotheses concerning quality management practices. The Chapter ends with the recommendations on the management practices appropriate for each stage of development.

Chapter 5 discusses the results of the in-depth case studies of seven manufacturing companies in Thailand and in Japan in order to validate the findings from the quantitative analyses. The characteristics of successful organizations are also revealed, leading to the identification of the critical issues in the transfer of management practices.

Chapter 6 presents the conclusions stemming from the research together with the framework for the transfer of quality management to the Thai manufacturing industry.

Chapter 2
Literature Review

2.1 Introduction

This chapter examines studies pertaining to competitive approaches, analyzes and critically reviews their findings, and identifies areas that are still unexplored.

In general, the studies are scattered across several disciplines, including production and operations management, social sciences, management sciences, finance, and accounting. In this study, the issues are grouped into three categories: organization, technology, and management.

According to the sociotechnical system perspective, an organization is made up of three subsystems: social, technical, and environmental that are inextricably related. The social subsystem is the organization and people; the technical subsystem consists of the tools, techniques, and methods used to produce a product or service; and the environmental subsystem consists of owners and other stakeholders, customers, and regulatory environment. The success of an organization depends upon the compatibility between the three subsystems (Michael et al., 1981). From an early work of Trist and Bamforth (1951) of the Tavistock Institute in London, the sociotechnical-system approach to organizational change involves the change activities that account for both the technological requirements and the social relationships of the people. The role of management is to integrate the social with the technical system in order to gain an optimum fit between the organization and its environment (Shani et al., 1992).

The first section of the Chapter focuses on the organizational system, and places emphasis on organizational learning as it is generally recognized as a key reason for competitiveness. In the second section, studies concerning the technological dimension are reviewed, followed by the impacts of technological adoption on organizational issues, and the timing of organizational versus technological changes. The next two sections review the management practices that have emerged from the 1970s to the present time and the roles of quality management practices in improving competitiveness. This is followed by discussions on various management practices including lean production, world-class manufacturing, just-in-time manufacturing, total quality management (TQM), and the ISO 9000 quality system. TQM is given particular attention as it is one of the most popular approaches. Then comparisons between various practices are conducted, and benefits and disadvantages are identified. The next section reviews the research on quality management with emphasis on TQM issues. This leads to the final discussion on the remaining research areas to be explored.

2.2 Organization

Organizations are social arrangements for the controlled performance of collective goals. In an organization, people strive to achieve control over the use of resources to produce goods and services efficiently (Huczynski & Buchanan, 1991).

In recent years, considerable attention has been given to the subject of organizational learning as it has been recognized as a source of competitiveness. It is also believed to be one of the key reasons attributable to the Japanese success (Bowonder and Miyake, 1993). Another reason for the heightened interests in organizational learning is the rapid technological changes which increase the uncertainties facing companies (Dodgson, 1993; Duffin, 1997; Huber, 1996). The relationship between organization learning and technology is that learning is a key feature in the process by which companies accumulate technology in order to compete (Akhilesh and Madanmohan, 1993; Coates, 1996; Karnoe, 1996; Voss, 1987).

Although several definitions of a learning organization have been offered in the literature as shown in Table 2.1, most of them view organizational learning as a process that evolves over time, and is linked with knowledge acquisition and improved performance (Garvin, 1993).

The two main concepts that are widely used in the literature to analyze organizational learning activities are: knowledge base and core competence.

The term knowledge base is used to analyze the form of knowledge and the focus of its accumulation. It is becoming common to find suggestions that specialized knowledge has become a crucial factor for business success (Blackler, 1993; Aaker, 1989). Organizational uniqueness is defined by knowledge bases and the processes of acquisition, organization, distribution, and enhancement of the knowledge over which it has control (Blackler, 1995; Dodgson, 1993; Huber, 1996). An organization can acquire knowledge from its everyday experience, its interaction with environments, and its direct purchasing of knowledge such as by joint venture and licensing (Huber, 1996). Through its normal operations, an organization can transform everyday experiences into organizational knowledge by creating a system of eliciting and utilizing the knowledge in order to stimulate organizational learning (Argote, 1996; Dodgson, 1993; Huber, 1996). An organization can also acquire knowledge by interacting with environments. This includes learning from the process of benchmarking best practices, and interaction with customers and suppliers (Boxwell, 1994).

Table 2.1 Definition of a learning organization

Definition of a learning organization
'A learning organization is a company that purposefully constructs structures and strategies so as to enhance and maximize organizational learning.' (Dodgson, 1993).
'Organizational learning means the process of improving actions through better knowledge and understanding.' (Fiol and Lyles, 1985)
'A learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights.' (Garvin, 1993)
'An organization learns when, through its processing of information, it increases the probability that its future actions will lead to improved performance.' (Huber, 1996).

The other concept that is related to organizational learning is that of core competencies. The concept of core competencies is similar to the above approach in that it also refers to the uniqueness of companies' knowledge and learning. According to Prahalad and Hamel (1990), the concept of core competencies is portrayed as the collective learning in the organization, especially that involving the ability to coordinate production skills and technologies into competencies that empower the company to adapt quickly to a changing environment. The competitiveness of a firm depends on its ability to build and manage organizational competencies which should be made difficult to imitate.

Similar to the notion of core competencies, some authors suggest the idea of organizational routines (Levitt and March, 1988) which, "makes the lessons of history accessible to subsequent organizational members". Among all these notions, it is important to note that the process of building such competencies should be continuous (Pavitt, 1991; Pfeffer, 1994; Weick, 1996).

The nature of the knowledge base or core competence is individual to each company and is a crucial factor affecting its competitiveness (Knott et al., 1996; Grant, 1991; Williams, 1992).

Although the subject of organizational learning has been widely discussed in the literature, most of the discussions are highly philosophical and lack guidelines for practice (Garvin, 1993). For example, some authors (e.g. Coates, 1996) suggest an approach to identify the organization's strategic core competence sets and to manage them for maximum values. However, few articles have been written about the actual process of creating core competence or organizational learning. Section 2.5 will discuss the management systems that help facilitate organizational learning.

The next section reviews the issue of technology since it is closely related to organizational learning. As cited earlier, learning is a key factor that helps companies accumulate technology by the innovation processes within the company or by an acquisition from external sources. The following section explains the benefits/disadvantages of technology and its impact on organizational issues.

2.3 Technology

The term 'technology' is rather ambiguous as it has been used with a large variety of meanings (Huczynski & Buchanan, 1991). For example, Winner (1977), a frequently referenced commentator on modern technology, identifies three different uses of the term 'technology': apparatus, technique, and organization. Apparatus is related to the physical devices that are used to accomplish a variety of tasks. Technique refers to the technical activities that are performed by people in order to achieve particular purposes. Organization is the social arrangements that are created to achieve technical ends. This study makes use of the word 'technology' by referring to the first two contexts. The definition which is most useful and thus adopted in this study is "the sequence of physical techniques used upon the workflow of the organization; the concept covers both the pattern of operations and the equipment used" (Pugh and Hickson, 1976).

There are both pessimistic and optimistic views regarding the adoption of technology. The potential drawbacks have been cited as the dehumanization of work, deskilling, and loss of employment (Braverman, 1974; Merton, 1947). The popularity of this notion has been partly due to the claims of vendors that investment in their equipment will be repaid by allowing companies to reduce the need for labour and by replacing expensive skilled labour with cheap unskilled labour (Storey, 1994). These negative views are counterbalanced by the various claims of benefits of technology.

Among the many cited benefits are, for instance, the replacement of dangerous and boring jobs, removing problems of human errors, upgrading skill requirements and teamwork (McLoughlin & Clark, 1988; Pugh and Hickson, 1976; Huczynski & Buchanan, 1991). Pfeffer (1994) discusses the increasing skills required by technology:

> More skills may be required to operate the more sophisticated and advanced equipment, and with a higher level of investment and employee, interruptions in the process are increasingly expensive. This means that the ability to effectively operate, maintain, and repair equipment- tasks all done by first line employees- becomes more critical (Pfeffer, 1994, pp. 9-28).

A higher level notion is that technology is a competitive weapon and investment in advanced process technology would strengthen the competitive advantage of manufacturers (Bessant, 1993; Cardone, 1993; Hass, 1987; Hayes and Wheelwright, 1984). Technological advances also hold potential benefits for improvements in all aspects ranging from quality, cost, flexibility, delivery, design and accuracy (Balan, 1994; Lei et al., 1996).

Regardless of which views are held on the benefits and disadvantages of technology, the implication is that technology has certain impacts on organizations, e.g. "Government agencies, technocrats, and manufacturing consultants are aware that their radical automation schemes presuppose more fundamental reforms of organizational structure and managerial practice" (Jones, 1991). The next section addresses the various impacts of technological adoption on organizational issues.

2.3.1 Impacts of technological adoption on organizational issues

There exist two different notions on the impacts of technological adoption on organization. The first asserts that technology determines skills and organization structures. The other more moderate view is that technology does not entirely determine the organization, but has limited impacts on organization as it is dependent upon management decisions (Huczynski & Buchanan, 1991; Robbins, 1989). Not only is the latter view held more widely, it is more appropriate as it does not oversimplify the implications of technology. Based on this notion, it is thus important that an organization understands the needs and constraints of technology so that it can effectively adopt technological advances and integrate them into the organizational environment.

The implementation of technology, especially advanced manufacturing technology (AMT), poses some challenges to the existing organizational infrastructure (Cutcher-Gershenfeld et al., 1994; Maffei and Meredith, 1994). AMT is a generic term given to a range of systems that have become widespread in manufacturing industry as a result of their capability to provide a technological basis for improved quality consistency and increased productivity. The impacts of their implementation encompass various organizational elements such as human resource, work organization and control, reward systems, and communication (Bessant, 1990; Hayes and Jaikumar, 1988; Meredith,1986).

First, the use of AMT generally demands greater workers' flexibility; for example, a flexible manufacturing system (FMS) requires workers to operate a range of machines rather than one large machine (Boer, 1994). Thus, workers need to be highly trained, multiskilled, and committed (Preece, 1995). The indirect support staff must be broadly skilled and capable of responding to various problems across the integrated system (Bessant, 1990).

In terms of impact on work organization, it needs to be adjusted in order to exploit the full benefits of the system's responsiveness and flexibility. Work organization should move from individual to group task design while control shifts from bureaucratic towards self-regulation based upon consensus in meeting common goals (Shani et al., 1992; Tidd, 1994). Span of control tends to be smaller as it allows for quick response from managers in case a problem breaks out (Daft, 1989).

The reward system and performance evaluation are the key tools that can be used to encourage new skill building and learning to maximize the benefits of technology. Performance evaluations will require more emphasis on the new set of skills that employees master, willingness to pursue change, flexibility, and ability to analyze problems (Miller, 1988).

In terms of communication, the adoption of AMT provides an integrated manufacture which eliminates the barriers between functions (Snell and Dean, 1992). Lateral communication becomes the basis for information sharing and flexibility across functional boundaries (Goldhar and Lei, 1994). Therefore, communication is increasingly important to achieve effective integration within the organization.

In order to achieve the full benefits of AMT, these impacts need to be dealt with by changing the organizational design so that it becomes more flexible and facilitates cross-functional and cross-firm integration. Cross-functional integration is important because it helps exploiting economies of scope and fast-response capabilities of technology by sharing the knowledge among functions (Lei et al., 1996). Organizational mechanisms that promote integration and flexibility should embody greater communication flow and responsiveness among the functions. These include, for example, semi-autonomous groups (Boer, 1994), multifunctional teams (e.g. Clark and Fujimoto, 1991), the use of integrators (Dean and Snell, 1991), and concurrent engineering (Bowonder and Miyake, 1993). As there is a variety of integrating mechanisms, the company should employ those which best suit their technology's needs and existing culture. A combination of these mechanisms may be employed after careful consideration of the linkages with the greatest potential for organizational integration (Twigg et al., 1991).

Cross-firm integration includes an open-system approach which creates a network of manufacturers, suppliers, and customers. It helps companies accomplish maximum economies of scope and flexibility of technology, and increases responsiveness to environmental changes (Lei et al., 1996). With or without technology, cross-firm integration has value on its own as it improves competitiveness by enabling companies to have the flexibility, creativity, coordination and scale associated with larger companies (Johnston and Lawrence, 1988). Companies working in a networked configuration can share their core competence and technical knowledge (Miles and Snow, 1986). While new technological tools (e.g. CAD/CAM and information technology) help facilitate inter-company integration, these technologies also need effective inter-company integration in order for their maximum potentials to be reached.

In summary, the adoption of technology plays an essential role in enhancing competitive positioning of an enterprise. It also exerts significant influence on the organization and the people. When a company plans to adopt advanced manufacturing technology (AMT), it must take into account the organizational adjustments otherwise the transfer of technology may fall far short of its potential.

2.3.2 Organizational vs. Technological changes

Since organizational changes need to accompany technological adoption, an important question arises as to when a company should adjust its social system to accommodate technological adoption. In general, organizational changes can be managed in four ways: concurrent changes, technical-system first, social-system first, and incremental sociotechnical approach (Liker et al., 1987).

The concurrent approach involves radical transformation in both technical and social systems at the same time. Companies that adopted this approach were trying to avoid the pitfalls of the piecemeal approach to automation that have been addressed by many authors. Thus, they decided to take on a revolutionary approach to technological adoption and made adjustments in the social system at the same time. Liker et al. (1987) found that the organizational changes could be more destructive rather than constructive according to their study of an equipment manufacturer, and the potential costs of this approach could be substantial.

The 'technical-system first' approach involves adopting technology and then gradually changing the organizational system while the technological system began to stabilize. According to the same authors, the potential benefits of this approach accrue from a more effective technology implementation process as company resources can be devoted to one process at a time. Besides, the organizational changes could also be made without pressures created during technology implementation. However, it was observed that companies that made changes in their social system after introducing AMT failed to exploit the full potential of technology (Shani et al., 1992). This approach also has a disadvantage due to the potential loss of synergistic relationship between social and technical changes. Based on the opinion that the design of technical system constrains the social system, it is argued that in the long run it will be most effective to plan both systems concurrently (Davis and Taylor, 1976).

The 'social-system first' approach includes making changes in the organizational system prior to adopting technology. In this way, companies can focus on understanding the business process and social implications before diving into automation. According to Zygmont (1986), the experience of John Deere, Inc. which is a pioneer in large-scale flexible manufacturing systems (FMSs), indicates that appropriately designed and implemented organizational changes can lessen the need for radical technological change (Liker et al., 1987). Another proponent of this approach is Tidd (1994), who referred to Japanese companies whose advantage of a capable workforce and open organizational system allows them to adopt less complex technology. This approach can also lead to a smooth technological transition; however, the drawback is that there is a risk of falling behind competitors that adopt AMT first. Thus it may be suitable for a company that has no urgent need to adopt AMT.

The incremental sociotechnical approach is the process of gradually staging organizational and technological changes that are concurrently designed and implemented. This phased approach permits each system change to be planned more thoroughly and reduces resource constraints. Another advantage is that companies can secure participation in sociotechnical design from various levels thus ensuring higher success potential. This approach is also in line with the process of systemization, which involves the preparation for automation by improving the existing manufacturing process, i.e. 'correcting data records, simplifying production processes, redesigning the product for automated manufacture'(Meredith and Hill, 1987). By first systemizing the technological system, it is easier to gradually adjust the organizational settings to accommodate further technological adoption. An additional advantage of an incremental approach is that it helps create an organization where change is the norm (Shani et al., 1992). This option is also supported by Miller (1988) who asserted that the implementation of changes should be evolutionary in order to gain wider support and acceptance, as well as minimizing investment risk.

The next section discusses the modern management practices which serve to integrate organizational and technological dimensions in order to create sustainable competitiveness.

2.4 Management practices: historical perspectives

As stated in Section 2.1, competitiveness can be derived from an integration between organization and technology in order to satisfy the requirements of the market environment. Management practice serves as a unifying framework to harmonize the organizational and technological dimensions of a company to ensure its smooth operation as well as to guide the process of organizational transformation. It has long been recognized that management makes a significant contribution to competitiveness as reflected in the long-term interest in the literature concerning the issue.

The first part of this section explores the literature on competitiveness in manufacturing. In the 1970s the literature on strategic perspectives was mainly concerned with external factors as evidenced by the popularity of the Growth Share Matrix created by the Boston Consulting Group (BCG). The BCG model focused mainly on financial measures such as market growth and market share which were external factors to the organization (Naylor, 1980).

The next decade (1980s) saw the shift in perspective from market growth to a more internal standpoint, and Porter's competitive strategy was a widely accepted model. He recommended an analysis of industry structure and competitive positioning, for which he suggested three generic strategies: overall cost leadership, differentiation, and focus. He asserted that companies needed to place emphasis on one of the three strategies in order to succeed (Porter, 1980). In a similar fashion, Slack (1991) discussed five performance objectives including quality, dependability, cost, speed, and flexibility. He suggested that they might be traded off against each other as external performance objectives. Skinner (1974) also addressed the notion of the 'focused factory' with the concept that no factory can be expected to perform well by every yardstick.

The view of competitiveness based on focus implies that companies need to make tradeoffs between the various dimensions (Corbett et al., 1993). Although this trend in competitiveness had shifted to a more internal viewpoint, it still focused upon the link between strategy and external environment. Most research into this area has been concerned with strategy implication and analysis of the organizational processes through which strategies emerge (Grant, 1991).

During the 1990s, there has been a trend toward a more internal perspective as companies increasingly value quality as a main source of competitiveness. By focusing on quality, a company can exert more control over its own future, thus the managerial perspective is shifted from an external to an internal viewpoint. The focus on quality has also changed the view regarding options among various competitive strategies (Belohlav, 1993). Several authors contend that recent developments in management paradigms, such as total quality management and just-in-time manufacturing, have substantially changed the nature of the traditional tradeoffs among various strategies. It is now believed that it is possible to accomplish these goals simultaneously, and the ability to support several success factors concurrently is essential to realizing competitive edge (Corsten, 1995; Schonberger, 1986; Tidd, 1994). Evidence from leading Japanese companies have also pointed out that they aim to achieve all success factors without making tradeoffs (Dixon et al., 1990).

The next section addresses the roles of quality management as the modern practices which have opened up significant opportunities for companies to improve competitiveness in multiple dimensions.

2.5 Roles of management practices in improving competitiveness

Feigenbaum (1983), an early originator of the concept of total quality control, defines a quality system as:

> A quality system is the agreed on, companywide and plantwide operating work structure, documented in effective, integrated technical and managerial procedures, for guiding the coordinated actions of the people, the machines, and the information of the company and plant in the best and most practical ways to assure customer quality satisfaction and economical costs of quality (Feigenbaum, 1983, pp. 14).

He also states that a total quality system should have four characteristics. First, it views quality activities as continuous work processes from customer requirements to customer satisfaction. Next, it is the basis for the documentation that identifies the key quality activities so that they are communicable throughout the firm. Thirdly, a total quality system is the foundation for making quality activities manageable. Finally, it is the basis for the systematic improvements throughout the major quality activities.

A total quality system employs an open system approach as it allows the organization to view its interaction with the environment as well as the relationships among internal components. It facilitates interaction with the external environments through the process of benchmarking and interacting with customers and suppliers. Benchmarking is an integral part of a total quality process that interacts with external organizations in order to learn from their best practices (Bank, 1992; Bendell et al., 1993). Interactions with customers and suppliers are also emphasized by a quality system, especially during the stage of new product development. Therefore, a total quality system allows the organization to be in touch with its environment. By facilitating this environmental interaction, a total quality system integrates the strategic perspective with the internal perspective.

In terms of the relationships among internal components, a total quality system coordinates among the various organizational subsystems by viewing quality activities as continuous work processes from customer requirements to customer satisfaction, as cited earlier in Feigenbaum's work. Of equal importance is its role in relating various organizational subsystems to facilitate organizational learning.

A quality system plays an important role in organizational learning by making the learning process actionable and manageable (Ma, 1996). Figure 2.1 shows how a quality system facilitates organizational learning and leads to core competencies.

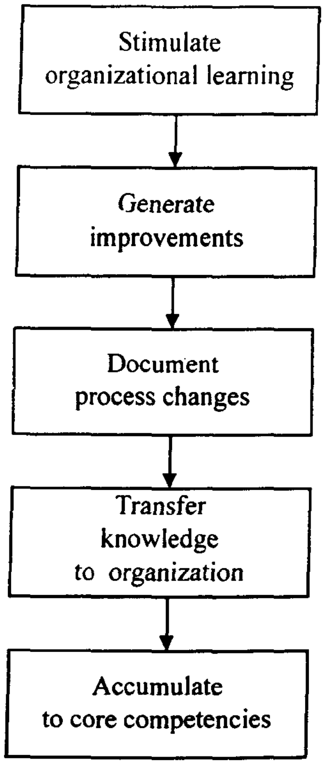

Figure 2.1 The role of quality system in facilitating organizational learning

According to Fig. 2.1, a quality system stimulates an organization to learn by utilizing information to analyze and solve problems as well as measure progress. This is evident from the systematic problem solving encouraged in most integrated management approaches. Another example is the process of benchmarking which utilizes information learned from industry's best practices to establish rational improvement goals (Boxwell, 1994).

Through the first process, improvement is generated as shown in the second box of Figure 2.1. At this step, a quality system not only generates improvements through learning, but it also emphasizes their continuity. This can be seen from the Deming's plan-do-check-action (PDCA) cycle which is widely adopted in most management concepts. It is generally emphasized that the Deming cycle should be followed in an indefinite circle in order to gain continuity.

Next, a quality system reflects the changes made from improvements by providing the means to document process changes. Once the improvements are assessed and documented, a quality system helps transfer knowledge to the rest of the organization by providing an integration throughout the organization (Ma, 1996). In TQM, there are several tools and techniques to facilitate communication both vertically and horizontally. For example, quality function deployment is a conceptual map that provides the means for interfunctional planning and communication in product development (Hauser and Clausing, 1988).

These two steps are very important because the full advantage of knowledge can only be realized if it is effectively stored and transferred so that it can be used by the right persons at the right time. Finally, the accumulated knowledge becomes core competencies which lead to sustainable competitive edge.

As a result of organizational learning process facilitated by a quality system, improvement in technology is inevitable. This is generally accepted by a number of scholars, for example, "Building technological competencies is an emerging property that stems from learning" (Karnoe, 1996). Ishikawa (1985) also provided an example of technological edge generated by the learning process within a quality system:

> "In our QCC we insist that the circle examine all operation standards, observe how they work, and amend them. The circle follows the new standards, examines them again, and repeats the process of amendment, observance, etc. As this process is repeated there will be improvement in technology itself" (Ishikawa, 1985, pp. 151).

Pavitt (1991) also suggested that the accumulated competencies of a company determines the range of possible choices of its technologies. Lei and Slocum (1992) asserted that continuous organizational learning that is focused on core competence allows a company to develop technologies and skills into future generations of new products.

Hence, a quality system facilitates organizational learning which helps building technological capabilities.

In summary, the two elements of organization and technology interact with each other. While organizational learning creates technological growth, technological adoption induces organizational changes. As illustrated in Figure 2.2, a quality system serves as an effective link between the two because: (1) it stimulates organizational learning that eventually leads to technological capabilities, and (2) it helps facilitate the process of organizational transformation that is necessary for technological implementation.

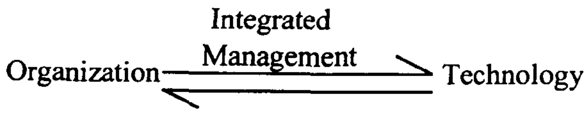

Figure 2.2 Interactions between organization and technology as facilitated by a quality system

Modern management practices such as total quality management and just-in-time share the characteristics of a quality system. These practices are integrated as they span all the functions within an organization and extend to suppliers and customers. As discussed above, they have the characteristics which facilitate organizational development and sustainable competitiveness. Therefore, this study will interchangeably use the term integrated management system, quality system, quality management system, and competitive practice.

The next section concerns the various types of competitive practices and shows that they have many common characteristics.

2.6 Various management practices

The approaches that are claimed to support various success factors simultaneously are the integrated management concepts which were originated under different names such as lean production, world-class manufacturing, kaizen, just-in-time (JIT) manufacturing, and total quality management. Over the years they have received considerable attention both from fieldwork and research work due to the increasing needs for companies to survive and compete successfully in the global market. This section reviews the studies pertinent to competitive practices, analyses and discusses their findings, and identifies areas which remain to be explored.

2.6.1 Lean Production

Lean production is the term labeled by the team of the MIT research project known as the International Motor Vehicle Program (IMVP), which investigated productivity and management practices in the world automobile industry involving 52 vehicle assembly plants in fourteen countries. Its results indicated a significant gap in quality and productivity between the Japanese assemblers and the others. It was also discovered that the Japanese were developing new products in much less time than their Western counterparts (Womack, Jones and Roos, 1990). The authors asserted that the superiority was the result of lean production, whose name was on account of the fact that it used less of everything as compared with mass production; for example, less human effort, less manufacturing space, and less tool investments. To put it simply, lean production is a process that optimizes the relationship between organizational resources, human, and the output in order to maximize customer satisfaction and profits (Juliard, 1997).

According to Womack et al. (1990), the main characteristics of lean production involve a combined system of work practices including close links with customers, close cooperation with suppliers, lean manufacturing operations with low work-in-process inventories and small-batch JIT production that expose operational inefficiencies and wastes in the manufacturing process, team-based work organization involving flexible and multiskilled workers with broad responsibilities, active shopfloor problem solving for continuous improvement, and cross-functional product development teams (Calkins and Cooper, 1997; Cutcher-Gershenfeld et al., 1994; Sohal and Egglestone, 1994).

The benefits of lean production are commonly cited as, for instance, better market positioning, improved customer relationship, improved quality, increased flexibility, lowered cycle times, and higher productivity. Examples of companies that have gained from implementing lean production include the Japanese lean production plants in the study of Womack et al.'s, DuPont (Billesbach, 1995), McDonnell Douglas Helicopter Systems (McGlothlin et al., 1997).

2.6.2 World-class manufacturing (WCM)

The term "world-class manufacturing" was first used by Hayes and Wheelwright (1984) to describe companies achieving global competitive edges through manufacturing capabilities. There were a number of practices cited by the authors as critical including workforce development, technically competent management, emphasis on quality, worker participation, and modern technology. Schonberger (1986) further developed these concepts while providing many case studies of world-class companies in the USA. Besides discussing the concepts advocated by Hayes and Wheelwright, Schonberger also addressed the development of supplier relationships, product design, total quality control (TQC), just-in-time (JIT), and total preventive maintenance, as dominant world-class manufacturing precepts. In a way, world-class manufacturing represents an attempt to combine the advantages of other practices in order to reach continuous and rapid improvement. Thus its benefits are those which can be achieved from the other practices to be discussed in the following sections.

2.6.3 Just-in-time manufacturing (JIT)

Just-in-time manufacturing has been widely known in Japan since the 1970s as the Toyata Production System. It was originated at Toyota by T. Ohno and Y. Monden. According to Ohno (1984), the two pillars of the Toyota production system are: 'right on time' and automation. The right-on-time system is the approach in which production is pulled through the system as and when it is needed. Automation refers to the system with built-in functions to prevent the production of defective parts and to automatically check on damage to the machine.

Although the early concept of the Toyota Production System was focused on the production line, it has been expanded to become the present approach called the just-in-time system, which still suffers from a lack of consensus about its meaning, at least on the part of manufacturing organizations. While some managers view it as a near total system of continuous improvement, others simply regard it as only the kanban pull system (Storey, 1994). Among the good number of authors favoring the larger scope of JIT meanings, it is regarded as a complicated philosophy comprising various techniques to improve productivity, reduce waste, and achieve continuous improvement (Safayeni et al., 1991; Tincher, 1995; Voss, 1987). According to Voss (1987), its techniques include those relating to manufacturing (e.g. cellular manufacturing, setup time reduction, and pull scheduling), production/material control (e.g. JIT-MRP, and schedule balance and smoothing), intercompany JIT (e.g. single sourcing, supplier quality certification, point-of-use delivery), and organizing for change (e.g. quality, continuous improvement, enforced problem solving, and workforce involvement).

The benefits of JIT include, for example, enhanced quality, higher productivity, reduced cost, decreased lead time, improved flexibility (Meredith, 1987; Monden, 1983; Schonberger, 1986).

It should be noted that JIT has been included in many other competitive practices such as world-class manufacturing (Schonberger, 1986), lean production (Womack et al., 1990), and kaizen (Imai, 1986). In this sense, it may be interpreted that the promoters of these practices view JIT in a narrow context, or it may be natural that the later approaches tend to embrace older approaches under their umbrellas.

2.6.4 Total quality management (TQM)

TQM is a comprehensive set of management philosophies, management tools, and improvement methods which is widely regarded as one of the most powerful tools for enhancing organizational competitiveness and company-wide quality success. Originating in the USA and first appreciated in Japan, TQM has now been globally recognized, and has been applied in various types of organizations including manufacturing, service, and higher education.

Over the years, TQM has attained such popularity that numerous new techniques and studies have been developed. Examples of recent ideas that emerge from the TQM concept are the consolidation of TQM and breakthrough thinking (e.g. Hofferr et al., 1993; Carty, 1995; Medina, 1996); the integration of TQM with other quality systems such as ISO 9000 (e.g. Castle, 1996); linked policy deployment which is an evolution of the policy deployment approach (e.g. Zurn, 1996); and the development of software support such as an integrated quality assurance system (e.g. Alexandru and Branici, 1995; Heredia et al., 1996) Considering these various developments, it can be concluded that TQM has grown to a mature management philosophy that is still increasing in dimensions.

Since the concept of total quality management has been expanding in both research and practices over time, it is difficult to construct a single definition for it. Rather than defining TQM, it would make more sense to identify its common elements which emerge from the literature. These elements can be arranged into a structure of TQM such as that explained by Kano (1993), who presented it in a brief and understandable format as shown in Figure 2.3 ('the House of TQM').

According to Figure 2.3, the roof shows customer satisfaction as the purpose of TQM, and the base is the intrinsic technology that is the driving technology specific to an industry. The floor represents the motivational approach necessary to create the conditions that will impel management and employees to take up TQM activities.

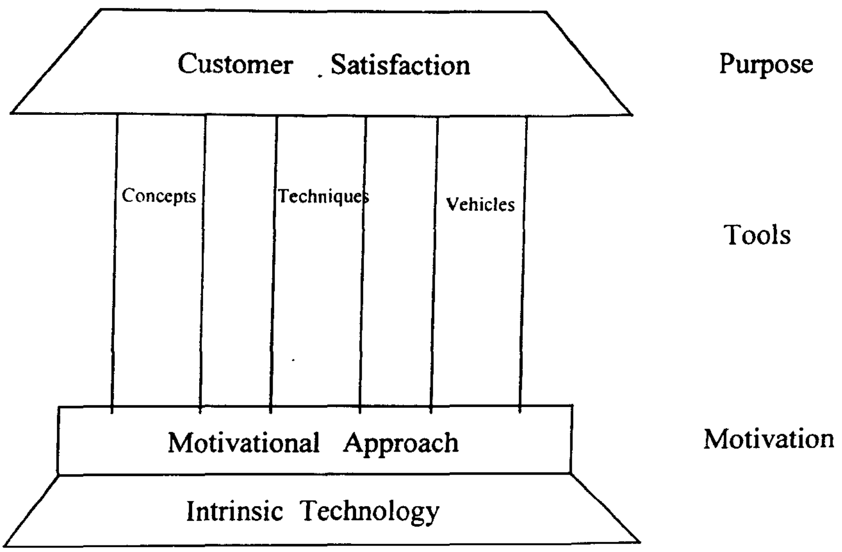

Figure 2.3 Kano's House of TQM (from Kano, 1993)

The three pillars are the concepts, techniques, and promotional vehicles. The concepts represent the approaches for proceeding from a particular perspective when a given intrinsic technology and motivation already exist. They consist of both a theory of quality (e.g. next-operation-as-customer concept (NOAC), quality as the satisfaction of customer), and a theory of management (e.g. the PDCA cycle). The second pillar stands for the techniques, which are the actual activities based on these concepts. Examples of techniques are the seven QC tools and statistical methods. Finally, the promotional vehicles are the methods for effectively promoting all the activities. Examples of such vehicles are policy management, daily management, and quality control circles.

In order to identify the common elements of TQM emerging from the literature, the work of quality advocates and practitioners are reviewed in Table 2.2. Deming (1986) originally approached quality management from a statistician's perspective, and then expanded it to his 14 principles of quality management aimed at creating an environment in which statistical methods would be effective.

Table 2.2 Requirements for effective quality management emphasized by selected authors

Deming's 14 points[1]	Juran's 10 steps to quality improvement[2]	Crosby's 14 steps to quality improvement[3]	Ishikawa's lists[4]
1. Create constancy of purpose 2. Adopt the philosophy 3. Cease relying on mass inspection 4. Do not award business on price 5. Improve constantly 6. Institute training on the job 7. Institute leadership 8. Drive out fear 9. Breakdown barriers 10. Eliminate slogans 11. Eliminate numerical quotas for the work-force and numerical goals for management 12. Remove barriers of pride of workmanship 13. Institute vigorous programs of education and retraining 14. Encourage total participation to achieve the transformation	1. Build awareness of the needs for improvement 2. Set goals to improve 3. Organize to reach goals (found 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 8. Communicate results 9. Keep score 10. Maintain momentum by making annual improvement part of the regular processes	1. Management commitment 2. Quality improvement team 3. Quality measurement 4. Cost of quality evaluation 5. Quality awareness through communication 6. Corrective action 7. Committee for the Zero Defects Program 8. Supervisor training 9. Zero defects day 10. Employee goal settings 11. Error cause removal 12. Recognition 13. Quality councils 14. Repetition of the program	1. Company-wide quality control, with all employees participating 2. Emphasis on education and training 3. Quality control circles 4. Total quality control audits 5. Application of statistical methods 6. Nationwide TQC promotion

Sources: [1]Deming (1986), [2]Toone (1994), [3]Crosby (1979), [4]Imai (1986)

From a practitioner's as well as an academician's viewpoint, Juran (1992) stresses both the management and technical aspects. Having been in the position of top management himself, his approaches emphasize the strategic side of quality planning, quality audits, and the systems approach to managing quality throughout the organization as reflected in the Juran's Trilogy (Juran, 1992). Another example of his work includes the Juran's 10 steps to quality improvement as shown in Table 2.2.

Crosby (1979) is another quality proponent who has gained his experiences from industrial practices. He most notably addresses the human, cultural and behavioral aspects of quality management. He also stresses the concepts of 'doing things right the first time' and 'zero defect'. His fourteen steps of quality improvement program is summarized in Table 2.2.

Ishikawa (1985) has played a crucial role in developing the quality control movement and quality control circles in Japan. As a leader in quality control circles and employee participation, he is well known for inventing the cause-and-effect diagram (or the fishbone diagram, and Ishikawa diagram) used for diagnosing quality problems. He has listed six features as characterizing the TQM movement in Japan, which is displayed in Table 2.2.

According to the literature, the common elements of TQM include: total employee involvement, human resource development, continuous improvement, application of statistical quality control techniques, and the focus on customers and suppliers.

(a) Total employee involvement

It is emphasized by all quality practitioners that total employee involvement is necessary at all levels of organization in order to achieve the quality goals. This is accomplished in TQM by giving employees more authority and responsibility in their work. Further, effective coordination is necessary throughout the organization from the top executive to the shop floor in order to gain employee commitment. There are various TQM promotional vehicles that facilitate communication such as policy management, quality control circles, and suggestion system (Kano, 1993).

Some quality experts (e.g. Ishikawa, 1985) emphasize the importance of employee involvement at the shopfloor level. Being the owner of the processes, workers can greatly contribute to the problem-solving and incremental improvement activities.

(b) Human resource development

TQM is seen as having the potential to improve industrial democracy (Hill, 1995; Wilkinson and Willmott 1995). Its advocacy of empowerment is a commitment to creating the organizational environments that are humanistic (Mohanty, 1997). This can be seen through the opportunities for participative decision making, employee ownership of the process, and the commitment to human resource development.

TQM develops and manages human resources by constructing and maintaining an environment for both personal and organizational growth. Education and training is an important element that enables employees to perform the ambitious tasks of continuous improvement. Feigenbaum (1983) described the two requirements that make education and training effective: (1) quality education must be job-related, and (2) it must be an integral part of TQM.

(C) Continuous improvement

Continuous improvement is a fundamental objective of TQM. It is the concept that was once challenged by business process reengineering (BPR). While BPR can help companies achieve a quantum leap in improvement by a radical redesign of business processes, it exposes the initiators to high risks (Allender, 1994), and could cause antagonistic feeling for employees for fear of being discharged (Tienthai, 1995). Total quality improvement, on the other hand, seeks cooperative relationship that helps secure employee commitment to continuous improvement. Although its incremental approach may take longer to accomplish, it has been observed that companies which select the incremental approach can eventually master a major change (Hayes and Wheelwright, 1984). Hence, it is suggested that the best approach to competitive progress is to adopt an incremental approach until a breakthrough occurs (e.g. Allender, 1994; Elzinga et al. 1995; Hayes and Wheelwright, 1984). In this sense, BPR could be incorporated within the TQM framework of continuous improvement.

(d) Application of statistical quality control techniques

It can be stated that TQM has developed from the application of statistical techniques since its early developers (e.g. Deming, Feigenbaum, Ishikawa) began with the interests in quality control. There are a large number of statistical techniques available within TQM which systematically help detecting variations, solving problems, and tracking progresses. Some of these tools and techniques are widely used even in companies which do not adopt TQM.

(e) Focus on customers and suppliers

Quality practitioners emphasize the need for the concept of internal and external customers. It is based on the notion that throughout the organization there exists a chain of customers and suppliers ultimately striving to achieve the satisfaction of external customers. A worker receives a job from an internal supplier, adds his contribution to it, and sends it to his internal customer. The objective is to meet the requirement of the internal customer, and create a chain of quality throughout the organization. In this sense, there needs to be measurement and feedback all through the chain of relationships.

Cooperative supplier relationship is also emphasized by well known quality practitioners, especially Deming (1986). The work of some other authors has been particularly dedicated to the subject of strategic supply management (e.g. Bhotes, 1989).

In addition to these five main elements, there are many more components of TQM as stated earlier. Over time, more tools and techniques seem to emerge with increasing applications and developments. In the course of this, an important theme runs through the literature concerning which are the critical elements to TQM success. This issue will be addressed in the next section.

2.6.5 Relations among various TQM components

It is generally agreed that the components of TQM implementation are a blend of tangible and intangible factors (Thiagarajan and Zairi, 1997; Wilkinson et al., 1992). According to Thiagarajan and Zairi (1997), the tangible factors are the tools and techniques that influence internal efficiency (e.g. statistical process control, cost of quality), and external effectiveness (e.g. benchmarking and customer surveys). The intangible factors emphasize customer awareness and employees' sense of responsibility for quality (Hill, 1995). They are the issues that impact on company-wide support and involvement towards quality goals. These factors are implicit and difficult to measure.

Based on this classification, many authors are particularly interested in the critical elements which drive TQM success. Although the results vary among studies, the intangible factors are often emphasized as crucial to successful TQM implementation. For instance, Powell (1995) developed a set of twelve measures of TQM from an exhaustive literature review, and found that competitive edge relied on 'certain tacit, behavioral, imperfectly imitable features', consisting of a culture receptive to change, top management commitment, and employee involvement. Similarly, Ahire et al. (1996) also investigated quality management in the TQM versus non-TQM firms through an empirical survey of 359 companies in the U.S. automobile part industries. Using the ten TQM constructs developed and tested by the authors, it was found that a company can achieve high quality performance through a "good management" philosophy without formally launching a TQM campaign. The results also referred to the importance of intangible resources such as top management commitment and employee empowerment.

Examples from several case studies also point to tacit factors as being critical to TQM success. For instance, British Steel Narrow Strip's Ayrton Godins profiling plant has found that cultural change was a critical approach to successful TQM adoption (Thomas, 1995), and Computer Products Asia-Pacific Ltd. (PCAP) in Hong Kong realized that a key to its competitiveness was the strong culture that encouraged continuous improvement (Lo, 1997). Other intangible resources that are cited in actual applications as significant to successful TQM include executive commitment (e.g. Goffin and Szwejczewski, 1996), employee involvement (e.g. Schmidt et al., 1995; Svetec, 1995), and communication (e.g. Gronstedt, 1996).

On a similar ground, many researchers assert that TQM is increasingly being used as a managerial attempt at cultural transformation (e.g. Dawson, 1994; Tuckman, 1994). The classic definition of culture is put forward by Hofstede (1980) as being the collective programming of the mind that distinguishes the members of one human group from another. In terms of organization culture, many definitions are based on the notion that it is a set of shared meanings that make it possible for group members to interpret and act upon their environment (Schein, 1984). In this context, TQM helps transforming the organizational culture by influencing the organizational routines and daily operational tasks in such a way that the desirable values and behaviors are instituted toward continuous improvement.

Van Donk and Sanders (1993) assert that the knowledge and understanding of organizational culture is necessary in managing quality:

> ... [organizational culture] is a starting point for formulating a quality management policy and selecting an appropriate way of implementing it. In some cultures it will be obvious that the approach of Juran or Crosby will yield success, while in other cultures the approach of Deming will be needed. Moreover, ..., knowledge of the actual culture provides information for where change is needed and where it is not (Van Donk and Sanders, 1993, pp. 14-15)

Thus, organization culture is found to be a determining factor in TQM implementation as well as other implicit factors such as management commitment, employee involvement, and communication.

From the review of the literature, it can be suggested that the intangible resources tend to be the critical factors in TQM success. While effective manipulation of these implicit factors is essential to the accomplishment of quality goals, it should be noted that TQM implementation will not be completed without the operational tools and techniques. As cited by Hogg (1993), Harry Roberts of University of Chicago put it, "TQM comprises much more than statistics but without statistics it can be a lot of smoke and mirrors." These 'hard' factors are the activities that track the path towards achieving quality goals, and they are needed as basic elements as shown in the Kano's House of TQM (Section 2.6.4) as the two pillars of techniques and promotional vehicles.

2.6.6 Benefits of TQM

Numerous articles have been written about the benefits of TQM. Besides enhancing operational efficiencies and quality, TQM helps in facilitating continuous improvement process; enables organizations to become flatter, leaner, and more flexible; and helps them to achieve faster response to changing markets (Hill, 1995; McQuater et al., 1994). Besides improving quality of products and processes, several industrial applications have also successfully used TQM to regain their technological superiority. For example, Xerox and Motorola have emerged as leaders in their industries as a result of implementing TQM (Leo, 1996; Wason and Bhalla, 1994).

As stated in Section 2.1, companies need to integrate their organizational and technological elements in order to succeed and grow prosperously. In this sense, TQM provides a concrete approach that helps in bridging the two factors. It may be regarded as the systematic interaction of human systems with technologies (Mohanty, 1997). Its practices of continuous improvement and human resource development make it possible for companies to achieve breakthrough in performance (Hayes and Wheelwright, 1984).

TQM also has a structural mechanism that is equipped with the organizational requirements necessary to help companies exploit the full benefits of technologies. It allows for effective utilization of technologies by facilitating organizational integration. For example, CAD/CAM requires integration across design, engineering, and manufacturing. TQM's Quality Function Deployment technique is a vehicle to incorporate various functions in product development, thus satisfying the needs for integration required by CAD/CAM. It has also been asserted that TQM and computer integrated manufacturing (CIM) complement each other (Jacobs and Clemson, 1994).

2.6.7 ISO 9000

The ISO 9000 quality system series is another approach which is gaining increasing attention in recent years. It has greatly contributed to manufacturing society by helping to promote worldwide quality awareness.

ISO 9000 is a set of five quality system standards (ISO 9000-9004) that establishes requirements for the management of quality (Yung, 1997). Up to the present, the need for registration has been addressed in a number of articles by consultants and practitioners (Morrow, 1993; Hutchins, 1993; Ferguson, 1994; McFayden, 1992). However, systematic analysis on its effectiveness has been somewhat limited. Examples of empirical studies on ISO 9000 include the significance of complying with ISO 9000 standards (Haug, 1994), the motivation for adopting ISO 9000 (Wolak, 1994; Meegan and Taylor, 1995; Mahesh, 1994), the registration process and experience (Withers and Ebrahimpour, 1996), the costs and benefits of certification (Wolak, 1994; Atwater and Discenza, 1993; Rayner and Porter, 1991), and the effects of registration on business performance (Mann and Kehoe, 1994).

One of the most important research themes concerning ISO 9000 is its contribution to continuous improvement, i.e. whether it can be used as a path toward TQM. This issue will be discussed in more detail in Section 2.10.6

2.7 Comparisons between various management practices

As companies are continually searching for the best practices which enable them to gain competitive edges, a number of management paradigms have emerged in recent years, many of which are the combinations of existing practices. For example, both world-class manufacturing and lean production incorporate TQM and JIT as the major elements of their practices. Business process reengineering (BPR) and concurrent engineering are similar to the process emphasis in TQM as they emphasize the importance of developing cross-functional approaches to the design and delivery of products. Some authors even call BPR a repackage of TQM ideas (Wilkinson and Willmott, 1995).

In a similar vein, agile manufacturing emerges as a practice which helps a company gain the speed and flexibility to cope with a fast-changing environment by assimilating the concepts of TQM, JIT, and lean production (Abair, 1995; Nagel and Goldman, 1993). Some of the latest trends that have recently emerged in the literature are, for example, manufacturing synchronization, which claims to help companies achieve several success factors at the same time (Stillman, 1996); and business process management, which is a combination of TQM and reengineering (Elzinga et al., 1995; Newitt, 1996).

There are many similarities between the various types of competitive practices. First of all, they share the same objectives of customer satisfaction and sustainable competitive advantage. They provide the capabilities to support several success factors simultaneously as to be discussed in the next section. As management philosophies, all of them hold the principles that nurture a culture of change and improvement. They are highly integrative since they include wide areas of responsibilities extending throughout and across the organization. They are based on the idea of cooperative industrial relationships which applies to all partners especially labor unions, suppliers and customers. They use integrated quality assurance systems through the concept of internal customers and other elements such as 'fool-proof' systems. They aim to achieve continuous improvement through teamwork and systematic problem solving. Finally, they place more emphasis on human resource management in terms of training, delegation of authorities, reward and motivation, and they claim to be more considerate to employees' needs and well being.

