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Introduction

The overall objectives of Industrial Technology (IT) programs are to develop and prepare supervisors and managers for industry. The program should contain a component that leads to an understanding and awareness of the impact of quality management practices in order to survive in this competitive market. In IT programs that offer quality management courses as a requirement or an elective, it has become the norm to prepare industrial technology students for management positions after graduation. One of the most widely respected and recognized standard of quality management practices is ISO 9000. Many organizations have decided to seek ISO 9000 certification and the popularity of ISO 9000 has spread throughout the world since it was first introduced in 1987.

Costin (1999) found that industry experts divide the evolution of the quality movement into four distinct eras: 1) formal inspections, 2) quality control (QC), 3) quality assurance (QA), and 4) strategic quality management, which includes total quality management (TQM). TQM includes QA, QC and formal inspection, and the highest levels of quality and activity. As noted by Costin (1999), the ISO 9000 standard for Quality Systems is the foundation of the third stage, QA. It focuses on prevention rather than correction, and provides the tools for assuring that quality systems are embedded in a cycle of continuous improvement. This study provides ideas for industries that wish to implement ISO 9000 in their organizations and want to understand the impact of ISO 9000 certification.

Purpose of the Study

The purpose of this study is to investigate the effects of ISO 9000 on quality management practices in Thai industry, primarily by replicating two previous studies on the impact of ISO 9000 on international companies. These original studies were carried out by Rao et al. (1997) and Quazi et al. (2002).

Statement of Problem

Research into the ISO 9000 quality management system and its impact on industry is still inadequate; no information at all has been gathered, in fact.

Constructs of Quality Management Practices and Quality Results

As this is a replicated study, the theoretical framework and methodology are similar to those used by Rao et al. (1997) and Quazi et al. (2002). They conceptualised the following quality management constructs, which were used to formulate the questionnaire in the survey instrument:

- 1) Leadership: Leadership is conceptualized as senior management's personal involvement; acceptance of responsibility; visibility; and shared vision and goals.
- 2) Information and analysis: Information and analysis is conceptualized as the availability of data; timeliness of data; and use of data.
- 3) Strategic quality planning: Strategic quality planning is viewed as the integration of quality management and customer satisfaction into organizational plans; a long-term vision for achieving quality; and the understanding and deployment of

quality goals.

4) Human resource development:

Human resource development is conceived as continuous training and education; empowerment; and the provision of resources and a conducive environment.

5) Quality assurance: Quality assurance is conceived to be as new product-design review procedures; designed-for-manufacturability procedures; control of specification procedures; preventive maintenance; and quality control activities along the value-added chain.

6) Supplier relationships: Supplier relationships are measured by considering supplier-selection criteria; the number of suppliers; the exchange of information and services; the involvement of suppliers in the development of new products; and the duration of the relationships with suppliers.

7) Customer orientation: Customer orientation is seen as a commitment to satisfying customers; the integration of customer satisfaction into the firm's goals and vision; knowledge of customers' needs and expectations; and use of customer feedback in a new level of interaction with customers.

8) Quality results: Quality results are measured by the consideration of levels of scrap and rework; throughput time; warranty costs; customer complaints; productivity; profitability; market share; costs; and competitive position.

Methodology

Cronbach's alpha for Rao et al. and Quazi et al. revealed an internal reliability of 0.92 and 0.95 respectively. Thus, these tests were highly reliable. In order to carry out this study in Thailand, we translated the survey instrument into Thai and had the translation verified by two scholars in Thailand.

The instrument consists of four statements about eight quality management practices. A five-point Likert-type scale was used, where 5 = very high and 1 = very low, with provision for 'unable to respond'.

Six hundred and fifty companies were randomly selected from the Ministry of Industry of Thailand's database. Companies that were identified by the Thai government as being part of the manufacturing industry were the focus of this study. The organizations were divided into groups according to size and industry type, and each group was divided into ISO 9000- and non-ISO 9000-certified organizations.

The researcher received 255 responses to the 650 survey instruments that were distributed. Ten responses were excluded from the study because they were incomplete. Each survey instrument was accompanied by a cover letter and a self-addressed, pre-paid envelope. Respondents were asked to respond within two weeks from the date of receipt and follow-up phone calls were used to increase the response rate.

