Total Quality Management & Business Excellence
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/ctqm20

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Published online: 25 Aug 2010.

To cite this article: Chao-Ton Su , Shao-Chang Li & Chin-Ho Su (2003) An empirical study of the Taiwan National Quality Award causal model, Total Quality Management & Business Excellence, 14:8, 875-893, DOI: 10.1080/1478336032000090815

To link to this article: http://dx.doi.org/10.1080/1478336032000090815

TQM & BUSINESS EXCELLENCE, VOL. 14, NO. 8, OCTOBER, 2003, 875–893

An empirical study of the Taiwan National Quality Award causal model

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ABSTRACT *In this study, the Taiwan National Quality Award (TNQA) is discussed in terms of a modelling approach for the first time since it was founded in 1990. A survey instrument involving 105 questions extracted from the 2001 TNQA criteria serves to measure the content of the TNQA. A causal model is proposed to reveal the relationships among TNQA categories. Structural equation modelling (SEM) is used to analyse the model and estimate path coefficients among TNQA categories. The statistical results show that many of the hypothesized causal relationships in the TNQA model are statistically significant. From path coefficients, the category of Leadership has a strong influence on that of Information Management. Simultaneously, Information Management has impacts on other TNQA system categories. Information Management is confirmed as an internal driver of TNQA system categories. Both Leadership and Innovation and Strategic Management show direct influence on Business Results. Generally, several conclusions are made as follows. First, the assumption that the TNQA model is recursive is supported by statistical results. Secondly, the prior theory of this causal model that Leadership is a driver of the system, which creates results is confirmed. Thirdly, the final causal model also represents an excellent model of business performance, which can predict expected results through system paths. Other conclusions and findings are discussed in the study.*

Introduction

The Taiwan National Quality Award (TNQA) has been successfully conducted for 12 years since it was established in 1990. At that time, Taiwanese companies were being affected by significant changes in economic circumstances, such as appreciation of the currency, sharp rises in labour costs, and increasing awareness of environmental protection. These circumstances caused a rapid increase in company costs, and many Taiwanese companies were gradually becoming less competitive. To create another economic miracle, quality enhancement could not be overemphasized. With the encouragement of the government over the past ten years, many Taiwanese companies have dedicated much effort to quality enhancement in competing for the TNQA. Winning the TNQA has generally been considered a guarantee of business growth. After employing total quality management (TQM) programmes, many

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ISSN 1478-3363 print/ISSN 1478-3371 online/03/080875-19
DOI: 10.1080/1478336032000090815

companies not only made improvements in quality of products and services, but also recognized the importance of TQM as a business model.

Many quality experts in academia and industry have offered their opinions on how Taiwanese companies might achieve success in the TNQA. Liao (1995) thought that the TNQA criteria examined whether the companies were operating appropriately. By applying the TNQA criteria, it was argued that companies not only enhanced the quality of their products, but also increased the productivity and loyalty of employees. Yang (1995) thought that companies would adopt the correct perspective when running for the TNQA, in that winning the TNQA should not only be an immediate goal, but also an ongoing commitment to the future prosperity and continuous improvement of the company. Tseng (1993) analysed the winners of the TNQA and suggested that strategic planning, process improvement, job assignment, and training were critical factors in companies winning the TNQA.

In 2001, the TNQA was modified, based on the 2000 Malcolm Baldrige Award, the 1998 Deming Award, the 1999 European Quality Award, and ISO 9000–2000 (CSD, 2001). At the same time, the non-manufacturing sector (including public organizations, private service firms, and the military forces) also became eligible to compete for the TNQA.

Currently, the TNQA consists of seven categories, with each category being assigned scores, as defined in the Taiwan National Quality Award Criteria Handbook. The total score adds up to 1000. Figure 1 shows the TNQA original model. From the category numbers in parentheses, it is apparent that the category of Leadership is associated with other categories. A close examination of the relationships among categories in Fig. 1 reveals that, in terms of TQM, the original model was actually composed of initiative (1), system (2, 3, 4, 5, 6), and result (7). Flynn *et al.* (1995) indicated that a typical framework for quality management consists of three componentsl—(i) top management support; (ii) quality management practices and (iii) quality performance. Flynn *et al.* (1995) and Kanji (1998, 2000, 2001, 2002) proposed a model of the relationship between quality management practices and performance which was confirmed as being recursive, and in which top management support (initiative) drives a quality management system (system) that creates quality performance (result). In Fig. 1, seven categories represent the most important contents of TQM. Therefore, we assume that the prior theory of TNQA is that leadership is the driver of the quality management system that creates results. From this, the recursive model with a TQM basis is proposed (see Fig. 2), after checking against the 2001 Taiwan National Quality Award Criteria Handbook (CSD, 2001).