In short, these practices are compatible and represent different aspects of a modern management paradigm. It should be noted that most publications tend to concentrate on only one approach, and this creates problems especially when there are attempts to isolate the crucial characteristics that are perceived as making the real difference (Storey, 1994).

2.8 Benefits and disadvantages of quality management

The implementations of these integrated management practices are beneficial to the organizations in many respects. First, quality is enhanced due to the concepts of waste avoidance and continuous improvement. Costs are reduced and productivity is higher as a result of effective organizational integration, continuous improvement, and waste elimination (Schonberger, 1986). Flexibility is increased because of organizational integration and effective teamwork. Lead time is lowered due to organizational integration, teamwork, and integrated product development.

There have been a number of negative opinions relating to these competitive practices, for example, TQM is criticized as extending management control and introducing management by stress. As Wilkinson and Willmott (1995) put it, "TQM requires employees to be responsible for managing the 'quality' of their individual contributions; and, relatedly, to accept and internalize forms of surveillance and control that monitor their activity and commitment"(pp. 9).

Some authors contend that worker empowerment was perceived as intensifying work without giving workers the decision-making authority (e.g. McArdle et al., 1995) Similarly, Webb (1995) regards employee participation as an object of 'managerialist and immoral expediency.' Lean production is also a subject of criticism on similar charges. It is perceived as leading to job losses, work intensification, and high level of stress (e.g. Garahan and Stewart, 1991).

Most of these criticisms come from the social scientists and humanists with interests in the issues of humanism. An interesting point made among the negative views is that the failure of a quality program may be due to its faulty underlying assumptions rather than the deficiencies of those responsible for its implementation. For example, Kerfoot and Knights (1995) argue that there is a contradiction in the assumption regarding employees, i.e. their obedience to the introduction of a quality program contradicts with their expected creativity. However, 'obedience' is a rather strong word when considering that companies need to make tremendous efforts in their preparations in order to gain employees' acceptance of the programs.

It is rather difficult to justify the real implications of the criticisms as many of them are based on subjective opinions and case studies. As Storey (1994) points out, there is a general absence of detailed empirical data regarding TQM implications on employment relations at work. Despite these negative comments, it is not necessary to deny the benefits of the competitive practices as the systems that have been surpassed also have problems of their own. Besides, the new practices have been shown to help companies gain simultaneous competitive goals like quality, cost, and flexibility while paying attention to the social organization. Therefore, the important issue is how to adopt the new approaches in such a way that they improve customer satisfaction while enhancing the quality of work life, as has been achieved in successful companies.

The next section reviews the various researches on quality management, with particular emphasis on the systematic research on TQM. As a result of the literature review, research areas are identified that need to be further explored.

2.9 Research on quality management

This section discusses the research on quality management. In general, publications on quality management have been found to be written by three parties: consultants, practitioners, and researchers. First, the literature abounds with those written by consultants with particular interests in promoting the practices. Some of them present examples of successful cases, but are usually not very detailed. These articles are mostly general and lack the dimension of systematic analysis. Their inherent values lie in the interests generated among the practitioners who wish to improve their operations.

There are also a number of case studies presented by practitioners. These are often reported in more detail as the authors are directly involved with the cases. Most of these studies tackle the issues of the requirements for successful management practices and their benefits and limitations from the authors' experiences. For example, Svetec (1995) explains the experience of a multidisciplinary architectural/engineering company which implemented TQM and found that the key to its success is employee participation. Sardos (1994) reports the benefits of TQM in improving customer service. Other case studies discuss the guidelines for implementing management practices. For example, Thomas (1995) describes the approach toward total quality of a British steel company by its gradual institutionalization of a new corporate culture. The case studies written by practitioners are often based on a single company; therefore a comparative analysis between organizations is not practical due to the varying instrument used to measure success.

Besides the two groups cited above, researchers have also taken vast interest in the field of quality management. Their presentations in the literature are the results of both case studies and systematic research design. Unlike those written by practitioners, case studies conducted on multiple companies are more common. These studies deal with a variety of issues such as the critical factors for successful quality management implementation. Quazi and Padibjo (1997) examine seven manufacturing companies in Singapore in the use of ISO 9000 as a foundation of TQM. Other themes for in-depth case studies include the relationships between the best practices and competitiveness. For example, Gronstedt (1996) accomplished a 3-year international study of the role of communications at 20 U.S. and European leading TQM firms. Goffin and Szwejczewski (1996) identify common dimensions for management commitment in TQM found in six case studies of U.K. companies.

Although these multiple case studies facilitate the comparison between organizations, the same problem still exists when there is an attempt to compare the studies of different researchers due to the variability of the measurement criteria.

The systematic research on quality management encompasses numerous issues including those taken from an integrated perspective and specific types of quality system such as TQM and ISO 9000.

Among the systematic research that is taken up from an integrated/interfunctional perspective, one of the earlier studies was conducted by Garvin (1983) who explored 18 air-conditioning plants in the U.S. and Japan to identify the sources of product quality. He concluded that successful management of production process lies in the integrated system of quality management, including (1) program, policy, and attitude, (2) information system, (3) product design, (4) production/workforce policies, and (5) vendor management.

Miyake, Enkawa and Fleury (1995) examined leading Japanese companies in their application of just-in-time, total quality management, and total productive maintenance. From the results, they suggested that the three paradigms can be used to reinforce each other, and that JIT, TPM, and TQM should be introduced stepwise in this sequence, and eventually applied simultaneously.

Among the various competitive practices, those which have been most systematically studied are TQM and JIT. While JIT studies are mostly focused on its technical aspects, TQM investigations tend to take a wider scope including its various techniques and the softer side of socio-technical issues. In practice, JIT seems to find limited applications due to the difficulties in applying certain of its elements. For example, it is not possible for Thai companies to apply the point-of-use JIT delivery due to the notorious Bangkok traffic jams and suppliers' limited response capabilities. By comparison, TQM is much more recognized among the Thai industrialists. For these reasons, TQM researches are discussed in more detail in this study.

2.10 Research on TQM

Since its inception, TQM has been analysed from various angles in many different settings. Some of the current systematic research on TQM include national traits in TQM practices, the potential barriers to TQM implementation, the use of TQM techniques, the performance measurement of TQM success, the evolution of quality management, and the relationship between TQM and other quality systems.

2.10.1 National traits in TQM practices

Although it is still debatable whether national culture affects the ability to implement TQM programmes, the emphasis that each country places on certain activities has been shown to vary. For example, Miller et al.(1992) describe the past and future emphases of quality activities in Japan, US., and UK. They are found to be different depending on each country's status. Lillrank (1995) examines the transfer of management innovations from Japan, and provides examples of its movement to other national settings.

Harrington (1996) reports on a three-year international study which highlights the national traits in TQM practices between three groups of countries (North America, Europe (Germany), and Japan). It was found that the similarity lies in the strategic planning process that considers customer satisfaction, and a major difference is in Japan's emphasis on process simplification. Other differences are in new product design and the use of improvement tools. Japan and Germany take a lead over North America in product design that incorporates customer expectation, and Japan and North America use improvement tools to a greater extent than Germany. Although this study provides an overview of the practices relevant to each country, it does not assess the performance of the companies under survey, making it difficult to evaluate the appropriateness of each country's applications.

2.10.2 Potential barriers to TQM implementation

Several studies have been undertaken to identify the potential barriers to TQM implementation. The knowledge of TQM barriers is valuable due to its practical implications for companies as it can be used as a necessary precaution to avoid the pitfalls.

Ngai and Cheng (1997) identify the potential barriers to TQM implementation by using principal component analysis (PCA)and correspondence analysis (CA). Based on a comprehensive literature review and interviews with quality practitioners, they constructed a list of TQM barriers, and used PCA on the data collected from 179 companies in Hong Kong. This resulted in four dimensions of the potential barriers: cultural and employee barrier, infrastructure barrier, managerial barrier, and organizational barrier. CA is then applied in order to corroborate the findings from PCA. Although the results indicate the relationship between the barriers, they do not provide information on the strengths or the precedence of the barriers specific to each situation.

Dale et al. (1997) identify the issues which impact negatively on the sustaining of TQM and group them into a TQM sustaining audit tool consisting of: internal/external environment, management style, policies, organization structure, and process of change. The tool was tested in six manufacturing companies, and most of the issues were identified as having impacts on the sustaining of TQM.

2.10.3 The use of TQM techniques

A number of studies have been conducted to examine the use of TQM techniques. For example, Ahire et al. (1996) examine the applications of TQM techniques in TQM and non-TQM companies that manufacture automobile parts in the US. In an attempt to study strategic quality management in Asia, the USA., and Europe, Aravindan et al.(1996) found that most manufacturing firms have not widely applied modern techniques such as quality function deployment, which are imperative in effecting strategic quality management. Lascelles and Dale (1990) examined the use of TQM techniques in the U.K. motor industry. They pointed out the importance of continuous improvement in achieving the most effective use of TQM, and the dangers in using techniques in isolation and the over-reliance on particular techniques.

Madu et al. (1996) empirically studied the perceptions of managers on the association between changes in quality dimensions (i.e. customer satisfaction, employee satisfaction, and employee service quality), and changes in organizational performance. Their study reveals that manufacturing firms tend to perceive more positive relationships between quality dimensions and organizational performance than service firms. While this study provides some insight into the perception of managers on the relationship between changes in quality dimensions and changes in organizational performance, it does not identify the actual quality practices in the companies and their relationship to organizational performance.

2.10.4 The performance measurement of TQM success

In order to compare the findings of each study, it is important that researchers use a common set of performance measures. Due to the lack of such measurement matrix, there has been an upsurge of interest in the issue of performance measurement of TQM success. The instrument measures are usually developed from comprehensive literature reviews and are empirically tested for validity and reliability.

For example, Tamimi (1995) synthesized a set of 50 quality management practices from Deming's philosophy, and applied exploratory factor analysis to extract eight critical quality management practices. Powell (1995), as already mentioned in Section 2.6.5, developed a set of twelve measures of TQM, and used it in his survey of critical factors in TQM implementation. Also mentioned in Section 2.6.5, Ahire et al. (1996) constructed ten measurements that were subsequently used in their investigation of quality management in the TQM versus non-TQM firms. Because these instruments are empirically constructed and tested, they need to be repeatedly applied in different types of organizations in order to validate their usefulness.

2.10.5 The evolution of quality management

Another theme of TQM research is concerned with the evolution of quality management. There has been a number of publications on this topic as it is increasingly realized that managers should have some knowledge about its quality development stage so that they can plan for further improvement. A number of tools have been developed that help companies identify their levels of quality development. Crosby's Maturity Grid is an example of a simple tool that can be used to measure quality development (Crosby, 1979). According to the developer, the Grid consists of five stages: uncertainty, awakening, enlightenment, wisdom, and certainty. It can be used to develop long range programs in quality as it provides recommendations for improvement actions.

Williams and Bertsch also proposed a five-stage model which was empirically derived from a multiple case study methodology involving eight companies in Asia, Europe, and the USA. Their model of growth toward quality maturity includes: top management consensus, company-wide education, problem solving, quality improvement management, and total control.

Based on their data from 120 organizations, Gluck et al.(1980) of McKinsey & Company recommended a four-phase evolutionary model of strategic management.

The first phase is basic financial planning that is characterized by the annual budgeting exercise and operational control. The second phase is the forecast-based planning that involves top management forecasting of environmental forces on alternative financing plans. The third phase is called externally-oriented planning that involves competitive analysis in order to respond to market needs. The final phase is strategic management that involves the utilization of all organizational resources to create competitive advantage.

Quinn and Cameron (1983) suggest four major stages of organizational development: entrepreneurial, collectivity, formalization and control, and elaboration of structure. Each of these stages are characterized by specific problems whose successful resolution leads the organization to the next stage.

Although several tools have been developed for assessing organizational development, no research has been undertaken to determine how companies should advance based on their level of quality development (Mann, 1992). There is also a lack of publications concerning the relationship between the level of quality development and the effectiveness in transferring quality practices.

2.10.6 TQM and other quality systems

Among the studies on the relationship between TQM and other quality systems, one of the themes that attracts a great deal of interest is the issue of ISO 9000 as a path to total quality management.

Some authors believe that the ISO 9000 quality system does not encompass the principles of total quality or continuous quality improvement (Yates, 1992; Dusharme, 1995; Binney, 1992). Binney (1992) asserts that ISO 9000 develops a culture which goes against the principles of continuous improvement and TQM. He believes that the route to quality should begin at a higher level approach such as TQM.

Many authors believe that ISO 9000 is a foundation for continuous improvement and total quality management (e.g. Small, 1997; Merrill, 1997). According to Bettes (1995), ISO 9000 can be used as the first step toward total quality because, "the key elements of continuous improvement are already in place in the ISO 9000 quality management system, in the forms of the internal audit cycle, management review and corrective action." Quazi and Padibjo (1997) also found that some Singaporean manufacturing companies were able to use ISO 9000 as a stepping stone toward TQM.

Among the other proponents of the ISO 9000 quality system are Elmuti and Kathawala (1997). After making statistical comparison of the two plants of a large corporation, they conclude that successful implementation of ISO 9000 standards helps improve quality, productivity, export sales, and quality of work life. However, careful judgment needs to be made of this conclusion due to the small sample size and other compounding factors within the organizations. Another positive view toward ISO 9000 is that it contributes to creating a quality awareness. According to Yung (1997), although the attempt to incorporate some elements of total quality management in the revised version of ISO 9000 (1994) fails to move it towards the principles of TQM, ISO 9000 is still the first step in creating a TQM awareness environment.

Another stream of opinion regards ISO 9000 and TQM as complementary to each other (e.g. Corrigan, 1994; Meegan and Taylor, 1995). Corrigan (1994) suggested an integrated approach to TQM and ISO, claiming that it should result in a mutual strengthening of both efforts. He stressed that it is essential to understand both approaches and their relationship to each other in order to ensure appropriate applications and achieve maximum benefits. Similarly, Dunstan (1993) stated that, "One should not try to compare TQM with ISO 9000; it is a matter of understanding both and seeing how they complement each other."

As for the roles and relationships of TQM and ISO 9000, so far there has been no empirical examination on the comparative impacts of ISO 9000 certification and TQM implementation on business performance and on organizational-technological development.

2.11 Business Excellence Model

Although there are a large number of quality practices as discussed in earlier sections, there was a lack of real framework within which to manage their implementation.

A recent initiative based on the European Quality Award (EQA) Criteria is the Business Excellence Model. It is a framework for the planning of business improvement that consists of the principles of business excellence which can be used for self assessment as well as assessment of performance against best practice.

National and international quality awards such as the Malcolm Baldrige National Quality Award (MBNQA) and the EQA award play an important role in promoting and rewarding quality and business excellence. They may be used as a framework within which TQM can be measured.

According to Hewitt (1998), the Business Excellence Model represents a philosophy that is fundamental to good management. The principles behind the philosophy of Business Excellence include:

- Leadership and consistency of purpose
- People development, involvement and satisfaction
- Customer focus
- Supplier partnerships
- Process management and measurement
- Continuous improvement and innovation
- Public responsibility

Essentially, Hewitt (1998) contends that the Model is a set of 'good management' concept around which a framework has been developed to enable these concepts to drive improvement within an organization. For many European organizations, the Business Excellence Model is the most effective means of measuring progress towards TQM, and many companies use self assessment techniques for that purpose.

2.12 Research areas to be explored

According to the literature, organization and technology are highly interrelated, and both dimensions need to be effectively integrated in order to achieve successful operations. It has also been found that management practices play crucial roles in bridging the two elements. As there is a lack of systematic evidence, this study aims to fill in the gap by exploring the impacts of quality practices (TQM, ISO 9000, both systems, and none) on the pattern of organizational-technological growth.

Research Area: Investigate the influence of quality practices (TQM, ISO 9000, both, and neither) on the pattern of organizational-technological development of Thai industries (Chapter 4)

A review of the literature indicates that there is a need for more empirical research in the comparative performance of companies adopting different quality systems. This leads to the following investigation.

Research Area: Investigate and compare the impacts of quality practices (TQM, ISO 9000, both, and neither) on performance (Chapter 4,5)

There is a limited number of publications concerning the relationship between the level of quality development and performance. This study aims to make use of Thai manufacturing companies to identify the various stages of quality management as well as their corresponding performance.

Research Area: Investigate the relationship between the levels of quality development and performance (Chapter 4, 5)

Finally, there is a need for more research on the relationship between the level of quality development and the effectiveness in transferring quality practices. Thus, the identification of the characteristics of organizations that successfully implement quality management is vital to achieving competitiveness.

Research Area: Investigate the characteristics of Thai organizations that successfully transfer management practices (Chapter 5)

2.13 Summary of chapter

This Chapter discusses a review of the literature concerning organization, technology, and management, and their relationship in helping companies achieve competitive advantage.

Section 2.2 explains the roles of organizational learning that influences competitiveness. Organizational learning is important as it leads to the accumulation of knowledge bases or core competencies. It not only helps companies achieve technological innovation, but it also shortens the learning curve during the implementation of technology.

Section 2.3 addresses the usefulness of technology and its impacts on organizational infrastructures including human resource, work organization and control, reward systems, and communication. In order to gain the full benefits of technology, organizational design needs to be adjusted so that it becomes more flexible and integrated. The issue of organizational versus technological changes is also discussed, and the literature review indicates that the incremental/sociotechnical approach seems most suitable for securing total participation.

Section 2.4 deals with the historical perspectives of management practices from the 1970s to the present. It can be seen that the views toward competitiveness shifted from an external/marketing oriented to a more internal oriented viewpoint. Most notable is the 1990s' emphasis on quality that has enabled companies to succeed in multiple criteria.

Section 2.5 refers to the roles of modern management practices in integrating organization and technology. It effects technological innovation by stimulating organizational learning, and assists in the process of organizational transformation that is necessary for effective technological adoption.

Section 2.6 reviews the various types of management practices, namely, lean production, world-class manufacturing, just-in-time manufacturing, total quality management, and ISO 9000 quality system. When they are compared in Section 2.7, it is found that these approaches have a number of shared characteristics that make it possible to commonly discuss their benefits and disadvantages as illustrated in Section 2.8

Section 2.9 reviews the researches on quality management in the form of case studies and empirical investigations. Particular emphasis is given to the research areas on TQM as revealed in Section 2.10. Section 2.11 provides a brief overview of the business excellence model.

The review of the literature identifies research areas that remain to be explored. The statement of the research problem and methodology are to be discussed in Chapter 3.

Chapter 3

Research Methodology

3.1 Statement of Research Problem

According to the literature, there are common elements pertaining to a number of competitive practices. These elements have been used in various contexts and cultures, and have been the subjects of research interest in the field of operations management. Among numerous research issues, one important theme is to explore whether the common elements of competitive practices are applicable in different settings.

The main purposes of this research are to identify the evolution of the Thai manufacturing industries toward quality management and to formulate a framework for the transfer of quality management for the Thai manufacturing industry by building on existing theories of best management practices.

The methodologies adopted in this study consists of both quantitative and qualitative methods. Quantitative studies mainly use empirical survey while qualitative methods deal with in-depth case studies.

The quantitative study aims to: (1) find the empirical pattern of organizational and technological development, (2) test a number of hypotheses concerning quality management practices, with particular emphasis on total quality management and ISO 9000, (3) recommend appropriate management practices for each stage of organizational-technological development.

The qualitative study involves in-depth case studies of four manufacturing companies in Thailand and three companies in Japan. The aim is to verify the issues emerging from the first part by conducting detailed investigation on the dimensions of organization, technology, and management. It also identifies the critical issues in the transfer of management practices.

This study is useful because the results provide an extension to existing theories on competitive practices by indicating whether the best practices applicable to the general Thai industries are similar to world-class practices. The results help explain why and how similarities exist in these different contexts in terms of the relationship between organization, technology, and management. The final conclusion also provides some insights into the evolution of the Thai industries toward quality management, and recommends the necessary changes and prerequisites for successful performance.

3.2 Research Method : Quantitative Analyses

The importance of empirical research in the field of operations management (OM) has been increasingly recognized to help narrowing the gap between theory and practice (Meredith,1993; Filippini, 1997). A number of researchers have complained that OM practitioners do not make use of research findings as they consider most OM research to be irrelevant, lacking, narrow, and impractical (Amoako-Gyampah & Meredith, 1989; Chase, 1980; Miller et al., 1981; Sprague & Sprague, 1976; Westbrook,1995). Empirical research can help bridge this gap by bringing the researchers to the field. According to Swamidass (1991), empirical theory is "one that could be and must be subjected to tests using empirical observations, in comparison to a theory that could only be tested using deductive logic. The accumulation of empirical theory-building efforts should result in the development of OM knowledge and general theories which could be utilized to improve the practice of operations management across the board (Filippini, 1997; Swamidass, 1991).

Many researchers have highlighted the need to develop empirical research, with particular emphasis on that which utilizes surveys, in order to support theory building in the field of operation management (Cummings, 1977; Sullivan, 1982; Sprague, 1977; Swamidass, 1991). The term survey means, "a collection of data, information and opinions of a large group of units, referred to as a population" (Filippini, 1997, p. 665). The survey is by far the most widely utilized method of empirical data collection used by operation management researchers (Westbrook, 1995). Survey research can have three aims: investigation, confirmation, or description of events. The investigation purpose refers to the determination of concepts which are related to a phenomenon. The confirmatory purpose involves testing of theory and establishing relationships between variables. The description purpose describes events, opinions, and/or their distribution (Filippini, 1997).

In this study, survey research is used for the purpose of investigation in order to determine which management concepts are related to the pattern of organizational and technological development of the Thai industries. It is also used to test a set of hypotheses concerning quality management and to provide a basis for the in-depth case studies.

The methods used in this survey research consist of formulation of hypotheses, development of the survey instrument, collection of data, construction of an organizational-technological map (O-T map), and analysis of variance. First, hypotheses are developed in Section 3.2.1 concerning the issues of organization, technology, and management. After collecting data from the questionnaire surveys, an O-T map is used to reveal the general pattern of organizational change and technological innovation among the companies practicing quality management. Based on the general pattern, the companies are grouped into various categories according to the O-T characteristics and the types of quality systems. Analysis of variance is then conducted to determine the effects of quality systems on performance. Finally, the results of quantitative analyses are used to test the hypotheses.

3.2.1 Hypothesis Development

As revealed from the literature search, competitive advantage can be achieved through integrating technology, organization, and management. The best combination is to have a balance between organization and technology, which can be accomplished by management paradigms. One purpose of this research is to identify the most suitable management practice(s) which bridge the organizational and technological dimensions. As total quality management emphasizes employee involvement while aiming for continuous improvement in the products and processes, it should provide an effective link between organization and technology. Therefore, proposition 1 and hypothesis 1 was formulated as follows.

Proposition 1: Total quality management (TQM) is one of the suitable management approaches which balance technology and organization and lead to improved performance and sustainable competitive advantage.
Hypothesis 1 : Companies adopting TQM exhibit better performance than those without quality systems.

The popularity of ISO 9000 has caused a great deal of controversy as reflected in the literature review. Although its many benefits have been cited, it has not been proved that ISO 9000 is a path to continuous improvement. Quality-related benefits are among the last reported by Thai manufacturers (Krasachol, Willey, and Tannock, 1998). It is thus crucial that manufacturing organizations understand the benefits and limitations of ISO 9000 in order to progress to sustainable development. This led to Hypothesis 2 as follows.

Proposition 2 : The adoption of ISO 9000 is generally of limited value on its own and does not necessarily lead to continuous improvement.
Hypothesis 2 : The level of performance of companies with ISO 9000 certificates is lower than or equal to that of companies adopting TQM.

It is probable that most companies in Thailand will sooner or later need to seek ISO 9000 registration due to international pressure. However, if Hypothesis 2 is true, it is necessary that companies look beyond ISO 9000 and pursue continuous improvement in order to sustain competitiveness. Hypothesis 3 aims to provide a possible solution.

Proposition 3 : The limitations of ISO 9000 quality system can be overcome by putting it in the context of TQM.
Hypothesis 3 : The level of performance of companies with TQM and ISO 9000 is higher than that of companies adopting only ISO 9000.

3.2.2 Data Collection

In this study, the subjects of interest are companies practicing, or interested in practicing quality management. As the number of such companies is not available, data collection is conducted by purposive sampling, which is a form of non-probability sampling where cases are judged by researchers as typical of cases of interest. This technique is appropriate when sampling frames are unavailable or the population is widely dispersed (de Vaus, 1990; Dixon et al., 1988; Salant and Dillman, 1994).

To obtain the necessary information by purposive sampling, questionnaires were distributed to participants at seminars on total quality management organized by the Federation of Thai Industry and seminars on ISO 9000 organized by Thammasat University rather than randomly distributed to all the companies in Thailand. As these two organizations are well-respected among industrial practitioners and the participants are mostly from companies with keen interests in improvement, the data source should be relatively reliable.

Out of 200 questionnaires, a total of 53 usable replies was received, constituting 26.5 percent response rate. The distribution of responses is shown in Chapter 4 (Table 4.1). Based on the types of quality management, the companies can be classified into four groups: no quality system, ISO 9000, TQM, and both. The number distribution is as follows: none (17 companies), ISO 9000 (10 companies), TQM (14 companies), and both (12 companies).

3.2.3 Survey Instrument

The survey instrument was constructed using a questionnaire designed by Sun (1994) which was intended to assess the pattern of organizational changes and technological innovations of thirty five companies in Denmark and Norway. For the purpose of this study, the questionnaire was slightly modified to include questions regarding the application of various types of quality systems, and questions about different elements of total quality management (Appendix A).

The questionnaire was divided into four parts: general information, organization, technology, and performance. The three main parts which were used to extract information on the general pattern are the organization, technology, and performance parts.

The first part contains general information about the number of employees and the types of adopted quality systems. The data is used to classify the companies into different types and sizes.

The organization part refers to the recognition of human resource, employee involvement, and departmental coordination. It also evaluates the trend of reorganizing activities in the past five years in order to include dynamic elements into the data. The aggregated scores for each respondent provide the data for the organizational index.

The technology part measures the degree of automation in various activities within a company, namely purchasing, design/engineering, production, marketing/sales, and finance/administration. It also assesses the use of information technology to transfer information between functions. The aggregated scores for each respondent provide the data for the technological index.

The level of company success is evaluated by measuring and projecting manufacturing performance. The performance part incorporates financial as well as non-financial perspectives. As the survey involves many types of industry, the performance measures are not industry specific, and they are assessed by the respondent's perception in terms of cost, quality, delivery, innovation, and employee involvement. This part also addresses the trend in performance concerning the overall growth of companies during the past five years.

For each part, the quantitative data is formulated into an aggregated index, i.e. organizational index (O-index), technological index (T-index), and performance index (P-index). In further analyses, the O- and T- indices for all companies are plotted on the O-T map in order to reveal the pattern of organizational and technological development. The P-index is used in the analysis of variance to determine the effects of management practices on performance.

The questionnaires have been pilot tested at fifteen companies before being put to use. Any redundancy resulting from the use of jargon or unclear words has been consequently resolved before the main survey was sent out. The data for the fifteen companies are not included in the analyses.

3.2.4 Organizational-Technological Map

A systematic perspective on company development can be approached by investigating the relationships between pairs of factors. An earlier work of this type can be dated back to 1958 when Bright (1958) studied the relationship between the level of mechanization and the demand made on human skills. Since then a similar approach has been adopted by a number of authors. In particular, the study on organizational-technological relationship has been conducted by such authors as Woodward (1965), Zwerman (1970), and Bessant (1990).

One of the analytical tools for studying the relations between organizational and technological developments is the O-T map, which is a two-dimensional coordinate diagram with the O- and T-index on the Y and X axis, respectively. According to Sun (1994), the O-T map is a suitable tool for describing the pattern of organizational changes and technological innovations in both dynamic and static manner. Similar diagrams have been used to subjectively explain the path of organizational changes and technological innovations (Ettlie, 1988; Twigg et al., 1991; Bessant,1991; Frick et al., 1992).

Although different definitions and conclusions were associated with these studies, Sun (1994) identified three distinguishable dynamic paths based on the studies as: organizationally-oriented (O-path), balanced (B-path), and technologically-oriented (T-path) as shown in Figure 3-1 (a). Mathematically, the different paths are represented by the slope dO/dT, which represents the speed of organizational changes relative to technological innovation.

Figure 3-1(b) illustrates the three types of static status which can be designated by the distance (DB) from a company's position to the balanced or B-path. The three types of static status are classified as organizationally centered (O-status, $DB < 0$), technologically-centred (T-status, $DB > 0$), and balanced (B-status, $DB = 0$) (Sun, 1994).

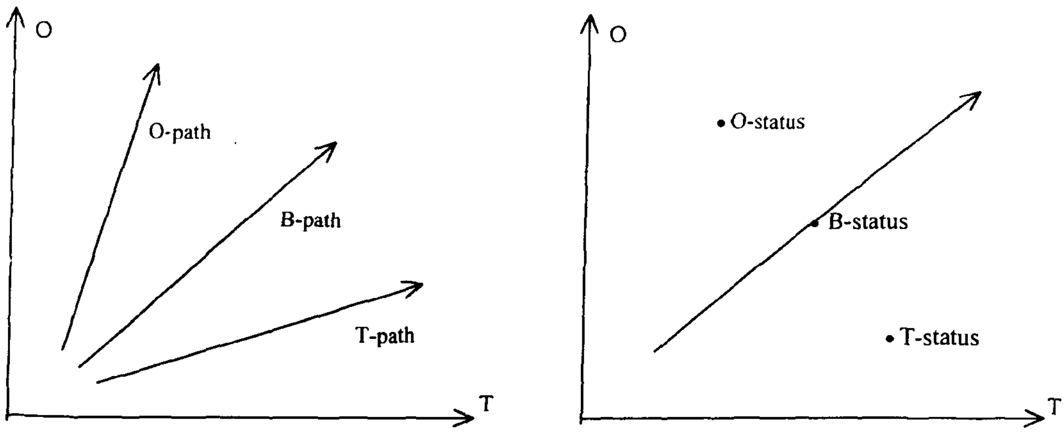

Figure 3.1 The O-T map, showing : (a) the dynamic path, (b) the static status

The pattern of organizational and technological development can be found by plotting the aggregated indexes which are obtained from the questionnaires on the O-T map, and conducting regression analysis to find the relation between the two variables. As the general pattern of the real data would not normally fit into any of the theoretical paths, the whole pattern has to be divided into smaller stages that are characterized by the static status and the dynamic paths.

From Sun's findings, the companies in different stages exhibit different performance, and the companies which are able to stay in the balanced status have the highest and increasing performance. He offers the following conclusion, "the performance of a company is partially influenced by the static status, the status being determined by the path that the company followed, and the path is guided by the vision or paradigm of manufacturing that a company has"(Sun, 1994, pp 219).

In the selection of a path for the near future, Sun suggests that any short-term path can be taken depending on the current status of a company, i.e. the path has to bring the company to the balanced status. In the long run, it is recommended that a company adopt the CHIM (computer and human integrated manufacturing) paradigm as it is believed to bring the company to a balanced future status.

Based on the above findings, this study makes use of the O-T map in order to explore the general pattern of organizational and technological development of the Thai manufacturing industry. Once the general pattern has been found, it is then divided into smaller stages of organizational and technological development in order to be examined in more detail. The next step is to analyze the performance of companies in these various stages by applying the analysis of variance method. The results should reveal whether there is any difference in the pattern of organizational-technological development between countries.

3.2.5 Analysis of Variance (ANOVA)

The next step is to analyze the performance of companies in various stages and the performance of companies adopting different management practices. The stage of a company as revealed from the O-T map (hereafter referred to as "stage") is characterized by the current status and the path it follows. The types of quality management practices are classified as total quality management, ISO 9000, both, and neither.

The effects of stage and type of quality system can be found by adopting the analysis of variance (ANOVA) approach. Analysis of variance (ANOVA) models are useful for studying the relation between a dependent variable and one or more independent variables. In this case, the dependent variable is performance, and the independent variables are stage and type. It should be noted that both of the independent variables (stage and type) are qualitative and categorical. Therefore, the ANOVA method is suitable because it does not require that the independent variables are quantitative, and it does not require making assumptions about the nature of the statistical relation (Neter et al., 1985).

If the analysis of variance reveals that the effects of stage and type are important, it becomes meaningful to describe the nature of the effects by comparing the mean performances. This can be done by multiple pairwise comparison methods, which should be suitable for unequal sample sizes such as the observational data in this study.

According to Kirk (1995), the different methods suitable for this type of data are Gabriel's test, Genizi and Hochberg's test, Hochberg's GT2 test, Hunter's H test, and the Tukey-Kramer test. Among these approaches, the best method is the Tukey-Kramer test as it controls the type I error at less than probability α and has the highest power of test among the procedures investigated.

Based on this information, this study selected the approaches which were available on SPSS: (1) Tukey's HSD (honestly significant difference), (2) the least significant difference (LSD) test, (3) Gabriel's, and (4) Hochberg's GT2 methods. Note that the Tukey's HSD method can also be used for unequal sample sizes in which case it will give conservative judgments (Neter, 1985; Christensen, 1996). The LSD method is also applied as it is one of the most widely used procedures although it is not recommended when an experiment has more than three treatment levels. In such a case, it tends to give a less conservative judgment because it fails to control the maximum family-wise error rate attainable under any complete or partial null hypothesis at a preselected level of significance (Keppel, 1973; Kirk, 1995).

The results of quantitative analysis were used to test the hypotheses developed earlier. The overall findings then provide the basis for the in-depth case studies as discussed in the following section.

3.3 Research Method: Qualitative Multiple Case Analyses

Surveys and case studies are common methods used for collecting empirical data in the field of operations and technology management. Each method has its own benefits and disadvantages, and the selection of methods depends on the research questions and purposes (Riis, 1991). While surveys have the advantage of producing a general pattern, the case study method is helpful in providing in-depth information and in answering questions in the form of 'how' and 'why' (Yin, 1989; Sun, 1994).

In the first part of this research, a survey has been utilized in order to provide the basis for subsequent case studies. The findings from the survey helped provide guidelines in the design of structured questionnaires used for the case studies. The findings are also used to classify the case studies into various stages of organizational and technological development.

Qualitative multiple case studies were conducted to capture detailed data and to reduce such noise effects as type, size, and nationality of companies. The methods include the formulation of research questions, identification of study sites, design of performance measures, data collection, and data analyses.

3.3.1 Research Questions

The aim of the qualitative multiple case analyses is to verify the conclusion as derived from the quantitative analyses and to answer the following questions.

- What is the evolution of quality management in the Thai companies under study?

The four Thai companies in the cases cover all types of management systems under investigation (TQM, ISO9000, BOTH, and none), and have been observed for an extended period of time (three years). The case studies can thus provide useful information on the evolution of quality management in these companies.

- What are the impacts of different types of quality systems on company performance?

The in-depth case studies can help verify the impacts of management practices which are obtained from the quantitative analyses. By allowing for detailed investigation, the case study method makes it possible to evaluate the extent to which companies adopt quality management. Rather than depending on respondents' perception, it eliminates the drawback of the survey method and helps support the results.

- What are the factors critical to successful adoption of management practices?

The case studies of both the Thai and Japanese companies reveal the characteristics of manufacturing practices responsible for superior competitive performance. The factors critical to successful adoption should be common among successful companies, and this would help build a framework for the transfer of quality practices to the Thai industries.

3.3.2 Identification of Study Sites

Appropriate study sites were identified by contacting the Office of the Board of Investment, local chambers of commerce, and manufacturing associations. Suitable types of industry are those which have been established for some time, are subject to local and foreign competition, not labour intensive, and able to provide data on organizational and technological development.

The study sites have been selected from the manufacturing industries in Thailand and in Japan in order to facilitate comparison between indigenous and world-class performance. The Thai database constitutes representatives from three Thai-Japanese joint ventures, and another small local company, all of which are engaged in the manufacturing and assembly of engines. The Japanese plants which provide the data for comparison include the partners of the three joint ventures. Together, the companies account for more than 80 % of the product shipments in each country. The selection of companies in the same industry helps facilitate comparison by establishing common grounds while confining other effects to a comparable level.

In terms of the study of quality management practices, the seven samples provide valid representatives of those adopting TQM and ISO 9000. One Thai company has been practicing TQM for nearly ten years before deciding to pursue ISO 9000 registration. Another Thai company achieved ISO 9000 certification prior to launching its TQM initiatives. The other two Thai firms are not involved in either practice. With regard to the Japanese organizations, all three of them are highly successful as reflected in various performance measures. They have been practicing total quality management for quite a long time before seeking ISO 9000 registration. Thus it can be seen that the seven companies provide suitable cases for studying the effects of quality practices.

3.3.3 Guidelines for the design of performance measurement system

In designing a suitable performance measurement system, the criteria for design have been discussed by various authors.

Maskell (1989) recommends seven principles in designing a performance measurement system; the system should (1) be relevant to manufacturing strategy, (2) include non-financial measure, (3) be situation specific, (4) be changeable with circumstances, (5) be simple and easy to use, (6) provide fast response, and (7) stimulate continuous improvement.

Dixon et al.(1990) also provide a list of attributes as a guideline for designing a performance measurement system. For example, the system should be: strategically relevant, easy to implement, customer-driven, and supportive of individual and organizational learning. They suggest that a good measurement system should include both situation-specific and generic measures.

While the guidelines provided by these authors are more geared toward the design of a system to be used within an organization, Kaplan and Norton (1993) suggest broader guidelines which can be used both for an organization and for external assessment. They recommended four basic elements to be addressed in a performance measurement system: customer perspective, internal perspective, innovation perspective, and financial perspective. While their system provides useful guidelines, it lacks the issue of system design process and the dimension concerning competitors (Hazell and Morrow, 1992; Kaplan and Norton 1993).

3.3.4 Available performance measurement systems

In order to design a performance measurement system for the case studies, there is a need to be aware of the problem concerning comparisons between studies. It is generally accepted that different researchers tend to employ different instruments thus making it difficult to compare the results.

At present, there are a large number of available criteria that are reported in the literature. The existing measurement instruments consist of: national quality award criteria, general frameworks recommended by researchers, and empirically-developed systems. Each instrument has its own benefits and limitations to be discussed in the following sections.

3.3.4.1 National Quality Award Criteria

The criteria for national quality awards are widely recognized and have been applied by a large number of organizations in many different settings. Some of the most widely accepted criteria are the U.S. Malcolm Baldrige National Quality Award (MBNQA), the European Quality Award, and the Japan's Deming Prize. These criteria are widely utilized not only by companies desiring to compete for the awards, but also by companies conducting self-assessment to measure organizational effectiveness (Jordan, 1994; Laszlo, 1997; Stephens, 1996). For example, the MBNQA criteria have been used annually by thousands of organizations to conduct self-assessment (Sunday and Liberty, 1992). The criteria consist of seven categories relating to quality: leadership, information and analysis, strategic quality planning, human resource development and management, process quality management, quality and operational results, and customer focus and satisfaction (Wisner and Eakins, 1994).

The Japan's Deming Prize is another national quality award that is widely cited. It is based on the following checklist consisting of 10 items: policy and objectives, organization and its operation, education and its dissemination, assembling and disseminating information and its utilization, analysis, standardization, control, quality assurance, effects, and future plans (Ishikawa, 1985).

3.3.4.2 The general Frameworks of performance measurement system

The general frameworks tend to be the complete frameworks of performance measurement system. They usually consist of a set of generic measures that are further divided into more specific elements. For example, Gunn (1992) suggests a set of performance measurement metrics consisting of 10 elements: time, waste, cost, quality, flexibility, value-added, productivity, asset utilization, customer satisfaction, data and information integration. He also provides examples of specific measures together with the appropriate outcomes for world-class standards.

Maskell (1991) discusses five broad categories of quality, delivery, process times, flexibility, and costs, all of which are further classified into various measures. Although the framework provides a list of measures, it does not offer guidelines in selecting the most suitable measures for a given company.

Kano and Koura (1990-91) discuss both the tangible and intangible criteria for measuring performance. Examples of the tangible criteria are growth, user merits, market competitiveness, production, and inventory. They also provide a list of more specific measures for each criterion. Like Maskell, they do not offer guidelines in selecting the most suitable measures for a given situation.

Although these general frameworks provide the key dimensions of manufacturing performance, they are mainly generic and may lead to confusion (Neely et al., 1995). As the generic terms usually encompass a variety of dimensions, different authors may employ different contexts thus leading to incompatibilities of the analyses.

One of the most respectable frameworks is suggested by Deming (1986). Deming's 14 points can be used as a framework for performance measurement and also as guidelines for companies wishing to take up quality management. The components of the Deming's 14 points are later listed in Section 3.3.5 (Table 3.1).

3.3.4.3 Empirically-developed performance measurement systems

There has been a number of systematic attempts in the literature to construct the measures of critical success factors of quality management, e.g. Ahire et al. (1996), Black (1993), Cupello (1994), Powell (1995), and Tamimi (1995). Most of these studies developed their measurement instruments from comprehensive literature reviews, and empirically tested them for validity and reliability. The instruments were then used in their own studies and were not repeatedly applied in more broadly based samples and in various industrial settings. Thus there is a lack of consistency and repeatability.

One of the most widely cited instruments was an early work conducted by Saraph, Benson and Schroeder (1989). Like most empirically-developed measures, their instrument was organized based on various critical factors that have been identified by quality gurus. It consists of a set of eight measures that were empirically tested for reliability and validity using perceptual data collected from 162 managers of 20 companies in the U.S. The instrument has also been retested by Badri et al. (1995) in a different setting. The eight critical factors include: management and quality policy, role of quality department, training, product/service design, supplier quality management, process management, quality data and reporting, and employee relations. The instrument is claimed to be valid and reliable as it is systematically constructed and tested, thus researchers can use it to examine certain hypotheses concerning quality management (Saraph et al., 1989).

3.3.5 Design of performance measurement system

In deciding on the criteria to be adopted in this study, the advantages of each system can be compared against each other. Some authors assert that national award criteria are better means for assessing organizational excellence than the systematically-developed systems, and that they are found to "reflect the most important components of effectiveness and competitiveness" (Thiagarajan and Zairi, 1997). It has also been suggested that organizations can gain valuable experiences by evaluating their progress against an accepted set of criteria (Ishikawa, 1985; Oakland, 1993). As these quality awards have been nationally recognized and used by a large number of organizations, they should provide consistent approaches to measuring competitiveness.

In comparison, the general frameworks of performance measurement system are largely generic. Although they provide a list of specific measures, they do not offer guidelines in selecting the most suitable measures for a given situation. The last type of measurement system is the empirically constructed instruments. Although they provide a testable method suitable for research work, the existing instruments have not been sufficiently tested for validity and reliability in various situations, and they have not been adequately applied in case studies.

Considering these reasons, the performance measures used for the case studies have been organized by combining the criteria from all the systems presented earlier. As shown in Table 3.1, the measures adopted consist of eight criteria that are comparable to the major systems already discussed: management commitment, organizational integration, quality policy, human resource management, management of process, quality system in manufacturing, supplier management, customer focus.

Table 3.1 Various criteria for performance measurement

Measures used in the study	MBQA[1]	Deming's 14 points[2]	Saraph et al.[3]
Management commitment.	Leadership.	Constancy of purpose. Adopting new philosophy toward not accepting defective products.	Role of top management and quality policy.
Organizational integration.	Information and analysis.	Drive out fear by encouraging two-way communication. Break down barriers.	Product/service design.
Quality policy.	Strategic quality planning.	Eliminate slogans.	Role of quality department.
Human resource management.	Human resource development and management.	Build pride of workmanship. Eliminate quality-related numerical goals and quotas. Training. Continuous education and retraining.	Training. Employee relations.
Management of process.	Management of process quality.	Eliminate dependence on mass inspection. Constant improvement.	Process management.
Quality system in manufacturing.	Quality and operational results	Supervision by ensuring immediate actions on quality problems. Make maximum use of statistical knowledge.	Quality data and reporting.
Supplier management.		Do not choose suppliers based on price alone.	Supplier quality management
Customer focus.	Customer focus and satisfaction		

Sources: [1]Wisner and Eakins (1994), [2]Deming (1986), [3]Saraph et al. (1989)

3.3.6 Structured data collection Methods

A multiple case study design utilizes multiple data collection methods (Yin, 1989). In particular, this study gathered information from a number of sources including in-depth interviews, plant observation, archival data, and secondary data at the customer level.

The utilization of multiple data collection methods are helpful as they reinforce each other's strengths and weaknesses. Some questions used in the questionnaire may have varied interpretations depending on specific situations. For example, the question regarding the number of employees requires clarification in case the company being interviewed is part of a large corporation consisting of subsidiaries. The interview process is very useful in interpreting questions and defining terms to reduce variability in respondents' perceptions to the questions. Archival data are helpful in extracting tangible information, however, certain quantitative data were not available due to limited access to information.

The multiple case studies consist of two parts, one of which was conducted in Thailand and the other in Japan. The Thai case studies were performed in two stages. The first stage involved data collection at various application sites to assess customer satisfaction with the products. The second stage was conducted at the plants through site observation, archival data, and in-depth interviews. The Japanese case studies involve site observation, archival data, and in-depth interviews. No customer survey was conducted due to time limitation.

3.3.6.1 Customer survey of the Thai cases

As shown in Appendix B, the questionnaire used in the customer survey was designed to evaluate customer opinion in terms of price, product features, after-sales service, and inquiry lead time. Customers were asked to make comparative judgment on the four brands on five-point scales, ranging from two (very poor) to ten (very good) for all measures.

The method of data collection was through interview with customers at various customer sites. Although the customers are scattered in the four regions of the country, a majority of them are in the central area which is the main rice plantation. Therefore, dealers in this area were approached for interview. The advantage of using dealers rather than end customers is that they are relatively more knowledgeable about the cost, quality, and delivery aspects, and they are easier to access. Due to time and financial constraints, forty out of approximately 500 dealers were interviewed, consisting of 8 percent of the total. The data from the customer survey are used with the other data collected during the plant visits.

3.3.6.2 In-depth Interviews : the Thai cases

For the plant visits in Thailand, the population sample in each plant included vice presidents, plant managers and one or two full-time engineers, all of whom received the questionnaires sent by mail in advance. The reason for interviewing these groups of people is because they represent various levels of organization: top management, middle management, and lower-level employees. Top management can provide useful data on the company strategy, quality policy, and overall corporate performance. Middle management implement top management decisions. Their interactions with both top management and lower-level employees tend to make their perception more considered and accurate. They can make good reflections on top management commitment and employee involvement. At lower levels, engineers work more closely with workers and they can provide data on the operating level.