The survey instruments were mailed directly to top and middle managers who were responsible for quality management practices. They were selected to ensure that the respondents had the organizational knowledge to respond to the questions accurately. Most of the responses received from ISO 9000-certified companies were from the managing directors, general managers, or quality managers.

Eight one-way ANOVA tests were conducted, one for each construct. The mean value for the given construct was taken as the dependent variable. The

independent variable was the respondents' ISO 9000 registration status, which could be ISO 9001:2000, ISO 9001:1994 / ISO 9002:1994 or non-ISO 9000 registration. Tukey HSD and least significant differences (LSD) tests to test significance at 0.05 levels were used for multiple comparison tests between the groups, based on ISO 9000 status.

Findings

Two hundred and forty-five companies participated in this study. Table 1 represents the sample by industry type, showing that it comprised 237 manufacturing and eight service industries. As indicated in the table, most participants in this study were manufacturing companies, representing 97 % of the total sample. These participants were classified into seven categories: 1) wood products, 2) electronics, 3) rubber products, 4) textiles and apparel, 5) plastic products, 6) motor vehicles, and 7) others. Table 2 shows the companies grouped in terms of number of employees. Most of the samples were taken from large manufacturing organizations. The ISO 9000-registered organizations in the study tended to have more employees than the non-ISO-registered organizations.

Tables 3 and 4 show the results of descriptive statistics and ANOVA. There were significant differences in all seven quality management practices - 1) leadership, 2) information and analysis, 3) strategic quality planning, 4) human resource development, 5) quality assur-

Table 1. Industry Type

| Industry | Non-ISO | ISO 9000:1994 | ISO 9000:2000 | Total |
|---------------------|---------|---------------|---------------|-------|
| Wood | 10 | 10 | 9 | 29 |
| Electronics | 1 | 9 | 15 | 25 |
| Rubber | 11 | 21 | 9 | 41 |
| Textile and apparel | 12 | 5 | 5 | 22 |
| Plastics | 12 | 5 | 18 | 35 |
| Motor vehicles | 8 | 12 | 9 | 29 |
| Others | 10 | 22 | 24 | 56 |
| Total | 64 | 84 | 89 | 237 |

ance, 6) supplier relationships, and 7) customer orientation - between non-ISO-, ISO 9000:1994-, and ISO 9000:2000-registered organizations. However, there was no significant difference among the three groups of companies with different ISO registration status. In addition, the ISO 9000-registered organizations had higher mean results in all of the quality management practices, but for the consumer complaints aspect, their results with regard to quality were no better. The mean values for quality management practices were the highest for ISO 9000:2000 members, and ISO 9000:1994 members had higher mean values than non-ISO-registered companies.

As shown in Tables 5 and 6, a comparison of the group means for each of the quality management practices shows that there are significant differences in five of the practices: leadership, information and analysis, quality planning, human resource development, and quality assurance. To test these differences statistically, a multiple comparison test (Turkey HSD and LSD test) was carried out between the following groups: 1) between non-ISO- and ISO 9000:1994-registered organizations, 2) between non-ISO- and ISO 9000:2000-registered organizations, and 3) between ISO 9000:1994- and ISO 9000:2000-registered organizations. These test results are presented in Tables 5, 6, and 7, respectively. The results in Tables 5, 6, and 7 show that no significant differences in quality results were found in these three pairs of multiple comparisons.

Discussion and Conclusion

It could be concluded that the requirements of ISO 9000 standardization made a particular impact on five of the quality management practices: 1) management responsibility affects leadership, 2) document and data control impinge on information and analysis, 3) quality goals and quality plans influence strategic quality planning, 4) human resource development is affected by the identification of training needs and the provision of training for

Table 2. Organization Size

| Size | Employees | Non-ISO | ISO 9000:1994 | ISO 9000:2000 | Total |
|--------|-----------|---------|---------------|---------------|-------|
| Small | < 50 | 15 | 4 | 4 | 23 |
| Medium | 50 - 149 | 26 | 18 | 29 | 73 |
| Large | >150 | 26 | 62 | 61 | 149 |
| | Total | 67 | 84 | 94 | 245 |