After a detailed trends analysis among 17 national quality awards (NQAs) worldwide, Tan & Lim (2000) noted certain variations in award criteria. Having reviewed these variations, we note that the TNQA differs from other NQAs in terms of: (i) the influence of globally recognized pioneering NQAs; (ii) differences in corporate culture and social climate; (iii) the market structure of the economy; and (iv) the emergence of more small and medium enterprises. Although other NQAs, such as the Malcolm Baldrige National Quality Award (MBNQA) and the European Quality Award (EQA), were already well established, it was necessary for the TNQA to be customized for Taiwanese companies to reflect the spirit of TQM as it is practised in Taiwan.

The objectives of the present study are therefore:

(i) to develop a systematic model to reflect the content of TNQA criteria;
(ii) to establish that the prior theory of TNQA is that Leadership is the driver of the quality management system that creates results;
(iii) to delineate the distinctive differences between the TNQA model and that of the MBNQA; and

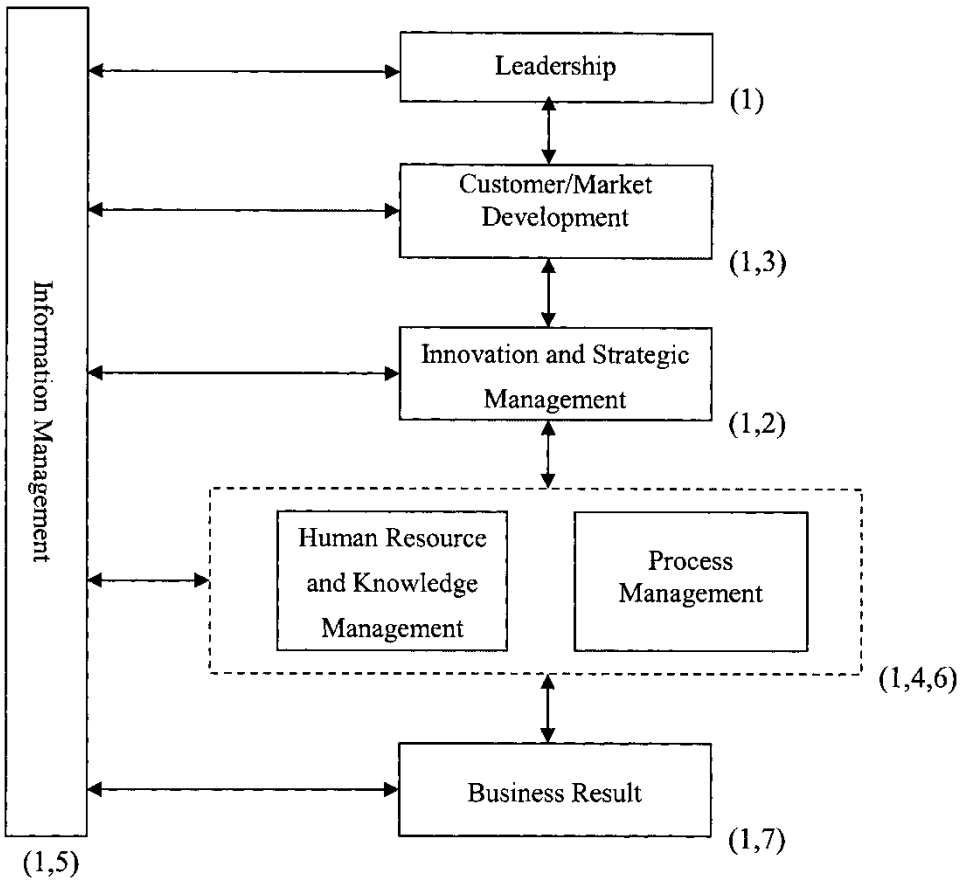

Figure 1. *Taiwan National Quality Award original model.*

(iv) to provide insight into the relative strengths and direction of causation among the seven TNQA categories.

Literature review

Although the TNQA has been conducted for 12 years in Taiwan, the present authors were unable to discover any published studies on the causal relationships among categories of the TNQA in terms of modelling approaches. However, a few studies have focused on how to become a winner of the TNQA.