The combined length of interview and plant tours generally lasted between three and four hours, and a total of 14 face-to-face interviews were undertaken at the four plants.

3.3.6.3 In-depth Interviews : the Japanese cases

For visits to the Japanese plants, data was collected by sending questionnaires prior to the visits followed by face-to-face interviews and plant observations. The participants consisted of vice presidents, plant managers, section managers, and engineers, representing various departments ranging from manufacturing to quality control, engineering, purchasing, and service. The combined length of interview and the plant tours lasted between five to six hours, and a total of three face-to-face interviews were completed at the three plants.

3.3.6.4 Structured Interviews

The questionnaire used for the structured interviews during the plant visits was designed to tap a wide range of issues and extract necessary information for the performance measures developed in Section 3.3.5. As shown in Appendix C, it consists of four sections, i.e. strategic management, management of organizational system, manufacturing infrastructure, and organizational infrastructure.

Section 1 (strategic management) assesses the strategic management of the company, and it is to be answered by top management. The questions assess the strength of competitive forces, strategic objectives, critical success factors, and general market characteristics.

Section 2 (management of organizational system) is concerned with management of quality and quality activities. As quality is among the most critical factors in achieving today's competitive edge, management of quality system will be assessed in terms of top management's perspective and support, quality pervasiveness, steering group, and degree of coordination among departments. Quality activities explore the use of teams, suggestion systems, and other activities.

Section 3 (manufacturing infrastructure) deals with the issues of the quality systems in manufacturing, manufacturing management, manufacturing capability, and production planning and control.

Section 4 (organizational infrastructure) consists of the assessment of performance evaluations, training, customer orientation function, and supplier relationship. Performance evaluation is assessed in terms of reward and recognition, and how it supports the use of teamwork and the willingness to learn new skills. Training evaluates the content and amount of training, and the extent to which training is done on the job and off the job. Customer orientation function identifies such customer-related issues as market surveys; evaluation of competitive products; continual contacts with customers; and interaction between sales, service, manufacturing, and engineering, to utilize field reliability data. Finally, supplier management determines the process of supplier selection and the relationship with suppliers.

In a comprehensive manner, the questions in all four sections satisfy the information needs for the eight criteria: management commitment (Section 1,2), organizational integration (Section 2), quality policy (Section 1,2), human resource management (Section 2,4), management of process (Section 2,3,4), quality system in manufacturing (Section 3), supplier management (Section 4), and customer focus (Section 4).

3.4 Data analyses

Data analyses are carried out according to the established set of performance measures. It begins with the assessment of environmental characteristics which identifies the industrial structures and the forces influencing the companies. The industrial structures are compared according to Porter's five competitive forces: threat of entry, threat of substitution, bargaining power of customers, bargaining power of suppliers, and rivalry among existing manufacturers (Porter, 1980).

Next the companies are analyzed in detail in various functional areas. The detailed analyses of companies are structured into the following topics: company strategy, manufacturing strategy, quality policy, quality system in manufacturing, manufacturing capabilities, production planning and control, customer service, supplier relationship, human resource management.

The Thai cases are then compared by using the performance measures developed in Section 3.3.5 in order to reveal the common characteristics and environments attributable to successful and unsuccessful performance.

Next, the Japanese partners are examined for the purpose of revealing success factors towards world-class performance. Finally, the Thai and Japanese participants are measured against each other in an attempt to answer the research questions. In this case, comparison can be made on a similar basis because the companies operate in similar competitive environment, employ similar technology, and produce the same types of products.

The results obtained from the above study are presented in Chapter 4 (Quantitative Analysis), Chapter 5 (Analyses of the Thai Case Studies), and Chapter 6 Analyses of the Japanese Case Studies.

Chapter 4

Quantitative Analyses

This chapter presents the results of quantitative analyses of the surveys of 53 Thai manufacturing companies. The first two sections summarize the respondents' profiles and describe the empirical pattern of organizational changes and technological innovation of the general Thai industries. The others sections discuss the classifications of companies into different stages and types of quality systems, followed by hypothesis testing. The chapter concludes with a discussion of the implications concerning the best approaches for companies at each stage of organizational and technological development.

4.1 General results

From a total of 200 questionnaires shown in Appendix A which were distributed at local seminars on TQM and ISO 9000, 53 usable replies are available. A summary of company profile is shown in Table 4.1.

Table 4.1 A summary of Company Profiles

Type of Industry	No. of companies	Size (number of employees)		
		Small (50-299)	Medium (300-999)	Large (> 1000)
1. Primary / fabricated metal	5	5	0	0
2. Industrial machinery & equipment	7	4	3	0
3. Electronic & other electric equipment	16	4	8	4
4. Chemicals & allied products	11	7	3	1
5. Rubber & plastic products	8	4	1	3
6. Food, textiles, leather	6	3	2	1
Total	53	27 (50.7 %)	17 (32.2 %)	9 (17.1 %)

4.2 The Survey Instrument

In order to find the pattern of organizational and technological development, this study employed two sets of instruments: a questionnaire (Appendix A), and an organizational-technological map (Section 3.2.4). Both instruments were used by Sun (1994) to assess the pattern of organizational changes and technological innovations of thirty five companies in Denmark and Norway. Frick et al. (1992) also used similar tools to characterize the organizational-technological pattern for 16 industrial companies in the same country.

As for this study, the two sets of instruments are adopted to identify the organizational-technological pattern of the Thai manufacturing industries. They are also used with an additional purpose to find the O-T pattern influenced by the adoption of quality management practices.

4.3 The empirical pattern of organizational and technological development

Using the questionnaires in Appendix A, the responses of 53 companies were formulated into aggregated indices, and the results are presented in Appendix D. The quantitative data of organization (O) and technology (T) were then plotted on an O-T map as illustrated in Figure 4.1, using the scales based on the raw scores that were aggregated from the responses.

In order to find the empirical pattern of the data, curve fitting was conducted on the scattered plot with the aid of regression analysis. Regression analysis is a statistical tool that utilizes the relation between two or more quantitative variables. It has been used by a number of researchers in describing the pattern of organizational changes and technological innovations. For example, Sun (1994) has used a 4^{th}-order polynomial regression model to describe thirty five companies in Denmark and Norway, and Frick et al. (1992) fitted a 5^{th}-order model to characterize a similar pattern for 16 industrial companies in the same countries. Similarly, regression analysis was applied for the 53 companies in this study.

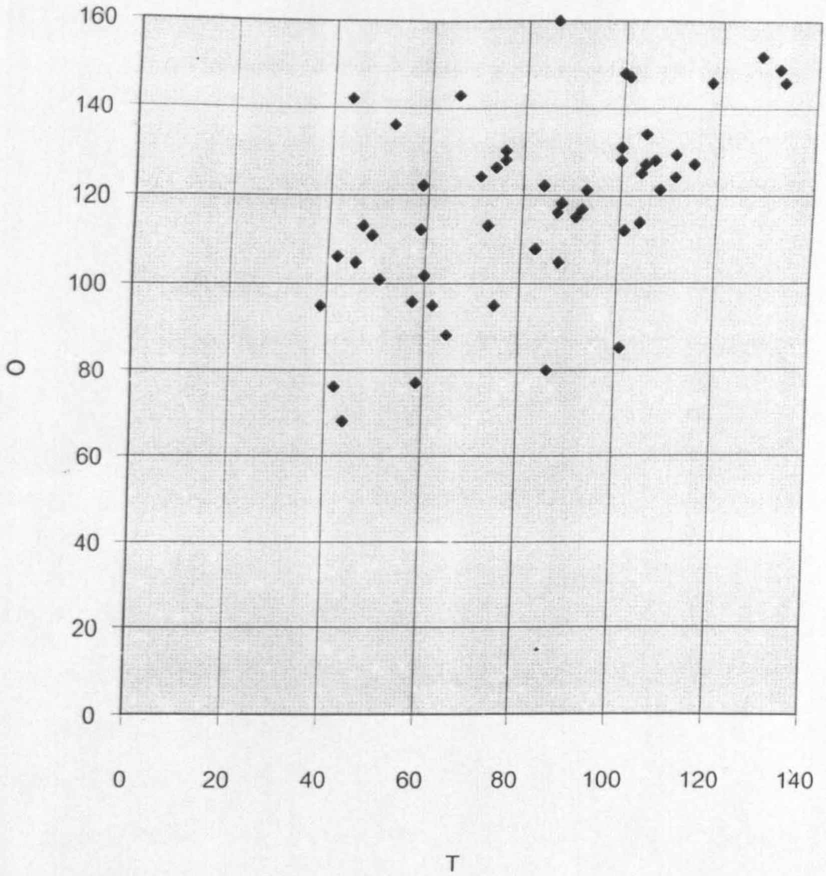

Figure 4.1 An O-T map showing the quantitative data of organization (O) and technology (T) of 53 companies.

As compared with the research mentioned earlier, the data from the 53 companies appeared more scattered. They were thus investigated for the presence of outliers by constructing a boxplot in Figure 4.2, which revealed that there was only one mild outlier. Investigation of the outlier (68,44) shows that the corresponding company had a rather low score on the O-index (68) as compared with the others. As it was only a mild outlier, the data points were included in further calculation, and regression analysis was conducted with all the data.

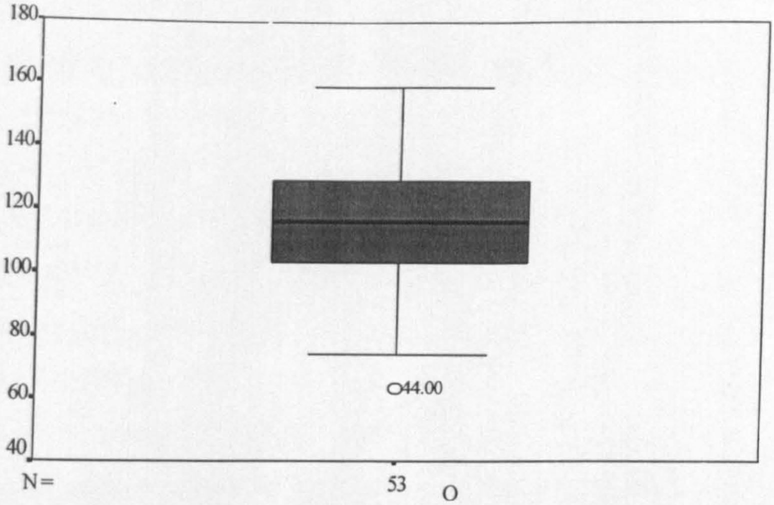

Figure 4.2 A boxplot of the 53 O-T indices, indicating the presence of a mild outlier.

To obtain the best fit, SPSS was employed by constructing regression models at higher orders and exploring whether the high-order terms could be dropped making a lower-order model adequate. The results were illustrated in Appendix E (Table 1) which contained the SPSS outputs of fitting five polynomial models with the standardized values in order to avoid overflow problems in calculation.

Appendix E (Table 1) shows that, at the level of significance of 0.05, the linear model (Model 1) was statistically the best fit.

Linear model (Model 1) :

$ZO = 1.049^{-15} + 0.558\ ZT$, $(R^2 = 0.311$, adjusted $R^2 = 0.298)$

where ZO = standardized O indices

ZT = standardized T indices

The above findings were compared with the outcomes of fitting the unstandardized values of O- and T- indices. The SPSS outputs in Appendix E (Table 2) also indicate that the most appropriate model is linear with the same adjusted R-square as shown below.

$O = 80.999 + 0.447\ T$ ($R^2 = 0.301$, and adjusted $R^2 = 0.287$).

In summary, the best empirical model which fitted the pattern of organizational and technological development was the linear model. These findings came as a surprise because it was initially expected that a higher-order model would be the best fit. In the similar works described earlier, the patterns were represented by higher-order models showing a slightly S-shaped curve. However, it was not statistically illustrated how they were regarded as the best fit. Although the patterns belonged to companies in different countries, the results should not have been much different in the sense of curve fitting.

Although the O-T diagram has been useful in describing the patterns of organizational and technological development, the approach of fitting a complex polynomial model in describing the pattern posed questions in terms of statistical validity. However, it was not the purpose of this study to deal with the problem but to look for the best approach to competitiveness.

If the general pattern could be divided into narrow stages of O-T development, it would become useful for helping to identify the approaches suitable for each stage. The classification of companies is discussed in the following section.

4.4 Classification of stages of O-T development

Since regression analysis revealed that the best fit model was linear, it became difficult to divide the pattern into smaller stages. One method is to classify the companies based on arbitrary O-T scores from the pattern. Another convenient method is to use a polynomial regression curve as found in the works cited earlier (Frick et al. (1992); Sun (1994)). Although not statistically the best fit, they can be used as a guideline for classification. As Section 4.3 revealed that polynomial models were not the best fit, their application would be restricted to classification purpose only. In this section, a 5^{th}-order polynomial curve is arbitrarily chosen to divide the companies into smaller stages. It should be emphasized that the curve is used for the purpose of classification only and is not involved in any other parts of the analyses.

When a 5^{th} -order polynomial model is used as a guideline, the companies could be divided into five smaller stages according to the distance DB and slope (dO/dT) (Figure 4.3). Most of the sample companies stayed in the three middle stages that occupied roughly 93 %, and the rest were located in the extreme O- or T- status (Nagswasdi and O'Brien, 1997). Using the findings from this 5th-order model, the companies were thus sorted into three stages (stage 1-3) as being in the low, medium, and high O-T positions (Figure 4.3). Classifying the data in this way has the advantage of letting the data define what is low, medium or high, rather than imposing definition based on arbitrary scores. The distribution of companies in the three stages are 32.1 %, 28.3 %, and 39.6 % as shown in Table 4.2.

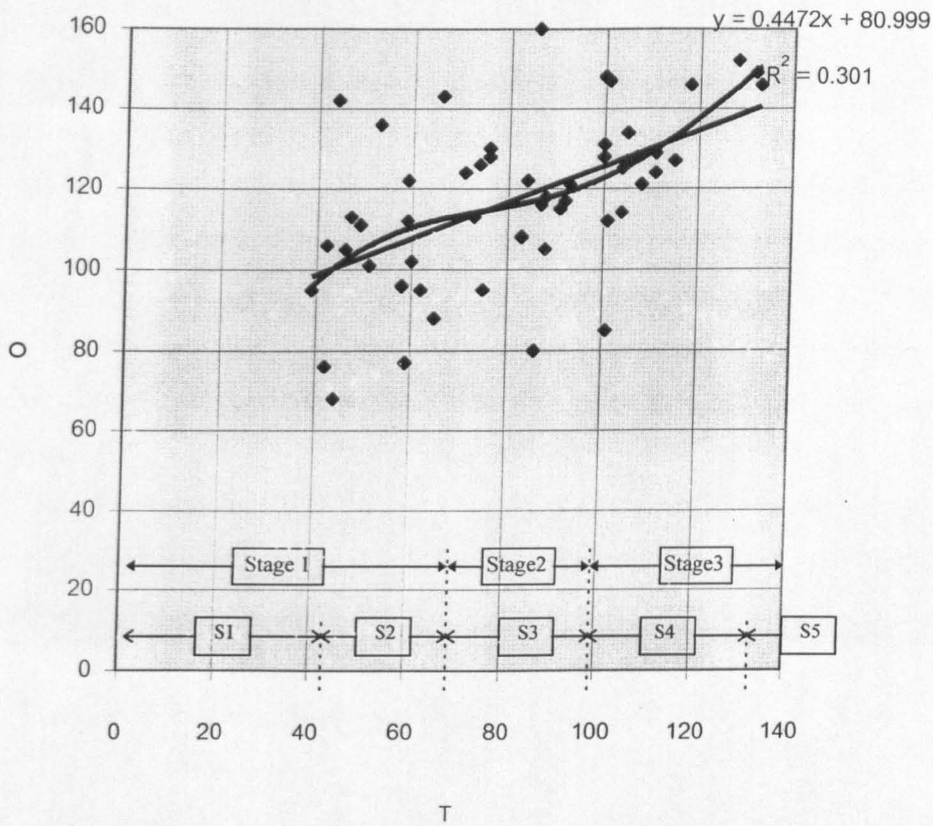

Figure 4.3 The empirical pattern of O-T development, showing the 5th-order model superimposing on the linear one. (S1 - S5 denote the five stages as derived from the 5th order model).

Table 4.2 Size distribution of companies in the three stages

Stage	Small	Medium	Large	Total
1	12	5	-	17 (32.1 %)
2	7	7	1	15 (28.3 %)
3	8	5	8	21 (39.6 %)

4.4.1 Low O-T companies (stage 1)

The companies in this group constitute about 32.1 percent of the total samples (17 data points), most of which employ less than 300 employees. They have lower scores on the organizational, technological, and performance indices. The low organizational indices imply that these companies do not generally have the established sets of rules and procedures. They do not have much active functional coordination, and they seem to place less emphasis on people and organization.

When the seventeen data points were fitted by regression analysis in order to find the organizational-technological relationship, the results are shown in Appendix F, revealing no clear pattern at a significance level of 0.05. This indicates that the companies in stage 1 do not have a consistent pattern of technological innovation and organizational change. Most of the companies in this group are not able to effectively cope with the changes in technology due to their low organizational adaptation. Similarly, their organizational systems do not allow for technological innovations to take place.

The companies in stage 1 do not have much experience with such management approaches as ISO and TQM. In fact, more than half of them do not adopt such approaches.

4.4.2 Medium O-T companies (stage 2)

The companies in this group consist of roughly 28.3 percent of the entire samples (15 data points). Nearly all of them are of small and medium size. They have higher scores on the O, T, and performance indices than those in stage 1, but generally lower than those in stage 3. When regression analysis was conducted on the 15 data points, it was found that no clear pattern emerged at a significance level of 0.05 as shown in Appendix G. Therefore, the companies in stage 2 do not exhibit any relationship between organization and technology, indicating that they do not have adequate infrastructure for organizational adaptation and technological innovation.

As for management approaches, more than two thirds of the companies have used TQM and ISO 9000. With the applications of quality management, these companies are likely to move beyond stage 2 and enter stage 3.

4.4.3 High O-T companies (stage 3)

The high O-T companies consist of approximately 39.6 percent of the collected samples (21 data points). The size of companies in this group are generally well distributed among small, medium, and large. On average, they have high organizational, technological, and performance indices. The high organizational indices reflect a strong emphasis on strategy formulation, functional coordination, as well as training and human resource management. Their people orientation have provided a sound basis for technology assimilation as well as organizational adaptation.

When regression analysis was conducted on the 21 data points, it was found that the companies exhibit linear organizational-technological relationship with the equation of $ZO = 0.511\ ZT$, R-square = 0.261, and adjusted R-square = 0.222 (Appendix H). This means that the organization tends to grow with technology or vice versa. As the companies adopt higher level of technology, they tend to adjust the organizational settings in a positively related direction. In other words, they appear to have high organizational adaptation which complements with effective technological adoption. In a similar manner, as companies increase the organizational dimension, they tend to pursue continuous improvements thus leading to higher technological innovations. Therefore, organization and technology tend to grow together for the high O-T companies.

It is likely that the mechanism behind this relationship is the adoption of management practices as most companies in this group are familiar with, or have implemented total quality management and ISO 9000 quality system.

4.4.4 Checking the relationship

It was found earlier that the overall pattern obtained from the O-T map did not hold across the subgroups. That is, the pattern of the entire data seems to be influenced by the linear pattern of companies in stage 3. The fact that no clear organi zational-technological relationship existed for companies at stage 1 and 2 may be due to the presence of outliers which may have obscured any existing patterns. Thus, further investigation was conducted in order to search for such outliers (Hamilton, 1990).

Figure 4.4 represents the boxplots for the companies in each stage, illustrating the presence of four mild outliers for stage 1 and 2, being (44,142), (44,68), and (86,160), (86,80), respectively.

To study the influence of these outliers, the four points were removed from the data and the models were refitted for stage 1, 2, and 3 as shown in Appendix I, J, and K, respectively. Without the outliers, the findings are still the same for each subgroup, i.e. no clear patterns can be identified for companies at stage 1 and 2 at significance level of 0.05, and a linear pattern was found for companies at stage 3 (zo = 0.571 zt, R-square = 0.326, adj. R-sq = 0.291). According to Appendix L, the overall pattern without the outliers was found to be linear with the following equation : zo = 0.576 zt, R-square = 0.431, and adj. R-sq = 0.419.

As these findings agree with the ones obtained from the data including all outliers, it can be concluded that the outliers do not have significant effects on the patterns. Therefore, the same conclusions are still held as in Section 4.3.1 - 4.3.3, and the outliers are to be included in further analysis.

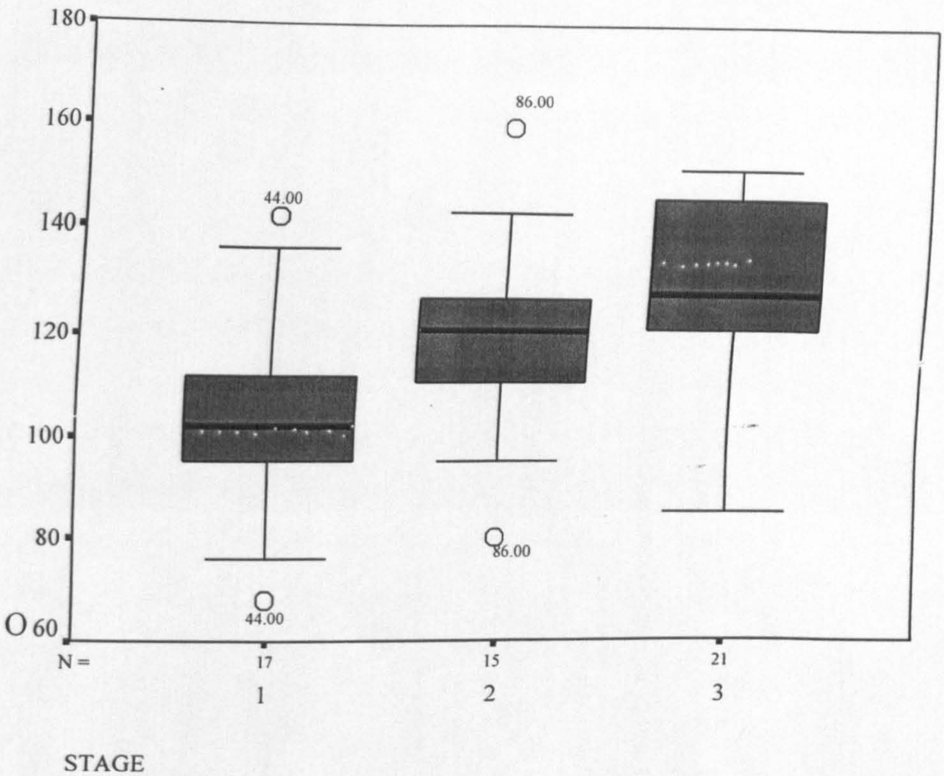

Figure 4.4 The boxplots for each stage, indicating 4 outliers for stage 1 and 2

4.5 Classification of types of quality systems

Based on the responses, the companies could be classified into four main groups according to the types of adopted quality system: no quality system, ISO 9000, TQM, and both. To reveal the O-T pattern of the different types of companies, regression analysis was conducted in a similar manner as that in Section 4.2.

The SPSS outputs of regression analysis are shown in Appendix M through P, revealing that only TQM companies exhibited a linear O-T pattern at 0.05 significance level while the other types of companies did not produce any patterns at the same level of significance.

The O-T pattern of companies adopting TQM is displayed in Figure 4.5, and the equation is as follows (from Appendix O).

ZTQM_O = 0.692 ZTQM_T - 3.05E-17

(R square = 0.479, adjusted R square = 0.436)

where ZTQM_O and ZTQM_T are standardized variables of O and T, respectively.

It should be noted that, at 0.05 significance level, the companies implementing BOTH (TQM and ISO) do not show any clear pattern while those adopting only TQM exhibit a linear pattern of organizational-technological development. This implies that the implementation of ISO 9000 might distract the organizational-technological path, with a possible reason that most Thai companies are not yet familiar with it. In fact, they have only been introduced to ISO 9000 a few years ago, and most companies need to seek registration in a short time due to international pressures. The adoption of ISO 9000 may, in this regard, have distracted the companies from the path that they were following.

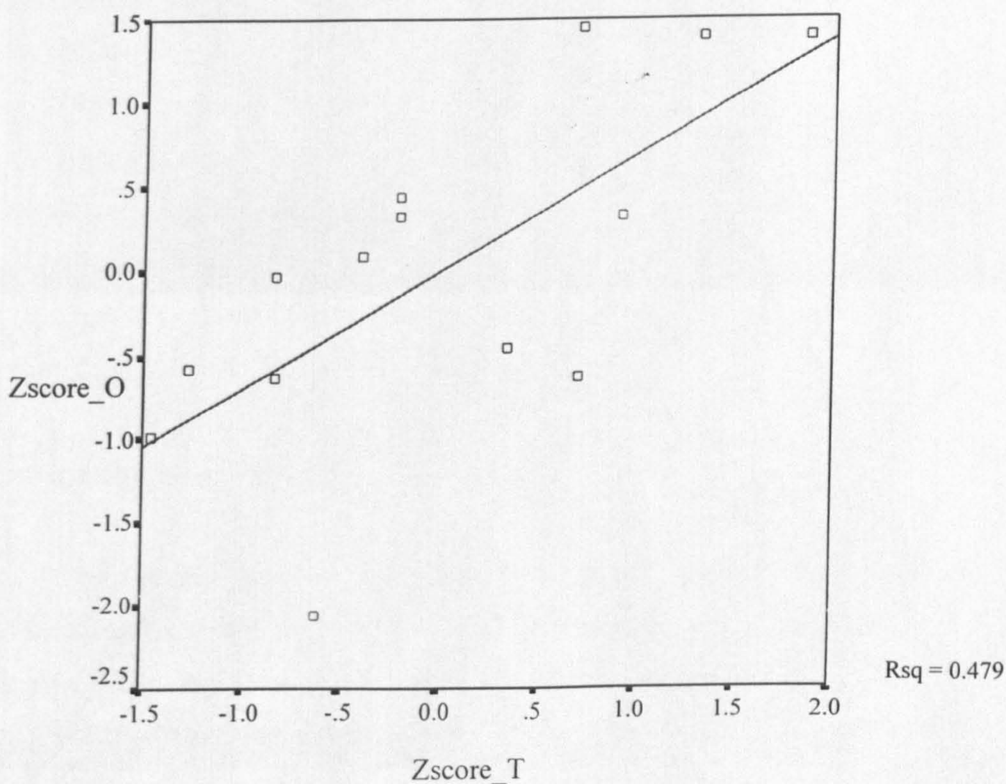

Figure 4.5 O-T map of companies adopting TQM, showing the best fit as linear. (The scales were based on standardized scores.)

4.6 Validation of responses

It may be argued that the classification of quality systems (TQM, ISO, BOTH, and none) was not absolutely reliable as it was subjected to the perception of respondents. In particular, it is rather difficult to truly assess the claims of the companies adopting TQM in a large-scale survey since there is no certification or award which can be used as a benchmark. Careful evaluation needs to be exercised on the extent to which the companies have embraced the TQM philosophy.

This section aims to validate the claims of the respondents regarding the adoption of TQM. As many of the TQM elements are included in the questionnaires, the companies that adopt TQM would generally have higher organizational indexes than non-TQM companies. This is found to be true when the four methods of multiple comparisons discussed in Section 3.2.5 were conducted to compare the O-index for companies with the four types of quality system (Appendix Q). The results can be summarized as follows.

Both > none

TQM > none (LSD)

From the results, it can be seen that the companies adopting BOTH (TQM and ISO 9000), and those adopting TQM appear to have higher organizational indexes than non-TQM companies.

Thus, it can be asserted that the claims of adopting TQM is generally valid, and the classification of companies was sufficiently reliable.

4.7 Impacts of stage and type

From the general pattern, it has been found that the companies can be divided into three stages with different organizational-technological characteristics and different performance. Also, when companies were grouped according to the type of quality system, different O-T characteristics were revealed. Table 4.3 summarizes the number of companies at different stages and types of quality systems together with their mean performance. The differences among performances are statistically analyzed in this section.

This section aims to investigate the effects of the two factors (stage and type) on performance by applying the two-factor analysis of variance. Table 4.4 contains the SPSS outputs which reveal that, at 0.05 significance level, both stage and type had substantial effects on performance while they had little or no interactions with each other.

As the two factors did not interact, their effects could be analyzed separately. The effects of each factor could be studied by comparing the mean performances among the different treatments. In this case, multiple pairwise comparisons were executed to estimate the differences among the means. The methods used were the Tukey's, Gabriel's, Hochberg's, and the least significant difference (LSD) methods. In general, all the methods yielded the same results except that the LSD method tended to be slightly more liberal while Tukey's tended to be more conservative.

4.7.1 Comparisons among the stages of O-T development

From Table 4.5, it can be seen that all the four comparison methods gave the same judgments. At 0.05 significance level, the companies at stage 3 showed the best performance followed by those at stage 2 and 1, respectively. Therefore, the most successful firms seem to be those which place great importance on organization and technology, implying that they have suitable infrastructures for achieving competitive advantage.

4.7.2 Comparisons among the types of quality systems

Table 4.6 contains the results of multiple comparisons among different types of quality systems. To facilitate the analysis, the following expressions were extracted from the Table, showing only those with significant differences. Essentially, all the methods gave the same judgments except for that in expression (2).

TQM > none (1)

TQM > ISO (2) (LSD method)

BOTH > ISO (3)

BOTH > none (4)

Table 4.3 Summary statistics on the number (N) of companies at different O-T stages and types of quality systems, and the mean performances.

Descriptive Statistics

	STAGE	TYPE	Mean	Std. Deviation	N
Y	1	ISO	34.0000	6.5574	3
		TQM	37.2000	6.9785	5
		none	32.8889	5.0360	9
		Total	34.3529	5.8303	17
	2	Both	42.5000	6.8557	4
		ISO	29.5000	.7071	2
		TQM	42.7500	2.5000	4
		none	38.4000	4.1593	5
		Total	39.4667	6.0577	15
	3	Both	45.8750	2.5319	8
		ISO	42.2000	3.7014	5
		TQM	45.2000	3.4205	5
		none	37.3333	8.5049	3
		Total	43.6190	4.8629	21
	Total	Both	44.7500	4.4339	12
		ISO	37.2000	6.7954	10
		TQM	41.6429	5.7326	14
		none	35.2941	5.7529	17
		Total	39.4717	6.7042	53

Table 4.4 SPSS outputs of the two-factor ANOVA on stage and type

Tests of Between-Subjects Effects

Dependent Variable: Y

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
Corrected Model	1332.927[b]	10	133.293	5.574	.000	55.744	.999
Intercept	69632.060	1	69632.060	2912.081	.000	2912.081	1.000
STAGE	347.099	2	173.549	7.258	.002	14.516	.919
TYPE	447.497	3	149.166	6.238	.001	18.715	.948
STAGE * TYPE	172.941	5	34.588	1.447	.228	7.233	.458
Error	1004.281	42	23.911				
Total	84912.000	53					
Corrected Total	2337.208	52					

a. Computed using alpha = .05

b. R Squared = .570 (Adjusted R Squared = .468)

Table 4.5 Multiple pairwise comparisons among the three stages

Multiple Comparisons

Dependent Variable: Y

	(I) STAGE	(J) STAGE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	1	2	-5.1137*	1.732	.014	-9.3222	-.9052
		3	-9.2661*	1.595	.000	-13.1421	-5.3902
	2	1	5.1137*	1.732	.014	.9052	9.3222
		3	-4.1524*	1.653	.041	-8.1686	-.1362
	3	1	9.2661*	1.595	.000	5.3902	13.1421
		2	4.1524*	1.653	.041	.1362	8.1686
LSD	1	2	-5.1137*	1.732	.005	-8.6095	-1.6179
		3	-9.2661*	1.595	.000	-12.4857	-6.0465
	2	1	5.1137*	1.732	.005	1.6179	8.6095
		3	-4.1524*	1.653	.016	-7.4885	-.8163
	3	1	9.2661*	1.595	.000	6.0465	12.4857
		2	4.1524*	1.653	.016	.8163	7.4885
Gabriel	1	2	-5.1137*	1.732	.015	-9.4123	-.8152
		3	-9.2661*	1.595	.000	-13.2215	-5.3108
	2	1	5.1137*	1.732	.015	.8152	9.4123
		3	-4.1524*	1.653	.046	-8.2422	-6.26E-02
	3	1	9.2661*	1.595	.000	5.3108	13.2215
		2	4.1524*	1.653	.046	6.256E-02	8.2422
Hochberg	1	2	-5.1137*	1.732	.015	-9.4144	-.8130
		3	-9.2661*	1.595	.000	-13.2270	-5.3052
	2	1	5.1137*	1.732	.015	.8130	9.4144
		3	-4.1524*	1.653	.047	-8.2566	-4.82E-02
	3	1	9.2661*	1.595	.000	5.3052	13.2270
		2	4.1524*	1.653	.047	4.819E-02	8.2566

Based on observed means. The error term is Error.

*. The mean difference is significant at the .05 level.

According to expression (1), the companies with TQM seem to have an edge over those without a quality system. Thus it can be generally asserted that the implementation of total quality management helps to improve performance. This confirms Hypothesis 1 that the companies adopting TQM exhibit better performance than those without quality systems.

In other words, Proposition 1 is satisfied that TQM is one of the suitable approaches which balance technology and organization thus leading to improved performance and sustainable development.

Expression (2) is derived from the less conservative LSD method, showing that TQM companies demonstrate higher performance than the ISO 9000 ones. This implies that ISO 9000 does not necessarily lea d to continuous improvement. Further, no evidence exists whether the companies with ISO 9000 have better performance than those without a quality system.

Thus, Hypothesis 2 and Proposition 2 are justified that the adoption of ISO 9000 is generally of limited value on its own and does not necessarily lead to continuous improvement.

Expression (3) reveals that the mean performance of companies with TQM and ISO 9000 is higher than that of companies with only ISO 9000. This implies that companies can gain more benefits from ISO 9000 if they also adopt the total quality management approach.

Accordingly, Hypothesis 3 and Proposition 3 are confirmed that the limitations of ISO 9000 can be overcome by putting it in the context of TQM. Therefore, companies which have already acquired ISO 9000 certificates should aim to progress in the direction of total quality management.

Expression (4) reveals that the companies implementing both systems exhibit greater performance than those without a quality system. This finding is not very exciting as it agrees with common expectation. However, there is no indication whether notable differences exist between the companies with both systems and those with TQM. As the mean performance of these two groups (BOTH and TQM) are not statistically different, it can be assumed that the presence of ISO 9000 is not of much value to the companies already practicing total quality management. Before reaching any conclusion, this issue needs to be further explored in the following section.

In summary, among the four types of quality systems (TQM, ISO, BOTH, none), TQM and BOTH appear to be the most promising approaches to achieving competitive edge.

4.8 The best approaches for each stage of O-T development

The previous section provided a general impression of the overall impacts of stage and type on performance of the sample companies. However, it did not suggest the most suitable approaches for the companies at each stage. This section aims to close the gap by presenting the results of ANOVA together with multiple comparisons within each stage in order to reveal the most suitable approaches.

Table 4.7 presents the ANOVA results of the three different stages. It can be seen that the type of quality system has no substantial effects on performance for companies at stage 1 whereas it does for companies at stages 2 and 3.

It should be noted that when multiple pairwise comparisons are performed within each stage, the sample sizes get much smaller thus the results cannot be considered definitive. However, they are useful at a general level of analysis, given due caution in interpretation.

Table 4.8 contains the details of multiple comparisons within each stage using Tukey's HSD and the LSD methods, and Appendix R illustrates the results using Gabriel's and Hochberg's GT2 methods. For the purpose of analysis, the findings from Table 4.8 and Appendix R are summarized below, presenting only the significant differences in performance. It can be seen that all the four methods gave the same judgments except for the LSD method in stages 2 and 3.

Stage 1.	No significant differences in performance are evident.
Stage 2.	TQM > ISO
	BOTH > ISO
	none > ISO (LSD method)
Stage 3.	TQM > none (LSD method)
	BOTH > none

Table 4.6 Multiple pairwise comparisons among different types of quality systems

Multiple Comparisons

Dependent Variable: Y

	(I) TYPE	(J) TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Tukey HSD	Both	ISO	7.5500*	2.094	.004	1.9493	13.1507
		none	9.4559*	1.844	.000	4.5241	14.3877
		TQM	3.1071	1.924	.381	-2.0387	8.2530
	ISO	Both	-7.5500*	2.094	.004	-13.1507	-1.9493
		none	1.9059	1.949	.763	-3.3070	7.1188
		TQM	-4.4429	2.025	.141	-9.8587	.9730
	none	Both	-9.4559*	1.844	.000	-14.3877	-4.5241
		ISO	-1.9059	1.949	.763	-7.1188	3.3070
		TQM	-6.3487*	1.765	.004	-11.0695	-1.6279
	TQM	Both	-3.1071	1.924	.381	-8.2530	2.0387
		ISO	4.4429	2.025	.141	-.9730	9.8587
		none	6.3487*	1.765	.004	1.6279	11.0695
LSD	Both	ISO	7.5500*	2.094	.001	3.3247	11.7753
		none	9.4559*	1.844	.000	5.7352	13.1766
		TQM	3.1071	1.924	.114	-.7750	6.9893
	ISO	Both	-7.5500*	2.094	.001	-11.7753	-3.3247
		none	1.9059	1.949	.334	-2.0269	5.8387
		TQM	-4.4429*	2.025	.034	-8.5287	-.3570
	none	Both	-9.4559*	1.844	.000	-13.1766	-5.7352
		ISO	-1.9059	1.949	.334	-5.8387	2.0269
		TQM	-6.3487*	1.765	.001	-9.9102	-2.7872
	TQM	Both	-3.1071	1.924	.114	-6.9893	.7750
		ISO	4.4429*	2.025	.034	.3570	8.5287
		none	6.3487*	1.765	.001	2.7872	9.9102
Gabriel	Both	ISO	7.5500*	2.094	.005	1.7904	13.3096
		none	9.4559*	1.844	.000	4.3979	14.5138
		TQM	3.1071	1.924	.501	-2.1862	8.4005
	ISO	Both	-7.5500*	2.094	.005	-13.3096	-1.7904
		none	1.9059	1.949	.901	-3.4144	7.2262
		TQM	-4.4429	2.025	.178	-9.9986	1.1129
	none	Both	-9.4559*	1.844	.000	-14.5138	-4.3979
		ISO	-1.9059	1.949	.901	-7.2262	3.4144
		TQM	-6.3487*	1.765	.005	-11.2028	-1.4947
	TQM	Both	-3.1071	1.924	.501	-8.4005	2.1862
		ISO	4.4429	2.025	.178	-1.1129	9.9986
		none	6.3487*	1.765	.005	1.4947	11.2028
Hochberg	Both	ISO	7.5500*	2.094	.005	1.7844	13.3156
		none	9.4559*	1.844	.000	4.3789	14.5329
		TQM	3.1071	1.924	.501	-2.1902	8.4045
	ISO	Both	-7.5500*	2.094	.005	-13.3156	-1.7844
		none	1.9059	1.949	.904	-3.4605	7.2723
		TQM	-4.4429	2.025	.181	-10.0181	1.1324
	none	Both	-9.4559*	1.844	.000	-14.5329	-4.3789
		ISO	-1.9059	1.949	.904	-7.2723	3.4605
		TQM	-6.3487*	1.765	.005	-11.2085	-1.4890
	TQM	Both	-3.1071	1.924	.501	-8.4045	2.1902
		ISO	4.4429	2.025	.181	-1.1324	10.0181
		none	6.3487*	1.765	.005	1.4890	11.2085

Based on observed means. The error term is Error.

*. The mean difference is significant at the .05 level.

Table 4.7 The ANOVA results of the three different stages

Tests of Between-Subjects Effects

Dependent Variable: Y

STAGE	Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Noncent. Parameter	Observed Power[a]
1	Corrected Model	60.193[b]	2	30.097	.871	.440	1.742	.170
	Intercept	16812.150	1	16812.150	486.615	.000	486.615	1.000
	STAGE	.000	0	.	.	.	.000	.
	TYPE	60.193	2	30.097	.871	.440	1.742	.170
	STAGE * TYPE	.000	0	.	.	.	.000	.
	Error	483.689	14	34.549				
	Total	20606.000	17					
	Corrected Total	543.882	16					
2	Corrected Model	284.283[c]	3	94.761	4.543	.026	13.629	.739
	Intercept	19545.769	1	19545.769	937.038	.000	937.038	1.000
	STAGE	.000	0	.	.	.	.000	.
	TYPE	284.283	3	94.761	4.543	.026	13.629	.739
	STAGE * TYPE	.000	0	.	.	.	.000	.
	Error	229.450	11	20.859				
	Total	23878.000	15					
	Corrected Total	513.733	14					
3	Corrected Model	181.811[d]	3	60.604	3.539	.037	10.616	.680
	Intercept	33911.305	1	33911.305	1980.109	.000	1980.109	1.000
	STAGE	.000	0	.	.	.	.000	.
	TYPE	181.811	3	60.604	3.539	.037	10.616	.680
	STAGE * TYPE	.000	0	.	.	.	.000	.
	Error	291.142	17	17.126				
	Total	40428.000	21					
	Corrected Total	472.952	20					

a. Computed using alpha = .05

b. R Squared = .111 (Adjusted R Squared = -.016)

c. R Squared = .553 (Adjusted R Squared = .432)

d. R Squared = .384 (Adjusted R Squared = .276)

Table 4.8 Multiple comparisons within each stage

Multiple Comparisons

Dependent Variable: Y

STAGE		(I) TYPE	(J) TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
	Tukey HSD	ISO	none	1.1111	3.919	.957	-9.1449	11.3672
			TQM	-3.2000	4.293	.741	-14.4349	8.0349
		none	ISO	-1.1111	3.919	.957	-11.3672	9.1449
			TQM	-4.3111	3.279	.410	-12.8919	4.2697
		TQM	ISO	3.2000	4.293	.741	-8.0349	14.4349
			none	4.3111	3.279	.410	-4.2697	12.8919
	LSD	ISO	none	1.1111	3.919	.781	-7.2934	9.5156
			TQM	-3.2000	4.293	.468	-12.4067	6.0067
		none	ISO	-1.1111	3.919	.781	-9.5156	7.2934
			TQM	-4.3111	3.279	.210	-11.3428	2.7206
		TQM	ISO	3.2000	4.293	.468	-6.0067	12.4067
			none	4.3111	3.279	.210	-2.7206	11.3428
2	Tukey HSD	ISO	none	-8.9000	3.821	.150	-20.4001	2.6001
			TQM	-13.2500*	3.955	.028	-25.1538	-1.3462
			Both	-13.0000*	3.955	.031	-24.9038	-1.0962
		none	ISO	8.9000	3.821	.150	-2.6001	20.4001
			TQM	-4.3500	3.064	.513	-13.5706	4.8706
			Both	-4.1000	3.064	.560	-13.3206	5.1206
		TQM	ISO	13.2500*	3.955	.028	1.3462	25.1538
			none	4.3500	3.064	.513	-4.8706	13.5706
			Both	.2500	3.229	1.000	-9.4694	9.9694
		Both	ISO	13.0000*	3.955	.031	1.0962	24.9038
			none	4.1000	3.064	.560	-5.1206	13.3206
			TQM	-.2500	3.229	1.000	-9.9694	9.4694
	LSD	ISO	none	-8.9000*	3.821	.040	-17.3103	-.4897
			TQM	-13.2500*	3.955	.006	-21.9555	-4.5445
			Both	-13.0000*	3.955	.007	-21.7055	-4.2945
		none	ISO	8.9000*	3.821	.040	.4897	17.3103
			TQM	-4.3500	3.064	.183	-11.0933	2.3933
			Both	-4.1000	3.064	.208	-10.8433	2.6433
		TQM	ISO	13.2500*	3.955	.006	4.5445	21.9555
			none	4.3500	3.064	.183	-2.3933	11.0933
			Both	.2500	3.229	.940	-6.8580	7.3580
		Both	ISO	13.0000*	3.955	.007	4.2945	21.7055
			none	4.1000	3.064	.208	-2.6433	10.8433
			TQM	-.2500	3.229	.940	-7.3580	6.8580
3	Tukey HSD	ISO	none	4.8667	3.022	.399	-3.7243	13.4576
			TQM	-3.0000	2.617	.667	-10.4400	4.4400
			Both	-3.6750	2.359	.427	-10.3813	3.0313
		none	ISO	-4.8667	3.022	.399	-13.4576	3.7243
			TQM	-7.8667	3.022	.079	-16.4576	.7243
			Both	-8.5417*	2.802	.033	-16.5057	-.5776
		TQM	ISO	3.0000	2.617	.667	-4.4400	10.4400
			none	7.8667	3.022	.079	-.7243	16.4576
			Both	-.6750	2.359	.992	-7.3813	6.0313
		Both	ISO	3.6750	2.359	.427	-3.0313	10.3813
			none	8.5417*	2.802	.033	.5776	16.5057
			TQM	.6750	2.359	.992	-6.0313	7.3813
	LSD	ISO	none	4.8667	3.022	.126	-1.5097	11.2430
			TQM	-3.0000	2.617	.268	-8.5221	2.5221
			Both	-3.6750	2.359	.138	-8.6525	1.3025
		none	ISO	-4.8667	3.022	.126	-11.2430	1.5097
			TQM	-7.8667*	3.022	.019	-14.2430	-1.4903
			Both	-8.5417*	2.802	.007	-14.4527	-2.6306
		TQM	ISO	3.0000	2.617	.268	-2.5221	8.5221
			none	7.8667*	3.022	.019	1.4903	14.2430
			Both	-.6750	2.359	.778	-5.6525	4.3025
		Both	ISO	3.6750	2.359	.138	-1.3025	8.6525
			none	8.5417*	2.802	.007	2.6306	14.4527
			TQM	.6750	2.359	.778	-4.3025	5.6525

Based on observed means. The error term is Error.

*. The mean difference is significant at the .05 level.

4.8.1 The best approaches for stage 1

For companies at the low O-T position, no substantial differences in performance were uncovered among various types of quality systems. Although no conclusion on the best approaches can be reached, it does not mean that there is no suitable quality system for this group of companies. The implication is that the companies in the low O-T position do not seem to attain notable benefits from quality systems, and they should aim to progress beyond this stage in order to realize more benefits.