Table 3. Descriptive Statistics

| Topic | Non-ISO | ISO 9000:1994 | ISO 9000:2000 | Average by Constructs |
|----------------------------|---------|---------------|---------------|-----------------------|
| Leadership | 3.90 | 4.14 | 4.13 | 4.07 |
| Information and analysis | 3.53 | 3.80 | 3.84 | 3.74 |
| Strategic quality planning | 3.67 | 3.90 | 3.96 | 3.86 |
| Human resource development | 3.30 | 3.53 | 3.73 | 3.55 |
| Quality assurance | 3.42 | 3.77 | 3.81 | 3.69 |
| Supplier relationship | 3.52 | 3.36 | 3.51 | 3.46 |
| Customer orientation | 3.99 | 4.01 | 4.15 | 4.06 |
| Quality results | 3.62 | 3.59 | 3.63 | 3.62 |
| Average by ISO status | 3.62 | 3.76 | 3.84 | 3.76 |

Table 4. Results of ANOVA Analysis

| Constructs | ISO status | Mean | F-Value |
|-------------------------------|---------------|------|---------|
| 1) Leadership | Non-ISO | 3.90 | 8.06* |
| | ISO 9000:1994 | 4.14 | |
| | ISO 9000:2000 | 4.13 | |
| 2) Information and analysis | Non-ISO | 3.53 | 8.34* |
| | ISO 9000:1994 | 3.80 | |
| | ISO 9000:2000 | 3.84 | |
| 3) Strategic quality planning | Non-ISO | 3.67 | 7.96* |
| | ISO 9000:1994 | 3.90 | |
| | ISO 9000:2000 | 3.96 | |
| 4) Human resource development | Non-ISO | 3.30 | 15.73* |
| | ISO 9000:1994 | 3.53 | |
| | ISO 9000:2000 | 3.73 | |
| 5) Quality assurance | Non-ISO | 3.42 | 12.76* |
| | ISO 9000:1994 | 3.77 | |
| | ISO 9000:2000 | 3.81 | |
| 6) Supplier relationship | Non-ISO | 3.52 | 3.28* |
| | ISO 9000:1994 | 3.36 | |
| | ISO 9000:2000 | 3.51 | |
| 7) Customer orientation | Non-ISO | 3.99 | 4.49* |
| | ISO 9000:1994 | 4.01 | |
| | ISO 9000:2000 | 4.15 | |
| 8) Quality results | Non-ISO | 3.62 | 0.22** |
| | ISO 9000:1994 | 3.59 | |
| | ISO 9000:2000 | 3.63 | |

* Significant at 0.05 level.

** Not Significant at 0.05 level.

all personnel who perform activities with an effect on quality, and 5) new product design review, specification and process control, preventive maintenance, and quality control have an effect on quality assurance.

'Quality results' is the only aspect of quality that has different results from those expected. These unexpected results can be explained by the fact that ISO members appear to have adopted the standard primarily to satisfy their customers' requirements, rather than for their own business benefits. In addition, at the beginning of the ISO 9000 implementation process, ISO-certified organizations have to spend a large portion of their budget to set up this quality management system. However, in the long term, ISO-registered organizations should reap many benefits from the improved system. From the survey results, the respondents appear to be considering only the short-term drawbacks of the system rather than its longer-term benefits.

The results in Table 7 show that there was no significant difference between ISO 9000:1994- and ISO 9000:2000-registered organizations in most quality management practices. Our general expectation is that the new version of ISO 9000 should result in better quality management practices than the older version. A possible reason for the lack of difference could be the amount of time spent on implementation. For example, many ISO 9000:2000-registered organizations are new ISO members, having started to implement this standard less than two years ago, whereas ISO 9000:1994 members have been working with the standard for a longer period. The ISO 9000:2000 version was issued in December 2000; thus, ISO 9000:2000 members that have never worked with ISO 9000:1994 have spent much less time implementing this standard than ISO 9000:1994 members.