Chang (1998) discussed the key factors in ensuring success for a company in contesting the TNQA. He surveyed some quality literature and synthesized six key successful factors or constructs in winning the TNQA. The six constructs were: (i) participation and determination of top management; (ii) operating factors for a TQM system; (iii) factual management; (iv) customer relationship; (v) employee authorization and participation; and (vi) training. Each construct consisted of several dimensions, with 32 dimensions being identified as important factors in winning the TNQA on the basis of responses to questionnaires put to the 500 top

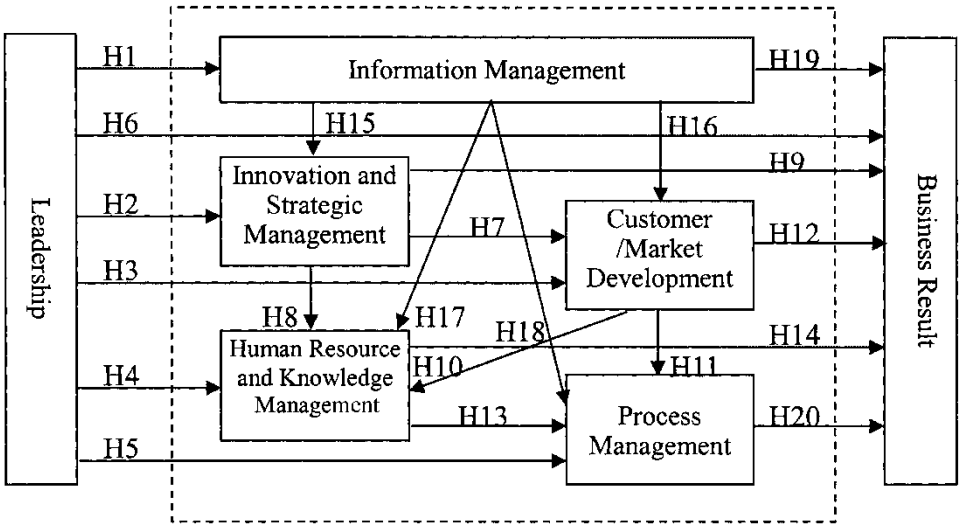

Figure 2. *Taiwan National Quality Award hypothesized causal model.*

manufacturing firms in Taiwan in 1995. Out of 32 dimensions, six were identified as critically impact factors in winning the TNQA. They were: (i) quality business concepts; (ii) a quality assurance system; (iii) quality audit and evaluation; (iv) a quality inspection system; (v) equipment maintenance; and (vi) customer-oriented product planning. However, most companies did not explain what they had done with respect to these factors. Chang merely extracted the main factors for winning the TNQA, but did not build up a framework to discuss the causal relationships among them.

Liao (2001) thought that the TNQA criteria and the eight principles of quality management of ISO 9001–2000 have almost the same framework. These eight principles are: (i) a customer focus; (ii) leadership; (iii) involvement of people; (iv) a process approach; (v) a system approach to management; (vi) continual improvement; (vii) a factual approach to decision-making; and (viii) mutually beneficial supplier relationships. Liao (2001) thought that the eight principles could be discerned in each category of the TNQA. The correlations between the principles and the TNQA categories can be expressed as follows: (i) customer focus to Customer/Market Development (3.0); (ii) leadership to Leadership (1.0); (iii) involvement of people to Leadership (1.0) and Human Resource and Knowledge Management (4.0); (iv) process approach to Process Management (6.0); (v) system approach to management to Business Result (7.0); (vi) continual improvement to innovation and Strategic Management (2.0); (vii) factual approach to decision-making to Information Management (5.0); and (viii) mutually beneficial supplier relationships to Process Management (6.0). However, he did not discuss the causal relationships among these eight principles.

Although there are no systematic studies of the TNQA in terms of causal relationships, several researchers have adopted systematic approaches to the MBNQA. To confirm that the MBNQA adequately captures the maj or dimensions of TMQ, Curkovic *et al.* (2000) proposed a second-order TQM confirmatory factor analysis (CFA) measurement model. Inthis model, the first-order part consisted of four constructs: (i) TQM strategic systems; (ii) TQM operational systems; (iii) TQM information systems; and (iv) TQM results. From

the MBNQA criteria, 29 questions were extracted to measure the four constructs. In the second-order part, the extraneous variable was designated as TQM. Structural equation modelling (SEM) was used to analyse the CFA model. In summary, all of the causal paths specified in the hypothesized model were found to be positive and statistically significant. These paths reflected the impact of TQM on TQM strategic systems, TQM operational systems, TQM information systems, and TQM results. That the MBNQA captures this unobserved but critical construct known as TQM was thus validated. However, the relationships among the various MBNQA categories were not further discussed in Curkovic's study.