4.8.2 The best approaches for stage 2

At stage 2, companies adopting TQM and BOTH exhibit superior performance to those adopting only ISO 9000. This agrees with the earlier results concerning the limitations of ISO 9000. Another interesting finding is from the less conservative LSD method which indicates that the companies with no quality system are more successful than those adopting ISO 9000. This may be because most companies are at an early phase of achieving the registration. While their medium O-T position makes them less adaptable to changes than those at the high O-T position, the quality system may interfere with their normal modes of operation. This together with substantially high startup costs may lead to poorer overall performance. Since the statement was derived from a less conservative method and the sample size in this category was rather small, the result is not conclusive on its own; but it is useful in strengthening the notion concerning ISO limitations.

For companies at stage 2, no evidence exists as to whether the implementations of TQM and BOTH have significant effects on performance as compared with the no-implementation option. In other words, the performances of companies are not much different whether they adopt quality management systems or not. This may be because, being at the medium O-T position, the companies are at the learning curve of technology adoption, and they are obtaining significant benefits from technology. It does not matter whether they adopt quality management systems or not, they still see increased performance from the adoption of technology. As the benefits from technology balance with those of management systems, the use of quality management does not seem to improve performance in these companies.

To secure long-term benefits of technology, the companies at stage 2 need to turn to management approaches which integrate the hardware and humanware. Based on the findings, it can be suggested that the most suitable approaches for these companies are: (1) TQM, or (2) TQM and ISO 9000.

4.8.3 The best approaches for stage 3

At stage 3, the mean performances of companies adopting TQM and BOTH are better than those adopting no quality system. This implies that the companies in this group have the best infrastructures that complement with quality systems, thus they are able to reap the full benefits. It can be concluded that the best approaches for high O-T positioned companies are: (1) TQM, or (2) TQM and ISO 9000.

4.8.4 TQM or BOTH ?

At this point, many questions are raised concerning the benefits of TQM and BOTH. (1) Which scheme gives more benefits? (2) Does ISO 9000 enhance performance in the companies already practicing TQM? (3) Should companies adopt TQM or BOTH?

The answers for questions (1) to (3) can be obtained by considering the multiple comparisons in Section 4.6.1 to 4.6.3.

It can be observed that, in all the three stages of organizational and technological development, there was no evidence as to whether TQM and BOTH yielded significantly different performances. Thus, the answer to the first question is "don't know" because it cannot be concluded which scheme gives more benefits.

As the companies adopting both practices do not necessarily have better performance than those adopting TQM, the answer to question (2) is "No, ISO 9000 does not substantially enhance performance in companies already practicing TQM". As discussed in Section 4.4, ISO 9000 could upset the path of organizational and technological development, it is thus important that companies identify any issues that may cause distractions.

Question (3) may seem easy to answer at a first glance. Since there is no difference in performance, one is tempted to assume that a company should only adopt TQM and not bother adopting both TQM and ISO in order to avoid spending extra resources and commitment. Unfortunately, the situation in real life is much more complicated because a company operates in a dynamic environment. If ISO 9000 has gained so much popularity, then most companies will eventually need to seek registration in order to satisfy their customers. This implies that companies may need both systems to survive in global markets. An important issue is that companies should implement both systems in such a way that they support each other in order to achieve maximum advantages.

4.9 Conclusion

This chapter presented the results of quantitative analyses on the survey of 53 manufacturing companies. Based on the findings, the companies were divided into three stages with different organization-technological positions, and four types according to the adopted quality systems. When multiple pairwise comparisons were conducted to discover the effects of stage and type on performance, the results led to the confirmation of Hypothesis 1-3.

The verification of Hypothesis 1-3 was very useful in demonstrating the impacts of management practices on performance. While pointing out the limitations of ISO 9000 in raising performance, the results suggested that they could be overcome by putting it in the context of TQM. The analyses also yielded useful outcomes in giving precautions that companies implementing ISO 9000 might run the risk of loosing socio-technical balance.

The quantitative analyses also led to the implications on the best approaches for the companies in each stage of O-T development. Companies in the low O-T position should aim to increase their organizational-technological standing in order to realize substantial gains from quality systems. The medium and high O-T companies have the choice of implementing TQM, or a combination of both TQM and ISO 9000.

Chapter 5

Analyses of the Thai Case Studies

5.1 Introduction

This chapter presents comparative analyses of the case studies involving four companies in Thailand in order to reveal the characteristics attributable to successful and unsuccessful performance. The analyses in this chapter are related to the quantitative analyses in Chapter 4 in that the issues of organization, technology, and management practices are considered in detail for the purpose of finding the relationships and success factors.

The four companies are engaged in the same business and employ similar technology to produce the same types of products. Three of them have joint venture or licensing relationships with Japanese companies. Due to the confidentiality agreements, the identification of companies are not revealed.

The chapter starts with the comparison of environmental characteristics between the Thai and Japanese business surroundings in order to identify the industrial structures and the forces influencing the companies. The critical success factors of the industry are also discussed based on the information obtained from the interviews and literature search.

Next, the Thai cases are investigated in detail by considering the issues concerning company strategy, manufacturing strategy, quality policy, quality system in manufacturing, manufacturing capabilities, production planning, customer service, supplier relationship, and human resource management. The four companies are then compared in terms of various performance measures that were developed in Chapter 3.

5.2 Comparison of environmental characteristics

The market environment will be assessed in terms of five competitive forces: threat of entry, threat of substitution, bargaining power of buyers, bargaining power of suppliers, and rivalry among current competitors (Porter, 1980). The section also discusses the success criteria of the products that are evaluated from the interviews.

5.2.1 Threat of entry

Both the Japanese and the Thai cases are protected by high entry barriers whose key elements are economies of scale in production, purchasing, distribution, and service network. The Thai participants have the additional advantages of preferential government subsidies, such as tax exemptions and prohibition of new establishments for a certain period which have given the firms lasting advantages.

5.2.2 Threat of substitution

Although the product demand seems to be increasing at a slower rate in both countries, substitution by alternative products seems to be non-threatening.

5.2.3 Buyers/Dealers

In both countries, the products are sold to end customers through customer cooperatives or through dealers. As the manufacturers do not have direct access to customers in selling the products, distribution channels are critical to success. In fact, the best company in the Thai case studies was found to have the most extensive distribution and service network among the other companies in the same industry.

5.2.4 Bargaining power of suppliers

Suppliers exert different levels of bargaining power depending on the size of the company and its sourcing policy. In Japan, the hierarchical supplier system (or keiretsu) is a distinct characteristic which differentiates it from most countries. All the three Japanese companies belong to different keiretsu groups which have larger and smaller companies above and below them. Cooperative supplier relationship is common among all the Japanese companies under study.

For the Thai cases, suppliers play a vital role due to the relatively weak stage of supporting industries. In earlier years, the Government imposed the local content regulations in order to improve suppliers' capabilities as manufacturers need to rely on indigenous suppliers for their products. The regulation is no longer applied now, but suppliers are not yet fully competent as reflected in the limited quality and unreliable delivery. Therefore, strong partnership with suppliers is one of the key competitive factors in the Thai case studies.

5.2.5 Rivalry among current competitors

The Japanese companies, on average, face a more diverse market environment in terms of their products, price, and customer service. While domestic competition among local companies is quite strong, competition from foreign products is not of much concern to the companies.

In comparison, the Thai manufacturers are in a less competitive environment due to a smaller number of participants. There seemed to be a cooperative atmosphere among the companies as each held an established position in the industry. In fact, market equilibrium has existed for nearly ten years with the best company dominating the industry. Upon the arrival of a newcomer in 1991, the business environment became more turbulent as the newcomer gained increasing recognition among the customers. Competition from cheaper foreign products is not severe because the products are of inferior quality and not attractive to the customers.

5.2.6 Rate of environmental changes

The rate of environmental changes is assessed in terms of technology and demand changes. It has been found that the Japanese companies face higher rate of technological change due to both domestic and foreign competition. Not only that new and improved models need to be introduced continually in order to satisfy sophisticated customers, but the models must also follow strict environmental regulations in order to satisfy the needs of export markets.

For the Thai cases, technological changes are not rapid as the companies primarily engage in product assembly rather than design. In general, product development is done only to the extent of modifying existing Japanese models. As the companies mainly serve local markets, they are not heavily constrained by international pressures. For example, they are not required by the market to pursue ISO 9000 registration or other types of quality systems, and they are not subjected to rigid environmental regulations.

As for demand changes, the rate of change largely depends on the stage of the market. While the Japanese market is in a maturity stage, the Thai market is in transition to maturity. It has been found that the companies in both countries are facing slower increase in product demand.

5.2.7 Critical Success Factors

Among the four success criteria (cost, quality, delivery, and service), quality of products and services seems to be the critical success factor, followed by delivery, and cost.

From the case studies, the quality of product is the main critical success factor because the product prices are not much different. The quality of service is also important as the customers are normally located in remote agricultural areas. According to the case studies, mobile service is an effective means that allows a company to reach its customers and win their loyalty.

In comparison, delivery is not as important as quality because the seasonal demand for the products allow the companies to make effective demand forecasts.

The following sections involve the investigations of four Thai companies, herein referred to as company A, B, C and D. Company A is the market dominator which distinguishes itself in terms of high product quality, wide distribution channels, and extensive customer service. It has been implementing total quality management for nearly seven years, and has recently achieved ISO 9002 certification. Company B is a newcomer with the second largest and increasing market shares. It has recently acquired ISO 9002 certification and is introducing total quality management.

Company C is an average performer who may be most threatened by increased market competition. Company D is a low-cost producer with limited resources.

In comparison, all the companies have similar manufacturing characteristics, but they are different in their strategies and the way they manage their suppliers and people.

5.3 Company A

Company A is a Thai-Japanese joint-venture which was established in 1978. Its Thai parent is an established local corporation with a very high reputation, and the Japanese parent is a large corporation with strong technological and service background. Through joint ventures, synergy arises from merging the strengths of the two partners (Newman, 1992).

Its top management consists of three main divisions: finance and administration, marketing, and manufacturing. Two additional organization units (total quality commitment (TQC) and research and development (R&D)) are placed directly below the managing director, reflecting its commitment to quality and research and development.

After the adoption of TQC, the company has surpassed others in terms of market share, and it has become the dominator for nearly ten years. Its recent achievement of an ISO 9002 certification, together with reinforcement from the TQC approach, should ensure its continued success.

5.3.1 Company Strategy

The strategic objective of company A is to become the market leader. It has achieved this objective by placing quality as the first priority, followed by customer service and distribution. Its emphasis on quality has brought about the adoption of total quality commitment (TQC) which gives it a quality advantage. The company has also succeeded in building customer loyalty over the years by providing extensive after-sales services through its large distribution network. Therefore, the relatively high product prices were compensated by high quality, wide distribution channels, and impressive customer services. The only issue of concern is that the company should improve its price competitiveness while company B is penetrating the market with similar strategies but with lower prices.

In developing company strategy, the managing director and the executive board provide the company's vision, which becomes the framework within which strategies are developed. In general, company A integrates marketing and manufacturing strategies within the company strategy. As marketing interfaces directly with customers, it is able to identify customer needs and simulate demand. The demand is fed to manufacturing which provides direction on investment in core technology, or the choice between licensing, joint ventures, and outsourcing. In this regard, the company is being driven by corporate, marketing and manufacturing strategies. The other strategies, such as research and development, purchasing, and finance, are developed from these strategies and do not primarily drive the company.

5.3.2 Manufacturing Strategy

The manufacturing function places emphasis on quality, followed by cost and delivery. Quality was taken as the leading target in all manufacturing activities. Cost objectives focus on the reduction of inventory, followed by overhead cost. Delivery objectives target production planning activities and plant activities which affect product delivery to the customers.

As its products are relatively higher in price, the company attempts to reduce inventory cost, which is the majority of all production costs, followed by overhead and direct labor costs. It also responds to challenges from the lower-cost producers by shifting manufacturing to low wage countries.

5.3.3 Quality Policy

With its quest for growth and survival in changing circumstances, the company has adopted the total quality commitment (TQC) policy, which stressed the importance of customer satisfaction, employee participation, and continuous improvement. As it realized that a quality program should start from the top, the company placed its TQC division directly below the managing director. The division is responsible for launching company-wide quality program.

The company-wide quality program is facilitated by applying the three elements of total quality management: policy management, daily management, and functional management. At the top level of the organization, policy management is used to cooperate company-wide activities in order to accomplish functional goals as established by the company strategy. Daily management is applied to implement activities which are necessary to fulfill the responsibilities of each function. Functional management facilitates cross-functional activities which are carried out to accomplish company strategies. Cross-functional integration is also promoted by adopting the concept of the internal customer. Each department must identify its own needs and the needs of the next department in order to create internal customer satisfaction agreement between departments.

In addition, the company-wide quality program includes various bottom-up activities which are heavily promoted with support from top management. For example, the techniques of 5s, suggestion system, and QCC are applied throughout the company. A 5s contest is held annually to encourage company-wide practice. The company has a system for individual suggestions as well as awards for individual or group inventions which make a major contribution to company activities. With adequate training and resources from top management, the number of suggestion and the percentage of suggestions approved by management are much higher than its competitors.

5.3.4 Quality System in Manufacturing

The quality system in manufacturing consists of incoming inspection, in-process quality control, final inspection, failure analysis, and guage and equipment calibration system. It should be noted that the quality problems coming from operators and manufacturing department are significantly lower as compared with the other companies.

For incoming inspection system, most inspection is done according to sampling plans and skip lot. Tokusai system is also used in the following cases: (1)

emergency, (2) when reject rate exceeds acceptable limit, and (3) when the type of defects does not affect product quality. In such cases, vendors can appeal for the parts to be used in the manufacturing process. If the appeal is accepted, 100 % inspection will be carried out by the vendors before sending the parts into production. It should be noted that certification from vendors is not applicable due to the limited capabilities of supporting industry.

In-process quality control involves the preparation of operation standard manuals, and quality control process charts. Operators perform in-process inspection by daily sampling and 100% inspection by check guage. They are also given authority to shut down a line in case of problems. Neighbor inspection and fool-proof system are used to eliminate operator's controllable defects. It is worth noting that the company installs fool-proof devices to a much greater extent than the other companies. Final inspection includes all dimensional checks by a line quality control person and quality assurance. Finished product inspection is required for every product in the form of running test. Other tests such as endurance and reliability tests are done by sampling.

In the quality control process, a number of techniques such as statistical process control (SPC) and design of experiment (DOE) are used. It should be noted that the company is the only one in this particular industry which uses DOE to reduce variations in process design and in the production process.

To sustain the effort of continuous improvement, the manufacturing function set up two quality teams ("kaizen" teams) in 1993. Each team is led by a competent foreman, and consists of four members selected from the group leaders. The teams are responsible for carrying out successive improvements in various processes even where no quality problems were found. The team draws its own quality improvement plan which takes approximately three months to accomplish. Examples of their improvement efforts include productivity improvement, work efficiency enhancement, and line balancing. For each project, advise may be sought from outside experts in various fields, and the team members may be given lectures on relevant subjects such as pneumatics. In addition, a Japanese expert is available to give general recommendation. Besides working within the plant, the kaizen teams also perform work improvement with vendors. The company claims that their kaizen projects have longer duration, tackle more detail, and achieve better results than those performed in other large Thai companies.

In comparison, the quality system in manufacturing for company A is different from its competitors in terms of the application of fool-proof systems, failure analysis capability, guage and equipment calibration system, the application of DOE techniques, and small group activities.

5.3.5 Manufacturing Capabilities

Company A has been involved in large capital investment concerning manufacturing capabilities within the past three years. It is also actively engaged in incremental improvements in manufacturing capabilities by promoting a large number of little investments over a long period of time.

The production process consists of two main lines: machining and assembly. As stand-alone numerical control machines are used, skill workmanship is not necessary. However, the company is planning to increase the level of automation in order to reduce the number of direct labors. Automated inspection and fool-proof devices can be found at critical points. Although a CAD/CAM system is utilized in drawing and manufacturing activities, no computer application is found in the design analysis. Information transfer between functions are mostly through hard media, but the company is attempting to adopt information technology in order to become a paperless factory.

In measuring manufacturing performance, the cost accounting system is based on traditional gathering of direct labor costs with overhead. There is an attempt to apply other performance measures such as direct costing which incorporate wider dimensions of activities.

In comparison, company A employed relatively higher level of technology than the others due to the fact that it continually attempts to improve manufacturing capabilities by making both small and large investments. While small improvement is made through the application of bottom-up activities, large investment is carried out through top management decisions.

5.3.6 Production Planning and Control

As the industry is very sensitive to demand fluctuation, delivery becomes the second most important goal in manufacturing. In company A, production planning consists of three-year aggregate planning, yearly production planning, six-month planning, monthly planning, and daily planning. Like most organization, the company adopts mixed plan between chase demand and level production plan to cope with fluctuation. During peak period, measures like overtime, subcontracted workforce, and subcontracted tasks to other suppliers, are used. However, the company still needs to improve its delivery performance in order to satisfy the demand during peak period.

No companies under study applies the concept of just-in-time in delivery and supply management due to their vendors' inability to respond. In company A, a production plan is sent to vendors every month, and a part inventory is kept during low season for use during peak time. In daily production planning, company A installs a production control board at the end of the line so that workers can autonomously control their production timing as a group.

5.3.7 Customer service

The marketing division of Company A consists of three departments: distribution, customer service, and educational services. As stated earlier, it places service and distribution as critical success factors, next only to quality. Therefore, it has the largest distribution network spanning all the main regions of the country. It has established good relationship with dealers by providing training and recognition. For customer service, there are a number of regional parts and service centers, together with mobile service units which regularly visit customers to provide free checking service and advice. Although all the companies have similar warranty policy, company A is able to dominate the market by having more access to customers and providing after-sales services for the lifetime of the products. It also offers educational services to young agriculturers in rural areas as a form of social contribution. Thus the company has been able to secure high customer loyalty for more than ten years.

To make use of the field data, its annual service plans include guidelines for systematic collection of field reliability data. Customer complaints are collected from technical service center, dealers, distributors, and customers. The marketing department then prepares technical claim report which are fed back to manufacturing. In this way, field problems are analyzed, corrected, and prevented.

In conclusion, the strength of company A lies in its distribution channel, service network, and its field quality feedback system.

5.3.8 Supplier Relationship

In all companies, it has been estimated that the major source of quality problems lies in purchased parts. Even though every company recognizes this fact, only company A has active cooperation with its vendors. As the company purchases more than 80 percent of its parts from domestic suppliers, cooperative relationship is crucial to achieving purchasing goals.

The company places quality as the most important purchasing goal, followed by reliable delivery, and cost. The process of selecting vendor is bidding and sourcing. Bidding/quotation is used for suppliers of standard raw materials such as lubricants, whereas sourcing is used for suppliers of parts and components. In selecting a vendor, the company considers past performance record, process capabilities, quality control system, and management system.

The company employs single sourcing, double sourcing, and multiple sourcing policies. Multiple sourcing is used to resolve shortages of parts due to demand fluctuation, and the maximum number of vendors in multiple sourcing is three. The company establishes no legal contracts with vendors as the relationship is based on mutual trust. In general, it rarely changes vendors, and it has an active partnership relationship with them. For example, the purchasing department (PU) works closely with vendors during the period of high demand. The manufacturing department also provides assistance to vendors through its kaizen teams. Vendors who are interested can apply to the supplier assistance program in order to be selected by the teams. This is made possible because each team member was initially assigned to ten vendors in order to familiarize himself with their operations. Another approach to selecting suppliers for assistance is based on the claim rate. In this case, the purchasing department provides a list of vendors with problems, and the teams decide which vendors should be selected. Once the problems are solved, it is the responsibility of PU to perform after-checks. Thus, cross-functional management between manufacturing and purchasing is essential to solving problems with vendors.

In general, the benefits associated with vendor kaizen are cost saving, productivitv improvement, and elimination of chronic quality problems. In contrast to its Japanese parent, the company provides assistance to vendors without charge, and lets the vendor keeps all the cost savings. As a result, most vendors are very cooperative, and the company is able to propagate its quality culture to vendors as well as extend its social contribution in the form of technology transfer.

5.3.9 Human Resource Management

Company A adopts the human resource management policy from its Thai parent, stating that 'We value our people". In this study, human resource management was assessed by considering the issues of employment system, employee training, employee participative climate, functional integration, decision-making mechanism, performance evaluation, and existing cultural pattern.

(a) Employment System

In general, company A recruits fresh graduates as well as experienced employees. As it has a prestigious Thai parent, the company is able to select highly qualified graduates who will be provided with their own career paths once entering the company. Although lifetime employment is not explicitly guaranteed, the company does not usually layoff its employees according to the policy of its Thai parent.

As job hopping is a widespread practice, it is not uncommon for employees to leave the company after two to three years of working in order to seek higher salaries elsewhere. Despite the relatively less turnover rate than most Thai firms, the company is sometimes regarded as a perfect starting place for those wishing to 'decorate' their curriculum vitas.

(b) Employee Training

Employee training is an issue which distinguishes company A from the rest. Not only that the company has adequate financial resources, it also has an advantage over others in its better educated and highly qualified workforce.

Its entry-level training for technical employees covers wide ranges of issues including technical skills, quality control, and knowledge of the production process. For ongoing training, the company provides both on-the-job and off-the-job training. On-the-job training is provided by peers, training personnel, and outside experts. The company regularly hires Japanese experts to provide training in various fields such as the seven quality tools, quality function deployment, and other technical subjects. Off-the-job training involves company-sponsored lectures and public seminars. The company also supports employees wishing to pursue higher education by giving full scholarships to them.

(C) Employee participative climate

In general, all the companies under study encourage employee participation. However, the top management of company A provides more concrete support due to its commitment to people. It constantly provides feedback and acknowledgment to maintain the morale of employees. For example, a reward and recognition system is established for all bottom-up activities such as 5s, suggestion system, and small-group activities.

(d) Functional Integration

Cross-functional integration is facilitated through the adoption of functional management which is part of the total quality management approach. The TQC department establishes cross-functional goals which must be held across various functions in terms of cost, quality, delivery, safety, and morale. The roles of each department toward the common goals are determined during interdepartmental meetings. At the end of each year, cross-functional audits are conducted in order to assess the extent to which the goals have been met and to discover problems and obstacles.

Cross-functional integration is also promoted in the form of formal meetings between departments. For instance, production quality meetings are held monthly between manufacturing, purchasing, and technical services in order to discuss the causes of quality problems which occurred during the past month. In this way, corrective and preventive actions can be implemented in a timely manner.

(e) Performance Evaluation

In company A, performance measurement and reward systems are based on both group and individual contribution. A goal-sharing financial plan exists which ties individual performance to group and company performance. In promotion criteria, each employee has his own career path so that he knows which direction he is following. Although the company generally values length of service, seniority-based promotion is not heavily practiced as in the Japanese cases. An example can be seen in the process of selecting top management. The prospective top executive should not only be 'born in the company', but he must also be highly competent and well-known both within and outside the organization.

(f) Existing Cultural Pattern

In company A, the traditional practice which fosters the growth of the company is its emphasis on people. Each employee is aware of his career path and his significance, resulting in pride in working for the company.

Another positive cultural aspect within company A is the quality pervasiveness which was a result of top management commitment and vision. Top management actively provides guidance and allocates resources to employees for their improvement efforts. Appropriate feedback and acknowledgment are given at the company level through annual functions. In addition, employees are continually reviewed with the fundamental concepts of quality, and they understand that there are no tradeoffs between quality and short-term convenience.

Continuous improvement is another positive cultural aspect at company A. Employees tend to be aware of the everlasting changes in the market environment which, in turn, induce changes in their jobs. They are adaptive to changes and eager to make improvements in every aspects of their work.

One of the typical problems for most Thai manufacturers is the existing gap between blue- and white-collar workers, which could impede effective coordination. In the case of company A, university graduates are placed immediately at higher ranks than non-university ones, and are trained in a different atmosphere without hands-on experience. The fact that the inexperienced university graduates receive higher financial and social status aggravates the differentiation. This gap is further enlarged by the different position classifications and different career paths.

5.3.10 Company A Summary

Company A has a number of advantages due to the reputation of its Thai parent, adequate financial resources, and highly-qualified personnel. It implemented the TQM approach due to the quest for organizational growth and continued success. It has an organizational culture which is amenable to change, and rapid organizational learning processes as a result of adopting TQM. This will ensure its continuing success and sustainable development.

The relatively high product prices of company A were compensated by the advantage of being the first producer with the largest distribution network and extensive after-sales services. However, the company has to improve its price competitiveness since company B is penetrating the market with similar strategies.

5.4 Company B

Company B is a licensee of the products made by one of the largest business corporations in Japan. Its Thai parent is a group of entrepreneurs which has recently made headlines by the impressive financial performance of its company in the stock market. Established in 1991, the company can be regarded as a newcomer as compared with the other participants. The company has recently achieved an ISO 9002 registration and are attempting to introduce the principles of total quality management in its operations.

5.4.1 Company Strategy

Besides profitability, the company's strategic objectives are to increase its market share by 10-15 percent within five years, and to become the leader in the Indochina markets. To increase market share, company B employed aggressive marketing strategy by promoting its products through various media and setting up a large distribution network that offers incentives to dealers reaching sales targets.

It also adopted a strategy which has proved to be effective in company A by providing regular after-sales service and social contribution to customers. In aiming to become the leader in the Indochina markets, the company has recently invested in a joint venture to establish an assembly plant in a neighboring country.

With the present rate of market growth, the company has now captured the second largest shares in the Thai market, and it seems that this young company has accomplished part of its strategy. As a newcomer, it has the advantage of a faster learning curve by using the experiences of others.

5.4.2 Manufacturing Strategy

Manufacturing strategy seems to be given less importance in the overall company strategy. This is because the company partly relies on its Japanese licenser for manufacturing investment and decisions. Another possible reason is that it might have perceived the needs to overcome existing customer loyalty, and therefore placed more emphasis on marketing strategy.

5.4.3 Quality Policy

As stated earlier, the company has recently acquired an ISO 9002 certificate, and it is introducing total quality management in the organization. A quality council was set up to plan and implement various quality activities which tend to be started in manufacturing. Rather than implementing a company-wide quality program, top management tends to focus on manufacturing activities and extends the efforts to other functions later.

5.4.4 Quality System in Manufacturing

Like company A, the quality system in manufacturing consists of incoming inspection, in-process quality control, final inspection, failure analysis, and guage and equipment calibration system. For incoming inspection, sampling plan and skip lot are utilized. Besides in-process quality control performed by operators, neighbor inspection is also used to minimize quality problems.

In general, the quality system and procedures are designed to comply with the ISO 9002 standard. As compared with company A, this company has more limited failure analysis capabilities, and it does not make extensive use of small group activities.

5.4.5 Manufacturing Capabilities

The company moved to its new plant in 1995, and it has updated the production process by installing computer-numerical controlled machines in the production lines. Like company A, the application of computing is found in various functions such as CAD/CAM in engineering and manufacturing, and MRP in production planning. The main difference lies in process innovations which are part of continuous improvement efforts. For example, automatic checking devices are not applied as much as in company A.

5.4.6 Production Planning and Control

The first impression of a visitor touring the plant is that the shop floor is very clean and organized, and there are a very small in-process inventories. Like company A, part/component inventories could be found at a relatively low level, and the main reason for keeping them is due to external suppliers rather than internal problems.

Unlike company A, the plant uses only overtime employment during peak per needs to respond to a lower demand. However, it seems to face more instabilit volume changes probably as a result of increasing market shares. In terms of lead time, the performance of company B is average as compared with th companies in the industry.

5.4.7 Customer Service

The company perceived customer service as its main strength due to th efforts being put into this area. It has adopted similar practices as those of com by providing regular mobile service to customers in the countryside. It has also emphasis on social contribution such as providing lunch funds for rural childre sponsoring major concerts with contribution to the children who are their customers. Further, the company sends medical doctors along with its technical to rural villages in order to provide medical and technical services.

5.4.8 Supplier Relationship

The company relies on 70 % of its parts from local suppliers, and the ot % are imported from its Japanese licenser. Like company A, it selects vend standard materials through bidding, and selects vendors of parts and components on their past performance records and process capabilities. In general, the compan long-term relationships with suppliers on the basis of trust rather than cont However, it does not provide supplier assistance program and technical he vendors. It is notable that the means of interacting with vendors are throug purchasing function and informal relationships among top management.

5.4.9 Human Resource Management

As company B is relatively new, job turnover is not of much conce management. To instill company loyalty, the managing director continually str that the company is for the employees and that the company tries to encourag enrichment in order to improve working conditions. Other issues concerning human resource management are discussed in the next sections.

(a) Employment System

Like most companies in Thailand, the company prefers recruiting experienced personnel from other companies rather than fresh graduates. This is partly because it is a newcomer which needs to catch up with existing companies. The drawback is that experienced employees may bring with them the work practices adopted from their previous jobs which may or may not be suitable for the company climate.

(b) Employee Training

Entry-level training of technical personnel consists of quality control skills and knowledge of the whole production process. Ongoing training is done in both formal and informal manner. Formal training is provided by sending employees to classes organized by universities whereas informal training is provided in house by visiting experts. The contents of training are both technical and general, covering other areas in the company not necessarily related to product quality. All employees must learn about their products and the customers in order to understand how their jobs are important to the products and to other functions.

(C) Employee participative climate

To promote employee involvement, company. B adopted suggestion systems, whose purposes were to increase job satisfaction, increase employee participation in work improvement, and promote employee initiation. Another form of employee participation is in the weekly reports from lower-level employees to the next-level management. The company also uses an open-door system in the office layout in which management's offices reside along the hall way thus providing easy access and no physical barriers between management and employees.

(d) Functional Integration

Cross-functional management in company B has not been done according to the method of functional management in the TQM approach. The present means of interdepartmental coordination is through weekly meetings among various functions. It can be asserted that the smaller company B is less bureaucratic than company A as reflected in the various means of communications.

(e) Performance Evaluation

As top management places high values on company loyalty, it tends to place more emphasis on length of service when promoting technical staff, followed by achievement in current job, ability appropriate to the next job, and business-generated contributions.

(f) Existing Cultural Pattern

As the company is relatively new, it is difficult to assess any existing cultural pattern if one exists at all. However, it may be asserted that the company adopts a less formal management style than that of company A. In addition, discipline and company loyalty are the underlying themes strongly emphasized by top management. Employees seem to be satisfied with their work, and are regularly informed about what is going on with their company and with the market.

5.4.10 Company B Summary

This company has a financial advantage due to its presence in the stock market, technological advantage due to the strong technological base of its Japanese licenser, and marketing advantage due to the use of a famous Japanese brand name. Most of all, it has the advantage of a shorter learning curve as it can learn from the experiences of others. These advantages have been used to facilitate investment in modern equipment and establish a large distribution network, and have helped the company catch up with existing manufacturers in a short time. Although management aggressiveness has led to a fast growth, it should avoid making a habit of relying on quick-fix solutions or short-term innovations. In the adoption of total quality management, top executives need to be aware not to jump right into the TQM programs without first preparing the groundwork. Otherwise, the approach will not gain company-wide acceptance and sustain long-term growth.

5.5 Company C

Company C is a Thai-Japanese Joint venture established in 1980. According to the customer survey, its products are average in terms of price, quality, and after-sales services. In the first few years of operation, the company earned equivalent market shares with company A, but it was surpassed by its competitor. With less than a 20 percent share over the past decade, the company appears to be content with its current situation.

5.5.1 Company Strategy

In the beginning of its operations, the company received an award for being among the plants with highest efficiency and quality, and was among the recipients of the Factory Health and Safety Standard Award. Despite the good start, it was overtaken by its competitor for a number of reasons, one of which is the company strategy.

In developing the company strategy, top management failed to recognize customer service and distribution network as the main success factors. When company A expanded its distribution network to popularize its products, it gradually built up market share until it exceeded that of company B. After-sales service was another factor which helped increase sales and secure customer loyalty. In an agrarian society, people are generally collective and easily influenced by groups. Therefore, company A's products were quickly spread through words of mouth and customer satisfaction. The lack of action on the part of company B has caused the drop in market share.

5.5.2 Manufacturing Strategy

Manufacturing strategy is not clearly declared, and the company might be called "stuck in the middle" according to Porter's term since it fails to develop strategy in at least one of the three directions: cost, differentiation, or focus (Porter, 1980). The company does not entail the lowest product price nor largest distribution network. Neither does it have the best after-sales service nor product quality.

5.5.3 Quality Policy

Although quality policy existed, it was not clearly communicated to employees leading to a lack of direction within the organization. There exists no responsible person or committee to oversee the quality policy and its implementation. Quality activities are only carried out in the area of manufacturing. Rather than adopting an integrated quality management system, the company tends to adopt certain techniques such as 5s, suggestion systems, and QCC, in isolation. These techniques were not fully effective when applied on their own.

5.5.4 Quality System in Manufacturing

Like company A and B, quality system in manufacturing consists of incoming inspection, in-process quality control, final inspection, failure analysis, and guage and equipment calibration system. Although in-process inspection is done by operators, neighbor inspection is not practiced to reduce operator's controllable defects. Thus, quality problems caused by human errors are relatively higher than those in Company A and B. Despite the fact that small group activities are practiced within manufacturing, there is a lack of a system to monitor new standards, leading to short-lived results.

5.5.5 Manufacturing Capabilities

Overall, the number of small and large investments carried out over the past three years is smaller than that of company A and B.

Assessment of manufacturing capabilities include an evaluation of the extent to which computers are used in design, production, production planning, process planning, and other administrative functions. The manufacturing capabilities of Company C were found to be lower than that of Company A and B in terms of failure analysis and equipment calibration, process innovations, and the use of information technology.

5.5.6 Production Planning and Control

In company C, aggregate planning span a shorter period than company A and B. Like all companies under study, it adopts a mixed plan, between chase demand and level production to cope with seasonal fluctuation. However, the company does not face problems in satisfying customer demand as reflected in its superior performance in inquiry lead time.

5.5.7 Customer Service

After-sales services are performed in a less extensive manner than those of company A and B. Although the company offers customer services during the warranty period, it does not provide regular mobile services to rural customers. Its after-sales services are perceived by customers to be slightly under the industry average. This is probably due to the high reputation that the first two companies have established. As for distribution, the company is at a disadvantage in that it has a smaller number of dealers than the first two companies. However, the company treats its dealers in the same manner as the other two firms by providing annual training.

5.5.8 Supplier Relationship

The process of selecting suppliers are based on cost and past performance. Like the other companies in the study, it has long-term relationship with all suppliers based on mutual trust. However, the company does not have technical collaboration with suppliers. The general practice is that when defective parts are found, they can simply be exchanged with on-spec products without further investigation or collaboration to find the causes.

5.5.9 Human Resource Management

(a) Employment System

The company generally prefers hiring experienced workers to fresh graduates. The level of education of an average worker is lower than that for company A and B.

(b) Employee Training

Employee training and development is not given much emphasis in the company strategies. As compared with company A, employee training is conducted in a less systematic manner. Entry-level training for technical employees does not include quality control skills, and ongoing training cannot be performed on a long-term basis due to employee turnover.

(C) Employee participative climate

Like company A and B, the company promotes employee involvement by the use of a suggestion system and small group activities. The number of suggestions approved by management is relatively lower than those of company A and B due to insufficient training. Although there is utilization of teams on the shopfloor, middle management is not entirely supportive because the organization is not structured to respond to initiatives from lower levels.

(d) Functional Integration

Cross-functional integration is carried out in routine interdepartmental meetings between production planning, manufacturing, and marketing. There seems to be a lack of common goals between departments in terms of cost, quality, and delivery. As there is insufficient coordination between distribution and manufacturing, field problems are not systematically corrected.

(e) Performance Evaluation

Due to the lack of direction, performance tends to be judged by isolated incidents and by functional goals rather than organizational goals. Length of service is generally valued because people who stay with the company are perceived as being loyal and should be rewarded.

(f) Existing Cultural Pattern

"Contentment" seems to be the right word that explains existing cultural pattern in company C. During the past twenty years, not many changes have occurred within the organization. Its stable market shares does not cause much concern to top management, and the company probably needs some types of crisis to revitalize its organization.

5.5.10 Company C Summary

For its lack of direction, company C can be compared with a ship floating in the sea. So far the weather has been good, and the ship stayed afloat just fine. Now that the water is getting turbulent, there is a high possibility that it will run aground or be capsized. This tragic situation can be avoided through the captain's leadership and commitment of his sailors. In order to improve overall performance, top management of company C needs to formulate a strategy which sustains long-term development and encourages everyone's participation.

5.6 Company D

Company D is a Thai company with the smallest production capacity and the smallest market share. It started production in 1980, but had to pause for a few years due to internal problems. Finally, the company was taken over by another group of entrepreneurs, and it now appears to be a small and somewhat family-owned organization. It imports certain parts from mainland China, making it the low-cost producer. As the company only manufactures a small range of products, it is a process-focused plant serving a single product market. Unlike other competitors, the company is not located in an industrial estate, but in a small province near Bangkok.

The organization chart of Company D consists of three main divisions: finance and administration, marketing, and manufacturing. At present, responsibilities for manufacturing and marketing are delegated to the plant manager due to the lack of management personnel. As compared with the others, the company is smallest in terms of registered capital, production capacity, and the number of employees.

5.6.1 Company Strategy

For company D, the main strategic objective is sales growth due to its smallest market shares. In response to this, top management aims to employ a marketing strategy which stresses promotion and advertisement. The emphasis on marketing strategy can be attributed to a number of reasons. First, promotional campaign consumes less time and efforts, and it gives quick results. The company also has limited financial resources, and its top management does not prefer to invest in a long-term plan. As the products are most competitive in price, they are attractive to low-end customers who are not too demanding about quality.

5.6.2 Manufacturing Strategy

Company D adopted no systematic approach to formulating manufacturing strategy. Besides satisfying the production plans, there is a lack of common goals within manufacturing. Even if there is a common goal, there is no vehicle to make it happen. Typically, the manufacturing manager is busy with short-term pressures to meet daily schedules and resolve operating problems. This is understandable considering the fact that he also acts as a marketing executive thus having little time to do anything else.

5.6.3 Quality Policy

The company has no quality policy as top management does not realize its importance. The approaches to quality problems tend to be reactive, and there exists no company-wide systematic efforts in quality improvement. Due to the lack of management support, few quality programs have been initiated, and those implemented were not completely successful.

5.6.4 Quality System in Manufacturing

In manufacturing, there is an attempt to use bottom-up activities such as a suggestion system. However, the percentage of suggestions approved by management is rather low (less than 20 %), reflecting the lack of appropriate training and management commitment. Small group activities were once introduced, but soon faded away due to the lack of motivation and support.

Unlike the other companies, there is no quality control department which keeps track of quality records and activities. Quality responsibilities are generally given to supervisors in relevant sections. In quality control, a sampling plan is used for receiving inspection. If quality problems are found, the defective parts will be sent back to suppliers in exchange for good products. In the production process, techniques such as statistical process control and design of experiment are not utilized as they are not known to workers and supervisors.

5.6.5 Manufacturing Capabilities

Due to limited financial resources, company D has not made many manufacturing investments over the past three years.

While the production process is the same as that in the other companies, the level of technology is relatively lower, particularly in process innovations. Due to insufficient training, workers were not able to acquire the capabilities to upgrade the production system. As for other functions, such as process planning, administration, accounting, marketing and sales, the extent to which computer application is adopted is low.

5.6.6 Production Planning and Control

In production planning, the company adopts a six-month aggregate plan, and utilizes chase demand and level production methods to cope with uncertainties. The plant generally faces little degree of operational instability due to schedule changes, expediting of orders, and volume fluctuation. This is because its production volume is small as compared with the others. It should be observed that company D has a large amount of work in process due to erratic process yields. However, it does not try to reduce the inventory levels as the company has rather limited resources.

5.6.7 Customer Service

Company D has a smaller number of dealers as compared with its competitors. It employs before-sales services by sending technicians to the dealers' premises in order to provide checking services prior to sales transactions. There are four technical service centers in the major parts of the country. However, the functional goals of the company's support service is not clearly established in terms of quality, delivery, and cost. The company has no annual service plan due to the lack of human resources. Neither does it have a quality feedback system which fosters overall quality efforts.

5.6.8 Supplier Relationship

For company D, the most important purchasing goal is high quality components. Sourcing is its process of selecting suppliers, and it is usually single or double-sourcing. Although no legal contracts are established, the company rarely changes suppliers of parts and components.

Like all the other participants, purchased parts are the major contribution to quality problems. Company D assists its vendors by sending technicians to help solve technical problems. However, the degree of cooperation is much smaller than that of company A.

Although local content government regulations are no longer valid, the company purchases more than 80 percent of its parts from domestic suppliers or vendors. Thus, cooperation with vendors is crucial to achieving purchasing goals.

5.6.9 Human Resource Management

(a) Employment System

Company D generally employs workers from local areas, and it has been facing problems with high turnover rate among technical employees. This is due to the fact that the company is small and situated in a remote area which are unattractive to labor forces in terms of location. Further, the company is not able to provide a satisfying work environment and high salaries to workers due to its financial limitations. It is thus very difficult for the company to recruit and retain workers. To help attract employees, the company provides in-house technical training to students from vocational schools around the areas. This approach has been effective in recruiting workers yet it could not relieve the turnover problem.

It should be noted that the company has only one university-graduated engineer from mainland China. It has no plan to recruit additional engineers because the company could not afford to pay high salaries.

(b) Employee Training

Most workers hold secondary education certificates, which are lower than those in the other three companies. Entry-level training for technical employees consists of technical skills and knowledge of the production process. Ongoing training is done on the job only, and is not formally structured. The company is in need of leadership training for supervisors as the workers who were promoted to the supervisory level severely lacked leadership skills. The company needs to train them so that they can communicate better with workers and stimulate positive involvement from them. However, the company does not have qualified training personnel, and it was not able to find a training institution around the area.

(C) Employee Participative Climate

Employee participative climate has a typical pattern in a family-owned organization due to the presence of cultural characteristics. As Thailand is a hierarchical society, the Thai employees tend to expect large hierarchical gaps between levels of management. Thus they are generally reluctant to initiate, and communication tends to be from top down only (Holmes and Tangtongtavy, 1995). Without appropriate channels, bottom-up communication would be very limited.

(d) Functional Integration

Without an established system, functional integration can be affected by certain cultural characteristics. Being a strongly collectivist society, the Thais are tightly integrated into groups (Holmes and Tangtongtavy, 1995). With a lack of common objectives among departments, this great sense of affiliation could create interdepartmental conflicts due to contradictory functional goals. As the organizational system in company D does not foster lateral relationships, this could be a potential problem in the organization.

(e) Performance Evaluation

The system of performance evaluation is similar to that of company C due to the lack of performance objectives. That is, performance tends to be judged by the length of service, and by individual achievements rather than the organizational goals.

(f) Existing Cultural Pattern

Company D is a local company which has a number of typical Thai characteristics as stated earlier. Since it is situated in a small province, most people are hired from the same area. Being familiar with each other, the employees sometimes have a hard time differentiating between work life and personal life. To maintain relationships, they try to avoid conflict as much as possible. This compromising nature has an affect on decision-making process because the best decisions may not be reached. It also affects the quality system in the plant as quality problems may be disregarded for fear of blaming others. For the same reason, the root causes of any operating problems may have never been found.

5.6.10 Company D Summary

Unlike all the other companies under study, company D has both financial and human resource limitations. Its top management is not committed to quality improvement, and its differentiation strategy in being the low-cost producer runs the risk of losing grounds if the competitors are able to reduce costs. While the other companies are adopting some types of integrated quality management system, company D remains the same. To keep its cost competitiveness, the company should adopt total productive maintenance (TPM) which maximizes equipment's effectiveness and yields cost reduction in a short run. This would also serve as a good start for the other types of quality system which would be beneficial for the company in the future.

5.7 Comparison among the four Thai companies

Table 5.1 contains certain performance characteristics of the four companies. It can be seen that the companies which have better performance than the others are companies A and B. According to the Table, both companies outperform the others in term of business results, market quality evaluation, and utilization of assets. For business results, A has the largest market share while B has the highest growth rate. The market quality evaluation reveals that the two firms enjoy higher customer satisfaction in product features and customer services. This is in line with the critical success factors of the industry being the quality of products and services. In terms of the utilization of assets, companies A and B have lower inventories at year end as a percentage of total assets. They also retain lower levels of work in process, reflecting better manufacturing performance.

The performance of the four companies can be assessed by employing the performance measures developed in Section 3.3.5. The eight criteria consist of: management commitment, organizational integration, quality policy, human resource management, management of process, quality system in manufacturing, supplier management, customer focus.