Recommendations

Future research needs to focus on the perceptions of different levels or categories of employees. We would expect different perceptions from top

Table 5 - Results of Multiple Comparisons between Non-ISO and ISO 9000:1994

| Constructs | Group | Mean | Mean Difference | Turkey HSD Test | LSD Test |
|-------------------------------|-----------------------------|--------------|-----------------|-----------------|----------|
| 1) Leadership | Non ISO ISO 9000:1994 | 3.90 4.14 | -0.24 | * | * |
| 2) Information and analysis | Non ISO ISO 9000:1994 | 3.53 3.80 | -0.27 | * | * |
| 3) Strategic quality planning | Non ISO ISO 9000:1994 | 3.67 3.90 | -0.23 | * | * |
| 4) Human resource development | Non ISO ISO 9000:1994 | 3.30 3.53 | -0.23 | * | * |
| 5) Quality assurance | Non ISO ISO 9000:1994 | 3.42 3.77 | -0.35 | * | * |
| 6) Supplier relationship | Non ISO ISO 9000:1994 | 3.52 3.36 | 0.17 | ** | * |
| 7) Customer orientation | Non ISO ISO 9000:1994 | 3.99 4.01 | -0.02 | ** | ** |
| 8) Quality results | Non ISO ISO 9000:1994 | 3.62 3.59 | 0.03 | ** | ** |

* Significant at 0.05 level. ** Not Significant at 0.05 level.

Table 6 - Results of Multiple Comparisons between Non-ISO and ISO 9000:2000

| Constructs | Group | Mean | Mean Difference | Turkey HSD Test | LSD Test |
|-------------------------------|-----------------------------|--------------|-----------------|-----------------|----------|
| 1) Leadership | Non ISO ISO 9000:2000 | 3.90 4.13 | -0.23 | * | * |
| 2) Information and analysis | Non ISO ISO 9000:2000 | 3.53 3.84 | -0.31 | * | * |
| 3) Strategic quality planning | Non ISO ISO 9000:2000 | 3.67 3.96 | -0.29 | * | * |
| 4) Human resource development | Non ISO ISO 9000:2000 | 3.30 3.73 | -0.43 | * | * |
| 5) Quality assurance | Non ISO ISO 9000:2000 | 3.42 3.81 | -0.39 | * | * |
| 6) Supplier relationship | Non ISO ISO 9000:2000 | 3.52 3.51 | 0.01 | ** | ** |
| 7) Customer orientation | Non ISO ISO 9000:2000 | 3.99 4.15 | -0.16 | * | * |
| 8) Quality results | Non ISO ISO 9000:2000 | 3.62 3.63 | -0.01 | ** | ** |

* Significant at 0.05 level. ** Not Significant at 0.05 level

management, middle management, quality management representatives (QMR), and front-line employees. Future studies should reduce some of the bias in the existing study by including employees from different levels in the organizations. In addition, it is recommended that future research include highly recognized companies. These companies could be the winners of the major quality awards in each geographical area, such as the Malcolm Baldrige Quality Award, the Deming Prize, the European Quality Award, the Singapore Quality Award, and the Thailand Quality Award.

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Table 7 - Results of Multiple Comparisons between ISO 9000:1994 and ISO 9000:2000

| Constructs | Group | Mean | Mean Difference | Turkey HSD Test | LSD Test |
|-------------------------------|---------------|------|-----------------|-----------------|----------|
| 1) Leadership | ISO 9000:1994 | 4.14 | 0.01 | ** | ** |
| | ISO 9000:2000 | 4.13 | | | |
| 2) Information and analysis | ISO 9000:1994 | 3.80 | -0.04 | ** | ** |
| | ISO 9000:2000 | 3.84 | | | |
| 3) Strategic quality planning | ISO 9000:1994 | 3.90 | -0.06 | ** | ** |
| | ISO 9000:2000 | 3.96 | | | |
| 4) Human resource development | ISO 9000:1994 | 3.53 | -0.20 | * | * |
| | ISO 9000:2000 | 3.73 | | | |
| 5) Quality assurance | ISO 9000:1994 | 3.77 | -0.04 | ** | ** |
| | ISO 9000:2000 | 3.81 | | | |
| 6) Supplier relationship | ISO 9000:1994 | 3.36 | -0.15 | ** | * |
| | ISO 9000:2000 | 3.51 | | | |
| 7) Customer orientation | ISO 9000:1994 | 4.01 | -0.14 | * | * |
| | ISO 9000:2000 | 4.15 | | | |
| 8) Quality results | ISO 9000:1994 | 3.59 | -0.04 | ** | ** |
| | ISO 9000:2000 | 3.63 | | | |

* Significant at 0.05 level. ** Not Significant at 0.05 level.