Wilson & Collier (2000) used SEM to analyse the causal relationships among MBNQA categories, based on a proposed recursive model. Their proposed model of MBNQA consisted of a driver (Leadership), a quality management system (Strategic Planning, Human Resource Development and Management, Information and Analysis, Process Management), and business results (Financial Results and Customer Satisfaction). After testing hypotheses, the path coefficients among categories were determined, and the model showed good fituess to data. The general theory behind the MBNQA is that leadership drives the system that creates result' supported by Wilson & Collier's (2000) study. In this proposed model, leadership drives system performance, and this produces financial results and customer satisfaction. The assumption that the MBNQA model is recursive was also supported by the results. In addition, Wilson & Collier found that the path coefficient between Process Management and Customer Satisfaction was almost twice that between Process Management and Financial Results. It therefore appeared that Process Management has much more of a direct effect on Customer Satisfaction than it does on Financial Performance. They explained this by noting that customer-driven quality is a core value of the MBNQA criteria, thus producing the greater customer focus.

Meyer & Collier (2001) also developed a causal model based on Baldrige Health Care Pilot Criteria for health care organizations. They built up a three-part framework using a similar procedure to that of Wilson & Collier (2000) to show the causal relationships among categories of pilot criteria. The first part of the model consisted of Leadership, the second part consisted of Strategic Planning, Human Resource Development and Management, Information and Analysis and Process Management, and the third part was composed of Organizational Performance Results and Focus on, and Satisfaction of, Patients and Other Stakeholders. This model was also evaluated by SEM. They reached almost the same conclusions as Wilson & Collier, but with a slight difference in that Organizational Performance Results was found to have a positive influence on Customer Satisfaction. This performance relationship supported the Baldrige theory that improving internal capabilities and performance results in improved external performance (NIST, 1995).

To obtain a better understanding of the relationships among the Baldridge categories, Pannirselvam & Ferguson (2001) developed another form of framework for the MBNQA. They thought that the MBNQA framework had four basic elements: (i) driver; (ii) system; (iii) measures of progress; and (iv) goals. According to their analysis, the categories of Leadership, Information and Analysis, Strategic Quality Planning, Human Resources Development and Management, and Management of Process Quality evaluate the quality management practices. The category of Quality and Operational Results measures internal business results. In their study, they focused on identifying the strength of the relationship between quality management practices and results from those practices. They therefore split the Customer Focus and Satisfaction category into two constructs one that evaluated the practices, and another that evaluated the results. Hence, in their MBNQA framework, a model with eight constructs was presented. The eight constructs were: (i) Leadership; (ii) Information Management; (iii) Strategic Quality Planning; (iv) Human Resources

Management; (v) Product and Process Management; (vi) Customer Focus and Relationship Management; (vii) Business Results; and (viii) Customer Satisfaction. In their proposed model, both Leadership and Information Management were exogenous variables, thus differing from the Wilson model. Path analysis was used to estimate the strength of the relationships among the eight constructs. The statistical results showed that Information Management had a strong influence on Human Resources Management, and Human Resources Management also showed strong impact on Product and Process Management and Customer Focus and Relationship Management. However, this research used data from the Arizona Governor's Quality Award (AGQA) to test the strength of the relationships among the MBNQA categories, and caution should therefore be exercised in drawing general conclusions from the results of their research. In making generalizations, consideration must be given to the extent to which the AGQA criteria and process parallel the MBNQA criteria and the extent to which the sample data reflect the population of organizations involved in the MBNQA.

Research methodology

Questionnaire design

In Fig. 1, we refer to the seven categories as 'constructs' and to their sub-areas as 'dimensions'. Constructs and Dimensions are not directly measurable, and they therefore need to be assessed by careful questionnaire design. To measure the content validity of TNQA, the survey questions used in the present study were extracted from the 2001 TNQA Criteria Handbook. Each survey question was related to a dimension and category of the TNQA, and was developed by several well-known quality experts in Taiwan. After slight modification, the survey questionnaires were finalized, and are listed in Appendix A. For the content validity of each dimension, a five-point Likert-type scale was used to show the respondent preference on each item (see Appendix A). Five-point scales were used because research has indicated that they are easily completed by respondents (Matell & Jacoby, 1971, 1972) and provide reliable data (Lissitz & Green, 1975; Jenkins & Tabor, 1977). The questions were targeted at respondents expected to be more knowledgeable about the content of each dimension. Respondents were therefore restricted to top management or quality managers.