Table 5.1 Performance characteristics of the four companies

	A	B	C	D
1. Management Commitment				
Market share	65 %	20 %	10 %	5 %
Sales growth rate	10-12 %	15 %	< 10 %	< 10 %
Commitment to quality	TQC division reports directly to 'top mgmt	Quality Council	No quality steering committee	No quality steering committee, no quality policy
2. Organizational integration				
Top-down	Policy mgmt. & deployment, daily mgmt. Shopfloor morning meetings, company brochures	Top mgmt. Meetings, shopfloor morning meetings, company brochures	Top mgmt. meetings, shopfloor morning meetings	Top mgmt. meetings, shopfloor morning meetings
Bottom-up	Suggestion, QCC, kaizen teams	Suggestion, QCC, Open-door system	Suggestion, QCC	Suggestion
Cross-functional	Functional mgmt., internal customer	Inter-departmental meetings	Inter-departmental meetings	Inter-departmental meetings
3. Quality policy				
Existence of quality policy	Yes	Yes	No	No
Quality practices	TQM, kaizen QCC, suggestion, 5s	TQM, QCC, suggestion, 5s	QCC, suggestion	Suggestion, 5s
Quality certificates	ISO 9002, TISI*	ISO 9002, TISI*	TISI*	TISI*
4. Human Resource Management				
Approx. no. of employees	320	200	170	110
Educational level	grade 12	grade 12	grade 9	grade 4
Suggestions/employee/ yr	9	8	5	3
Suggestions approved by mgmt.	61-70 %	61-70 %	21-40 %	< 20 %
Training frequency (times/mo)	≥ 4	2-3	1	< 1
5. Management of process				
Production capacity (units/yr)	340,000	227,000	180,000	120,000
Total inventory (yr end) (% of total assets)	26-35	26-35	26-35	26-35
Part/component inventory (% of total assets)	16-25	16-25	16-25	16-25

WIP inventory (% of total assets)	< 15	< 15	16-25	16-25
Attempt to reduce inventory	high	high	moderate	little
Work standardization	high, by teams	high, by teams	high, by mgr.	low
6. Quality system in manufacture				
Incoming inspection	Sampling plan and skip lot, tokusai system	Sampling plan and skip lot	Sampling plan and skip lot	Sampling plan
In-process inspection	Operation standard manuals, neighbor inspection, poka-yoke, SPC/DOE, kaizen, QCC	Operation standard manuals, neighbor inspection, SPC, QCC	SPC QCC	--
Final inspection	Individual running test, endurance and reliability tests by sampling	Individual running test, endurance and reliability tests by sampling	Individual running test, endurance and reliability tests by sampling	Individual running test, endurance and reliability tests by sampling
7. Supplier Management				
Supplier relationship	mutual trust	mutual trust	mutual trust	mutual trust
% of long-term suppliers	> 80	> 80	> 80	> 80
Suppliers into JIT/TQM program	20 %	none	none	none
Technical cooperation with suppliers	Yes	No	No	Yes
8. Customer Focus				
Design technology expertise				
-R&D expenses (% of sales)	> 5	> 5	> 5	> 5
-R&D activities	modify Japanese models	none	none	none
Customer service	Service centers, mobile services, education services.	Service centers, mobile services, medical services, lunch funds,	Service centers	Service centers, before-sale service
Field quality feedback system	Service/mkt/ manufacturing	--	--	--
Existence of market research	Yes	Yes	Yes	No regular basis
Customer survey comparison (Rating Score = 10)				
- Price (8.2**)	6.4	8.2	8.5	9.7
- Product features (7.83**)	9.3	8.3	7.6	6.1
- Service (7.93**)	9.9	8.4	7.4	6
- Inquiry lead-time (8**)	7.5	8	8.4	8.1

* TISI = Thai Industrial Standard Institute ** The industry averages

5.7.1. Management Commitment

Management commitment is more obvious in Companies A and B. As one of the earliest companies to adopt TQM in Thailand, Company A adopted it without any crisis requirement. Being partially influenced by the success of its Japanese partner, top management at Company A believe that TQM is the right tool for competitiveness, and they wholeheartedly adopt the philosophy. Management commitment is evident in that the Total Quality Commitment (TQC) Division reports directly to the Managing Director. All the executives undergo TQM education and training, and are all familiar with policy management and deployment. They conduct TQM audits on a yearly basis in order to sustain the efforts of continuous improvement. They allocate resources and budgets to the employees at lower levels for their improvement activities, and are present at the company's annual QCC contests to give out awards and recognition.

At Company B, management commitment can be viewed through its active involvement in acquiring an ISO 9000 certificate. Top executives are eager to learn about new competitive approaches as they are constantly attending seminars and courses. They also initiated the TQM movement within the company, and set up a quality council to oversee the planning and implementation.

Top management at Companies C and D are not committed to continuous improvement. They lack the vision to make changes in the organization in order to become more competitive.

5.7.2 Organizational integration

Company A attempts to integrate the various elements of the organization by implementing TQM promotional vehicles. Policy deployment, cross-functional management, and bottom-up activities are used to promote communication in the top-down, interfunctional, and bottom-up directions. As it is vital that organizational goals are communicated and understood throughout the company, policy deployment helps make the organizational goals more concrete as they are passed down to lower levels. Cross-functional communication is facilitated by adopting the concept of internal customers which also reduces interfunctional conflicts. Small group activities are used to stimulate bottom-up communication, and quality progress is communicated all over the company through various publications. Employees seem to have quality awareness, feel similar sense of pride, and are alert for changes. It can thus be stated that Company A has succeeded in instilling a culture of continuous improvement.

In Company B, management executives try to unite the organization by heavily stressing that the company is for the employees. They adopt an open door policy in an attempt to become accessible to the members of the organization. Quality control circles and suggestion system are used to stimulate employee involvement at the shop floor level, but other TQM promotional vehicles have not been implemented. In general, employees are tied to the company through the somewhat family-like atmosphere and economic benefits from the company's well-being.

In Companies C and D, there is a lack of vehicles to promote organizational integration, and communications tend to be in the top down direction. Although the companies are small, interdepartmental goal conflicts sometimes occur due to the differentiation by functions. Without quality initiatives at lower levels, full employee involvement potential cannot be reaped.

5.7.3 Quality policy

Quality policy in Companies A and B clearly states the company's commitment to delivering quality products to customers. In particular, Company A declares that quality is everyone's responsibility, including suppliers; and its quality strategy not only covers the manufacturing areas but also all the other functions that are associated with the customers and the general operation of the company. The quality goals are realistic and are supported with adequate resources.

Companies C and D do not have a quality policy as they lack the quality goals and do not realize their significance.

5.7.4 Human resource management

Company A highly values its people as the source of competitiveness. It emphasizes continuous education and training in both technical and administrative aspects. It also adopts job rotation and on the job learning in order to help bridging the functional differences. There exists a systematic career development plan that serves as a motivational tool and human resource development. Performance evaluation is based on both group and individual contribution, and there exists a goal-sharing financial plan which ties individual performance to organizational performance.

Company B also trains workers on a regular basis, but it does not establish a career development plan for employees. Top management places high emphasis on company loyalty, and length of employment is the main promotional criteria.

Although Companies C and D see the importance of their people, they are not systematically engaged in human resource development. Management of human resource sometimes encounters problems due to certain cultural characteristics such as high status differences which results in the lack of employee involvement.

5.7.5 Management of process

Companies A and B have adopted the ISO 9000 quality system that provides the means for tracking the system of operations. Company A is different from the others in that it establishes the concept of internal customers in order to create a chain of quality throughout the organization by having each department identify its own needs and the needs of the next department. Process improvements are also attempted from the supplier end to final inspection. The internal customer satisfaction, ISO 9000 documentation, and continuous process improvement result in consistency, reliability, and better quality of products and services.

5.7.6 Quality system in manufacturing

In Company A, the incoming parts are evaluated in order to gain a clear understanding of problematic suppliers. The results are fed to purchasing and quality teams that will work with the suppliers. In the manufacturing process, workers are trained to perform inspections of the work done at the upstream process before starting their own tasks. Company A also installs fool-proof systems that help identify quality problems. Such equipment is designed by the quality teams, and is lacking in the other companies. The company also employs statistical methods in problem solving and process-variation detection to a much greater extent than the others.

The quality system in manufacturing within Company B is similar to all the others in that it consists of incoming inspection, in-process quality control, final inspection, failure analysis, and guage and equipment calibration system. Like Company A, neighbor inspection is used in manufacturing to minimize quality problems together with in-process quality control performed by operators. The difference is that Company B makes less extensive use of problem solving and small group activities.

In Company C, neighbor inspection is not practiced to reduce operator's controllable defects although in-process inspection is done by operators. Thus, quality problems caused by human errors are relatively higher than those in the first two firms. Small group activities are used to solve problems, but there is a lack of a system to monitor the new standard, leading to short-lived results.

Company D does not have a quality control department that keeps track of quality records and activities. It lacks a system of defect prevention and simply employs a reactive approach to quality problems. For example, defective parts are reworked and repaired without attempting to find the root causes. Techniques such as small group activities and statistical process control are not utilized within manufacturing.

5.7.7 Supplier management

In general, all the companies establish long-term relationships with their suppliers on the basis of trust rather than contracts. Bidding/quotation is normally used for suppliers of standard raw materials while sourcing is used for suppliers of parts and components. In selecting a vendor, Company A considers past performance records, process capabilities, quality control system, and management system. Others select their suppliers based on past performance records, costs, and existing connections.

Company A stresses the quality of purchased parts, and it is sometimes prepared to pay higher prices. The company also works closely with its suppliers in order to solve problems and improve quality and cost competitiveness. This is the main difference between Company A and the others.

Company D also provides technical assistance to suppliers, but to a much less extent due to its limited resources. Companies B and C do not have technical affiliation with their suppliers. The general practice is that when defective parts are found, they can simply be exchanged with on-spec products without further investigation or collaboration to find the causes.

5.7.8 Customer focus

Company A is dedicated to satisfying both internal and external customers. Internal customer satisfaction agreement is created between departments in order to be used as a guideline to satisfy the needs of external customers. The company also conducts customer satisfaction surveys on a regular basis in order to find its strengths and weaknesses. According to this study, the results of customer surveys indicated that Company A is superior to the others in terms of product quality and customer service. Despite the relatively higher prices, customer loyalty is very strong due to the quality of products and services. However, the company needs to focus on improving its delivery lead time during the peak demand.

Company B also stresses after-sales service, and conducts mobile services as well as provides lunch funds to future customers. Its products are increasingly recognized among the users as they are competitive in price, product quality, and after sales service.

Companies C and D are ahead of the others in terms of price, but inferior in terms of customer services. Although they have good delivery performance, they need to attend to enhancing the quality of products and services.

This chapter discusses the four Thai cases and compares them using the performance measures developed in Chapter 3. These companies are to be compared with the Japanese cases in the following chapter in order to reveal the critical factors to successful performance.

Chapter 6
Analyses of the Japanese Case Studies

The three Japanese companies analyzed in this chapter are the joint venture partners of the Thai companies A, B, and C discussed earlier. Referred to as Company E, F, and G, they can be considered world class as they are the winners of the Deming Prize. While these companies differ in such aspects as origins and organizational sizes, they share a number of characteristics which are discussed in the following sections.

6.1 Company E

Starting production in 1890 as a manufacturer of cast iron pipes, the company later expanded to offer a broad range of products coming from five main divisions: farm and industrial machinery, pipe and fluid systems engineering, environmental control plant, materials, and housing materials and utilities. The number of employees involved in the division under study is approximately 2,500 people. The company's main strengths lie in strong technological and sales capabilities that have been transferred to its Thai joint venture (Company A). It was awarded the Deming Prize in 1976, and acquired an ISO 9002 certificate in 1994.

The company adopted its strategies in response to rapid changes in business environment characterized by a highly information-oriented society, leading-edge technological innovation, globalization, and economic maturity. In response to these changes, the company has been working to reorganize its business structure, and making company-wide efforts to reduce costs. This resulted in three consecutive years of increase in domestic and overseas sales of its principal products during the harsh economic environment.

As the demand for its main products is maturing, the company is striving to expand sales by raising the added value of its products and cultivating peripheral markets. It also pursues vigorous cost-reduction activities that include increasing the use of common parts and expanding overseas procurement. In addition, it is progressing with research and development in the fields which are expected to grow during its continuing operations.

6.2 Company F

The company was founded in 1912 as an engine manufacturer, and it has grown to become one of the world's few engine manufacturers that make all of its own parts. As compared with the other two Japanese companies, this firm seems to be smaller and more specialized. Over the past sixty years, it has made significant achievements in inventing new types of engines, and became the first Japanese manufacturer to be awarded the Deming Prize in 1968. It acquired the ISO 9001 certification in 1992.

The company has many divisions producing different types of engines, fuel injection equipment and other engine components, generator and cogeneration systems, construction machinery, agricultural machinery, numerical controlled machine tools, precision metal molds, and hydraulic equipment. The number of employees in the engine division is approximately 1000.

In response to the future demand for its main products, the company aims to develop better engines in terms of cleaner exhaust emission, and reduced vibration and noise. It also conducts research and development on new types of engines such as the hydrogen engine and hybrid types.

6.3 Company G

The company was established in 1884 as a shipbuilding company. It later expanded into a broad range of business activities including manufacture of ships, steel structures, power systems, air-conditioners, heavy machinery, airplanes, and railroad cars. The number of employees in the engine division is roughly 2,700. At present, the company belongs to one of the largest financially-linked industrial groups in Japan.

The company conducts business on a global scale by utilizing technological expertise accumulated over a century to continuously develop unexplored areas and improve existing products. Besides upgrading product reliability and safety, it is constantly refining its technology to meet such societal concerns as energy conservation, noise reduction and fuel efficiency.

To respond to the harsh market environment during the last few years, the plant made great efforts to reduce material and manufacturing costs by every possible means such as improving product design, and encouraging price competition among suppliers through open tender and overseas purchasing. It has recently reduced the workforce by more than 400 employees, all of whom were offered new job opportunities in subsidiary companies for continuation of employment.

6.4 Discussion of the three Japanese companies

6.4.1 Company Strategy

The strategic objectives were different in each company depending on their respective situations and on who filled out the questionnaires. Responses from top management tended to be more concerned with product quality and employee's well being while answers from middle management were more directed toward operating aspects such as profitability and costs. All the companies respond to changing market environment by broadening and innovating the product lines, expanding the production systems to other countries, and pursuing cost reduction activities.

Like most Japanese companies, the three companies establish their strategies based on both financial and non-financial goals. While financial goals involve such factors as profitability and market share, non-financial goals are related to overall improvements in the company's various systems and cross-functional activities.

Annual policies are generally formulated at the beginning of the year in terms of long-range goals. They are transferred to lower levels by having the next-level managers define the goals in a more specific terms. In this way the policies become increasingly concrete and action-oriented as they are passed down the organization. This method of policy deployment helps secure commitment at lower levels as it calls for involvement of lower-level managers in establishing and deploying the goals. To examine whether the deployed policies have been properly executed, policy audits (or sometimes called TQC audits) are conducted yearly at all levels of management starting from top management level. If deviations are detected, management will attempt to identify the causes in order to apply corrective measures (Imai, 1986).

6.4.2 Quality policy

Total quality management (TQM) is applied in all the three companies, and companies E and F won the highly prestigious Deming Prize in 1968 and 1976. To gain international recognition, all the companies have acquired either the ISO 9001 or ISO 9002 certificates for their main products, and two of them are currently aiming to achieve ISO 14000 certifications. It is worth noting that not only do the companies strive for continuous improvements, they constantly look for some kind of achievement target. According to one respondent, this helps to focus everyone in the same direction, "As our company is a large corporation, we need a flag so that everyone can follow."

Another "flag" that attracts interests among the Japanese manufacturers is the Total Productive Maintenance (TPM) Prize. The TPM approach aims at maximizing equipment's overall effectiveness by transferring maintenance-related tasks to front-line operators. It is gaining much attention during the current harsh economic environment because TPM yields faster and more tangible outcomes especially in cost reduction (Miyake et al., 1995).

In general, each company has a quality council headed by a top-management executive to oversee the quality policy and its implementation. Normally, quality policy is translated into a quality plan for each department, and further deployed into quality targets and finally activities.

Several means are employed to ensure that the quality policy announced by top management is understood throughout the organization. At company G, quality policy is displayed in all relative sections with serial numbers, and employees can relate their lower level activities to the top management policies by comparing serial numbers. At company F, company policy is announced at the President's meeting, and a video on the President's announcement is made available to all employees. To monitor progress on quality activities, each manager is required to report progress by the end of the fiscal year.

Various forms of quality meetings are held on a regular basis at different levels. For instance, company E has a quality management committee and a quality control committee which are organized so that employees from each plant can meet and exchange quality problems. Company F holds several meetings such as those for discussing company policy, manager meetings, and design reviews. Company G holds monthly meetings among sectional managers in order to discuss quality problems.

6.4.3 Quality System in Manufacturing

For each company, the ratio of quality personnel to total technical staff is quite low (between 3-4 percent), indicating that quality responsibilities are given to the process operators. For example, in-process inspection is practiced throughout manufacturing, where each operator has a check sheet to check measurements. Employees are organized into small groups who conduct improvement activities on a regular basis.

6.4.4 Design and manufacturing capabilities

All of the Japanese manufacturers place emphasis on design, engineering and manufacturing. For a large organization, there are R & D departments central to the organization as well as within each of the business divisions. The central R&D function usually cooperates with each business division to provide information on the rapidly changing social environment and assists in the process of creating technological innovation.

Within each business division, vertical linkage and cross-functional communication is emphasized. In the design function, there is strong user-manufacturer cooperation during the development phase. Customer feedback is systematically processed and fed to design, manufacturing, and marketing functions so that customer requirements can be translated into design specifications by quality function deployment.

Manufacturing competence is reflected in the performance of continuous improvement activities. Continuous process improvement is prevalent on the shop floor, and the application of automatic-checking devices is extensive throughout the production process. Most of the mechanical equipment is equipped with self-stopped devices, fixed-position stop system, and a large variety of safety devices.

6.4.5 Service and distribution

All the companies place great emphasis on providing reliable customer service. Regular visits are made to customers to provide periodic inspections and maintenance. The companies also provide repairs and consultations on how to use the products more efficiently and effectively. Field service data is continually fed to the design and manufacturing functions in order to find the root causes and to help design new models.

As for distribution, the three companies have set up several local and overseas sales and service network. In order to establish close operational linkage with overseas regions, company E has configured a global network directly linked with regional markets to cover all phases of business operation from development and production to marketing. Company F operates its part supply management with an on-line processing system that handles all phases from order receipt to product shipment. Company G also utilizes information technology to improve communication within and outside the company.

6.4.6 Supplier relationship

In the case studies, the manufacturers rely on external subcontractors for an average of 65-70 % of its parts, which are supplied on a just-in-time basis. This heavy reliance on suppliers is typical of most major manufacturers, making suppliers critical to their production. For example, one of the plants under study had to halt its operation for one day due to a snow storm that obstructed suppliers' delivery.

In general, the Japanese system of subcontracting is in the form of a pyramidal structure called the keiretsu system. A keiretsu is a group of individual business units viewed together as a hierarchical organization. In the case of the manufacturing industry, a keiretsu usually consists of tiers of subcontractors producing parts for the companies in the level above it. The number of levels depend on the complexities of products and processes. Within a keiretsu, there is a strong traditional bond which prevents a subcontractor working for more than one organization. Although some marginal subcontractors are treated as if they were shock absorbers of recession, parent companies generally take good care of their suppliers because the quality of the finished product depends on the parts supplied by them (Miyashita and Russell, 1996). Another interesting feature of keiretsu is that suppliers are normally expected to provide parts with improvement beyond the parent's expectation and without requests from the parent. This is made possible only through the long-term relationship which ensures that suppliers can expect promising returns on their investments.

For the case studies, the companies maintain steady communications with their suppliers on product development, product quality, and delivery schedules. They also assist their suppliers in initiating quality improvement programs while presenting annual awards to those who have satisfied their quality or delivery requirements. In addition, each company organizes subcontractor association for its suppliers so that they can meet and solve problems jointly.

In recent years, the prolonged economic slump has induced some changes, and parent companies are beginning to select independent suppliers as well as members of its keiretsu. In fact, one of the companies under study started to select independent suppliers based on cost in addition to sourcing parts from their keiretsu. Fortunately, the emphasis on cost reduction does not sacrifice quality because Japanese companies have always been involved with quality development and continuous improvement.

6.4.7 Human resource management

(a) Employment system

Like most organizations in Japan, the three companies normally recruit employees only once a year at the time they complete their educational courses. In general, workers are hired immediately after graduation and work for the same company until retirement. Thus, recruitment is regarded as an irreversible decision where the applicants are asked to entirely commit themselves to the company, and where the company assumes responsibility for the workers' livelihood (Sato and Hoshino, 1984).

In Japan, life time employment is implicitly guaranteed in most large organizations because employees are protected by the union while the companies try to avoid layoffs. As loyalty is highly valued, employees rarely change jobs and those who seek new jobs in the middle of their careers tend to get lower startup salaries than those at the same positions. The minimal turnover rate has led to the advantage of very little transfer of knowledge and expertise to other companies. In this way, design and manufacturing competence can be accumulated within the workforce.

Recently, the situation is beginning to change as the Japanese economy goes through a sluggish period. In response to this, several companies adopted such measures as business structure reorganization and rigorous cost-reduction efforts. The attempt toward business structure reorganization is reflected in the heightened interests in information technology which usually results in flattened organizational structures. Another factor leading to reorganization is the growth in factory automation leading to the need to slim down the workforce.

In response to the need for workforce reduction, several large companies in Japan transferred their employees to subsidiaries while others introduced early retirement plan. In the effort to keep employees on the job, some large corporations set up subsidiary companies which provided auxiliary services to the mother company. The employees were sent to the subsidiaries and assigned new jobs that were usually unrelated to their previous assignments. For example, it has been recalled by an executive of a large firm that he once saw a former maintenance worker who was transferred to a houseplant keeper position.

Although most Japanese companies strive to avoid discharging employees, some young employees see the uncertainties and seek to improve their qualification with self-directed, off-the-job training. Some look for new jobs to strengthen their specialization, thus making them more experienced and valuable to the job market. The trend for job hopping is increasing among younger generation, and it may be useful for the industry as a whole due to the exchange of expertise.

(b) Employee training

In the three companies, entry-level training is provided for an average of one year, and ongoing training is carried out in a longer duration .

Since Japanese companies have very low employee turnover, most organizations can invest in long-term human resource development. The most common form of training is in-house and executed on the job through rotation. Employees are usually rotated from one section to another every three to five years so that they become a generalist by the time they reach management level. The multiple skills acquired through job rotation are desirable in that they facilitate cross-functional communications and enable workers to effectively function in increasingly complex technological systems. Job rotation is also suitable for mass production as it reduces the monotony of the workers' job. Finally, it provides companies with the ability to adapt to environmental changes, e.g. companies can transfer employees to other sectors of the same corporate groups during recession.

Besides informal training through job rotation, formal training programs may also be designed as part of career development plan particularly in large organizations. In the three companies, employees who have been working after a certain period need to complete a number of courses as specified by the personnel department prior to being promoted. The content and duration of the formal training programs depend on the nature of job, and are usually short-term due to the emphasis on informal and on-the-job training.

In general, the system of job rotation implies that workers must acquire multiple skills in order to be promoted to higher positions. In practice, this becomes seniority-based promotion since it is closely related to years of experience.

(C) Employee participative climate

In the three companies under investigation, techniques such as 5s, suggestion system, and small group activities were used throughout the organization. Employees tend to view improvement activities as part of their jobs and usually participate without management coercion.

It should be noted that, in Japan, there is minimal distinction between blue-collar and white-collar workers for a number of reasons. First, both university and non-university graduates can climb up the corporate ladder through on-the-job training and rotation system. Next, university graduates are normally placed and trained in the plants as ordinary workers before they are transferred to other positions (Sasaki et al, 1981). In terms of salary scales, those of blue- and white-collar workers are not much different, and mostly depends on the length of service in a company. Finally, regular blue-collar and white-collar workers join the same company union which includes most managers below section chief.

(d) Functional Integration

The mechanism of functional integration generally starts from the formulation of cross-functional goals in terms of cost, quality, and delivery. These goals are established by a cross-functional committee organized at the top management level. At the same time, the measures needed to achieve the cross-functional goals are defined in order that each department can assume appropriate roles and responsibilities.

Functional integration is also carried out in other forms, for example, at company E representatives from each department meet at the corporate budget meeting in order to discuss policy planning and yearly budget preparation. Cross-functional communication is also facilitated through a large number of projects such as product development meetings, voluntary group activities, and ad-hoc committees. It should be noted that ad-hoc committee is a very common form of interdepartmental coordination in Japan because managers are well familiar with each other while they were rotated among functions.

(e) Decision-making mechanism

The mechanism of decision-making used in most Japanese companies is called the Ringi system. The word *ringi* refers to the process of obtaining approval from other members of the organization prior to making decision. This is done by circulating document to the relevant members in the vertical, or sometimes horizontal direction. In most cases, it is the middle managers who take the initiatives in making proposals and making the relevant decisions (Hattori, 1978; Sour, 1982). As the initiators belong to the middle management, it is very important that they have established networks of contacts and are knowledgeable about the whole organization. This is made possible by on-the-job training and job rotation within the company.

The advantages of the consensus decision making system have been widely cited as allowing for a greater number of reasonable alternatives to be considered, and taking less time to implement despite the relatively slow decision-making process (e.g. Drucker, 1971; Hattori, 1978; Hatvany et al., 1981).

(f) Performance Evaluation

The three companies under study use the following criteria for technical staff promotion: ability appropriate to the job being promoted, achievement in the current job, and business-generated contributions. While the order of importance varied among companies, length of service was claimed to be the lowest priority in spite of the fact that seniority-based promotion was generally recognized as a traditional practice in most Japanese companies.

In general, performance measurement incorporates both the short-term results and subjective assessment of elements of teamwork and efforts (Nishikawa, 1997). For management promotion, most companies place high value on a managers' capability as a generalist, their interpersonal skills, and credibility and popularity within the company (Baillie, 1982; Kagono et.al, 1984; Yang, 1977).

6.4.8 Existing Cultural Pattern

As stated earlier, the traditional characteristics of Japanese-style management is cooperate paternalism featuring lifetime employment, seniority wages, and cooperative management-labor relations as accommodated in the in-house union. The system is practiced in most large manufacturing companies, and has a number of advantages. For example, life-time employment facilitates long-term employee development and provides nearly absolute organizational control due to the lack of labor mobility. It compliments the system of job rotation which develops employees' general skills while guaranteeing job security throughout workers' careers.

This management style was considered appropriate for reconstructing Japan's economy during the postwar period when skilled labor and good managers were scarce. However, it is now seen by a number of authors as a burden now that this goal has been accomplished and Japan has entered a period of low growth.

From the viewpoint of the employee, lifetime employment tends to make a person lose their availability to other companies since they are trained to suit only one company climate. It also makes a person become an anonymous element of the organization as everyone must try to fit in with the company culture. Further, the system of seniority-based salaries does not generate an individual's incentive for training because a person does not get a higher wage even if he develops his own capacity. It is said that Japanese companies generally try not to differentiate between capable and less-capable workers (Sasaki, 1981; Flynn, 1982).

Hitoshi et al. (1997) suggests that Japanese-style management is going through some changes as the period of unrelenting economic growth has come to an end. For example, the employment systems in some companies like Toyota and Fujitsu have changed from once-a-year recruitment to a year-round hiring. These companies are beginning to look for specialists able to function in any company rather than generalists able to function in any internal division. These companies have created a smaller number of core positions in order to avoid fixed payrolls. As companies are no longer able to sustain lifetime employment, they are beginning to restructure the performance evaluation by placing more emphasis on merit-based pay systems as well as the seniority-based wages.

6.5 Comparison among the Three Japanese companies

The performance of the three Japanese companies can be assessed by employing the performance measures developed in Section 3.3.5. The eight criteria consist of: management commitment, organizational integration, quality policy, human resource management, management of process, quality system in manufacturing, supplier management, and customer focus. Table 5.2 contains the comparisons of the three companies using the eight criteria.

Table 6.1 Performance characteristics of the three companies

	E	F	G
1. Management Commitment			
Market share	N/A	N/A	N/A
Sales growth rate	12-13 %	10-12 %	10-15 %
Commitment to quality	Policy audits, TQM audits, quality steering committee	Policy audits, TQM audits, quality steering committee	Policy audits, TQM audits, quality steering committee
2. Organizational integration			
Top-down	Policy management and deployment, daily management, shopfloor morning briefings, video, brochures, noticeboards	Policy management and deployment, daily management, shopfloor morning briefings, video, brochures, noticeboards	Policy management and deployment, daily management, shopfloor morning briefings, video, brochures, noticeboards
Bottom-up	Suggestion, QCC, team activities	Suggestion, QCC, team activities	Suggestion, QCC, team activities
Cross-functional	Functional mgmt., internal customer, ad-hoc meetings, interdepartmental meetings	Functional mgmt., internal customer, ad-hoc meetings, interdepartmental meetings	Functional mgmt., internal customer, ad-hoc meetings, interdepartmental meetings
3. Quality policy			
Existence of quality policy	Yes	Yes	Yes
Quality practices	TQM, TPM, kaizen, QCC, suggestion, 5s	TQM, TPM, kaizen, QCC, suggestion, 5s	TQM, TPM, kaizen, QCC, suggestion, 5s
Quality certificates	Deming Prize, JIS ISO 9002	Deming Prize, JIS ISO 9001	JIS, ISO 9002
4. Human Resource Management			
Approx. no. of employees	2,500	1,000	2,700
Educational level	grade 12	grade 12	grade 12
Suggestions/ employee/ yr	18	20	21
Suggestions approved by mgmt.	> 70 %	> 70 %	> 70 %
Training Frequency (times/mo)	≥ 4	≥ 4	≥ 4
5. Management of process			
Production capacity (units/yr)	N/A	N/A	N/A
Total inventory (yr end) (% of total assets)	< 15	< 15	< 15
Part/component inventory	JIT	JIT	JIT

(% of total assets) WIP inventory (% of total assets) Attempt to reduce inventory Work standardization	JIT high high, by teams	JIT high high, by teams	JIT high high, by teams
6. <u>Quality system in manufacturing</u>			
Incoming inspection	Supplier certification	Supplier certification	Supplier certification
In-process inspection	Operation standard manuals, neighbor inspection, poka-yoke, SPC/DOE, improvement teams, QCC	Operation standard manuals, neighbor inspection, poka,yoke, SPC/DOE, improvement teams, QCC	Operation standard manuals, neighbor inspection, poka-yoke, SPC/DOE improvement teams, QCC
Final inspection	FMEA	FMEA	FMEA
7. <u>Supplier Management</u>			
Supplier relationship % of long-term suppliers Suppliers into JIT/TQM program Technical cooperation with suppliers	Mutual trust > 80 All Yes	Mutual trust > 80 All Yes	Mutual trust > 80 All Yes
8. <u>Customer Focus</u>			
Design technology expertise - R&D expenses (% of sales) - R&D activities	Less than 5 Model changes, product design, QFD	Less than 5 Model changes, product design, QFD	Less than 5 Model changes, product design, QFD
Customer service	Global network, parts and services centers, mobile services	On-line processing system, parts and services centers, mobile services	On-line processing system, parts and services centers, mobile services
Field quality feedback system	Service/marketing /mfg/design	Service/marketing /mfg/design	Service/marketing /mfg/design
Existence of market research	Yes	Yes	Yes

6.5.1 Management commitment

Top management plays a crucial role in building a quality culture within an organization. In the three world-class companies, management makes sure that their policies are followed throughout the organization by carrying out TQM audits or policy audits at all levels. They are also present in the quality steering committees that plan and oversee the implementation of TQM.

6.5.2 Organizational integration

Organizational integration is facilitated in all three directions by using a number of TQM vehicles. As shown in Table 5.2, top-down communication is done through policy management and daily management, shopfloor morning briefings at the start of each shift, noticeboards for communication, and company videos and brochures. Bottom-up communication is facilitated by suggestion systems, QCC, and small-group activities. Cross-functional communication is promoted by functional management, the internal customer concept, ad-hoc meetings, and interdepartmental meetings.

It should be noted that organizational integration in Japanese companies is made easier by the cultural factor of group loyalty. Collectivism has been attributed as one of the success factors for most Japanese organizations (Chang, 1982; Hatvany et al., 1981; Marengo, 1979; Murayama, 1982). It facilitates teamwork, communication processes, and company-wide improvement efforts. Strong group consciousness is instilled in a Japanese person from a very young age. For example, there is a national running race for groups of young students to run with each leg tied to another person. As all members of the group must move together as a single entity in order to win the race, team spirit is encouraged and the virtue of group loyalty is realized.

6.5.3 Quality policy

Quality is an important policy in strategic planning. As it is the only item of common concern to both manufacturer and customer, appeals to improve quality are more easily accepted than cost or productivity initiatives (Kondo, 1997). In the case studies of the three Japanese companies, total quality seems to be a way of life as reflected in the very long-term adoption of TQM and kaizen. Other initiatives such as total productive maintenance and ISO 9000 are also adopted. As stated earlier in Section 5.6.4.2, total productive maintenance is complementary to TQM as it maximizes the effectiveness of plant and equipment, and it yields faster benefits than TQM. Although ISO 9000 is not seen as an essential element to quality improvement, it represents an attempt by Japanese companies to stay competitive in international markets.

6.5.4 Human resource management

Human resource management system is discussed in terms of training, performance evaluation, and labor management relationships.

For each employee, the company will plan for training and skill development depending on the nature of the job. In general, the personnel department will keep track of the employees' record, and make sure that he has fulfilled the requirement for on-the-job and off-the-job training. Because of the lifetime employment system, employee training and development can be planned in a long-term, continuous, and systematic manner. The informal training system of job rotation has been viewed as a motivational factor especially for workers in mass production systems. It also provides workers with multiple skills which become a source of organizational adaptability. It reduces compartmentalization and promotes an awareness of the operations of the company as a whole (Drucker, 1971; Hatvany et al, 1981).

Performance evaluation is geared toward both individual and group performance. Although seniority is not openly admitted to be practiced in most of the cases, it is still a major factor in promotion decision as the length of service is directly related to the skills that an employee has accumulated throughout his career.

As for labor-management relationship, each company generally has only one labor union consisting of employees at the level below section managers. The primary role of Japanese unions is concerned with lifetime employment security rather than wage negotiation which is more of a function of company productivity and national wage norms. As most unions are company unions rather than trade or craft unions, the communication between labor and management is effective and cooperative (Cole, 1980; Leonard et al. 1982).

6.5.5 Management of process

An important vehicle that facilitates the management of quality in the business process is the internal customer concept. Quality activities are viewed as continuous work processes ranging from customer requirements to customer satisfaction. Each department establishes an internal customer agreement that helps clarify each other's responsibilities on quality and identify the duty to satisfy internal customers. The concept not only helps strengthen the quality culture, it helps trace quality problems to the source while avoiding interdepartmental conflicts. Another characteristic of process management is that incremental improvement is believed to be the source of competitiveness. Inventory is normally kept at minimum as a result of the use of just-in-time in manufacturing.

6.5.6 Quality system in manufacturing

Quality responsibilities are generally given to the process operators, and operation standard manuals are made up which also include the inspection of the work completed upstream in the process flow. A fool-proof system or automatic checking system is installed throughout the production process in order to make manufacturing process steps simple and error free. Employees are organized into small groups that perform improvement activities using such tools as the seven quality tools, and the seven new tools.

6.5.7 Supplier management

As already discussed in Section 5.6.4.6, supplier management in the Japanese system takes the form of a keiretsu, or pyramidal structure consisting of tiers of suppliers working for the ones above. Suppliers are organized into a supplier association that is the place for them to meet and discuss problems. The relationships between manufacturers and suppliers are generally cooperative and long-term, and the suppliers in the top tier are closest to the manufacturer thus enabling them to gain the most benefits in terms of assistance. The long-term relationship makes it possible for both parties to work together toward quality improvement of products and processes. Suppliers are generally involved in the early stage of product development in order to find the best and cheapest way to make a product.

6.5.8 Customer focus

In the three Japanese companies, customer focus is reflected from product inception to product delivery and after-sales services. In new product development, the three companies applied quality function deployment (QFD) to translate customer requirements to engineering and product characteristics. Within the company, the concept of internal customer is used throughout the business process. The companies also emphasize after-sales services by offering training and demonstration, extension services, and on-line processing system. The data from field service is fed back to manufacturing, engineering, and marketing, in order to identify the quality problems and customer responses.

6.6 Reasons for success

Now that the performance of all the Thai and Japanese companies have been evaluated, the reasons for success can be discussed in terms of technology, organization, and management.

6.6.1 Organization

It was found that human resource management practice is similar between the best Thai companies and the three Japanese companies. They both emphasize employee development, effective communication within the organization, continuous improvement, and organizational loyalty. Although the best Thai companies do not guarantee lifetime employment, they have never resorted to discharging employees during turbulent economic times. Another similar feature is the cooperative relation between management and workforce. Although labor unions do not have much role in most Thai organizations due to their relatively short histories and less bargaining power, the best Thai companies seem to have cooperative relationship with their labor unions.

Another issue relating to organization is supplier relationship. It should be noted that most Thai companies have long-term relationship with their suppliers based on trust. Although this is similar to most Japanese organizations, the Thai companies do not generally engage in technical cooperation with their suppliers due to limited resources or lack of vision. However, the best company in the Thai cases has illustrated that effective supplier cooperation is beneficial to the manufacturers.

The studies reveal an essential difference in organizational aspects involving the relationship between blue- and white-collar workers. Unlike the Japanese cases, the Thai organizations usually embody large status gaps between these two types of employees, resulting in communication barriers.

6.6.2 Technology

In general, the Japanese companies under study have higher technological capabilities than the Thai counterparts in terms of manufacturing and research & development. For manufacturing, the best Thai company is following the same pattern as the Japanese in terms of process innovations on the shop floor. Due to the shortage of technical employees and job hopping problems, it is difficult for any Thai organization to develop intrinsic technologies. Thus, most of them are searching to purchase technology rather than developing it. In such cases, the most important issue is to develop organizational skills which can best absorb technology.

6.6.3 Management

The best Thai companies tend to adopt similar management approaches to the Japanese cases. Company A was able to successfully implement total quality management and has been reaping its benefits for nearly seven years. The company is also extending its continuous improvement activities to suppliers by sending its kaizen teams to work with them. Company B has adopted many of the Japanese management practices such as policy deployment, and it is beginning improvement activities, starting with suggestion systems and quality control circles in manufacturing. Despite the different cultures and backgrounds, these management practices have been found to be applicable to a Thai organization as they integrate the organizational and technological elements in a coherent framework.

6.7 Conclusion

Chapter 5 and 6 present the results of qualitative analyses as obtained from the case studies of four Thai companies and three Japanese joint venture partners. It can be seen that the best companies have similar characteristics. First, these companies place high emphasis on human resource and organizational adaptation. They also increase their technological capabilities in product and process innovation through continuous improvement efforts. Finally, they adopt integrated management practices which utilize technological knowledge and human resource in order to achieve the corporate goals.

These findings are related to the results obtained from the quantitative analyses in Chapter 4 as it helps compare the impacts of various quality practices on performance. Company A represents an organization implementing TQM and finding it to be a source of sustainable competitiveness. It later obtained an ISO 9002 certificate and thus became one of those adopting both systems. Company B is in the group of those with ISO 9000, and it is attempting to introduce TQM. As the performance of the company is found to be improving, this indicates that the achievement of ISO certification does not necessarily lead to competitive edge unless it is put into the framework of TQM. Companies C and D are in the group which do not adopt any quality systems, and their performances were found to be least successful. Besides comparisons among the Thai companies, the case studies also extend to the Japanese participants. It was found that all of them employed total quality management and just-in-time approaches as competitive weapons.

The findings from Chapters 4, 5, and 6 present the information that leads to the conclusions in the next chapter, regarding the framework for the transfer of quality management to the Thai manufacturing industry.

Chapter 7

Conclusions

7.1 Introduction

The growth of Thai industries in recent years has been due to the industrializing policy and the influx of foreign direct investment. This together with the effects of globalization has led to the increasing awareness of technology transfer as one of the key factors in accelerating economic development.

One of the issues which emerge from technology transfer is the transfer of competitive practices. There are numerous practices which are claimed to be the source of competitive advantage. Among those which have attracted particular interest among the Thai practitioners are total quality management (TQM), business process reengineering (BPR), and kaizen.

As for TQM, there have been ongoing efforts to create a national quality award in order to increase quality awareness and TQM practices in the country. Business process reengineering was made popular a few years ago by the influence of a major banker who was an advocate of the preaching of Michael Hammer. Kaizen was introduced after TQM, and mostly found its place in Japanese joint ventures. Other management tools which have been utilized for nearly two decades are quality control circles, 5s, and suggestion systems. In short, it can be asserted that the Thai manufacturers have been able to moderately keep up with management trends and practices.

This study investigates the transfer and application of management practices that are believed to be the source of competitive edge. The important issues involve how the companies adapt and assimilate management innovation, and the impacts of management practices on upgrading company performance. By making use of a survey and multiple case studies, the following conclusions have been reached.

7.2 Conclusions: Quantitative Analyses

The quantitative analyses began with establishing a set of hypotheses regarding quality management. The data were obtained from a survey of 53 Thai companies using a set of questionnaires that assess the organizational, technological, and performance dimensions. In order to find the relationship between organization, technology, and management practices, an organizational-technological diagram was used to reveal existing patterns, with the aid of regression analysis. Further, analysis of variance (ANOVA) was used to analyze the effects on performance. The entire set of results are summarized below.

7.2.1 The pattern of organizational and technological development

The general pattern of organizational and technological development of the 53 Thai manufacturing companies were found to be linear, which could be divided into three stages: low O-T positioned, medium O-T positioned, and high O-T positioned companies. The performance of companies at stage 3 was highest, followed by those at stages 2 and 1, respectively. It was found that the companies in the first two stages exhibited no organizational-technological relationship, and the companies in stage 3 demonstrated a linear relationship. The linear model indicates that these companies exhibit a clear pattern of organizational-technological development. As far as quality systems are concerned, TQM and ISO 9000 quality systems were mostly adopted by the companies at stages 2 and 3.

7.2.2 The relationship between organization, technology, and management

Based on the types of management practices, the companies can be classified into four groups: TQM, ISO 9000, BOTH, and none. When regression analysis was conducted to reveal the O-T pattern for each type of quality system, it was found that the TQM group exhibited a clear linear relationship that indicates simultaneous growth of organization and technology (Section 4.4), showing that TQM can effectively bridge the two dimensions.

7.2.3 Impact of the types of quality systems on company performance

The impacts of quality system on performance were revealed by testing the hypotheses formed earlier. The results strengthen the proposition that total quality management is one of the suitable approaches which bridge technology and organization and lead to improved performance and sustainable development. The second proposition was also verified that ISO 9000 is of limited value on its own and does not necessarily lead to continuous improvement. Finally, the third proposition was supported that the limitation of ISO 9000 can be overcome by putting it in the context of TQM.

7.2.4 Suitable approaches for companies at each stage

For companies in the low O-T position, the best approaches could not be statistically identified. However, it was suggested that the companies in this group should aim to enhance their organizational-technological positions in order to realize substantial benefits from any management approaches. As for the companies in the medium and high O-T positions,. the best approaches appear to be TQM, or a combination of TQM and ISO 9000. These two groups of companies possess sufficient infrastructure which enabled them to gain meaningful advantages from quality management systems. Although the companies at stage 2 presented no distinct organizational-technological pattern, they should be able to move to higher O-T positions under the direction of such integrated management practices.

On the choice between adopting TQM or BOTH (TQM and ISO 9000), it was suggested that both TQM and ISO 9000 would be necessary for a company to survive in the global marketplace. Despite the potential of ISO 9000 for disrupting the path of organizational and technological development, it is needed for gaining acceptance in international trade. Therefore, companies should search for the best way to unite the two systems in order to achieve sustainable competitive advantages.

7.3 Conclusions: Qualitative Multiple Case Analyses

The qualitative multiple case analyses consist of investigation of four manufacturing companies in Thailand and three in Japan. To provide a link with the quantitative analyses, the companies could be classified into different stages as follows.

For the Thai cases, company A is in the high organizational-technological position according to its scores in the survey. The findings from the case study also revealed that it placed great significance on both hardware and people. Its adoption of TQM results in a well-balanced socio-technical status and leading performance. The company later pursued ISO 9000 registration as it was aiming to expand to export markets. Its motivation for pursuing registration was to enhance the competitive edge, and ISO 9000 registration was seen as reasonably important to its survival. The registration efforts were mostly in-house with little external help. The company could pursue ISO 9000 on its own through its continuous accumulation of knowledge.

Company B is in the medium organizational-technological position (stage 2). When it was first established, the company sought ISO 9000 certification to gain marketing advantage for its export strategy. It is now aiming to introduce total quality management in order to sustain competitiveness. With the adoption of such integrated management practices, the company has a tendency to move to a higher status.

Companies C and D are in the low organizational-technological position. They do not place emphasis on either dimension as reflected in their lack of strategy. One of them has attempted to introduce bottom-up activities, but finally gave up as it failed to achieve substantial benefits. This agrees with the findings obtained from the quantitative analyses that the low O-T companies lack sufficient infrastructure or supporting organization which enables them to attain benefits from quality practices.

As for the Japanese companies E, F, and G, they are in the high organizational-technological positions. These companies can be regarded as world-class as evidenced by their achievements in winning the Deming Prize and other performance measures. In terms of organizational learning, it was found that Japanese organizations were not only capable of continuous process learning, but they were also effectively learning about product innovation through their R&D commitment. These companies also extend their learning culture to external organizations including customers, suppliers, and other significant affiliations.

7.4 Critical Success Factors for the Adoption of Quality Management

An important objective of this study is to suggest a framework for the transfer of quality practices which can be used by Thai industries to gain sustainable competitive advantage. As numerous practices have already been proposed in the literature, this research will not add another terminology just to confuse the practitioners. Rather, it is preferable to find the common theme behind those world-class practices, suggest the critical issues in their adoption, and test them against the findings from the research.

The underlying philosophy behind most world-class practices is that competitiveness can be achieved through harmonization between organizational and technological developments. As a comprehensive management innovation, TQM has been confirmed in this study to be one of the approaches which balance the dimensions of organization and technology. According to the study, TQM elements have been adopted by many companies, but the ones that are most successful seem to be those which can create the organizational culture conducive to learning and change. This 'right' culture is commonly cited in the literature, and is also suitable for Thai companies. It consists of the following factors.

7.4.1 Top management commitment

The importance of top management commitment has been widely cited by academicians and practitioners. Top management must be motivated and understand the need for change in order to create an appropriate strategy. Depending on the competitive setting, each industry has different critical success factors, and a company must choose a strategy suitable for its competitive environment and its own strengths. In all the successful companies under study, leadership quality has been one of the differentiating factors. Through its vision and power, top management can provide resources, recognition, and other organizational means to achieve the company strategy. In the Thai situation, top management commitment is very important because the large communication gap between management and lower-level employees tends to limit improvement initiatives. As communication tends to be top-down only, top management must show their strong commitment so that employees feel confident to try the new initiatives.

7.4.2 Effective communication

Perhaps second in importance to Thai companies is effective communication which must be facilitated in all three directions (top-down, bottom-up, and cross-functional). Top down communication is important in carrying management strategy to lower levels. Bottom-up communication is necessary to overcome the effects of large hierarchical gaps in the Thai culture. In particular, it is needed to secure worker participation and to foster a participative climate for employees.

Cross-functional integration is also necessary to reduce the effects of strong collectivism which lead to interdepartmental conflict. All departments need some kind of formal communication channels so that they can work toward common goals. Communication must also extend to external organizations such as suppliers and customers. Supplier coordination was found to be a differentiating factor in the best companies in the Thai case studies.