Pilot test

If a survey questionnaire is to be used as a measurement tool for a conceptual model, its validity and reliability must be established before mailing. To achieve this validity and reliability, two steps were undertaken.

First, several members of the Chinese Society for Quality (CSQ) in Taiwan were invited to review the survey questions. After their evaluation of each question, it was suggested that three items be deleted because these were too similar to other questions. One was removed from original dimension 1.2, and the other two were erased from dimension 7.3 (the performance of market development). Following this, the two items left in 7.3 were moved to dimension 7.1. The final total number of questions was 105.

Secondly, to check the reliability of the questionnaires, the CSQ members suggested that a pilot test be conducted by mailing the questionnaires to 100 companies in the Science Industrial Park which were claimed to implement TQM programmes. Of these 100, 35 companies returned the surveys, giving a response rate of 35%. After this pilot test of survey questions, the Cronbach alpha (Churchill, 1979; Cronbach, 1951) for each dimension was

Table 1. *Main survey factor analysis statistics for pilot-test*

Category and items (Category number in parenthesis)	Percentage of variance explained	Cronbach α (number of survey questions)
Leadership (1.0)		
Business Concepts/Values (1.1)	60.77	0.740 (4)
Organization Mission/Vision (1.2)	66.21	0.736 (3)
Senior Executive Leadership (1.3)	69.50	0.889 (5)
Total Quality Culture (1.4)	66.53	0.822 (4)
Corporate Citizenship (1.5)	59.61	0.737 (4)
Innovation and Strategic Management (2.0)		
Innovation Values (2.1)	74.62	0.826 (3)
Business Model and Strategic Planning (2.2)	60.43	0.828 (5)
Strategy Development and Deployment (2.3)	66.27	0.826 (4)
Customer/Market Development (3.0)		
Product/Service and Market Strategy (3.1)	70.45	0.780 (3)
Customer and Business Information Management (3.2)	62.93	0.793 (4)
Customer Relationship Management (3.3)	68.38	0.904 (6)
Human Resource and Knowledge Management (4.0)		
Human Resource Planning (4.1)	80.31	0.917 (4)
Human Resource Development (4.2)	70.62	0.841 (4)
Human Resource Usage (4.3)	70.80	0.849 (4)
Employee Relationship Management (4.4)	48.57	0.816 (7)
Knowledge Management (4.5)	44.63	0.735 (6)
Information Management (5.0)		
Information Strategic Planning (5.1)	76.71	0.938 (6)
Information Application (5.2)	86.14	0.919 (3)
Process Management (6.0)		
Product Process Management (6.1)	52.40	0.875 (9)
Organizational Relationship Management (6.3)	54.42	0.780 (5)
Business Result (7.0)		
Customer Satisfaction (7.1)	65.93	0.894 (6)
Company Financial Result (7.3)	67.34	0.898 (6)

computed to check internal consistency (see Table 1). Cronbach alpha is a commonly used method of evaluating reliability, and a guideline of 0.6 was used for the new scale in this study, with 0.7 or higher being acceptable (Nunnally, 1978; Flynn *et al.*, 1990). As shown in Table 1, pilot-test Cronbach alphas ranged from 0.735 to 0.938, thus establishing the reliability of the survey questionnaire. Scale uni-dimensionality was also tested according to the guideline by Carmines & Zeller (1979) in which the first component should explain atzleast 40% of the variance in the items (Meyer & Collier, 2001). It was found that thevariance explained in each dimension was more than 40% (see Table 1). There was thus no need to add or remove an item to change the content validity of the scale.

Sampling

The Corporate Synergy Development Center (CSD) is in charge of business for the TNQA and has a databank of more than 1000 profiles of excellent manufacturing firms in Taiwan.

From this databank, with the cooperation of the CSD, 800 manufacturing firms (of whom 390 had entered the TNQA in the past ten years) were selected and requested to fill in questionnaires by mail. Of these 800 requests, 126 surveys were returned, for an initial response rate of 15.8%. Based on follow-up e-mails and telephone calls to non-respondents, a further 65 firms mailed back their responses to provide a final total of 191 respondents, representing a response rate of 23.9%. Among the 191 respondents, 33 claimed that they did not implement TQM programmes, and were therefore deemed to be non-qualified respondents. The average company had 1280 employees, with the minimum being 260, and the maximum being 13 000. The plants, all located in Taiwan, represented different kinds of industries, as follows: textile mill production (3.8%), chemicals and allied products (4.4%), rubber and plastic products (5%), fabricated metal products (17%), electronic and electric equipment (47%), automatic and mechanical products (20%), and others (2.8%). Of the 158 qualified responses, all questionnaires were fully completed. It was therefore not necessary to replace missing data. Statistical tests similar to the pilot test were computed as shown in Table 2.

Research hypotheses

Since the proposed TNQA model (Fig. 2) is recursive, according to Bollen (1989: 81) it is a system of equations that contains no reciprocal causation (two-headed arrows) or feedback (circular) loops. To prove the theory that leadership is the driver of the quality management system that creates results, the paths between categories need to be clearly defined. In Fig. 2, each path with a one-headed arrow corresponds to a hypothesis of causal relationship between two categories. Each hypothesis is described as follows:

- H_1: Leadership (1.0) has a positive influence on Information Management (5.0)
- H_2: Leadership (1.0) has a positive influence on Innovation and Strategic Management (2.0)
- H_3: Leadership (1.0) has a positive influence on Customer/Market Development (3.0)
- H_4: Leadership (1.0) has a positive influence on Human Resource and Knowledge Management (4.0)
- H_5: Leadership (1.0) has a positive influence on Process Management (6.0)
- H_6: Leadership (1.0) has a positive influence on Business Result (7.0)
- H_7: Innovation and Strategic Management (2.0) has a positive influence on Customer/Market Development (3.0)
- H_8: Innovation and Strategic Management (2.0) has a positive influence on Human Resource and Knowledge Management (4.0)
- H_9: Innovation and Strategic Management (2.0) has a positive influence on Business Result (7.0)
- H_{10}: Customer/Market Development (3.0) has a positive influence on Human Resource and Knowledge Management (4.0)
- H_{11}: Customer/Market Development (3.0) has a positive influence on Process Management (6.0)
- H_{12}: Customer/Market Development (3.0) has a positive influence on Business Result (7.0)
- H_{13}: Human Resource and Knowledge Management (4.0) has a positive influence on Process Management (6.0)
- H_{14}: Human Resource and Knowledge Management (4.0) has a positive influence on Business Result (7.0)

Table 2. *Main survey factor analysis statistics for final model*

Category and items (Category number in parenthesis)	Percentage of variance explained	Cronbach α (number of survey questions)
Leadership (1.0)		
Business Concepts/Values (1.1)	53.46	0.707 (4)
Organization Mission/Vision (1.2)	50.79	0.512 (3)
Senior Executive Leadership (1.3)	47.71	0.723 (5)
Total Quality Culture (1.4)	62.86	0.803 (4)
Corporate Citizenship (1.5)	52.22	0.711 (4)
Innovation and Strategic Management (2.0)		
Innovation Values (2.1)	66.89	0.752 (3)
Business Model and Strategic Planning (2.2)	63.16	0.853 (5)
Strategy Development and Deployment (2.3)	65.44	0.822 (4)
Customer/Market Development (3.0)		
Product/Service and Market Strategy (3.1)	71.32	0.797 (3)
Customer and Business Information Management (3.2)	67.37	0.838 (4)
Customer Relationship Management (3.3)	62.16	0.877 (6)
Human Resource and Knowledge Management (4.0)		
Human Resource Planning (4.1)	62.51	0.796 (4)
Human Resource Development (4.2)	60.44	0.781 (4)
Human Resource Usage (4.3)	64.37	0.814 (4)
Employee Relationship Management (4.4)	51.24	0.841 (7)
Knowledge Management (4.5)	49.61	0.795 (6)
Information Management (5.0)		
Information Strategic Planning (5.1)	64.74	0.890 (6)
Information Application (5.2)	73.78	0.822 (3)
Process Management (6.0)		
Product Process Management (6.1)	50.61	0.876 (9)
Organizational Relationship Management (6.3)	51.97	0.768 (5)
Business Result (7.0)		
Customer Satisfaction (7.1)	54.03	0.825 (6)
Company Financial Result (7.3)	61.75	0.875 (6)

H_{15}: Information Management (5.0) has a positive influence on Innovation and Strategic Management (2.0)

H_{16}: Information Management (5.0) has a positive influence on Customer/Market Development (3.0)

H_{17}: Information Management (5.0) has a positive influence on Human Resource and Knowledge Management (4.0)

H_{18}: Information Management (5.0) has a positive influence on Process Management (6.0)

H_{19}: Information Management (5.0) has a positive influence on Business Result (7.0)

H_{20}: Process Management (6.0) has a positive influence on Business Result (7.0)

Each hypothesis should be tested through a statistical procedure to conclude whether the causal relationship between categories is significant or not. Simultaneously, each path coefficient is also determined to show a strong or weak influence from one category to another.