7.4.3 Human resource capabilities

Another important factor to the success of the best companies under study is human resource capabilities. It is important that companies should institute a climate which encourages their members to learn and develop their full potential. "Jop-hopping" is very common in Thai business. It has been found that the best Thai companies actively invest in human resource development even if the risk of losing employees through job turnover is high. The training efforts are repaid through the relatively lower turnover rate, and by the competent employees who can perform continuous improvement activities.

7.4.4 Employee involvement

Company-wide employee involvement is crucial to the success of any organizational efforts. Although its importance seems to be a matter of common sense, total employee involvement is not easily achieved. As reflected in the case studies as well as in the literature, an organization needs a set of common goals which must be effectively communicated in order to win everyone's participation. Such common goals are needed to sustain the momentum for improvement. For example, the goal could be to acquire an ISO 9000 certificate, or to win a national quality recognition.

7.4.5 Continuous improvement of product and process

In the Thai situation, continuous improvement can only be effectively realized after the other factors in Section 6.4.1-6.4.4 have been achieved. This is because continuous improvement activities need to be performed at the operating level which tends to be affected by cultural characteristics as stated earlier. Thus there is a need to prepare the groundwork.

As incremental improvements require considerable expertise at the lower levels, education and training must be provided to employees. During the improvement process, employees keep on learning and accumulating expertise. Therefore, continuous improvements can eventually result in a major innovation. In fact, it has been suggested by researchers and practitioners that the best approach to competitive progress is to adopt an incremental approach until a breakthrough occurs (Hayes and Wheelwright, 1984; Allender, 1994).

In summary, these factors are necessary for successful implementation of quality management practices. They agree with earlier research on organizational learning and core competencies as the sources of competitiveness. In the particular case of TQM, empirical research has been conducted as discussed in Section 2.6.5, which reveals that there are certain tacit features that are the foundation for TQM success, the most notable being executive commitment, open culture, and employee empowerment. The findings of these studies agree with the results obtained from this research.

7.5 Roles of ISO 9000 as a framework for quality model

The role of ISO 9000 in Thai industry should be discussed as it was included in the study due to its increasing popularity as a quality system. In general, ISO 9000 has been useful in establishing documentation and record-keeping practice. In many Thai cases, better documentation would be particularly helpful in dealing with the problems of job hopping. ISO 9000 can be an effective means to mitigate the effects of job turnover as it provides a documentation system which helps retain the knowledge in the organizational structure.

In general, ISO 9000 has brought quality awareness to the Thai companies, but whether it also brings a cultural change in attitudes toward quality is a key question. Under international pressure, ISO 9000 may be transferred to a majority of Thai firms with a low level of understanding and through a simple motivation to satisfy customer requirements. Besides increasing quality awareness, it has not contributed much to initiatives toward quality improvement. From the study, ISO 9000 does not necessarily improve performance, and it has a tendency to disturb the path of organizational-technological development. As it may not bring about cultural change toward quality improvement, the potential of ISO 9000 as a foundation for continuous improvement is greatly reduced.

As reflected in the study, ISO 9000 may be used as a framework for quality improvement if it is incorporated with TQM. Under the context of TQM, ISO 9000 can serve as a powerful tool for the documentation system. However, there is very little empirical work being published on transitions between ISO 9000 and TQM implementation, and further research in this area would be useful.

7.6 Evolution of Thai companies toward quality management

As suggested from the study, the companies could be classified into three levels of organizational-technological (O-T) position which are characterized by the organizational-technological developments and the adoption of quality practices.

7.6.1 Low O-T positioned companies

The companies in the low O-T position generally lack business experience and knowledge. Some of them are also faced with financial and human resource limitations. Their management has no awareness of quality as a management tool. They may adopt certain tools which are in vogue, but without genuine understanding of the purposes.

Due to the inadequate emphasis on organization and technology, the companies at this stage are not likely to reap full benefits from quality practices. However, certain practices may be useful in situations where companies are influenced by undesirable cultural values.

In particular, due to the lack of an established set of practices, the organizational culture may be highly influenced by certain national traits. For example, although Thai workers are found to be hard working, easily trained, energetic and have an entrepreneurial spirit [Wong, 1995], they are also seen as lacking in discipline, "They create fun by horse-playing with their fellow workers, they seek convenience by short-cutting work procedures; and they enjoy comfort by working as necessary and no more" [Tansuwan, 1993]. This lack of discipline may be overcome by establishing working practices as adopted from the Japanese bottom-up activities: 5s, suggestion systems, and small group activities. These tools help eliminate undesirable behaviors, improve the working environment, increase worker morale, and encourage a teamwork spirit.

The tools for bottom-up activities may be useful as a starting point for improvement, and their effects may accumulate into a higher organizational-technological status. As evidenced from one of the Thai companies under study, bottom-up activities failed due to the lack of management support. Therefore, the most critical factor to ensure success at this stage is top management who must provide proper education, and make certain that employee contributions are properly utilized and recognized.

7.6.2 Medium O-T positioned companies

The companies in this group generally possess greater technological and organizational capabilities than the companies in the first stage. In terms of quality management, these companies are characterized by greater management understanding and motivation toward quality. Top management tends to take a long-range view rather than operational control toward competitiveness. By adopting a more strategic view toward quality, quality improvement efforts become more concrete as reflected in the adoption of higher-level management principles.

According to the studies, these companies can gain useful benefits from quality management. The extent of benefits depends, obviously, on the effectiveness of the transfer of management practices and the organizational capabilities accumulated within the firm.

From the study, the most suitable approaches for this group of companies are: TQM, or TQM and ISO 9000. As reflected in one of the companies under study, the implementation of ISO 9000 will be more fruitful if accompanied by TQM. However, if adopted on its own, ISO 9000 has a tendency to disturb the company's operation at least in the beginning. While the long-term effects have yet to be studied, companies need to be aware of this possible negative effect so that they are prepared to deal with it.

7.6.3 High O-T positioned companies

The companies in this stage generally place great emphasis on organizational and technological developments. They have the infrastructures which enable them to gain meaningful benefits from quality management leading to competitiveness. This agrees with the notion of core competencies or tacit resources that are accredited by many authors to be the sources of competitiveness.

As stated in the literature review, these complementary resources have been accumulated through organizational learning and reside within the employees, in the organization's technology, and in organizational structure including documents and standard operating procedures. Through this, organizational adaptation and technological innovation can evolve in a natural progression. That is, organizational growth stimulates technological advances, and adoption of modern technology will be met with compatible organizational adaptation.

Most companies in this group adopt integrated management practices like TQM, which generally involves the management and coordination of quality improvement across the entire organization. Company-wide education has resulted in employee understanding and involvement at all levels toward TQM. Some of the companies in this group progress toward integrating quality with strategic planning by adopting the approach of policy management (Hoshin Kanri) as used by many successful Japanese organizations.

7.7 Comparison with other models

The three stages of quality management evolution for the Thai industry as proposed in this study can be compared with other models cited in Section 2.10.5. Table 6.1 displays the comparison.

Table 7.1 Comparison among various models of evolution of quality management (adapted from Calingo (1996))

	Low O-T (stage 1)		Medium O-T (stage 2)	High O-T (stage 3)	
Crosby's: quality management maturity grid	*Uncertainty.* No quality activities. No understanding of quality activities	*Awakening.* Trying motivational short-range efforts	*Enlightenment.* Formal quality improvement program	*Wisdom.* More effective quality improvement program.	*Certainty.* Quality improvement is a normal and continued activity.
Calingo's: strategy-quality integration	*Annual budgeting* No specific quality values	*Long-range planning.* Product reliability. Zero defects	*Strategic quality planning.* Quality focus on business process.	*Management by quality.* Quality is in the fabric of the business.	*Strategic quality management.* Quality as excellence in execution
Williams and Bertsch: quality maturity		*Top management consensus.* Top management wholeheartedly embraces TQM.	*Company-wide education.* *Problem solving.*	*Quality improvement management.* Coordination of the quality improvement process across the entire organization.	*Total control.* Integration of quality management and business strategy
Gluck et al.: evolution of strategic management	*Basic financial planning.* Operational control.	*Forecast-based planning.* More effective planning for growth	*Externally-oriented planning* Increasing response to markets and competition		*Strategic management.* Orchestration of all resources to create competitive edge.
Quinn and Cameron: organizational life	*Entrepreneurial.* Non-bureaucratic *Collectivity* Pre-bureaucratic	*Formalization and control.* Bureaucratic	*Elaboration of structure.* Very bureaucratic.		

The low O-T stage is equivalent to the uncertainty and awakening stages according to Crosby's model. However, most low O-T companies in this study would be classified as awakening as they generally implement some types of management tools. This is because the study focused mainly on the companies interested in quality management. Although there may be a lot more companies in the uncertainty stages, they are not particularly covered in this study.

The companies in the medium O-T stage may be classified enlightened according to Crosby. These companies have started to implement a formal quality improvement program, and the most popular one in this study seems to be ISO 9000. Through seeking registration, they gain better appreciation of quality as a critical success factor. The companies which seek to attain ISO 9000 certification prior to TQM tend to be placed in this group.

The companies in the high O-T group may be put in the stages of wisdom and certainty according to Crosby's maturity grid. In this study, it is not possible to classify the companies to this level of detail as the survey cannot fully reveal detailed characteristics. However, deeper aspects can be disclosed from the case studies of the seven companies. Based on the cases, the best Thai company can be classified as being in the wisdom stage in transition to the certainty stage, and all the Japanese companies can be placed in the certainty stage. There are only a few companies in the certainty stage as it is difficult to attain. Those companies tend to be the winners of the different national quality awards as seen in the Japanese case studies.

7.8 Framework for the Transfer of quality management

Based on the stages of organizational-technological development, it can be seen that the higher the O-T level, the more benefits a company can obtain from management practices. In fact, successful adoption of quality management depends on the effectiveness of transfer of management innovation which is related to the progression along different stages of organizational-technological development.

In general, the transfer of management innovation can be divided into three forms: principles, organizational vehicles, and tools [Lillrank, 1995]. Management principles are related to the paradigms and specify some success factors. They can be formulated into strategies when applied to specific organizations and situations. Organizational vehicles refer to the structures that are required for implementing a strategy. The transfer of organizational vehicles is very complex and requires careful adaptation to the local environment. Management tools are straightforward techniques such as statistical process control and problem-solving techniques. They are easiest to implement and can be applied in a variety of organizational settings.

As viewed in this context, the progression of organizational-technological development for the Thai companies depends on the levels of management transfer and their effectiveness as shown in Figure 7.1.

According to Figure 7.1, the companies in the low O-T stage tend to transfer only management tools such as statistical process control, suggestion systems and quality control circles. Although these tools can be easily adopted and require minimal organizational adaptation, their effects are quite limited to operational results. To achieve the full benefits, such management tools need organizational support which tends to be insufficient in this group of companies. Thus they fail to acquire full advantages from most management practices. .

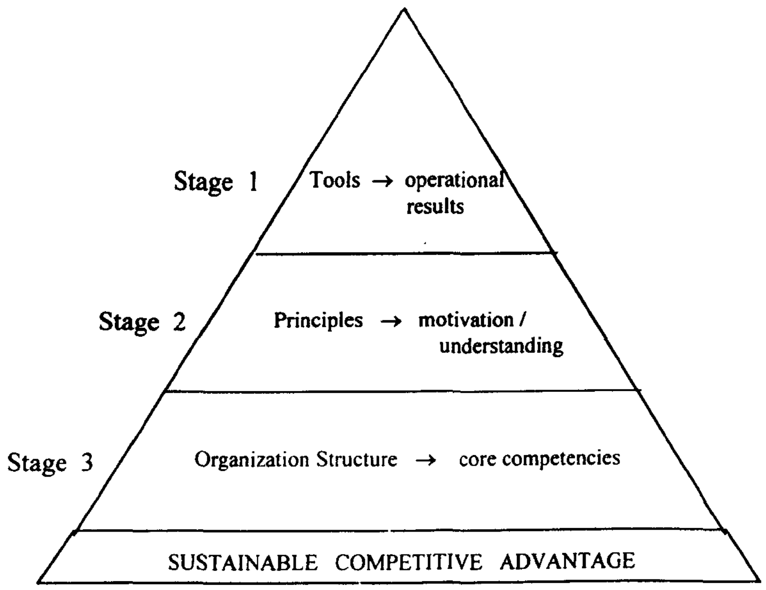

Figure 7.1 Framework for the transfer of quality management

For companies in the medium O-T stage, the transfer involves both tools and management principles. The adoption of management principles leads to better understanding and motivation that, in turn, result in commitment at management level.

This ensures necessary organizational support such as resource allocation, training of personnel, and the climate favorable to quality improvement. Therefore, effective tool use is promoted, and the companies are able to enjoy greater benefit from quality management. At the end of this stage, the company should be able to secure organizational commitment which helps in transition to the higher stage.

Finally, companies in the high O-T stage are those that can effectively transfer management tools, management principles, and organizational structure. Organization structure is defined as the established pattern of relationships between the components or parts of an organization that distinguishes and delineates the relationship between them, outlining the communication, control and authority patterns (Kast and Rosenzweig, 1979; Wilson and Rosenfield, 1990). As a result of adopting an appropriate organizational structure, the organizational system will be designed to support employee initiatives and organizational learning, thus cultivating a culture conducive to quality improvement. This eventually accumulates to core competencies and complementary resources that are the basis for organizational/technological innovation. The companies which have progressed to this stage will achieve sustainable competitive edge, and also gain maximum advantage from management approaches.

What this investigation has emphasized in the adoption of management practices is that companies should not only adopt tools and understand management principles, they should also try to create a culture that accommodates these philosophies. In essence, management principles, organizational vehicles, and tools are complementary to each other, and the achievement of all three will lead to sustainable competitive advantage.

Summary

A main purpose of this study was to create a model for the transfer of management innovation by studying the evolution of quality within Thai manufacturing industry.

First of all, a survey of 53 Thai manufacturing companies that are interested in or adopting quality management was conducted. Based on two popular management practices (TQM and ISO 9000), three hypotheses were tested regarding their impacts on performance: (1) companies adopting TQM exhibit better performance than those without quality systems, (2) the level of performance of companies with ISO 9000 certificates is lower than or equal to that of companies adopting TQM, and (3) the level of performance of companies with TQM and ISO 9000 is higher than that of companies adopting only ISO 9000.

The three hypotheses were tested by adopting a diagram that displays the relationship between organizational and technological development (O-T map), and using analysis of variance techniques. It was found that all the three hypotheses were supported. Besides identifying the appropriate management practices for the Thai industries, the results also help identify the evolution of quality management within the Thai manufacturing industries.

To validate the findings and conduct further analysis, a qualitative study was carried out by adopting a multiple case study approach. Seven manufacturing companies in Thailand and Japan were investigated in terms of their performance, adoption of management innovation, and the critical factors to successful adoption. The results of the analyses strengthened the hypotheses tested in the quantitative survey regarding TQM and ISO 9000, and highlighted the various stages in the evolution of quality management.

Finally, a model for the transfer of management innovation was created based on the findings from the quantitative survey and the qualitative case studies. It is suggested that the transfer of management innovation involves three levels from low to high: (1) the transfer of tools and techniques, (2) the transfer of management principles, and (3) the transfer of organizational structure and culture. The higher the level of transfer, the more benefits a company can obtain from quality management.

The findings emphasized that companies should attempt to create a culture that accommodates the tools and management principles in order to enjoy sustainable competitive advantage.

References

Aaker, D.A., 'Managing assets and skills: the key to a sustainable competitive advantage', California Management Review, Vol. 31, No. 2, 1989, pp. 91-106

Abair, R.A., 'Agile manfuacturing: this is not just repackaging of material requirements planning and just-in-time', Proceedings of the 1995 38th APICA International Conference and Exhibition, 1995, pp. 196-198

Ahire, S.L., Waller, M.A. and Golhar, D.Y. "Quality management in TQM versus non-TQM firms: an empirical investigation", International Journal of Quality and Reliability Management, Vol. 13 No. 8, 1996, pp. 8-27

Alexandru, A. and Branici, V., 'Development of an integrated quality assurance system for manufacturing industries', IEEE Symposium on Emerging Technologies & Factory Automation, Vol. 1, 1995, pp. 611-618

Allender, H.D. "Is Reengineering Compatible with Total Quality Management?", Industrial Engineering, volume 26, number 9, September 1994, pp 45-46

Alvesson, M. 'Organizations as Rhetoric: knowledge-intensive firms and the struggle with ambiguity', Journal of Management Studies, Vol. 30 No. 6, 1993 pp. 997-1015

Akhilesh, K.B.and MadanMohan, TR., 'Organizational preparedness', IEEE International Engineering Management Conference, 1993, pp. 143-144

Amoako-Gyampah, K. and Meredith, J.R. "The operations management research agenda: An update" Journal of Operations Management, Vol. 8 ,1989 pp. 250-262

Aravindan, P., Devadasan, S.R. and Selladurai, V., 'A focused system model for strategic quality management', International Journal of Quality and Reliability Management, Vol. 13, No. 8, 1996, pp. 79-96

Argote, L. "Organizational learning curves: persistence, transfer and turnover" International Journal of Technology Management, Vol 11, No.7/8, 1996, pp. 759-769

Atwater, J.B. and Discenza, R., "ISO 9000: implications for US business", 1993 Proceedings, Decision Sciences Institute, Vol. 3, 1993, pp. 1784-6

Baillie, A.S. "Education, the Foundation of the Japanese Productive System?" Japanese Management: Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982, pp. 199-211

Badri, M.A., Davis, Donald and Davis, Donna, "A study of measuring the critical factors of quality management", International Journal of Quality and Reliability Management, Vol. 12, No. 2, 1995. pp. 36-53

Balan, S. Manufacturing Technology Management: Key Issues in the Adoption, Implementation and Evaluation of Advanced Manufacturing Technology. Ph.D. Thesis University of Canterbury, New Zealand, 1994

Bank, J. The Essence of Total Quality Management, Prentice Hall: London 1992

References

Belohlav, J.A., 'Quality, strategy, and competitiveness', California Management Review, Vol. 35, No. 3, 1993, pp. 55-67

Bendell, T, Boulter, L. and Kelly, J. Benchmarking for Competitive Advantage. Pitman Publilshing: London, 1993

Bessant, J. Organizational adaptation and advanced manufacturing, in Proceedings of the Final IIASA Conference on Computer Integrated Manufacturing: "Technology, Organization and People in transition", Austria, 1990, pp. 349-360

Bessant, J., Managing Advanced Manufacturing Technology: The Challenge of the Fifth waves, NCC Blackwell, 1991

Bessant, J. 'The lessons of failure: learning to manage new manufacturing technology', International Journal of Technology Management, Vol. 8, No. 3/4/5, 1993 pp.197-215

Bettes, D., 'Moving from ISO 9000 towards total quality', Quality World, Vol.21, No.9, 1995, pp.610-613

Bettis, R.A. and Hall, W.K., 'Strategic Portfolio Management in the Multibusiness Firm', California Management Review, Fall 1981, pp. 23-38

Bhote, K.R. Strategic Supply Management. New York: American Management Association, 1989

Billesbach, T. J., 'Applying lean production principles to a process facility', Production and Inventory Management Journal, Third Quarter, Vol.35, No.3, 1995, pp.40-44

Binney, G., Making Quality Work: Lessons from Europe's Leading Companies, The Economist Intelligence Unit. Special Report No. P655, Ashridge, 1992

Black, S.A. "Measuring the critical factors of total quality management", University of Bradford, Unpublished PhD thesis, 1993

Blackler, F. 'Knowledge and the theory of organizations' Journal of Management Studies. Vol. 30 No. 6, 1993 pp. 861-884

Blackler, F. 'Knowledge, knowledge work and organizations: an overview and interpretation', Organization Studies, Vol. 16, No. 6, 1995, pp. 1021-1046

Blume, M.E. " The Financial markets" Britain's Economic Performance. Edited by Caves, R. and Krause, L. Brockings, Washington, 1980

Boer, H., 'Flexible manufacturing systems', New Wave Manufacturing, edited by John Storey, Paul Chapman Publishing, 1994, pp. 80-102

Bowonder, B. and Miyake, T. 'Japanese innovations in advanced technologies : and analysis of functional integration', International Journal of Technology Management, Vol. 8, No. 1/2, 1993, pp. 135-156

Bowonder, B. and Miyake, T. 'Creating and sustaining competitiveness: an analysis of the Japanese robotics industry' Int. J. Technology Management, Vol. 9, Nos5/6/7, 1994

References

Boxwell, R.J. Benchmarking for Competitive Advantage. McGraw Hill, 1994

Braverman, H. Labor and Monopoly Capital: The Degradation of Work in the Twentieth Century, Monthly Review Press, New York, 1974

Bright, J.R. Automation and Management, Division of Research, Harvard Business School, Boston, 1958

Buzzell, R.D. and Gale, B.T., The PIMS Principles: linking strategy to performance. The Free Press, 1987

Calingo, L.M.R. "The evolution of strategic quality management", International Journal of Quality and Reliability Management Vol. 13, No. 9, 1996, pp. 19-37

Calkins, J.A. and Cooper, M.H.I., 'Stop the insanity! Manufacturers get lean!', Proceedings of the 1997 40th International Conference and Exhibition, pp. 536-539

Cardone, R.J., "Achieving world-class manufacturing", Business and Economic Review, Vol 40, Issue 1, October-December 1993, pp. 31-32

Carty, L., 'Integrating elements of reengineering within a total quality management framework', Northcon Conference Record, 1995, pp. 195-199

Castle, J.A., 'Integrated model in quality management, positioning TQM, BPR, and ISO 9000', TQM Magazine, Vol. 8, No. 5, 1996, pp. 7-13

Chang, C.S. "Individualism in the Japanese Management System" in Japanese Management : Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982 pp. 82-88

Chase, R.B. "A classification and evaluation of research in operations management" Journal of Operations Management, Vol. 1, 1980, pp. 9-14

Christensen, R., Analysis of Variance, Design and Regression. Chapman & Hall, 1996

Clark, K.B., and Fujimoto, T. Product Development Performance: Strategy, Organization and Management in the world auto industry. Harvard Business School Press, Boston, 1991

Coates, D. 'Putting core competency thinking into practice', International Journal of Technology Management, Vol. 11, No.3 /4, 1996, pp. 441-451

Cole, R.E. "Learning from the Japanese: Prospects and Pitfalls", Management Review, Vol. 69, No. 9, September 1980, pp 22-28

Corbett, C. and Wessenhove, L.V., 'Trade-offs? What trade-offs? Competence and competitiveness in manufacturing strategy', California Management Review, Vol. 35, No. 4, 1993, pp. 107-122

Corrigan, J.P., ' Is ISO 9000 the path to TQM?', Quality Progress, May 1994, pp. 33-6

Corsten, H. and Will T. 'Integrated production concepts- structural reasons for superior competitive performance' Management International Review, Vol. 35, No. 1, 1995 pp. 69-88

Crosby, P. B. Quality is free: the art of making quality certain. McGraw Hill: New York, 1979

Crosby, P.B., 'Quality management in emerging nations', Productivity, Vol. 32, No.3, 1991, pp. 415-420

Cummings, L. L. "Needed research in production/operations management: A behavioral perspective" Academy of Management Review, Vol. 2, 1977, pp 500-504

Cupello, J.M., "A new paradigm for measuring TQM progress", Quality Progress, May 1994, pp. 79-82

Cutcher-Gershenfeld, J., Nitta, M., Barrett, B., Belhedi, N., Bullard, J., Courchie, C., Inaba, T., Ishino, I., Lee, S., Lin, W., Mothersell, W., Rabine, S., Ramanand, S., Strolle, M., Wheaton, A., 'Japanese Team-based Work Systems in North America: Explaining the Diversity", California Management Review, Vol. 37, No.1, Fall 1994. pp. 42-64

Daft, R.L. Organization Theory and Design, Third Edition, West Publishing Company, 1989

Dale, B.G., Boaden, R.F., Wilcox, M.and McQuater, "Sustaining total quality management: what are the key issues?", The TQM magazine, Vol. 9, No. 5, 1997, pp. 372-380

Davis, L.W. and Taylor, J.C., 'Technology, organization , and job structure', in Handbook of work, organization, and society, edited by R. Dubin, Rand McNally: Chicago, 1976

Dawson, P., 'Total quality management', New Wave Manufacturing, edited by John Storey, Paul Chapman Publishing, 1994, pp.103-121

de Vaus, D.A., Surveys in Social Research, 2nd edition. London: Unwin Hyman,1990

Dean, J.W. and Snell, S.A. "Integrated manufacturing and job design: moderating effects of organizational inertia" Academy of Management Journal, 34, 1991, pp. 776-804

Deming, W.E., Out of the Crisis: Quality, Productivity and Competitive Position. Cambridge: Cambridge University Press, 1986

Dixon, B.R., Bouma, G.D. and Atkinson, G.B.J. A Handbook of social science research. Oxford University Press, 1988

Dixon, J.R., Nanni, A.J. and Vollmann, T.E. The new performance challenge- measuring operations for world-class challenge. Dow Jones-Irwin, Homewood, IL. 1990

Dodgson, M. "Organizational learning: a review of some literatures", Organization Studies, Vol. 14 No. 3, 1993, pp. 375-94

Drucker, P.F. "What can we learn from Japanese management" Harvard Business Review, Vol. 49, No. 2, 1971, pp 110-22

References

Duffin, M., "Some thoughts on the dimensional evolution of producing organizations", The TQM magazine, Vol. 9, No. 5, 1997 pp. 322-323

Dunstan, I., "International defence", European Quality, June 1993, pp.51-3

Dusharme, D., "European Commission Wants Companies to Rethink ISO 9000's Use." Quality Digest, August, 1995

Elmuti, D. and Kathawala, Y., "An Investigation into the Effects of ISO 9000 on Participants' Attitudes and Job Performance", Production and Inventory Management Journal, second quarter, 1997, p. 52-57

Elzinga, D.J., Horak, T., Lee, C.Y. and Bruner, C., 'Business process management: survey and methodology', IEEE Transactions on Engineering Management, Vol. 42, No.2, 1995, pp. 119-128

Ettlie, J.E. Taking Charge of manufacturing : How companies are combining technological and organizational innovations to compete successfully, Jossey-Bass Publishers, San Francisco, 1988.

Ferguson, W., "The voluntary standard that is now mandatory", Industrial Management, Vol. 36 No. 5, September/October 1994, pp. 22-4

Feigenbaum, A.V., Total Quality Control, 3rd Edition. New York: McGraw Hill, 1983

Filippini, R., "Operations management research: some reflections on evolution, models and empirical studies in OM", International Journal of Operations & Production Management, Vol. 17 No. 7, 1997, pp. 655-670

Fiol, C.M. and Lyles, M.A., 'Organizational learning', Academy of Management Review, October, 1985

Flynn, B.B., Schroeder, R.G., Flynn, E.J., Sakakibara, S., and Bates, K.A. "World-class manufacturing project: overview and selected results", International Journal of Operations & Productions Management, Vol. 17 No. 7, 1997, pp. 671-685

Flynn, D.M. "Japanese Values and Management Processes" in Japanese Management : Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982 pp. 72-81

French, G. and Eltringham, D., 'Experiences of introducing ISO 9000 and total quality management in U.K. shipbuilding and ship repairing', Journal of Ship Production, Vol.11, No.3, 1995, pp.196-202

Frick, J., Gertsen, F., Hansen, P.H.K., Riis, J., and Sun, H., 'Evolutionary, CIM Implementation-An empirical study of technological-organizational development and market dynamics, Computer Integrated Manufacturing', in Proceedings of the Eighth CIM-Europe Annual Conference, 27-29 May 1992. Birmingham, U.K., edited by C. O'Brien, MacConaill and W.V. Puymbroeck, Springer-Verlag, London

Garrahan, P. and Stewart, P., 'Work organizations in transition: the human resource management implications of the 'Nisson Way'', Human Resource Management Journal, Vol. 2, No.2 , 1991, pp. 46-62

Garvin, D.A., 'Quality on the line', Harvard Business Review, Vol. 61, No. 5, 1983, pp.65-75

Garvin, D.A., 'Building a learning organization', Harvard Business Review, Vol 71, No. 4, 1993, pp. 78-91

Gluck, F.W., Kaufman, S.P. and Walleck, A.S., 'Strategic management for competitive advantage', Harvard Business Review, Vol. 58, No. 4, 1980, pp. 154-161

Goffin, K. and Szwejczewski, M., 'Is management commitment to quality just 'a given'?', TQM Magazine, Vol. 8, No.2, 1996, pp. 26-31

Goldhar, J.D. and Lei, D., 'Organizing and managing the CIM/FMS firm for maximum competitive advantage', International Journal of Technology Management, Vol. 9, Nos. 5/6/7, 1994, pp. 709-732

Grant, R.M., 'The resource-based theory of competitive advantage: implication for strategy formulation, California Management Review, Vol. 33, No. 3, 1991, pp. 114-135

Gronstedt, A., 'How communications support TQM', Annual Quality Congress Transactions, 1996, pp. 496-503

Gunn, T.G., 21st Century Manufacturing : Creating Winning Business Performance, Oliver Wight Publications, Inc., 1992, pp 191-225

Hamilton, L.C. Modern Data Analysis : A first course in Applied Statistics, Brooks/Cole Publishing Company: California,1990

Harber, D, Burgess, K., and Barclay, D., "Total Quality Management as a Cultural Intervention: An Empirical Study", International Journal of Quality & Reliability Management, Vol. 10, No. 6, 1993, pp. 28-46

Harrison, A., 'Just-in-time manufacturing', in New Wave Manufacturing, edited by John Storey, Paul Chapman Publishing, 1994, pp. 175-203

Harrington, H.J., 'National Traits in TQM principles and practices', TQM Magazine, Vol. 8, No. 4, 1996, pp. 49-54

Hass, E.A., "Breakthrough Management", Harvard Business Review, March-April, 1987, pp. 75-81

Hattori, I., "A Proposition on Efficient Decision-Making in the Japanese Corporation" Columbia Journal of World Business, 1978, pp 7-15

Hatvany, N. and Pucik, V. "Japanese management practices and productivity" Organizational Dynamics, Vol.9, No. 4, 1981, pp 4-21

Haug, P. " An empirical investigation of ISO 9000 quality standards, registration process, and competitive effects", 1994 Proceedings, Decision Sciences Institute, Vol. 3, 1994, pp. 1954

Hauser, J.R. and Clausing, D., 'The house of quality', Harvard Business Review, May-June 1988, pp. 63-73

Hayes, R.H and Jaikumar, R. 'Manufacturing's crisis: new technologies, obsolete organizations', Harvard Business Review, Vol. 66, 1988, pp.77-85

Hayes, R.H. and Wheelwright, S.C. Restoring Our Competitive Edge: Competing Through Manufacturing. John Wiley and Sons: New York, 1984

Hazell, M. and Morrow, M., 'Performance measurement and benchmarking', Management Accounting, December 1992, pp. 44-45

Heredia, J.A., Fan, I.S., Romero, F. and Rosado, P., 'Framework for an integrated quality system', Journal of Materials Processing Technology, Vol. 61, No. 1-2, 1996, pp. 195-200

Hewitt, S., 'An investigation into the use of the Business Excellence Model in small businesses in the U.K.', Ph.D. Thesis, University of the West of England, Bristol, September, 1998

Hill, S., 'From qualitiy circles to total quality management', in Making quality critical: new perspectives on organizational change, edited by A. Wilkinson and H. Willmott, Routledge: London, 1995, pp. 33-53

Hitoshi, C, Ryuko, I. and Osamu, S. 'Salaryman today and into tomorrow', Look Japan, May 1997

Hofferr, G., Moran J., Nadler, G. Breakthrough Thinking in TQM, Prentice Hall, 1993

Hofstede, G. Culture's Consequences: International Differences in Work-Related Values. Beverly Hills, CA: Sage Publishers, 1980

Hogg, R.V, 'A quality journey', Total Quality Management, Vol. 4, No. 2, 1993, pp. 195-214

Holmes and Tangtongtavy *Working with the Thais*, White Lotus, Thailand, 1995

Hom S.K.M., "Is the ISO 9000 series for total quality management?", International Journal of Quality & Reliability Management, Vol. 11, No. 9, 1994, pp.74-89

Horvath, D. and Mcmillan, C. "Industrial Planning in Japan" California Management Review, Vol. 23 No. 1, 1980, pp 11-21

Huber, G.P. "Organizational learning: a guide for executives in technology-critical organizations" International Journal of Technology Management, Vol.11, No. 7/8, 1996, pp. 821-832

Huczynski, A. A. and Buchanan, D.A. Organizational Behaviour: An Introductory Text, 2nd Edition Prentice Hall, 1991

Hutchins, G., "ISO 9000 offers a global mark of excellence", Public Utilities Fortnightly, Vol. 131 No. 8, 15 April 1993, pp. 35-6

Ishikawa, K. What is total quality control? The Japanese Way. Translated by David J.Lu Prentice Hall, 1985

Imai, M., Kaizen-the Key to Japan's Competitive Success, Random House, New York, 1986

Jacobs, D.A. and Clemson, B., 'TQM and CIM can work together', Engineering Management Journal, Vol. 6, No. 2, 1994, pp. 31-39 (BIDS)

Johnston, R. and Lawrence, P.R., 'Beyond vertical integration- the rise of the value-adding partnership', Harvard Business Review, July-August, 1988, pp.94-104

Jones, B. 'Technological convergence and limits to managerial control: flexible manufacturing systems in Britain, the USA, and Japan" in The Power to Manage?: employees and industrial relations in comparative-historical perspective. Edited by S. Tolliday and J. Zeitlin. Routleadge: London, 1991 pp. 231-255

Jordan, D.W., 'Using the Baldrige criteria for self assessment', Engineering Management Journal, Vol. 6, No.2, 1994, pp. 16-19

Juliard, P. "Lean manufacturing: a process for all seasons", Proceedings of the Electrical/Electronics Insulation Conference, 1997, pp. 849-851

Juran, J., Juran on Quality by Design. Free Press: New York, 1992

Kast, F.E. and Rosenzweig, J.E., Organization and Management: a systems and contingency approach, 3rd Edition. McGraw Hill, 1979

Kagono, T., Nonaka, I., Okumura, A., Sakakibara, K., Komatsu,Y., and Sakashita, A., 'Mechanistic vs. Organic management systems : A comparative study of adaptive patterns of American and Japanese firms' The Anatomy of Japanese Business. Edited by K. Sato, and Y. Hoshino, New York: M.E. Sharpe, 1984 pp. 27-69

Kano, N., 'A perspective on quality activities in American firms', California Management Review, Vol. 35, No. 3, 1993, pp. 12-31

Kano, N. and Koura, K. 'Development of Quality Control Seen Through Companies Awarded the Deming Prize', Report of Statistical Application Research, JUSE , V. 37, No. 1-2, 1990-91, pp 79-105

Kaplan, R.S. and Norton, D.P. 'Putting the balanced scorecard to work' HBR, September-October 1993, pp. 134-147

Karnoe, P. 'The social process of competence building' International Journal of Technology Management Vol. 11, No. 7/8, 1996, pp. 770-789

Keppel, G. Design and analysis : a researcher's handbook. Prentice Hall, 1973

Kerfoot, D. and Knights, D., 'Empowering the 'quality worker'?: the seduction and contradiction of the total quality phenomenon', in Making Quality Critical: new perspectives on organizational change edited by A. Wilkinson and H. Willmott, London: Routledge, 1995, pp. 219-240

Kirk, R. E. Experimental Design: Procedures for the Behavioral Sciences, 3rd edition Brooks/Cole Publishing Co., 1995

Knott, P., Pearson, A. and Taylor, R., 'A new approach to competence analysis', International Journal of Technology Management, Vol. 11, No.3 /4, 1996, pp. 494-503

Kondo, Y., 'Quality as a source of empowerment', TQM Magazine, Vol. 9, No. 5, 1997, pp. 357-363

Krasachol, L., Willey, P.C.T., and Tannock, J.D.T., 'The progress of quality management in Thailand', The TQM Magazine, Vol. 10, No.1, 1998, pp. 40-44

Krafcik, J. F. 'Triumph of the Lean Production System' Sloan Management Review, Fall 1988 pp 41-52

Laszlo, G.P., "US and Canadian national quality awards: increased emphasis on business results", The TQM Magazine, Vol. 9, No. 5, 1997, pp. 372-380

Lascelles, D.M. and Dale, B.G., 'The use of quality management techniques', Quality Forum, Vol. 16, No.4, 1990, pp. 188-192

Lei, D., Hitt, M.A. and Goldhar, J.D. "Advanced Manufacturing Technology: Organizational Design and Strategic Flexibility" Organization Studies Vol. 17 No.3, 1996, pp. 501-523

Lei, D. and Slocum, J.W., "Global strategy, competence-building and strategic alliances", California Management Review, Vol. 35, No.1, 1992, pp. 81-97

Leo, R.J., 'Is TQM dead? Not having it almost killed Xerox', Annual Quality Congress Transactions, 1996, pp. 485-495

Leonard, J.W. and Thanopoulos, J. " Japanese management: Reasons for Success" Japanese Management : Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982 pp. 139-147

Levitt, B. and March J. ' Organizational learning' American Review of Sociology Vol. 14, 1988, pp. 319-340

Liao, Z., Cheung, M.T. and Lai, Y.L., 'ISO 9000 and its integration with TQM', Proceedings of the 1995 IEEE Annual International Engineering Management Conference, pp.214-217

Liker, J.K., Roitman, D.B, and Roskies, E. 'Changing everything all at once: work life and technological change', Sloan Management Review, Vol. 28, No. 4, 1987, pp. 29-47

Lillrank, P. 'The transfer of management innovations from Japan', Organization Studies, Vol. 16, No. 6, 1995, pp. 971-989

Lo, W.K. "Application of Deming's principles in the management of change-a Hong Kong experience", The TQM magazine, Vol. 9, No. 5, 1997, pp. 336-343

Ma, R. 'Quality System: an integral part of total quality management', Computers and Industrial Engineering, Vol. 31, No. 3/4, 1996, pp. 753-757

Madu, C. N., Kuei C. H. and Jacob, R. A., 'Empirical assessment of the influence of quality dimensions on organizational performance', International Journal of Production Research, Vol.34, No.7, 1996, pp.1943-1962

Maffei, M.J. and Meredith, J., ' The organizational side of flexible manufacturing technology: guidelines for managers', International Journal of Operations & Production Management, Vol. 14, No. 8, 1994, pp. 17-34

Mahesh, S., "Motivation to adopt the ISO 9000 quality standard : a survey of current application", 1994 Proceedings, Decision Sciences Institute, Vol. 3, 1994, pp. 2103-05

Mann, R.S., The Development of a Framework to Assist in the Implementation of Total Quality Management (TQM), Ph.D. Thesis, University of Liverpool, 1992

Mann, R. and Kehoe, D. "An evaluation of the effects of quality improvement activities on business performance", International Journal of Quality & Reliability Management, Vol. 11 No. 4, 1994, pp. 29-44

Marengo, F. D. "Learning from the Japanese: What or How?", Management International Review, Vol. 19, No. 4, 1979, pp 39-46

Maskell, B. 'Performance measures of world class manufacturing', Management Accounting, May 1989, pp. 32-33

Maskell, B. Performance measurement for world-class manufacturing: a model for American companies. Productivity Press: Cambridge (Massachusetts), 1991

McArdle, L., Rowlinson, M., Procter, S., Hassard, J. and Forrester, P., 'Total quality management and participation: employee empowerment, or the enhancement of exploitation?', in Making Quality Critical: new perspectives on organizational change edited by A. Wilkinson and H. Willmott, London: Routledge, 1995, pp. 156-172

McFayden, T. and Walsh, T., "Is ISO 9000 worth the paper it's written on?", Journal of Quality and Participation, Vol. 15 No. 2, 1992, pp. 20-3

McGlothlin, D.H., Hughes, C.W., and Lewis, J.R. , 'Lean manufacturing at McDonnell Douglas Helicopter Systems', Annual Forum Proceedings - American Helicopter Society, 1997, Vol.2, pp.1515-1520

McLoughlin, I. and Clark, J. Technological Change at Work. Open University Press, Milton Keynes, 1988

McMillan, C.J. The Japanese Industrial System. Walter de Gruyter & Co: Berlin 1984

McQuater, R.E., Dale, B.G., Wilcox, M. and Boaden, R.J., 'Effectiveness of quality manageemnt techniques and tools in the continuous improvement process: an examination', IEE Conference Publication, No. 398, 1994, pp. 574-580

Medina, S.P., 'Re-engineering: TQM in a hurry!', Annual Quality Congress Transactions, 1996, pp. 843-852

Meegan, S.T. and Taylor, W.A., "Factors influencing a successful transition from ISO 9000 to TQM: The influence of understanding and motivation", International Journal of Quality & Reliability Management, Vol. 14, No. 2, 1995, p.100 -117

Meredith, J., "Automation strategy must give careful attention to the firm's infrastructure", Industrial Engineering, May 1986, pp. 68-73

Meredith, J., 'Theory Building Through Conceptual Methods', International Journal of Operations & Production Management, Vol. 13, No. 5, 1993, pp. 3-11

Meredith, J.R. and Hill, M.M., 'Justifying new manufacturing systems: a managerial approach', Sloan Mangement Review, Vol. 28, No. 4, 1987, pp. 49-61

Merrill, P. "ISO 9000-life beyond registration", Annual Quality Congress Transactions, 1997, pp. 686-692

Merton, R.K. "The machine, the worker, and the engineer", Science, Vol. 105, 1947, pp. 79-84

Michael, S.R., Luthans, F., Odiorne, G.S., Burke, W.W. and Hayden, S. Techniques of Organizational Change. McGraw-Hill 1981

Miles, R. and Snow, C.C. "Network organizations: New concepts for new firms" California Management Review Vol. 28, 1986, pp. 62-73

Miller, D.J., 'Managing technology change in manufacturing', Technology Management 1, edited by Tarek M. Khalil, Bulent A. Bayraktar and Johnson A. Edosomwan, Inderscience Enterprises Ltd., 1988, pp. 435-443

Miller, J.G., De Meyer, A. and Nakane, J., Benchmarking Global Manufacturing, Business One Irwin, 1992

Miller, J.G., Graham, M.B., Freeland, J.R., Hottenstein, M., Maister, D.H., Meredith, J. and Schmenner, R.W. "Production/operations management: Agenda for the '80s" Decision Sciences, Vol. 12, 1981, pp. 547-571

Miyake, D.I., Enkawa, T., and Fleury, A. C.C., 'Improving manufacturing systems performance by complementary application of just-in-time, total quality control and total productive maintenance paradigms', Total Quality Management, Vol. 6, NO. 4, 1995

Miyashita, K. and Russell, D., Keiretsu, McGraw Hill, 1996

Mohanty, R.P., 'TQM: some issues for deliberation', Production Planning & Control, Vol. 8, No. 1, 1997, pp. 10-13

Monden, Y., The Toyota production system: A practical approach to production management. Industrial Engineering and management Press, Atlanta, 1983

Morrow, M. "International agreements increase clout of ISO 9000", Chemical Week, Vol. 152, No. 13, 7 April 1993, p.32

Mulder, Niels (1992) *Inside Thai Society : An Interpretation of Everyday Life*, Editions Duang Kamol, Thailand

Murayama, M. "Kazokushugi and Shudanshugi management Approaches: Source of concept variance in Japanese Business Settings" Japanese Management : Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982, pp. 171 -198

Muzikowski, J.A.,' Self-assessment of TQM progress', Proceedings of the 53rd Annual Technical Conference. Part 3, Vol.3, 1995, pp.4007-4011

Nagel, R.N. and Goldman, S.L. 'Management, technology and agility: the emergence of a new era in manufacturing', International Journal of Technology Management, Vol. 8, Nos1/2, 1993, pp. 18-38

Nagswasdi, M. and O'Brien, C., 'Patterns of organizational and technological development in the Thai manufacturing industry', Proceedings of the 14th International Conference on Production Research, Vol. 1, August 4-8, 1997, pp. 324-327

Naylor, T.H., Strategic Planning Management, Planning Forum, Oxford, 1980

Neely, A., Gregory, M. and Platts, K. 'Performance measurement system design: a literature review and research agenda International Journal of Operations and Production Management, V. 15 N. 4, 1995, pp. 80-116

Neter, J., Wasserman, W., and Kutner, M.H., Applied Linear Statistical Models, 2nd Edition, IRWIN, 1985

Newitt, D.J.H., 'Beyond BPR & TQM- managing through processes:is Kaizen enough?, IEE Colloquium (Digest), No. 125, 1996, pp. 3/1-3/5

Newman, W.H. 'Launching a viable joint venture', California Management Review, Vol. 35, No.1, Fall 1992, pp. 68-80

Ngai, E.W.at and Cheng, T.C.E., 'Identifying potential barriers to total quality management using principal component analysis and correspondence analysis', International Journal of Quality & Reliability Management, Vol. 14, No. 4, 1997, pp. 391-408

Nishikawa, F. 'Business Systems and TQM Practices' Proc. TQM Symposium on Toward TQM Progress in Thailand: The Role of University. Thammasat University, Thailand. March 31, 1997

Oakland, J.S. Total Quality Management. Butterworth-Heinemann, Oxford. 1993

Ohno, T. "How the Toyota production system was created" The Anatomy of Japanese Business. Edited by Sato, K., and Hoshino, Y. New York: M.E. Sharpe, 1984, pp 197-215

Pavitt, K. 'Key characteristics of the large innovating firm', British Journal of management Vol. 2, 1991, pp. 41-50

Pfeffer, J. 'Competitive Advantage Through People" California Management Review, Vol. 36 No. 2, 1994, pp. 9-28

Porter, M. E. *Competitive Strategy*. New York: The Free Press, 1980

Powell, T.C. 'Total quality management as competitive advantage: a review and empirical study', Strategic Management Journal, Vol. 16, 1995, pp. 15-37

Prahalad, C.K. and Hamel, G. "The core competence of the corporation' Harvard Business Review Vol. 68 No. 4, 1990 pp 79-93

Preece, D. Organizations and Technical Change: strategy, objectives, and involvement Routledge: London, 1995

Pugh, D.S. and Hickson, D.J. Organization Structure in its Context: The Aston Programme 1, Saxon House, Aldershot, 1976, pp. 93

Quazi, H. A. and Padibjo, S. R., 'A Journey towards total quality management through ISO 9000 certification - a Singapore experience', TQM Magazine, Vol. 9, No. 5, 1997, pp. 364-371

Quinn, R.E. and Cameron, K., 'Organizational life cycles and shifting criteria of effectiveness', Management Science, Vol. 29, No.1, 1983, pp. 33-51

Rayner, P. and Porter, L., "ISO 9000: the experience of small and medium sized firms", International Journal of Quality & Reliability Management, Vol. 9, No.6, 1991, pp. 16-28

Reynolds, L. Beyond Total Quality Management. Sheldon Press: London, 1994

Riis, J.O., 'Research methodology'. Working paper, The 4th IPS Research Seminar, Fugls∅, Denmark, 1991

Robbins, S.P. Organizational Behavior: Concepts, controversies, and applications, 4th Edition Prentice-Hall International, Inc., 1989

Safayeni, F., Purdy, L., Engelen, R.V. and Pal, S., 'Difficulties of Just-in-time implementation: a classification scheme', International Journal of Operations and Production management, Vol. 11, No.7, 1991, pp. 27-36

Salant, P. and Dillman, D.A. How to conduct your own survey. John Wiley & Sons, 1994

Saraph, J.V., Benson, P.G. and Schroeder, R.G., "An instrument for measuring the critical factors of quality management", Decision Sciences, Vol.20, No.4, 1989, pp. 810-29

Sardos, P.A. "Quality management - a case study" IEEE International Engineering Management Conference, 1994, pp. 40-42

Sasaki, N. Management & Industrial Structure in Japan. Oxford: Pergamon Press, 1981

Sasaki, N. "QC Circles and Social Sciences", The Japanese Approach to Product Quality: Its Applicability to the West. Edited by Sasaki, N. and Hutchins, D. Pergamon Press, 1984

Sato, K., and Hoshino, Y. 'Introduction', The Anatomy of Japanese Business. Edited by Sato, K., and Hoshino, Y. New York: M.E. Sharpe, 1984

Schein, E.H., 'Coming to a new awareness of organizational culture', Sloan Management Review, Vol. 25, No. 2, 1984, pp. 3-16

Schmidt, J., DeWitt, F. and Pelote, V., 'We are molding our customers' future: one company's experience with TQM and employee involvement', Annual Technical Conference-ANTEC, Conference Proceedings, Vol. 3, 1995, pp. 3472-3478

Schonberger, R.J., World Class Manufacturing: The Lessons of Simplicity Appied, The Free Press, New York, NY, 1986

Shani, A.B., Grant,R. M., Krishnan, R. and Thompson, E., 'Advanced manufacturing systems and organizational choice: sociotechnical system approach', California Management Review, Vol. 34, No. 4, 1992, pp. 91-111

Skinner, W., 'The focused factory', Harvard Business Review, May/June 1974, pp. 112-121

Slack, N. The Manufacturing Advantage. Mercury 1991

Small, J.E. "Using ISO 9000 as a foundation for TQM" Annual Quality Congress Transactions, 1997, pp. 201-204

Snell, A.S. and Dean, J.W., 'Integrated Manufacturing and human resource management: a human capital perspective', Academy Management Journal, Vol. 35, No.3, 1992, pp. 467-504

Sohal, A.S. and Egglestone, A. 'Lean production: experience among Australian organizations', International Journal of Operations & Production Management, Vol. 14, No. 11, 1994, pp.35-51

Sours, M.H. "The Influence of Japanese Culture on the Japanese Management System" in Japanese Management : Cultural and Environmental Considerations. Edited by Lee, S.M. and Schwendiman, G. Praeger Publishers, 1982 pp. 27-38

Spencer, M.S. and Guide, V.D., 'An exploration of the components of JIT- case study and survey results', International Journal of Operations and Production Management, Vol. 15, No. 5, 1995, pp. 72-83

Sprague, L.G. "Needed research in organizational behavior: A production/operations management perspective" Academy of Management Review, Vol. 2, 1977, pp. 504-507

Sprague, L.G. and Sprague, C.R. "Management science" Interfaces, Vol. 7, No. 1, 1976, pp. 57-62

SPSS Base 7.5 Applications Guide, SPSS, Chicago, IL, 1996

Stephens, K.S., 'National quality awards- complements to quality systems', Annual Quality Congress Transactions, 1996, pp. 735-742

Stillman, W.E., 'Manufacturing synchronization: the future of quality management', Proceedings of the 1996 ASQC's 50th Annual Quality Congress, 1996, pp. 828-834

Storey, J., 'New wave manufacturing strategies: an introduction', in New Wave Manufacturing, edited by John Storey, Paul Chapman Publishing, 1994, pp. 1-21

Sullivan, R.S., "The service sector: Challenges and imperatives for research in operations management", Journal of Operations Management, Vol. 2, 1982, pp. 211-214

Sun, H., "Patterns of organizational changes and technological innovations", International Journal of Technology Management, Vol. 9, No. 2, 1994, pp. 213-226

Sunday, J.L. and Liberty, L. "Benchmarking the Baldrige Award", Quality Progress, Vol. 25, No. 9, 1992, pp. 75-77

Svetec, E.F., 'Application of team concept to initiate and develop TQM', Journal of Architectural Engineering, Vol. 1 No. 1, 1995, pp. 18-24

Swamidass, P.M. "Empirical Science: New Frontier in Operations Management Research" Academy of Management Review, Vol. 16 No. 4, 1991, pp 793-814

Tamimi, N., 'Empirical investigation of critical TQM factors using exploratory factor analysis', International Journal of Production Research, Vol. 33, No.11, 1995, pp. 3041-3051

Tansuvan, P., ' Some Thai Behaviors As Barriers To TQC ', Proc. International Convention On QC Circles, 7-13 December, Bangkok, Thailand, 1993

Thiagarajan, T. and Zairi, M. "A review of total quality management in practice: understanding the fundamentals through examples of best practice applications- part II", The TQM magazine, Vol. 9, No. 5, 1997 pp.344-356.