Analysis

SEM was used to test the research hypotheses and analyse the model (Fig. 2). SEM is composed of a measurement model and a structural model (Hair *et al.*, 1995; Hoyle, 1995; Bollen & Long, 1993; Bollen, 1989). The measurement model includes the relationships between the dimensions and the questionnaire items that measure the content of each dimension. In the structural (causal) model, there are two types of variables: the exogenous variable and the endogenous variable. The endogenous variable is the result with which we are concerned, and the exogenous variable is the cause that creates effects on other variables. However, the variances of the exogenous variable are related to some variables, which are not included in the causal model (Mueller, 1993). In the TNQA hypothesized causal model (Fig. 2), Leadership is an exogenous variable not influenced by the other measured variables in the model, whereas all other variables are endogenous variables. Furthermore, the model consists of the relationships that link all dimensions to their respective categories, as well as the dependent causal relationships that link all categories to one another.

The present study used a two-stage process of SEM (Hair *et al.*, 1995: 635). The measurement model was first estimated using factor analysis to obtain a factor score for each TNQA category. In the second stage, the measurement model was fixed when the structural model was estimated (Wilson & Collier, 2000). As Hair *et al.* (1995) have noted: 'the rationale of this approach is that accurate representation of the reliability of the indicators is best accomplished in two stages to avoid the interaction of measurement and structural models'. Similarly, Wilson & Collier (2000) have observed: 'if a single-stage analysis withthe simultaneous estimation of both the measurement and structural models had been done, the model specification and interpretability would be more complex'. In this study, the interaction of the measurement and structural models could be made more complicated by sampling variation. Thus, the adoption of a two-stage modelling approach helped to maintain the validity and reliability of the TNQA measurement model.

2 Statistical results

As can be seen in Fig. 2, the hypothesis between any two categories in the TNQA hypothesized causal model should be tested to show significant internal relationships of the model so that the model fitness can be justified. The method of maximum likelihood estimation (MLE) is a popular statistical approach employed by many researchers to estimate the parameters in SEM. In recent years, several software packages have been developed to solve the problems in SEM. Among these software packages operating on the basis of MLE, Analysis of Moment Structure is very user friendly and powerful, and was adopted as the analytical tool for the present study.

The overall model fit statistics are shown in Table 3. There are six statistics to indicate overall model fit.

- The chi-square test statistic was far from being significant with a p-value of 0.566. This supported the null hypothesis that data for fitness of the model cannot be significantly rejected at the 0.05 level.
- The goodness-of fit (GFI) index devised by Joreskog & Sorbom (1984);
- and the adjusted goodness-of-fit (AGED model), which measure the percentage of total variance and covariance explained by the hypothesized model, were greater than 0.9 and close to 1 (unity), which indicated a perfect fit.
- The root mean square residual (RMR) is the square root of the average squared amount by which the sample variances and covariances differ from their estimates

Table 3. *Overall model fit statistics*

Overall model fit statistic	statistic value
p-value of test statistic	0.566
GFI	0.998
AGFI	0.971
RMR	0.021
RMSEA	0.0
Test statistic/degree of freedom (χ^2df)	0.569

obtained under the assumption model. The RMR, in a sense, reflects the magnitude of the residual, so that a smaller result is a better result, with an RMR of zero indicating a perfect fit. It is best to get an RMR smaller than 0.025 (Bollen, 1989). In the present study, the RMR equalled 0.021 (see Table 3), which supports the model.

- Furthermore, the root mean square error of approximation (RMSEA) is a measure of model fit that is not dependent on sample size (Steiger, 1990). Following the rule of thumb provided by Browne & Cudeck (1993) that practical experience has made us feel that a value of the RMSEA of about 0.05 or less would indicate a close fit of the model in relation to the degree of freedom—the assumption model was deemed to be correct, with an RMSEA of 0.0.
- χ^2/df is also a good indicator to measure the model fit (see Table 3). Carmines & McZver (1981) said this ratio is indicative of an acceptable fit between the hypothetical model and the sample data. Byrne (1989) recommended that a χ^2/df ratio greater than 2.0 represents an inadequate fit. Therefore, in this study, the χ^2/df ratio of 0.569 was deemed to be acceptable for model fit (Table 3).