Thiagarajan, T. and Zairi, M. "A review of total quality management in practice: understanding the fundamentals through examples of best practice applications- part III", The TQM magazine, Vol. 9, No. 6, 1997 pp.414-417

Thomas, T. 'Step by step towards total quality', Steel Times, Vol. 223, No. 2, 1995, pp 76

Tidd, J., ' The link between manufacturing strategy, organization, and technology', New Wave Manufacturing, edited by John Storey, Paul Chapman Publishing, 1994, pp.22-40

Tienthai, J., Reengineering and the Thai society, (in Thai language), The Nation's Press, 1995

Tincher, M.G., 'Just-in-time is the end result, not the beginning', Annual International Conference Proceedings- American Production and Inventory Control Society, 1995, pp. 123-128

Toone, R. Manufacturing Success: How to manage your competitive edge. Prentice Hall 1994.

Trist, E. and Bamforth, K, "Some social and psychological consequences of the Long Wall method of Goal Setting," Human Relations, Vol. 4, 1951, pp. 1-8

Tuckman, A., 'The yellow brick road: total quality management and the restructuring of organizational culture', Organization studies, Vol. 15, No. 5, 1994, pp. 727-752

References

Twigg, D., Voss, C. and Winch, G., 'Implementing integrating technologies- developing managerial integration for CAD/CAM', 3rd International Production Management Conference on Management and New Productions Systems, May 26-29, 1991, Gothenburg, Sweden, pp. 750-764

van Donk, D.P. and Sanders, G., 'Organizational culture as a missing link in quality management', International Journal of Quality & Reliability Management, Vol. 10, No. 5, 1993, pp. 5-15

Voss, C. "Success and failure in advanced manufacturing technology", International Journal of Technology Management, Vol. 3, 1987, pp. 285-297

Wason, S.K, and Bhalla, S.K., 'Managing the technological process', Quality Progress, Vol. 27, No. 1, 1994, pp. 81-85

Walsh, C. "Japan's Sure Road to Success" Business America, Vol. 4, No. 6, 1981, pp. 3-4

Webb, J. , 'Quality management and the management of quality', in Making Quality Critical: new perspectives on organizational change edited by A. Wilkinson and H. Willmott, London: Routledge, 1995, pp.105-126

Weick, K.E. 'The role of renewal in organizational learning', International Journal of Technology Management, Vol. 11, No. 7/8, 1996, pp. 738-746

Westbrook, R., 'Action research: a new paradigm for research in production and operations management', International Journal of Operations & Production Management, Vol. 15, No. 12, 1995, pp. 6-20

Williams, J.R., 'How sustainable is your competitive advantage', California Management Review, Vol. 34, No. 3, 1992, pp. 29-51

Williams, R. and Bertsch, B., 'Stages in the management of quality improvement programmes', in Proceedings of the 15th Annual Conference of the European International Business Association, Helsinki, Finland, pp. 868-879

Wilkinson, A., Marchington, J., Goodman, M. and Ackers, P., 'Total quality management and employee involvement, Human Resource Management Journal, Vol.2, No. 4, 1992, pp. 1-2

Wilkinson, A. and Willmott, H., Making Quality Critical: new perspectives on organizational change, London: Routledge, 1995

Wilson, D.C. and Rosenfeld, R.H. Managing Organization. McGraw Hill, London, 1990

Winner, L. Autonomous Technology: Technics out-of-control as a theme in Political Thought. MIT Press, Cambridge, MA, 1977

Wisner, J.D. and Eakins, S.G. "A Performance Assessment of the US Baldrige Quality Award Winners", International Journal of Quality & Relability Management, Vol.22, No.2, 1994, pp. 8-25

Withers, B.E. and Ebrahimpour, M. "An examination of ISO 9000 registration practices of American, German and Japanese firms operating in the USA" International Journal of Quality & Relability Management, Vol.13, No.7, 1996, pp. 8-22

Wolak , J., " ISO 9000 - a software market", Quality, March 1994, p. 44

Womack, J.P., Jones, D. J. and Roos, D. The Machine that Changed the World, Rawson Associates, New York, 1990

Wong, J.K. 'Technology transfer in Thailand: descriptive validation of a technology transfer model' Int. J. of Technology Management, Vol. 10, No. 7/8, 1995, pp. 788-796

Woodward, J., Industrial Organization: Theory and Practice. Oxford University Press, 1965

Yang, C.Y. "Management Style: American vis-s-vis Japanese", Columbia Journal of World Business, Fall 1977, pp. 23-31

Yates, R. "U.S. Lags on Rigorous New Quality Standard." The Chicago Tribune, November 16, 1992, p 38, 42

Yin, R.K. Case Study Research: Design and methods, Sage Publications, 1989

Yung, W,K.C., "The values of TQM in the revised ISO 9000 quality system", International journal of Operations & Production Management, Vol. 17, No. 2, 1997, pp. 221-230

Zurn, J.T., 'Linked policy deployment', Annual Quality Congress Tranactions, 1996, pp. 812-821

Zwerman, W.L., New Perspectives on Organization Theory. Greenwood Publishing Corporation: Connecticut, 1970

Zygmont, J., 'Flexible manufacturing systems: curing the cure-all', High technology, October 1986, pp. 23-24

Appendix A

Letter to respondents

The following questionnaire is used in a survey of the Thai manufacturing companies in order to assess the pattern of organizational and technological development. It is part of ongoing research activities carried out by a staff member of Thammasat University in cooperation with the University of Nottingham, U.K.. Your responses will be very useful in providing information on the organizational changes versus technological innovations in order to analyze the development pattern.

Please note that your name and affiliation is needed only for the purpose of rechecking in case of incomplete data. Otherwise it will be kept confidential and will be used for this research only.

****

Company Name ____________________ Types of Product ____________________
Is your company a joint venture? __________ If yes, with which country ______________
Your name ____________________________ Position ____________________________
Telephone ____________________________

****

Part I General Information

1. Please fill in the numbers about different types of employees in your organization

   1.1 total number wage-earning employees ____________

   1.2 the number of skilled employees earning wages __________

   1.3 total number of salaried employees __________

   1.4 the number of salaried employees with college education __________

2. Please circle the figure showing whether your company adopts the following management philosophies.

(1) No, without future plan.
(2) No, with future plan.
(3) Yes.

2.1 achieving ISO 9000 or other quality standards	1	2	3
2.2 total quality management	1	2	3
2.3 quality control circle	1	2	3
2.4 suggestion system	1	2	3
2.5 others (please specify)______________________	1	2	3

Part II Organization

1. Please circle the proper figure showing the characteristics of organizational structures in your company.

(1) nothing, (2) little, (3) some, (4) much, (5) very much

1.1 Are there any self-controlling groups in the production area?	1	2	3	4	5
1.2 Are there any matrix structures including sales, design and production in new product development?	1	2	3	4	5
1.3 Are there any cross functional groups- ad hoc or permanent- for solving cross-functional problems?	1	2	3	4	5

2. Please choose the figure showing the characteristics of coordination among the following department.

(1) informality (2) little formality (3) some formality (4) high formality (5) v. high formality

2.1 production and marketing/sales	1	2	3	4	5
2.2 design and administration/ finance	1	2	3	4	5
2.3 purchasing and production	1	2	3	4	5

2.4 purchasing and design 1 2 3 4 5
2.5 production and design 1 2 3 4 5

3. Please circle the proper figure showing the characteristics of the following management systems in your company.

(1) not existing
(2) very unformalized
(3) unformalized, dependent upon specific person
(4) formalized, dependent upon specific person
(5) formalized, responsibility of a group

3.1 strategic planning system	1	2	3	4	5
3.2 strategy deployment	1	2	3	4	5
3.3 quality assurance system	1	2	3	4	5
3.4 education and training system	1	2	3	4	5
3.5 sales forecasting system	1	2	3	4	5
3.6 cost accounting system	1	2	3	4	5
3.7 performance evaluation system for department	1	2	3	4	5
3.8 project planning system	1	2	3	4	5
3.9 maintenance system for machines	1	2	3	4	5
3.10 others________________________	1	2	3	4	5

4. Please select the proper figure showing the efforts in carrying out the following activities.

(1) nothing, (2) little, (3) some, (4) much, (5) very much

4.1 Training and educating employees	1	2	3	4	5
4.2 Developing individual initiatives	1	2	3	4	5
4.3 Encouraging employee participation in problem solving	1	2	3	4	5
4.4 Empowering employees' decision making	1	2	3	4	5
4.5 Instilling quality consciousness in employees	1	2	3	4	5
4.6 Encouraging the internal customer concept	1	2	3	4	5
4.7 Improving work environment and safety	1	2	3	4	5
4.8 Encouraging job rotation	1	2	3	4	5
4.9 Establishing individual performance objectives	1	2	3	4	5
4.10 Establishing individual performance incentives	1	2	3	4	5
4.11 Communicating common organizational goals across functions	1	2	3	4	5
4.12 Providing assistance to suppliers in problem solving	1	2	3	4	5
4.13 Utilizing suppliers know how in the design process	1	2	3	4	5

5. Please circle the proper figure showing the amount of re-organizing activities in the last five years in the following department.

(1) nothing, (2) little, (3) some, (4) much, (5) very much

5.1 purchasing	1	2	3	4	5
5.2 design and engineering	1	2	3	4	5
5.3 production	1	2	3	4	5
5.4 marketing	1	2	3	4	5
5.5 finance/administration	1	2	3	4	5

Part III Technology

1. To what extent are computer-controlled machines used in the following manufacturing activities?

(1) nothing, (2) little, (3) some. (4) much, (5) very much

1.1 materials handling	1	2	3	4	5
1.2 transporting	1	2	3	4	5

1.3 assembling/welding	1 2 3 4 5
1.4 measuring and testing	1 2 3 4 5
1.5 fabricating	1 2 3 4 5
1.6 others (please specify) ______________________	1 2 3 4 5

2. To what extent is computer used in the following design activities?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

2.1 drawing	1 2 3 4 5
2.2 design of component	1 2 3 4 5
2.3 engineering calculations	1 2 3 4 5
2.4 product performance simulation	1 2 3 4 5
2.5 parameter design	1 2 3 4 5
2.6 retrieval	1 2 3 4 5
2.7 use of 3D techniques	1 2 3 4 5
2.8 others (please specify) ______________________	1 2 3 4 5

3. To what extent is computer used in information processing and information flow regarding the following process planning activities?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

3.1 programming	1 2 3 4 5
3.2 simulation of processes	1 2 3 4 5
3.3 process routings	1 2 3 4 5
3.4 others (please specify) ______________________	1 2 3 4 5

4. To what extent is computer used in information processing and information flow regarding the following production planning activities?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

4.1 material requirement planning	1 2 3 4 5
4.2 scheduling	1 2 3 4 5
4.3 capacity planning	1 2 3 4 5
4.4 data collection	1 2 3 4 5
4.5 following up the suppliers	1 2 3 4 5
4.6 others (please specify) ______________________	1 2 3 4 5

5. To what extent is computer used in the information processing and information flow in the following finance/administration/ accounting activities?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

5.1 inventory status	1 2 3 4 5
5.2 management reporting systems	1 2 3 4 5
5.3 others (please specify) ______________________	1 2 3 4 5

6. To what extent is computer used in the information processing and information flow in the following marketing/ sales activities?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

6.1 sales forecasting	1 2 3 4 5
6.2 order specification	1 2 3 4 5
6.3 sales reporting systems	1 2 3 4 5

7. To what extent is information transferred between functions through computer systems?

(1) nothing, (2) little, (3) some, (4) much, (5) very much

7.1 production and marketing/ sales	1	2	3	4	5
7.2 marketing/sales and design	1	2	3	4	5
7.3 design and administration/ finance	1	2	3	4	5
7.4 purchasing and production	1	2	3	4	5
7.5 purchasing and design	1	2	3	4	5
7.6 production and design	1	2	3	4	5

Part IV Performance

1. To what extent have you achieved goals in the following criteria?

(1) negative or not-at-all (2) less than expected (3) as expected (4) more than expected

1.1 sales growth	1	2	3	4
1.2 increase in market share	1	2	3	4
1.3 rate of new product introduction	1	2	3	4
1.4 growth of earning	1	2	3	4
1.5 return on investment	1	2	3	4
1.6 improvement on product quality	1	2	3	4
1.7 improvement on productivity	1	2	3	4
1.8 improvement in participation of employees	1	2	3	4
1.9 development of human resource	1	2	3	4
1.10 turn of inventory	1	2	3	4
1.11 delivery	1	2	3	4
1.12 other ______________________	1	2	3	4

2. To what extent is the overall company growth?

(1) negative or not-at-all (2) less than expected (3) as expected (4) more than expected

2.1 during the last five years?	1	2	3	4
2.2 during the last four years?	1	2	3	4
2.3 during the last three years?	1	2	3	4
2.4 during the last two years?	1	2	3	4
2.5 during the last years?	1	2	3	4

Part I General Information

Question 1 extracts the general information of companies in terms of the number of employees. This information is used to classify the companies into different sizes. Question 2 is used to categorize the companies into those adopting TQM, ISO, BOTH, and neither. It also reveals the different types of management practices that are adopted in the companies

Part II Organization

Part II evaluates the organizational dimension by including strategic quality and planning process, functional coordination, teamwork, human resource management, and supplier relationship. Each question is based on a five-point likert scale, and the total scores are 180.

Part III Technology

Part III measures the technological dimension of companies by referring to the use of advanced automation technology in various functions and between functions. The total scores are 180, and the aggregated scores for each respondent provide the data for the technological index.

Part IV Performance

Part IV measures the company performance in terms of financial growth, product innovation, quality improvement, employee participation, and delivery performance. Question 2 to 6 assess the overall performance during the past five years in order to provide information about the trend in performance. The aggregated scores of this part provide the data on performance of each respondent.

Appendix B Customer Survey

Customer Concerns	Mfg. (A)					Mfg. (B)					Mfg. (C)					Mfg. (D)				
(Key Purchase Criteria)	v.poor	poor	fair	good	v. good	v.poor	poor	fair	good	v. good	v.poor	poor	fair	good	v. good	v.poor	poor	fair	good	v. good
Product-related factors	2	4	6	8	10	2	4	6	8	10	2	4	6	8	10	2	4	6	8	10
1. Price																				
2. Product features																				
Service-related factors																				
1. After-sales service																				
2. Inquiry lead-time																				
Total																				

Appendix C

Appendix C Structured Interview

Section 1. Strategic Management

1. Please rank the relative importance of the following forces affecting your organization. (1 being the most important)
   Threat of entry ________
   Substitution ________
   Suppliers ________
   Customers ________
   Competition ________
   Government Regulations ________

2. Please rank your company's strategic objectives. (1 being the most important)
   Profitability ________
   Sales growth ________
   Technological leader ________
   Market leader ________
   Social contribution ________

3. What is the degree of impact the following attributes have on improving competitiveness?
   a. Improving product quality — Very unimportant 1 2 3 4 5 Very important
   b. Improving delivery performance — Very unimportant 1 2 3 4 5 Very important
   c. Lowering product cost — Very unimportant 1 2 3 4 5 Very important
   d. Improving customer service — Very unimportant 1 2 3 4 5 Very important

4. The stage of development of your main product during the last three years is :
   (a) introductory stage: Primary demand just starts to grow.
   (b) growth stage: Demand is growing at a minimum of 10 % in real terms, technology or competitive structure is still changing.
   (c) maturity stage: Products are familiar to most prospective users; technology and competitive structure are reasonably stable.
   (d) decline stage: Products are viewed as commodities; weaker competitors start to exit.

5. What is the degree of emphasis being placed on each type of activity over the next 5 years?
   a. Broadening of product line — Little emphasis 1 2 3 4 5 Great emphasis
   b. Vertical integration — Little emphasis 1 2 3 4 5 Great emphasis
   c. Expanding to other geographic regions — Little emphasis 1 2 3 4 5 Great emphasis
   d. Implementing a quality system (please specify________________) — Little emphasis 1 2 3 4 5 Great emphasis

6. Does your company have a strategic plan? a. yes b. no
7. Does manufacturing contribute to the strategic planning process ? a. yes b. no

Section 2. Management of Organisational System

Management of Quality

1. Is quality one of the key strategy relegated by top management ?
   a. yes b. no

2. Is quality strategy formulated into quality plans ?
   a. yes b. no

3. Does your company have a quality steering group to oversee the quality policy and implementation?

a. yes b. no

4. Is there a comprehensive quality system in the company?
a. yes (specify________________) b. no

5. If yes to question (4), what is the initial purpose of implementing the company's quality system ?

6. If yes to question (4), what are the main benefits of the quality system? (e.g. product quality, work in progress, lead time, customer satisfaction, communication, business control, employee morale)

7. Does your company have a quality policy ?
a. yes b. no

8. If yes to question (7), how is quality policy communicated to lower levels?
9. If yes to question (7), how is quality policy communicated among functions?

10. Have you documented work instructions and procedures? a. yes b. no
11. Do you use internal audits? a. yes b. no

12. What is the degree of emphasis top management place on quality improvement?
Little emphasis 1 2 3 4 5 Great emphasis

13. How are quality responsibilities delegated to various functions?
14. How are quality responsibilities delegated to lower levels?
15. How does management facilitate vertical communications?
16. How does management facilitate cross-functional communications?

Quality Activities

17. Suggestion System
Is there a utilization of suggestion system?
a. yes b. no

If no, has it been considered or used in the past? Why is it not utilized now?

What is the number of suggestions / employee/ year?
What is the percentage of suggestions approved by management?

What is the degree of emphasis being given to financial benefits?
Little emphasis 1 2 3 4 5 Great emphasis

What is the degree of emphasis being given to employee benefits (i.e. increased employee morale) ?
Little emphasis 1 2 3 4 5 Great emphasis

What are the other benefits achieved from suggestion system? (e.g. product quality, work in progress, lead time, customer satisfaction, communication, business control, employee morale)

What reward systems are provided? (e.g. monetary reward, prizes, non-monetary recognition)

18. Small Group Activities
Is there a utilization of teams that engage in problem solving and continuous improvement?
a. yes b. no

If no, has it been considered or used in the past? Why is it not utilized now?

What departments do teams exist in?

Appendix C

Who selects the problem to be tackled by the teams?

a. management b. the teams

Are the teams properly trained in problem analysis and solving?

a. yes b. no

What are the benefits achieved? (discuss in terms of economic, operational, and organizational benefits)

19. What are the other quality activities implemented in the organization? (e.g. internal customer concept, quality costing, quality function deployment)

Section 3. <u>Manufacturing Infrastructure</u>

Quality systems in manufacturing

1. How is incoming inspection done on incoming parts?

a. heavy incoming inspection b. reduced incoming inspection
c. skip lot d. certification

2. Is there a systematic policy to reduce incoming inspection (from 100% inspection to sampling to skip lot, and finally to full certification)?

a. yes b. no

3. Are the following techniques used in manufacturing?

Statistical process control (SPC) a. yes b. no
Design of experiment a. yes b. no
Poka yoke (fool proof system) a. yes b. no

4. How is your failure analysis capability as compared with the best competitor?

Much lower 1 2 3 4 5 Much better

5. Do you have an effective gauge and equipment calibration system?

a. yes b. no

6. Who carries the responsibilities of gauge and equipment calibration?

(a) operator (b) foreman (c) supervisor (d) QA/QC dept. (e) others__________

7. Please rank the relative importance of the factors causing product quality problems.
(Enter 1 for the most important factor).

Purchased parts __________
Processes/ equipment __________
Operators __________

Manufacturing management

8. To what extent are workers encouraged to acquire multiple skills for maximum manufacturing flexibility?

Little extent 1 2 3 4 5 Great extent

9. To what extent is job rotation applied among workers?

Little extent 1 2 3 4 5 Great extent

10. Are workers given authority to shut down a line in case of problems or unacceptable quality?

a. yes b. no

11. Are workers grouped into small problem-solving teams?

a. yes b. no

12. Are workers trained to perform inspection of the previous work prior to carrying on his own tasks?
a. yes b. no

Manufacturing capability

13. Have there been large capital investment concerning manufacturing capabilities within the past 3 years?
a. yes b. no

14. Have there been little investment concerning manufacturing capabilities within the past 3 years?
a. yes b. no

15. Is CAD (computer aided design) used in drawing and design to improve engineering effectiveness?
a. yes b. no

16. Is CAM (computer aided in manufacturing) applied to incorporate design with production process?
a. yes b. no

17. Is CAE (computer aided in engineering) used in the design and analysis of your product?
a. yes b. no

18. Is CAPP (computer aided in production planning) used in production planning and control?
a. yes b. no

19. To what extent is an attempt to increase automation being made?
Little extent 1 2 3 4 5 Great extent

20. What is the main purpose of introducing automation?
(a) reduce direct labor (b) increase process flexibility
(c) remove drudgery (d) increase safety
(e) others________________________________

21. To what extent is the collection and analysis of data being used by information technology?
Little extent 1 2 3 4 5 Great extent

Production Planning and Control

22. How far forward does your aggregate planning extend?
(a) 6 months (b) 12 months (c) 18 months (d) 24 months (e) others________

23. How do you cope with peak demand?
(a) refuse business in order to bring the demand in line with capacity
(b) use overtime
(c) subcontract workforce
(d) subcontract tasks to outside suppliers
(e) others ________________________________

24. The degree of instability in your plant operation due to product variety is:
(a) none (b) little (c) average (d) above average (e) outstanding

25. The degree of instability in your plant operation due to schedule changes is:
(a) none (b) little (c) average (d) above average (e) outstanding

26. The degree of instability in your plant operation due to expediting of orders is:
(a) none (b) little (c) average (d) above average (e) outstanding

27. The degree of instability in your plant operation due to volume fluctuations is:
(a) none (b) little (c) average (d) above average (e) a great deal

28. What percentage of total inventory accounts for the asset total?
(a) less than 15 % (b) 16-25 % (c) 26-35% (d)36-45 % (e) more than 45 %

29. What percentage of part/component inventory accounts for the asset total?
(a) less than 15 % (b) 16-25 % (c) 26-35% (d)36-45 % (e) more than 45 %

30. What percentage of WIP inventory accounts for the asset total?
(a) less than 15 % (b) 16-25 % (c) 26-35% (d)36-45 % (e) more than 45 %

31. Please rank the relative importance of the reasons for keeping WIP inventory.
________erratic process yields
________unreliable equipment
________long setup time
________constantly changing production schedule
________unreliable suppliers

Section 4. <u>Organizational infrastructure</u>

Human Resource Management : Performance Evaluations

1. Is there a goal-sharing scheme that ties individual performance to company performance?
a. yes b. no

2. In evaluating individual performance, how much emphasis is placed on worker's contribution to his team?
Little emphasis 1 2 3 4 5 Great emphasis

3. What is the basis for promoting an employee?
   a. ability appropriate to the job being promoted
   b. the performance of the employee's current job
   c. seniority
   d. others ______________________________

4. Is there recognition and reward for those achieving quality goals? a. yes b. no
5. Is there recognition and reward for those willing to learn multiple skills? a. yes b. no
6. What reward systems are provided? (e.g. promotion, monetary rewards, certificates)

Training

7. What is the average educational level of workers?

8. What are the issues of entry-level training provided to workers?
9. What are the issues of entry-level training provided to white-collar employees?

10. To what extent are your employees given opportunities for on-the-job training?
Little extent 1 2 3 4 5 Great extent

11. To what extent are your employees given opportunities for off-the-job training?
Little extent 1 2 3 4 5 Great extent

12. How many days per year do the following personnel spend on formal training?
Top management
Middle management
Supervisors
Operators

Customer Orientation Function

13. To what extent are the following customer-driven activities undertaken on the key product?

Market surveys Little extent 1 2 3 4 5 Great extent

Evaluation of competitive products Little extent 1 2 3 4 5 Great extent

Continual contacts with customers Little extent 1 2 3 4 5 Great extent

Interaction between sales, service, manufacturing, and engineering to utilize field reliability data Little extent 1 2 3 4 5 Great extent

14. How would customer orientation be described in the company?

Supplier Management

15. What is your sourcing policy?

a. multiple sourcing b. reduced supplier base c. double sourcing d. single sourcing

16. Are you attempting to reduce your supplier base?

a. yes b. no

17. What is the process of selecting your suppliers?

a. bidding/quotation b. negotiation c. sourcing d. others ________________

18. Do you establish any long-term legal contracts with your suppliers?

a. yes b. no

19. How long does your company usually stay with one supplier?

a. 1-2 years b. 3-5 years c. 6-8 years d. more than 8 years

20. Please rank the importance of the basis for selecting your suppliers. (1 being the most important)

price ______

quality ______

product/ process capabilities ______

past performance ______

total cost (price, and cost of poor quality and delivery) ______

21. How do you describe the relationship with your suppliers?

a. distrust b. suspicion c. limited trust d. full trust

22. Do you have an active partnership relationship with your key suppliers?

a. yes b. no

23. Do you encourage your suppliers to move toward partnership?

a. yes b. no

24. To what extent is information on production process shared between you and your suppliers?

Little extent 1 2 3 4 5 Great extent

25. To what extent is information on production costs shared between you and your suppliers?

Little extent 1 2 3 4 5 Great extent

26. To what extent are there consultations with the suppliers on such issues as design, cost trade-offs in specifications, and systematic reductions in cycle-time?

Little extent 1 2 3 4 5 Great extent

27. To what extent do you encourage early supplier involvement in your initial designs?

Little extent 1 2 3 4 5 Great extent

28. Do you have a supplier improvement program?

a. yes b. no

29. How do you evaluate your suppliers?

a. no evaluation
b. based on the number of defects
c. based on costs
d. evaluation based on delivery
e. others ______________________

Appendix D

Appendix D

The responses of 53 companies that were formulated into aggregated indices.

TYPE*	O	T	P	Activities
1	1:5	91	42	TQM, ISO plan, QCC
1	125	104	45	BPR, TQM, QCC plan, *ISO9000*
1	96	58	36	TPM, ISO plan, TQM plan
1	80	86	39	TQMplan, TPMplan, QCC plan
1	113	73	30	BPR, *ISO 9000*, QCC, TQMplan,TPMplan
2	152	128	47	TQM, *ISO 9000*, QCC
2	131	100	45	TPM, *ISO 9000*, QCC plan,TQMplan
2	113	47	32	TQM, QCC, TPM, BPR
2	106	42	35	TQM, TPM plan
2	121	93	42	BPR,TPM,ISO plan,TQMplan, QCC plan
2	95	75	29	BPR,TQM-TPM-QCC plan, *ISO* ,lean
2	77	59	31	BPRplan,TPM plan,QCC plan, kaizen
3	136	53	41	BPR,TPM,TQM plan, QCC, *ISO 9000*
3	122	84	42	BPR,TPM,TQM,QCC plan, *ISO 9000*
3	127	115	46	BPR,TPMplan,TQM, QCC, *ISO 9000*
3	116	87	41	TPM,TQM, QCC, *ISO 9000*
3	126	74	32	BPRplan,TQMplan,TPM, QCC
3	111	49	42	TQM-TPMplan, QCC plan, ISO plan
3	128	107	45	TQM,TPM-QCC plan, ISOplan,BPRplan
3	124	111	45	BPR,TQM-TPM-QCC plan,*ISO9000*
3	148	100	47	BPR,TQM-TPM plan, QCC, ISO plan
3	118	88	48	BPR,TPM,TQM,*ISO 9000*, QCC
3	128	100	50	TQM,QCC,*ISO9000*,ISO14000,TPMplan
3	85	101	31	ISO plan
3	121	108	43	TQM-TPM plan, QCC, *ISO 9000*
3	114	104	36	TQM-TPMplan, QCC plan, *ISO 9000*
3	108	83	42	BPR-TQM-TPMplan,QCCplan,ISOplan
3	160	86	47	BPR,TQM,TPM,QCC,*ISO9000*,*ISO14000*

 Appendix D

Appendix D (continued)

TYPE*	O	T	P	Activities
4	68	44	28	TQM-TPM plan,QCC plan, ISO plan
4	95	39	36	QCC plan, ISO plan
4	122	59	46	BPR, TPM, TQM, QCC
4	95	62	30	TQM-TPMplan, QCC plan, ISO plan
4	146	133	51	TPM,TQM, QCC
4	134	105	46	TPMplan,TQM ,QCC plan, *ISO 9000*
4	127	105	38	BPR, TPM,TQMplan, *ISO 9000*
4	76	42	28	TQM-TPMplan, QCC plan, ISO plan
4	101	51	32	TPM,TQM plan,QCC plan, *ISO 9000*
4	105	46	28	BPR,TPM-TQM plan, QCC plan
4	149	132	45	BPR,TPM,TQM, QCC, *ISO 9000*
5	146	118	44	BPRplan,TPM,TQM, QCC plan, ISO plan
5	112	101	42	BPR plan, TPM, TQM
5	88	65	30	BPR,TPM,TQM, QCC plan
5	129	111	47	TPM, TQM, *ISO 9000*
5	105	88	33	TPM, TQM, *ISO 9000*
5	117	92	34	BPR,TPM,TQM plan, QCC plan
5	112	59	43	BPR, TPM, TQM, QCC plan
5	102	60	33	TPM,TQM plan, *ISO 9000*
6	130	76	46	BPR,TPMplan,TQM
6	124	71	40	BPRplan,TPM,TQM, QCC
6	128	76	43	BPR,TPM,TQM, QCC, ISO plan
6	143	66	37	BPR, TPM,TQM-QCC plan, ISO plan
6	147	101	44	TPMplan,TQM, QCC, ISO plan
6	142	44	37	BPR, TPM,TQM plan, QCC

* Note
Type 1 = primary/fabricated metal
Type 2 = Industrial machinery & equipment
Type 3 = Electronic & other electric equipment
Type 4 = Chemicals & allied products
Type 5 = Rubber & plastic products
Type 6 = Food, textiles, leather

Appendix E

Table 1 shows the results of regression analysis of the standardized values of O and T. A common approach in searching for the most appropriate model is to fit a higher order model and test whether the highest term is significant. Table 1 © reveals that, at the level of significance 0.05;

Model 5 The p-value of the 5th-order term (ZT5) indicates that this term is insignificant.
Model 4 The p-value of the 4th-order term (ZT4) indicates that this term is insignificant.
Model 3 The p-value of the 3th-order term (ZT3) indicates that this term is insignificant.
Model 2 The p-value of the 2nd-order term (ZT2) indicates that this term is insignificant.
Model 1 The p-value of the 1st-order term (Zscore) indicates that this term is significant.

Thus the results reveal that at the level of significance of 0.05, the linear model (Model 1) was statistically the best fit. According to Table 1 (a), it has the highest value of adjusted R-square (.298). The equation is:

$ZO = 1.049^{-15} + 0.558\ ZT$, (adjusted R square = 0.298)

where ZO = standardized O indices
ZT = standardized T indices

Table 2 shows the results of regression analysis of the nonstandardized values of O and T. Similar to the standardized values, the results reveal that, at the level of significance of 0.05, the linear model (Model 1) was statistically the best fit.

$O = 80.999 + 0.447\ T$, (adjusted R square = 0.287)

Table 1 Regression analysis of the standardized values of O and T (53 data points)

Table 1 (a) Model summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.558[a]	.311	.298	.8381519
2	.563[b]	.317	.290	.8428593
3	.569[c]	.324	.282	.8470745
4	.571[d]	.326	.270	.8544414
5	.571[e]	.326	.254	.8634782

a. Predictors: (Constant), Zscore(T)

b. Predictors: (Constant), Zscore(T), ZT2

c. Predictors: (Constant), Zscore(T), ZT2,

d. Predictors: (Constant), Zscore(T), ZT2, ZT3,

e. Predictors: (Constant), Zscore(T), ZT2, ZT3, ZT4,

Table 1 (b) ANOVA tables

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	16.173	1	16.173	23.022	.000[a]
	Residual	35.827	51	.702		
	Total	52.000	52			
2	Regression	16.479	2	8.240	11.598	.000[b]
	Residual	35.521	50	.710		
	Total	52.000	52			
3	Regression	16.841	3	5.614	7.823	.000[c]
	Residual	35.159	49	.718		
	Total	52.000	52			
4	Regression	16.957	4	4.239	5.807	.001[d]
	Residual	35.043	48	.730		
	Total	52.000	52			
5	Regression	16.957	5	3.391	4.549	.002[e]
	Residual	35.043	47	.746		
	Total	52.000	52			

a. Predictors: (Constant), Zscore(T)

b. Predictors: (Constant), Zscore(T), ZT2

c. Predictors: (Constant), Zscore(T), ZT2, ZT3

d. Predictors: (Constant), Zscore(T), ZT2, ZT3, ZT4

e. Predictors: (Constant), Zscore(T), ZT2, ZT3, ZT4, ZT5

f. Dependent Variable: Zscore(O)

Table 1 (c) Coefficients of the fitted models

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.049E-15	.115		.000	1.000
	Zscore(T)	.558	.116	.558	4.798	.000
2	(Constant)	-7.59E-02	.164		-.464	.644
	Zscore(T)	.556	.117	.556	4.758	.000
	ZT2	7.739E-02	.118	.077	.657	.514
3	(Constant)	-4.20E-02	.171		-.245	.807
	Zscore(T)	.395	.256	.395	1.540	.130
	ZT2	4.117E-02	.129	.041	.319	.751
	ZT3	8.251E-02	.116	.186	.710	.481
4	(Constant)	-9.37E-02	.216		-.434	.667
	Zscore(T)	.354	.278	.354	1.273	.209
	ZT2	.200	.420	.199	.477	.636
	ZT3	.115	.143	.260	.805	.425
	ZT4	-5.45E-02	.137	-.184	-.398	.692
5	(Constant)	-9.25E-02	.225		-.412	.682
	Zscore(T)	.345	.479	.345	.719	.476
	ZT2	.196	.463	.195	.424	.674
	ZT3	.129	.613	.292	.211	.834
	ZT4	-5.21E-02	.171	-.176	-.304	.762
	ZT5	-3.88E-03	.163	-.027	-.024	.981

a. Dependent Variable: Zscore(O)

Table 1 (d) Excluded variables

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT2	.077[a]	.657	.514	.093	1.000
	ZT3	.219[a]	.919	.363	.129	.238
	ZT4	.077[a]	.648	.520	.091	.979
	ZT5	.150[a]	.887	.379	.124	.474
2	ZT3	.186[b]	.710	.481	.101	.201
	ZT4	.029[b]	.078	.938	.011	9.846E-02
	ZT5	.126[b]	.636	.528	.090	.353
3	ZT4	-.184[c]	-.398	.692	-.057	6.602E-02
	ZT5	-.232[c]	-.254	.801	-.037	1.680E-02
4	ZT5	-.027[d]	-.024	.981	-.003	1.096E-02

a. Predictors in the Model: (Constant), Zscore(T)

b. Predictors in the Model: (Constant), Zscore(T), ZT2

c. Predictors in the Model: (Constant), Zscore(T), ZT2, ZT3

d. Predictors in the Model: (Constant), Zscore(T), ZT2, ZT3, ZT4

e. Dependent Variable: Zscore(O)

Table 2 Regression analysis of the unstandardized values of O and T (53 data points)
Table 2 (a) Model summary

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.549[a]	.301	.287	17.7069
2	.556[b]	.309	.282	17.7777
3	.566[c]	.321	.279	17.8098

a. Predictors: (Constant), T

b. Predictors: (Constant), T, T2

c. Predictors: (Constant), T, T2, T3

Table 2 (b) ANOVA tables

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6884.467	1	6884.467	21.958	.000[a]
	Residual	15990.288	51	313.535		
	Total	22874.755	52			
2	Regression	7072.384	2	3536.192	11.189	.000[b]
	Residual	15802.371	50	316.047		
	Total	22874.755	52			
3	Regression	7332.436	3	2444.145	7.706	.000[c]
	Residual	15542.319	49	317.190		
	Total	22874.755	52			

a. Predictors: (Constant), T

b. Predictors: (Constant), T, T2

c. Predictors: (Constant), T, T2, T3

d. Dependent Variable: O

Table 2 (c) Coefficients of the fitted models

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	80.999	8.205		9.872	.000
	T	.447	.095	.549	4.686	.000
2	(Constant)	98.742	24.441		4.040	.000
	T	-2.93E-02	.625	-.036	-.047	.963
	T2	2.893E-03	.004	.592	.771	.444
3	(Constant)	31.660	78.027		.406	.687
	T	2.671	3.048	3.277	.876	.385
	T2	-3.06E-02	.037	-6.253	-.823	.415
	T3	1.299E-04	.000	3.608	.905	.370

a. Dependent Variable: O

Table 2 (d) Excluded variables

Excluded Variables[d]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	T2	.592[a]	.771	.444	.108	2.347E-02
	T3	.346[a]	.860	.394	.121	8.534E-02
	T4	.265[a]	.930	.357	.130	.169
	T5	.226[a]	.981	.331	.137	.259
2	T3	3.608[b]	.905	.370	.128	8.731E-04
	T4	1.331[b]	.889	.378	.126	6.193E-03
	T5	.748[b]	.870	.388	.123	1.880E-02
3	T4	-5.240[c]	-.222	.825	-.032	2.538E-05
	T5	-1.590[c]	-.224	.824	-.032	2.813E-04

a. Predictors in the Model: (Constant), T

b. Predictors in the Model: (Constant), T, T2

c. Predictors in the Model: (Constant), T, T2, T3

d. Dependent Variable: O

Appendix F

Appendix F

Regression analysis of companies at stage 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.013[a]	.000	-.066	1.0327090
2	.423[b]	.179	.062	.9684962
3	.425[c]	.181	-.008	1.0040625
4	.452[d]	.205	-.061	1.0298670
5	.453[e]	.205	-.156	1.0753116

a. Predictors: (Constant), Zscore(T1)

b. Predictors: (Constant), Zscore(T1), ZT12

c. Predictors: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14, ZT15

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.681E-03	1	2.681E-03	.003	.961[a]
	Residual	15.997	15	1.066		
	Total	16.000	16			
2	Regression	2.868	2	1.434	1.529	.251[b]
	Residual	13.132	14	.938		
	Total	16.000	16			
3	Regression	2.894	3	.965	.957	.442[c]
	Residual	13.106	13	1.008		
	Total	16.000	16			
4	Regression	3.272	4	.818	.771	.564[d]
	Residual	12.728	12	1.061		
	Total	16.000	16			
5	Regression	3.281	5	.656	.567	.724[e]
	Residual	12.719	11	1.156		
	Total	16.000	16			

a. Predictors: (Constant), Zscore(T1)

b. Predictors: (Constant), Zscore(T1), ZT12

c. Predictors: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14, ZT15

f. Dependent Variable: Zscore(O1)

Appendix F

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	9.593E-16	.250		.000	1.000
	Zscore(T1)	-1.29E-02	.258	-.013	-.050	.961
2	(Constant)	.536	.386		1.387	.187
	Zscore(T1)	7.576E-03	.242	.008	.031	.976
	ZT12	-.569	.326	-.424	-1.748	.102
3	(Constant)	.534	.400		1.334	.205
	Zscore(T1)	8.820E-02	.562	.088	.157	.878
	ZT12	-.565	.338	-.421	-1.671	.119
	ZT13	-5.40E-02	.337	-.090	-.160	.875
4	(Constant)	.772	.573		1.349	.202
	Zscore(T1)	.167	.591	.167	.283	.782
	ZT12	-1.195	1.110	-.890	-1.077	.303
	ZT13	-.113	.359	-.189	-.314	.759
	ZT14	.253	.424	.499	.597	.561
5	(Constant)	.784	.613		1.279	.227
	Zscore(T1)	.281	1.479	.281	.190	.853
	ZT12	-1.208	1.169	-.899	-1.033	.324
	ZT13	-.295	2.181	-.493	-.135	.895
	ZT14	.253	.443	.499	.572	.579
	ZT15	5.668E-02	.670	.211	.085	.934

a. Dependent Variable: Zscore(O1)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT12	-.424[a]	-1.748	.102	-.423	.998
	ZT13	-.154[a]	-.258	.800	-.069	.200
	ZT14	-.358[a]	-1.429	.175	-.357	.996
	ZT15	-.140[a]	-.346	.734	-.092	.433
2	ZT13	-.090[b]	-.160	.875	-.044	.199
	ZT14	.427[b]	.551	.591	.151	.103
	ZT15	-.055[b]	-.143	.888	-.040	.426
3	ZT14	.499[c]	.597	.561	.170	9.506E-02
	ZT15	.208[c]	.086	.933	.025	1.166E-02
4	ZT15	.211[d]	.085	.934	.025	1.166E-02

a. Predictors in the Model: (Constant), Zscore(T1)

b. Predictors in the Model: (Constant), Zscore(T1), ZT12

c. Predictors in the Model: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors in the Model: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Dependent Variable: Zscore(O1)

Appendix G

Regression analysis of companies at stage 2

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.212[a]	.045	-.029	1.0141656
2	.346[b]	.120	-.027	1.0132484
3	.387[c]	.150	-.082	1.0401252
4	.404[d]	.164	-.171	1.0821285
5	.407[e]	.166	-.297	1.1390618

a. Predictors: (Constant), Zscore(T2)

b. Predictors: (Constant), Zscore(T2), ZT22

c. Predictors: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24, ZT25

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	.629	1	.629	.612	.448[a]
	Residual	13.371	13	1.029		
	Total	14.000	14			
2	Regression	1.680	2	.840	.818	.464[b]
	Residual	12.320	12	1.027		
	Total	14.000	14			
3	Regression	2.100	3	.700	.647	.601[c]
	Residual	11.900	11	1.082		
	Total	14.000	14			
4	Regression	2.290	4	.572	.489	.744[d]
	Residual	11.710	10	1.171		
	Total	14.000	14			
5	Regression	2.323	5	.465	.358	.865[e]
	Residual	11.677	9	1.297		
	Total	14.000	14			

a. Predictors: (Constant), Zscore(T2)

b. Predictors: (Constant), Zscore(T2), ZT22

c. Predictors: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24, ZT25

f. Dependent Variable: Zscore(O2)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-2.88E-16	.262		.000	1.000
	Zscore(T2)	-.212	.271	-.212	-.782	.448
2	(Constant)	-.296	.392		-.754	.466
	Zscore(T2)	-.167	.274	-.167	-.609	.554
	ZT22	.317	.313	.278	1.012	.332
3	(Constant)	-.242	.412		-.588	.569
	Zscore(T2)	.129	.553	.129	.234	.819
	ZT22	.234	.348	.205	.671	.516
	ZT23	-.181	.291	-.361	-.623	.546
4	(Constant)	-1.88E-02	.700		-.027	.979
	Zscore(T2)	2.379E-02	.632	.024	.038	.971
	ZT22	-.328	1.440	-.288	-.228	.824
	ZT23	-8.25E-02	.389	-.164	-.212	.836
	ZT24	.198	.491	.564	.403	.695
5	(Constant)	-3.23E-02	.742		-.044	.966
	Zscore(T2)	-.139	1.219	-.139	-.114	.912
	ZT22	-.255	1.585	-.223	-.161	.876
	ZT23	.218	1.930	.433	.113	.913
	ZT24	.149	.602	.424	.247	.811
	ZT25	-9.37E-02	.588	-.523	-.159	.877

a. Dependent Variable: Zscore(O2)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT22	.278[a]	1.012	.332	.280	.974
	ZT23	-.510[a]	-.976	.348	-.271	.270
	ZT24	.329[a]	1.193	.256	.326	.937
	ZT25	-.431[a]	-1.124	.283	-.309	.491
2	ZT23	-.361[b]	-.623	.546	-.185	.230
	ZT24	.751[b]	.722	.485	.213	7.062E-02
	ZT25	-.313[b]	-.680	.510	-.201	.364
3	ZT24	.564[c]	.403	.695	.127	4.271E-02
	ZT25	-.940[c]	-.350	.733	-.110	1.167E-02
4	ZT25	-.523[d]	-.159	.877	-.053	8.588E-03

a. Predictors in the Model: (Constant), Zscore(T2)

b. Predictors in the Model: (Constant), Zscore(T2), ZT22

c. Predictors in the Model: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors in the Model: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Dependent Variable: Zscore(O2)

Appendix H

Regression analysis of companies at stage 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.511[a]	.261	.222	.8820619
2	.519[b]	.270	.188	.9008358
3	.524[c]	.274	.146	.9238678
4	.552[d]	.305	.131	.9321133
5	.566[e]	.320	.094	.9519647

a. Predictors: (Constant), Zscore(T3)

b. Predictors: (Constant), Zscore(T3), ZT32

c. Predictors: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34, ZT35

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5.217	1	5.217	6.706	.018[a]
	Residual	14.783	19	.778		
	Total	20.000	20			
2	Regression	5.393	2	2.696	3.323	.059[b]
	Residual	14.607	18	.812		
	Total	20.000	20			
3	Regression	5.490	3	1.830	2.144	.132[c]
	Residual	14.510	17	.854		
	Total	20.000	20			
4	Regression	6.099	4	1.525	1.755	.187[d]
	Residual	13.901	16	.869		
	Total	20.000	20			
5	Regression	6.406	5	1.281	1.414	.275[e]
	Residual	13.594	15	.906		
	Total	20.000	20			

a. Predictors: (Constant), Zscore(T3)

b. Predictors: (Constant), Zscore(T3), ZT32

c. Predictors: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34, ZT35

f. Dependent Variable: Zscore(O3)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-5.31E-16	.192		.000	1.000
	Zscore(T3)	.511	.197	.511	2.590	.018
2	(Constant)	-7.38E-02	.253		-.292	.773
	Zscore(T3)	.454	.235	.454	1.933	.069
	ZT32	7.752E-02	.167	.109	.465	.647
3	(Constant)	-5.95E-02	.263		-.227	.824
	Zscore(T3)	.612	.526	.612	1.163	.261
	ZT32	.107	.192	.150	.557	.585
	ZT33	-6.09E-02	.180	-.195	-.337	.740
4	(Constant)	-.215	.324		-.665	.516
	Zscore(T3)	.505	.546	.505	.925	.369
	ZT32	.725	.763	1.022	.950	.356
	ZT33	3.732E-02	.217	.120	.172	.865
	ZT34	-.179	.214	-1.043	-.837	.415
5	(Constant)	-.194	.333		-.583	.569
	Zscore(T3)	.210	.754	.210	.278	.785
	ZT32	.449	.912	.633	.492	.630
	ZT33	.503	.829	1.615	.607	.553
	ZT34	-6.65E-02	.291	-.388	-.229	.822
	ZT35	-.118	.202	-1.483	-.583	.569

a. Dependent Variable: Zscore(O3)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT32	.109[a]	.465	.647	.109	.734
	ZT33	-.050[a]	-.098	.923	-.023	.160
	ZT34	.056[a]	.220	.828	.052	.634
	ZT35	-.089[a]	-.227	.823	-.054	.267
2	ZT33	-.195[b]	-.337	.740	-.082	.127
	ZT34	-.926[b]	-.911	.375	-.216	3.961E-02
	ZT35	-.290[b]	-.596	.559	-.143	.178
3	ZT34	-1.043[c]	-.837	.415	-.205	2.799E-02
	ZT35	-1.868[c]	-1.010	.328	-.245	1.245E-02
4	ZT35	-1.483[d]	-.583	.569	-.149	6.994E-03

a. Predictors in the Model: (Constant), Zscore(T3)

b. Predictors in the Model: (Constant), Zscore(T3), ZT32

c. Predictors in the Model: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors in the Model: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Dependent Variable: Zscore(O3)

Appendix I

Regression analysis of companies at stage 1 (no outliers)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(T1)[a]	.	Enter
2	ZT12[a]	.	Enter
3	ZT13[a]	.	Enter
4	ZT14[a]	.	Enter
5	ZT15[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(O1)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.006[a]	.000	-.077	1.0377313
2	.523[b]	.274	.153	.9204823
3	.524[c]	.275	.077	.9607574
4	.581[d]	.337	.072	.9632760
5	.581[e]	.338	-.030	1.0148478

a. Predictors: (Constant), Zscore(T1)

b. Predictors: (Constant), Zscore(T1), ZT12

c. Predictors: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14, ZT15

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.778E-04	1	4.778E-04	.000	.984[a]
	Residual	14.000	13	1.077		
	Total	14.000	14			
2	Regression	3.833	2	1.916	2.262	.147[b]
	Residual	10.167	12	.847		
	Total	14.000	14			
3	Regression	3.846	3	1.282	1.389	.298[c]
	Residual	10.154	11	.923		
	Total	14.000	14			
4	Regression	4.721	4	1.180	1.272	.344[d]
	Residual	9.279	10	.928		
	Total	14.000	14			
5	Regression	4.731	5	.946	.919	.511[e]
	Residual	9.269	9	1.030		
	Total	14.000	14			

a. Predictors: (Constant), Zscore(T1)

b. Predictors: (Constant), Zscore(T1), ZT12

c. Predictors: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Predictors: (Constant), Zscore(T1), ZT12, ZT13, ZT14, ZT15

f. Dependent Variable: Zscore(O1)

Appendix I

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-5.67E-16	.268		.000	1.000
	Zscore(T1)	-5.84E-03	.277	-.006	-.021	.984
2	(Constant)	.615	.374		1.643	.126
	Zscore(T1)	-.150	.255	-.150	-.586	.569
	ZT12	-.659	.310	-.543	-2.127	.055
3	(Constant)	.618	.392		1.579	.143
	Zscore(T1)	-8.57E-02	.586	-.086	-.146	.886
	ZT12	-.671	.339	-.553	-1.980	.073
	ZT13	-4.14E-02	.338	-.074	-.122	.905
4	(Constant)	.982	.543		1.809	.101
	Zscore(T1)	-.115	.588	-.115	-.195	.849
	ZT12	-1.723	1.136	-1.419	-1.517	.160
	ZT13	2.873E-02	.346	.052	.083	.935
	ZT14	.420	.433	.943	.971	.355
5	(Constant)	.955	.635		1.505	.167
	Zscore(T1)	-.225	1.289	-.225	-.174	.865
	ZT12	-1.639	1.479	-1.350	-1.108	.297
	ZT13	.217	1.964	.390	.110	.915
	ZT14	.382	.599	.858	.638	.539
	ZT15	-6.18E-02	.635	-.259	-.097	.925

a. Dependent Variable: Zscore(O1)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT12	-.543[a]	-2.127	.055	-.523	.930
	ZT13	.287[a]	.444	.665	.127	.197
	ZT14	-.455[a]	-1.645	.126	-.429	.890
	ZT15	.175[a]	.380	.711	.109	.388
2	ZT13	-.074[b]	-.122	.905	-.037	.179
	ZT14	.926[b]	1.022	.329	.295	7.340E-02
	ZT15	-.123[b]	-.282	.783	-.085	.344
3	ZT14	.943[c]	.971	.355	.293	7.021E-02
	ZT15	-1.360[c]	-.693	.504	-.214	1.797E-02
4	ZT15	-.259[d]	-.097	.925	-.032	1.041E-02

a. Predictors in the Model: (Constant), Zscore(T1)

b. Predictors in the Model: (Constant), Zscore(T1), ZT12

c. Predictors in the Model: (Constant), Zscore(T1), ZT12, ZT13

d. Predictors in the Model: (Constant), Zscore(T1), ZT12, ZT13, ZT14

e. Dependent Variable: Zscore(O1)

Appendix J

Regression analysis of companies at stage 2 (no outliers)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(T2)[a]	.	Enter
2	ZT22[a]	.	Enter
3	ZT23[a]	.	Enter
4	ZT24[a]	.	Enter
5	ZT25[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(O2)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.400[a]	.160	.084	.9572057
2	.588[b]	.346	.215	.8862112
3	.596[c]	.356	.141	.9269601
4	.640[d]	.409	.114	.9411854
5	.640[e]	.410	-.012	1.0060885

a. Predictors: (Constant), Zscore(T2)

b. Predictors: (Constant), Zscore(T2), ZT22

c. Predictors: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24, ZT25

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.921	1	1.921	2.097	.175[a]
	Residual	10.079	11	.916		
	Total	12.000	12			
2	Regression	4.146	2	2.073	2.640	.120[b]
	Residual	7.854	10	.785		
	Total	12.000	12			
3	Regression	4.267	3	1.422	1.655	.245[c]
	Residual	7.733	9	.859		
	Total	12.000	12			
4	Regression	4.913	4	1.228	1.387	.321[d]
	Residual	7.087	8	.886		
	Total	12.000	12			
5	Regression	4.915	5	.983	.971	.495[e]
	Residual	7.085	7	1.012		
	Total	12.000	12			

a. Predictors: (Constant), Zscore(T2)

b. Predictors: (Constant), Zscore(T2), ZT22

c. Predictors: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Predictors: (Constant), Zscore(T2), ZT22, ZT23, ZT24, ZT25

f. Dependent Variable: Zscore(O2)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	1.064E-19	.265		.000	1.000
	Zscore(T2)	-.400	.276	-.400	-1.448	.175
2	(Constant)	-.471	.372		-1.264	.235
	Zscore(T2)	-.453	.258	-.453	-1.757	.109
	ZT22	.510	.303	.434	1.683	.123
3	(Constant)	-.433	.402		-1.077	.310
	Zscore(T2)	-.253	.598	-.253	-.423	.682
	ZT22	.482	.326	.410	1.478	.174
	ZT23	-.120	.319	-.222	-.374	.717
4	(Constant)	-2.53E-02	.628		-.040	.969
	Zscore(T2)	-.257	.607	-.257	-.423	.683
	ZT22	-.674	1.393	-.574	-.484	.641
	ZT23	-6.99E-02	.329	-.130	-.212	.837
	ZT24	.431	.504	1.015	.854	.418
5	(Constant)	-2.58E-02	.672		-.038	.970
	Zscore(T2)	-.293	1.254	-.293	-.234	.822
	ZT22	-.679	1.494	-.577	-.454	.663
	ZT23	-1.50E-03	2.067	-.003	-.001	.999
	ZT24	.431	.539	1.014	.799	.450
	ZT25	-2.20E-02	.654	-.097	-.034	.974

a. Dependent Variable: Zscore(O2)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT22	.434[a]	1.683	.123	.470	.985
	ZT23	-.426[a]	-.698	.501	-.216	.215
	ZT24	.476[a]	1.922	.083	.519	.998
	ZT25	-.353[a]	-.783	.452	-.240	.389
2	ZT23	-.222[b]	-.374	.717	-.124	.203
	ZT24	1.059[b]	.958	.363	.304	5.403E-02
	ZT25	-.168[b]	-.376	.716	-.124	.357
3	ZT24	1.015[c]	.854	.418	.289	5.234E-02
	ZT25	-.105[c]	-.037	.971	-.013	1.004E-02
4	ZT25	-.097[d]	-.034	.974	-.013	1.004E-02

a. Predictors in the Model: (Constant), Zscore(T2)

b. Predictors in the Model: (Constant), Zscore(T2), ZT22

c. Predictors in the Model: (Constant), Zscore(T2), ZT22, ZT23

d. Predictors in the Model: (Constant), Zscore(T2), ZT22, ZT23, ZT24

e. Dependent Variable: Zscore(O2)

Appendix K

Regression analysis of companies at stage 3 (no outliers)

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(T3)[a]	.	Enter
2	ZT32[a]	.	Enter
3	ZT33[a]	.	Enter
4	ZT34[a]	.	Enter
5	ZT35[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(O3)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.571[a]	.326	.291	.8420504
2	.580[b]	.336	.263	.8586603
3	.580[c]	.337	.220	.8834318
4	.608[d]	.370	.212	.8876629
5	.610[e]	.372	.163	.9148774

a. Predictors: (Constant), Zscore(T3)

b. Predictors: (Constant), Zscore(T3), ZT32

c. Predictors: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34, ZT35

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.528	1	6.528	9.207	.007[a]
	Residual	13.472	19	.709		
	Total	20.000	20			
2	Regression	6.729	2	3.364	4.563	.025[b]
	Residual	13.271	18	.737		
	Total	20.000	20			
3	Regression	6.732	3	2.244	2.875	.067[c]
	Residual	13.268	17	.780		
	Total	20.000	20			
4	Regression	7.393	4	1.848	2.346	.099[d]
	Residual	12.607	16	.788		
	Total	20.000	20			
5	Regression	7.445	5	1.489	1.779	.178[e]
	Residual	12.555	15	.837		
	Total	20.000	20			

a. Predictors: (Constant), Zscore(T3)

b. Predictors: (Constant), Zscore(T3), ZT32

c. Predictors: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Predictors: (Constant), Zscore(T3), ZT32, ZT33, ZT34, ZT35

f. Dependent Variable: Zscore(O3)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-3.53E-16	.184		.000	1.000
	Zscore(T3)	.571	.188	.571	3.034	.007
2	(Constant)	-7.89E-02	.241		-.328	.747
	Zscore(T3)	.511	.224	.511	2.281	.035
	ZT32	8.286E-02	.159	.117	.522	.608
3	(Constant)	-7.61E-02	.251		-.303	.765
	Zscore(T3)	.542	.503	.542	1.076	.297
	ZT32	8.854E-02	.183	.125	.483	.635
	ZT33	-1.18E-02	.173	-.038	-.069	.946
4	(Constant)	-.238	.308		-.773	.451
	Zscore(T3)	.431	.520	.431	.828	.420
	ZT32	.732	.727	1.033	1.008	.329
	ZT33	9.045E-02	.206	.290	.438	.667
	ZT34	-.186	.203	-1.086	-.916	.373
5	(Constant)	-.229	.320		-.718	.484
	Zscore(T3)	.309	.725	.309	.426	.676
	ZT32	.619	.876	.872	.706	.491
	ZT33	.282	.797	.905	.354	.728
	ZT34	-.140	.280	-.817	-.501	.624
	ZT35	-4.84E-02	.194	-.610	-.250	.806

a. Dependent Variable: Zscore(O3)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT32	.117[a]	.522	.608	.122	.734
	ZT33	.083[a]	.171	.866	.040	.160
	ZT34	.072[a]	.295	.771	.069	.634
	ZT35	.025[a]	.066	.948	.016	.267
2	ZT33	-.038[b]	-.069	.946	-.017	.127
	ZT34	-.805[b]	-.827	.420	-.197	3.961E-02
	ZT35	-.130[b]	-.279	.784	-.068	.178
3	ZT34	-1.086[c]	-.916	.373	-.223	2.799E-02
	ZT35	-1.421[c]	-.794	.439	-.195	1.245E-02
4	ZT35	-.610[d]	-.250	.806	-.064	6.994E-03

a. Predictors in the Model: (Constant), Zscore(T3)

b. Predictors in the Model: (Constant), Zscore(T3), ZT32

c. Predictors in the Model: (Constant), Zscore(T3), ZT32, ZT33

d. Predictors in the Model: (Constant), Zscore(T3), ZT32, ZT33, ZT34

e. Dependent Variable: Zscore(O3)

Appendix L

Regression analysis of standardized O-T values (49 data points - no outliers)

Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	ZT[a]	.	Enter
2	ZT2[a]	.	Enter
3	ZT3[a]	.	Enter
4	ZT4[a]	.	Enter
5	ZT5[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: ZO

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.657[a]	.431	.419	.6646
2	.661[b]	.437	.413	.6683
3	.670[c]	.449	.413	.6683
4	.674[d]	.454	.404	.6734
5	.674[e]	.454	.390	.6811

a. Predictors: (Constant), ZT

b. Predictors: (Constant), ZT, ZT2

c. Predictors: (Constant), ZT, ZT2, ZT3

d. Predictors: (Constant), ZT, ZT2, ZT3, ZT4

e. Predictors: (Constant), ZT, ZT2, ZT3, ZT4, ZT5

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.754	1	15.754	35.667	.000[a]
	Residual	20.759	47	.442		
	Total	36.513	48			
2	Regression	15.968	2	7.984	17.875	.000[b]
	Residual	20.545	46	.447		
	Total	36.513	48			
3	Regression	16.413	3	5.471	12.248	.000[c]
	Residual	20.100	45	.447		
	Total	36.513	48			
4	Regression	16.562	4	4.141	9.132	.000[d]
	Residual	19.950	44	.453		
	Total	36.513	48			
5	Regression	16.566	5	3.313	7.142	.000[e]
	Residual	19.947	43	.464		
	Total	36.513	48			

a. Predictors: (Constant), ZT

b. Predictors: (Constant), ZT, ZT2

c. Predictors: (Constant), ZT, ZT2, ZT3

d. Predictors: (Constant), ZT, ZT2, ZT3, ZT4

e. Predictors: (Constant), ZT, ZT2, ZT3, ZT4, ZT5

f. Dependent Variable: ZO

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-1.20E-02	.095		-.126	.900
	ZT	.576	.097	.657	5.972	.000
2	(Constant)	-7.79E-02	.135		-.577	.567
	ZT	.569	.098	.649	5.835	.000
	ZT2	6.825E-02	.099	.077	.692	.492
3	(Constant)	-3.75E-02	.141		-.266	.791
	ZT	.393	.202	.447	1.942	.058
	ZT2	2.177E-02	.109	.025	.200	.843
	ZT3	9.336E-02	.094	.240	.998	.324
4	(Constant)	-.103	.182		-.567	.574
	ZT	.345	.220	.393	1.569	.124
	ZT2	.211	.346	.237	.608	.546
	ZT3	.132	.116	.339	1.141	.260
	ZT4	-6.39E-02	.111	-.252	-.575	.568
5	(Constant)	-.100	.189		-.529	.599
	ZT	.319	.382	.364	.835	.408
	ZT2	.198	.380	.224	.523	.604
	ZT3	.172	.492	.442	.349	.729
	ZT4	-5.73E-02	.138	-.226	-.416	.679
	ZT5	-1.08E-02	.130	-.088	-.083	.934

a. Dependent Variable: ZO

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZT2	.077[a]	.692	.492	.102	.989
	ZT3	.261[a]	1.211	.232	.176	.258
	ZT4	.078[a]	.690	.494	.101	.955
	ZT5	.176[a]	1.128	.265	.164	.496
2	ZT3	.240[b]	.998	.324	.147	.211
	ZT4	.037[b]	.104	.917	.016	9.740E-02
	ZT5	.164[b]	.885	.381	.131	.360
3	ZT4	-.252[c]	-.575	.568	-.086	6.474E-02
	ZT5	-.343[c]	-.400	.691	-.060	1.692E-02
4	ZT5	-.088[d]	-.083	.934	-.013	1.129E-02

a. Predictors in the Model: (Constant), ZT

b. Predictors in the Model: (Constant), ZT, ZT2

c. Predictors in the Model: (Constant), ZT, ZT2, ZT3

d. Predictors in the Model: (Constant), ZT, ZT2, ZT3, ZT4

e. Dependent Variable: ZO

Appendix M

Regression Analysis of type 'none'
Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(NONE_T)[a]	.	Enter
2	ZNONE_T2[a]	.	Enter
3	ZNONE_T3[a]	.	Enter
4	ZNONE_T4[a]	.	Enter
5	ZNONE_T5[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(NONE_O)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.276[a]	.076	.015	.9926853
2	.284[b]	.080	-.051	1.0251723
3	.286[c]	.082	-.130	1.0630426
4	.288[d]	.083	-.223	1.1059262
5	.288[e]	.083	-.334	1.1549689

a. Predictors: (Constant), Zscore(NONE_T)

b. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2

c. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3

d. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3, ZNONE_T4

e. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3, ZNONE_T4, ZNONE_T5

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.219	1	1.219	1.237	.284[a]
	Residual	14.781	15	.985		
	Total	16.000	16			
2	Regression	1.286	2	.643	.612	.556[b]
	Residual	14.714	14	1.051		
	Total	16.000	16			
3	Regression	1.309	3	.436	.386	.765[c]
	Residual	14.691	13	1.130		
	Total	16.000	16			
4	Regression	1.323	4	.331	.270	.891[d]
	Residual	14.677	12	1.223		
	Total	16.000	16			
5	Regression	1.327	5	.265	.199	.956[e]
	Residual	14.673	11	1.334		
	Total	16.000	16			

a. Predictors: (Constant), Zscore(NONE_T)

b. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2

c. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3

d. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3, ZNONE_T4

e. Predictors: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3, ZNONE_T4, ZNONE_T5

f. Dependent Variable: Zscore(NONE_O)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	8.989E-18	.241		.000	1.000
	Zscore(NONE_T)	.276	.248	.276	1.112	.284
2	(Constant)	8.677E-02	.423		.205	.840
	Zscore(NONE_T)	.300	.273	.300	1.099	.290
	ZNONE_T2	-9.22E-02	.363	-.069	-.254	.803
3	(Constant)	9.652E-02	.444		.218	.831
	Zscore(NONE_T)	.198	.769	.198	.257	.801
	ZNONE_T2	-.121	.428	-.091	-.283	.782
	ZNONE_T3	7.263E-02	.510	.117	.142	.889
4	(Constant)	.134	.580		.231	.821
	Zscore(NONE_T)	.253	.953	.253	.266	.795
	ZNONE_T2	-.266	1.430	-.200	-.186	.855
	ZNONE_T3	1.706E-02	.744	.028	.023	.982
	ZNONE_T4	7.925E-02	.743	.141	.107	.917
5	(Constant)	.134	.606		.222	.829
	Zscore(NONE_T)	.321	1.673	.321	.192	.851
	ZNONE_T2	-.234	1.625	-.176	-.144	.888
	ZNONE_T3	-.111	2.654	-.179	-.042	.967
	ZNONE_T4	5.069E-02	.961	.090	.053	.959
	ZNONE_T5	5.231E-02	1.038	.170	.050	.961

a. Dependent Variable: Zscore(NONE_O)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZNONE_T2	-.069[a]	-.254	.803	-.068	.883
	ZNONE_T3	.006[a]	.009	.993	.002	.134
	ZNONE_T4	-.052[a]	-.178	.861	-.047	.784
	ZNONE_T5	-.003[a]	-.007	.994	-.002	.323
2	ZNONE_T3	.117[b]	.142	.889	.039	.104
	ZNONE_T4	.162[b]	.179	.861	.050	8.584E-02
	ZNONE_T5	.094[b]	.164	.873	.045	.216
3	ZNONE_T4	.141[c]	.107	.917	.031	4.367E-02
	ZNONE_T5	.275[c]	.105	.918	.030	1.119E-02
4	ZNONE_T5	.170[d]	.050	.961	.015	7.303E-03

a. Predictors in the Model: (Constant), Zscore(NONE_T)

b. Predictors in the Model: (Constant), Zscore(NONE_T), ZNONE_T2

c. Predictors in the Model: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3

d. Predictors in the Model: (Constant), Zscore(NONE_T), ZNONE_T2, ZNONE_T3, ZNONE_T4

e. Dependent Variable: Zscore(NONE_O)

Appendix N

Regression Analysis of type 'ISO'

Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(ISO_T)[a]	.	Enter
2	ZISO_T2[a]	.	Enter
3	ZISO_T3[a]	.	Enter
4	ZISO_T4[a]	.	Enter
5	ZISO_T5[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(ISO_O)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.401[a]	.161	.056	.9714366
2	.531[b]	.282	.076	.9610875
3	.578[c]	.334	.001	.9992958
4	.600[d]	.360	-.152	1.0732631
5	.696[e]	.484	-.162	1.0777638

a. Predictors: (Constant), Zscore(ISO_T)

b. Predictors: (Constant), Zscore(ISO_T), ZISO_T2

c. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3

d. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3, ZISO_T4

e. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3, ZISO_T4, ZISO_T5

Appendix N

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.450	1	1.450	1.537	.250[a]
	Residual	7.550	8	.944		
	Total	9.000	9			
2	Regression	2.534	2	1.267	1.372	.314[b]
	Residual	6.466	7	.924		
	Total	9.000	9			
3	Regression	3.008	3	1.003	1.004	.453[c]
	Residual	5.992	6	.999		
	Total	9.000	9			
4	Regression	3.241	4	.810	.703	.622[d]
	Residual	5.759	5	1.152		
	Total	9.000	9			
5	Regression	4.354	5	.871	.750	.627[e]
	Residual	4.646	4	1.162		
	Total	9.000	9			

a. Predictors: (Constant), Zscore(ISO_T)

b. Predictors: (Constant), Zscore(ISO_T), ZISO_T2

c. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3

d. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3, ZISO_T4

e. Predictors: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3, ZISO_T4, ZISO_T5

f. Dependent Variable: Zscore(ISO_O)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-2.12E-16	.307		.000	1.000
	Zscore(ISO_T)	.401	.324	.401	1.240	.250
2	(Constant)	-.583	.618		-.943	.377
	Zscore(ISO_T)	.539	.345	.539	1.564	.162
	ZISO_T2	.647	.598	.373	1.083	.315
3	(Constant)	-.355	.722		-.492	.641
	Zscore(ISO_T)	1.307	1.171	1.307	1.116	.307
	ZISO_T2	.247	.850	.143	.291	.781
	ZISO_T3	-.692	1.005	-.909	-.689	.516
4	(Constant)	-.707	1.102		-.641	.550
	Zscore(ISO_T)	1.309	1.258	1.309	1.041	.346
	ZISO_T2	1.537	3.014	.886	.510	.632
	ZISO_T3	-.851	1.136	-1.118	-.750	.487
	ZISO_T4	-.757	1.685	-.892	-.449	.672
5	(Constant)	.881	1.964		.449	.677
	Zscore(ISO_T)	4.771	3.756	4.771	1.270	.273
	ZISO_T2	-3.323	5.815	-1.916	-.572	.598
	ZISO_T3	-8.334	7.728	-10.944	-1.078	.342
	ZISO_T4	2.359	3.605	2.781	.654	.549
	ZISO_T5	3.770	3.851	7.729	.979	.383

a. Dependent Variable: Zscore(ISO_O)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZISO_T2	.373[a]	1.083	.315	.379	.865
	ZISO_T3	-1.171[a]	-1.303	.234	-.442	.119
	ZISO_T4	.376[a]	.988	.356	.350	.725
	ZISO_T5	-.674[a]	-1.067	.321	-.374	.259
2	ZISO_T3	-.909[b]	-.689	.516	-.271	6.373E-02
	ZISO_T4	-.427[b]	-.235	.822	-.096	3.590E-02
	ZISO_T5	-.384[b]	-.407	.698	-.164	.131
3	ZISO_T4	-.892[c]	-.449	.672	-.197	3.241E-02
	ZISO_T5	3.167[c]	.908	.406	.376	9.391E-03
4	ZISO_T5	7.729[d]	.979	.383	.440	2.071E-03

a. Predictors in the Model: (Constant), Zscore(ISO_T)

b. Predictors in the Model: (Constant), Zscore(ISO_T), ZISO_T2

c. Predictors in the Model: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3

d. Predictors in the Model: (Constant), Zscore(ISO_T), ZISO_T2, ZISO_T3, ZISO_T4

e. Dependent Variable: Zscore(ISO_O)

Appendix O

Regression Analysis of type 'TQM'

Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(TQM_T)[a]	.	Enter
2	ZTQM_T2[a]	.	Enter
3	ZTQM_T3[a]	.	Enter
4	ZTQM_T4[a]	.	Enter
5	ZTQM_T5[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(TQM_O)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.692[a]	.479	.436	.7511882
2	.698[b]	.487	.394	.7784789
3	.698[c]	.487	.334	.8163345
4	.699[d]	.488	.261	.8598827
5	.710[e]	.504	.193	.8981234

a. Predictors: (Constant), Zscore(TQM_T)

b. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2

c. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3

d. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3, ZTQM_T4

e. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3, ZTQM_T4, ZTQM_T5

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.229	1	6.229	11.038	.006[a]
	Residual	6.771	12	.564		
	Total	13.000	13			
2	Regression	6.334	2	3.167	5.226	.025[b]
	Residual	6.666	11	.606		
	Total	13.000	13			
3	Regression	6.336	3	2.112	3.169	.072[c]
	Residual	6.664	10	.666		
	Total	13.000	13			
4	Regression	6.345	4	1.586	2.145	.157[d]
	Residual	6.655	9	.739		
	Total	13.000	13			
5	Regression	6.547	5	1.309	1.623	.258[e]
	Residual	6.453	8	.807		
	Total	13.000	13			

a. Predictors: (Constant), Zscore(TQM_T)

b. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2

c. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3

d. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3, ZTQM_T4

e. Predictors: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3, ZTQM_T4, ZTQM_T5

f. Dependent Variable: Zscore(TQM_O)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-3.05E-17	.201		.000	1.000
	Zscore(TQM_T)	.692	.208	.692	3.322	.006
2	(Constant)	-8.75E-02	.296		-.296	.773
	Zscore(TQM_T)	.665	.225	.665	2.951	.013
	ZTQM_T2	9.427E-02	.226	.094	.416	.685
3	(Constant)	-8.40E-02	.316		-.266	.796
	Zscore(TQM_T)	.640	.483	.640	1.325	.215
	ZTQM_T2	8.641E-02	.273	.086	.317	.758
	ZTQM_T3	1.408E-02	.240	.031	.059	.954
4	(Constant)	-.119	.453		-.262	.799
	Zscore(TQM_T)	.605	.597	.605	1.014	.337
	ZTQM_T2	.193	.982	.192	.196	.849
	ZTQM_T3	4.433E-02	.368	.098	.120	.907
	ZTQM_T4	-4.03E-02	.357	-.135	-.113	.913
5	(Constant)	-6.17E-02	.487		-.127	.902
	Zscore(TQM_T)	.248	.949	.248	.261	.801
	ZTQM_T2	-.151	1.235	-.151	-.122	.906
	ZTQM_T3	.714	1.395	1.576	.512	.622
	ZTQM_T4	.160	.547	.534	.292	.778
	ZTQM_T5	-.222	.444	-1.486	-.500	.631

a. Dependent Variable: Zscore(TQM_O)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance
1	ZTQM_T2	.094[a]	.416	.685	.125	.918
	ZTQM_T3	.113[a]	.257	.802	.077	.242
	ZTQM_T4	.090[a]	.381	.710	.114	.844
	ZTQM_T5	.068[a]	.212	.836	.064	.457
2	ZTQM_T3	.031[b]	.059	.954	.019	.184
	ZTQM_T4	-.030[b]	-.039	.970	-.012	8.505E-02
	ZTQM_T5	-.021[b]	-.049	.962	-.015	.287
3	ZTQM_T4	-.135[c]	-.113	.913	-.038	3.999E-02
	ZTQM_T5	-.850[c]	-.443	.668	-.146	1.513E-02
4	ZTQM_T5	-1.486[d]	-.500	.631	-.174	7.022E-03

a. Predictors in the Model: (Constant), Zscore(TQM_T)

b. Predictors in the Model: (Constant), Zscore(TQM_T), ZTQM_T2

c. Predictors in the Model: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3

d. Predictors in the Model: (Constant), Zscore(TQM_T), ZTQM_T2, ZTQM_T3, ZTQM_T4

e. Dependent Variable: Zscore(TQM_O)

Appendix P

Regression Analysis of type 'BOTH' Regression

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	Zscore(BOTH_T)[a]	.	Enter
2	ZBOTH_T2[a]	.	Enter
3	ZBOTH_T3[a]	.	Enter
4	ZBOTH_T4[a]	.	Enter
5	ZBOTH_T5[a]	.	Enter

a. All requested variables entered.

b. Dependent Variable: Zscore(BOTH_O)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.508[a]	.259	.184	.9030935
2	.579[b]	.336	.188	.9011050
3	.583[c]	.340	.092	.9528969
4	.592[d]	.350	-.021	1.0103436
5	.627[e]	.394	-.112	1.0544425

a. Predictors. (Constant), Zscore(BOTH_T)

b. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2

c. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3

d. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3, ZBOTH_T4

e. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3, ZBOTH_T4, ZBOTH_T5

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.844	1	2.844	3.487	.091[a]
	Residual	8.156	10	.816		
	Total	11.000	11			
2	Regression	3.692	2	1.846	2.273	.159[b]
	Residual	7.308	9	.812		
	Total	11.000	11			
3	Regression	3.736	3	1.245	1.371	.319[c]
	Residual	7.264	8	.908		
	Total	11.000	11			
4	Regression	3.854	4	.964	.944	.492[d]
	Residual	7.146	7	1.021		
	Total	11.000	11			
5	Regression	4.329	5	.866	.779	.599[e]
	Residual	6.671	6	1.112		
	Total	11.000	11			

a. Predictors: (Constant), Zscore(BOTH_T)

b. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2

c. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3

d. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3, ZBOTH_T4

e. Predictors: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3, ZBOTH_T4, ZBOTH_T5

f. Dependent Variable: Zscore(BOTH_O)

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	-8.79E-16	.261		.000	1.000
	Zscore(BOTH_T)	.508	.272	.508	1.867	.091
2	(Constant)	-.307	.397		-.772	.460
	Zscore(BOTH_T)	.338	.319	.338	1.061	.316
	ZBOTH_T2	.335	.328	.326	1.022	.334
3	(Constant)	-.370	.510		-.727	.488
	Zscore(BOTH_T)	.535	.957	.535	.559	.591
	ZBOTH_T2	.478	.736	.465	.649	.535
	ZBOTH_T3	-.145	.658	-.301	-.220	.832
4	(Constant)	-.335	.550		-.609	.562
	Zscore(BOTH_T)	.830	1.334	.830	.622	.554
	ZBOTH_T2	8.399E-02	1.394	.082	.060	.954
	ZBOTH_T3	-.527	1.322	-1.097	-.399	.702
	ZBOTH_T4	.295	.866	.911	.341	.743
5	(Constant)	-.143	.645		-.222	.832
	Zscore(BOTH_T)	.334	1.586	.334	.210	.840
	ZBOTH_T2	-1.106	2.331	-1.076	-.474	.652
	ZBOTH_T3	.542	2.140	1.127	.253	.809
	ZBOTH_T4	1.229	1.691	3.790	.727	.495
	ZBOTH_T5	-.622	.953	-3.588	-.653	.538

a. Dependent Variable: Zscore(BOTH_O)

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
						Tolerance
1	ZBOTH_T2	.326[a]	1.022	.334	.322	.726
	ZBOTH_T3	.483[a]	.775	.458	.250	.199
	ZBOTH_T4	.362[a]	.973	.356	.309	.540
	ZBOTH_T5	.343[a]	.753	.471	.243	.372
2	ZBOTH_T3	-.301[b]	-.220	.832	-.077	4.401E-02
	ZBOTH_T4	.006[b]	.004	.997	.001	4.663E-02
	ZBOTH_T5	-.226[b]	-.234	.821	-.083	8.860E-02
3	ZBOTH_T4	.911[c]	.341	.743	.128	1.300E-02
	ZBOTH_T5	-.215[c]	-.076	.942	-.029	1.172E-02
4	ZBOTH_T5	-3.588[d]	-.653	.538	-.258	3.351E-03

a. Predictors in the Model: (Constant), Zscore(BOTH_T)

b. Predictors in the Model: (Constant), Zscore(BOTH_T), ZBOTH_T2

c. Predictors in the Model: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3

d. Predictors in the Model: (Constant), Zscore(BOTH_T), ZBOTH_T2, ZBOTH_T3, ZBOTH_T4

e. Dependent Variable: Zscore(BOTH_O)

Appendix Q

Appendix Q

Multiple comparisons of O-index for different types of quality systems

Multiple Comparisons

Dependent Variable: O

	(I) TYPE	(J) TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
Tukey HSD	both	iso	14.0167	8.214	.331	-7.8282	35.8615
		none	24.9461*	7.233	.006	5.7102	44.1819
		tqm	7.7738	7.547	.733	-12.2968	27.8444
	iso	both	-14.0167	8.214	.331	-35.8615	7.8282
		none	10.9294	7.645	.487	-9.4028	31.2617
		tqm	-6.2429	7.943	.860	-27.3665	14.8808
	none	both	-24.9461*	7.233	.006	-44.1819	-5.7102
		iso	-10.9294	7.645	.487	-31.2617	9.4028
		tqm	-17.1723	6.923	.076	-35.5851	1.2405
	tqm	both	-7.7738	7.547	.733	-27.8444	12.2968
		iso	6.2429	7.943	.860	-14.8808	27.3665
		none	17.1723	6.923	.076	-1.2405	35.5851
LSD	both	iso	14.0167	8.214	.094	-2.4900	30.5233
		none	24.9461*	7.233	.001	10.4109	39.4813
		tqm	7.7738	7.547	.308	-7.3921	22.9398
	iso	both	-14.0167	8.214	.094	-30.5233	2.4900
		none	10.9294	7.645	.159	-4.4343	26.2931
		tqm	-6.2429	7.943	.436	-22.2046	9.7188
	none	both	-24.9461*	7.233	.001	-39.4813	-10.4109
		iso	-10.9294	7.645	.159	-26.2931	4.4343
		tqm	-17.1723*	6.923	.017	-31.0856	-3.2590
	tqm	both	-7.7738	7.547	.308	-22.9398	7.3921
		iso	6.2429	7.943	.436	-9.7188	22.2046
		none	17.1723*	6.923	.017	3.2590	31.0856
Gabriel	both	iso	14.0167	8.214	.436	-8.4310	36.4643
		none	24.9461*	7.233	.007	5.2331	44.6590
		tqm	7.7738	7.547	.882	-12.8567	28.4043
	iso	both	-14.0167	8.214	.436	-36.4643	8.4310
		none	10.9294	7.645	.625	-9.8060	31.6648
		tqm	-6.2429	7.943	.964	-27.8958	15.4101
	none	both	-24.9461*	7.233	.007	-44.6590	-5.2331
		iso	-10.9294	7.645	.625	-31.6648	9.8060
		tqm	-17.1723	6.923	.093	-36.0906	1.7460
	tqm	both	-7.7738	7.547	.882	-28.4043	12.8567
		iso	6.2429	7.943	.964	-15.4101	27.8958
		none	17.1723	6.923	.093	-1.7460	36.0906
Hochberg	both	iso	14.0167	8.214	.437	-8.4542	36.4876
		none	24.9461*	7.233	.007	5.1589	44.7332
		tqm	7.7738	7.547	.882	-12.8720	28.4196
	iso	both	-14.0167	8.214	.437	-36.4876	8.4542
		none	10.9294	7.645	.634	-9.9855	31.8444
		tqm	-6.2429	7.943	.964	-27.9719	15.4862
	none	both	-24.9461*	7.233	.007	-44.7332	-5.1589
		iso	-10.9294	7.645	.634	-31.8444	9.9855
		tqm	-17.1723	6.923	.094	-36.1128	1.7683
	tqm	both	-7.7738	7.547	.882	-28.4196	12.8720
		iso	6.2429	7.943	.964	-15.4862	27.9719
		none	17.1723	6.923	.094	-1.7683	36.1128

Based on observed means. The error term is Error.

*. The mean difference is significant at the .05 level.

Appendix R

Appendix R

Multiple comparisons within stages
(Using the Gabriel's and the Hochberg's GT2 Tests)

Multiple Comparisons

Dependent Variable: Y

STAGE		(I) TYPE	(J) TYPE	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	Gabriel	ISO	none	1.1111	3.919	.987	-9.0748	11.2971
			TQM	-3.2000	4.293	.835	-14.6597	8.2597
		none	ISO	-1.1111	3.919	.987	-11.2971	9.0748
			TQM	-4.3111	3.279	.481	-13.0415	4.4193
		TQM	ISO	3.2000	4.293	.835	-8.2597	14.6597
			none	4.3111	3.279	.481	-4.4193	13.0415
	Hochberg	ISO	none	1.1111	3.919	.988	-9.4342	11.6564
			TQM	-3.2000	4.293	.838	-14.7518	8.3518
		none	ISO	-1.1111	3.919	.988	-11.6564	9.4342
			TQM	-4.3111	3.279	.489	-13.1339	4.5117
		TQM	ISO	3.2000	4.293	.838	-8.3518	14.7518
			none	4.3111	3.279	.489	-4.5117	13.1339
2	Gabriel	ISO	none	-8.9000	3.821	.176	-20.6112	2.8112
			TQM	-13.2500*	3.955	.032	-25.4968	-1.0032
			Both	-13.0000*	3.955	.036	-25.2468	-.7532
		none	ISO	8.9000	3.821	.176	-2.8112	20.6112
			TQM	-4.3500	3.064	.648	-13.9600	5.2600
			Both	-4.1000	3.064	.700	-13.7100	5.5100
		TQM	ISO	13.2500*	3.955	.032	1.0032	25.4968
			none	4.3500	3.064	.648	-5.2600	13.9600
			Both	.2500	3.229	1.000	-9.8955	10.3955
		Both	ISO	13.0000*	3.955	.036	.7532	25.2468
			none	4.1000	3.064	.700	-5.5100	13.7100
			TQM	-.2500	3.229	1.000	-10.3955	9.8955
	Hochberg	ISO	none	-8.9000	3.821	.193	-20.9044	3.1044
			TQM	-13.2500*	3.955	.035	-25.6757	-.8243
			Both	-13.0000*	3.955	.039	-25.4257	-.5743
		none	ISO	8.9000	3.821	.193	-3.1044	20.9044
			TQM	-4.3500	3.064	.650	-13.9749	5.2749
			Both	-4.1000	3.064	.701	-13.7249	5.5249
		TQM	ISO	13.2500*	3.955	.035	.8243	25.6757
			none	4.3500	3.064	.650	-5.2749	13.9749
			Both	.2500	3.229	1.000	-9.8955	10.3955
		Both	ISO	13.0000*	3.955	.039	.5743	25.4257
			none	4.1000	3.064	.701	-5.5249	13.7249
			TQM	-.2500	3.229	1.000	-10.3955	9.8955
3	Gabriel	ISO	none	4.8667	3.022	.510	-3.9718	13.7052
			TQM	-3.0000	2.617	.817	-10.7159	4.7159
			Both	-3.6750	2.359	.546	-10.5829	3.2329
		none	ISO	-4.8667	3.022	.510	-13.7052	3.9718
			TQM	-7.8667	3.022	.096	-16.7052	.9718
			Both	-8.5417*	2.802	.034	-16.5722	-.5111
		TQM	ISO	3.0000	2.617	.817	-4.7159	10.7159
			none	7.8667	3.022	.096	-.9718	16.7052
			Both	-.6750	2.359	1.000	-7.5829	6.2329
		Both	ISO	3.6750	2.359	.546	-3.2329	10.5829
			none	8.5417*	2.802	.034	.5111	16.5722
			TQM	.6750	2.359	1.000	-6.2329	7.5829
	Hochberg	ISO	none	4.8667	3.022	.519	-4.0429	13.7762
			TQM	-3.0000	2.617	.817	-10.7159	4.7159
			Both	-3.6750	2.359	.553	-10.6300	3.2800
		none	ISO	-4.8667	3.022	.519	-13.7762	4.0429
			TQM	-7.8667	3.022	.100	-16.7762	1.0429
			Both	-8.5417*	2.802	.041	-16.8010	-.2823
		TQM	ISO	3.0000	2.617	.817	-4.7159	10.7159
			none	7.8667	3.022	.100	-1.0429	16.7762
			Both	-.6750	2.359	1.000	-7.6300	6.2800
		Both	ISO	3.6750	2.359	.553	-3.2800	10.6300
			none	8.5417*	2.802	.041	.2823	16.8010
			TQM	.6750	2.359	1.000	-6.2800	7.6300

Based on observed means. The error term is Error.

*. The mean difference is significant at the .05 level.