Based on the indicators in Table 3, the structural model (Fig. 2) is reasonable.
In Fig. 3, five categories constitute the system. These are Innovation and Strategic

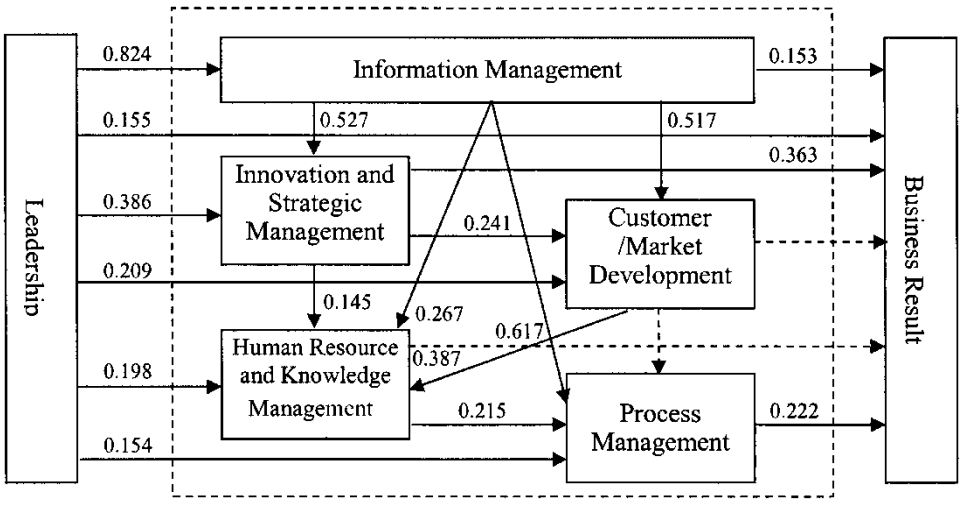

Figure 3. *Taiwan National Quality Award final causal model.*

Management, Customer/Market Development, Human Resource and Knowledge Management, Information Management, and Process Management. As was expected, Leadership was revealed to be the driver of the system because all path relations between Leadership and each of the five categories showed statistical significance. See Table 4, which shows the results for path estimates of the TNQA final causal model. In these analytical results, three links showed insignificant relationships. They were: (i) Customer/Market Development (3.0) to Process Management (6.0); (ii) Customer/Market Development (3.0) to Business Result (7.0), and Human Resource and Knowledge Management (4.0) to Business Result (7.0). Thus, hypotheses H_{11}, H_{12}, and H_{14} were not supported by the statistical tests. All the others showed significant relationships among those categories, and the causal relationships were justified. Figure 3 demonstrates all relationships for the TNQA final causal model.

Discussion of results

As previously noted, the present study transformed questionnaires into a measuring scaleto measure the content of the TNQA criteria, and a structural model was constructed to show causal relationships among categories of the TNQA criteria after testing 20 hypotheses. As revealed in the statistical results shown above, the present study confirms that the TNQA model should be recursive, as illustrated by many paths with one-headed arrows linking two categories to represent the causal relationships between them. The causal relationships include a direct and indirect influence from one category to another. For example, in Fig. 3, Leadership can be seen to have a direct impact and indirect influences (through the system categories) on Business Results. Leadership has a key role in the TNQA causal model. It is the only exogenous variable of this model. Without it, any causal relationships among other categories become meaningless, and it drives the system to create results. However, whether these results are good or bad must therefore be associated with right or wrong leadership, especially in the case of leadership from top management. For example, John F. Welch, the president of the GE company, told the managers of his company that they would never be promoted before acquiring the 'black belts' of the six-sigma program (Su, 2002). Leadership can therefore shape company culture to follow a correct 'road map', and thus reach goals. In Fig. 3, path coefficients from Leadership to various system categories (Innovation and Strategic Management, Customer/Market Development, Human Resource and Knowledge Management, Information Management and Process Management) show positive impacts with a '+' sign. In other words, improving Leadership will strengthen the system categories of the TNQA. This confirms the prior theory of TNQA that leadership is the driver of the quality management system that creates results. Obviously, both MBNQA and TNQA have the same underlying theory, which is based on TQM.

In Fig. 3, each path coefficient ranging from -1 to $+1$ is expressed as standardized scores estimated by MLE. In such cases, the result is the same as the coefficient of correlation for a linear regression model. It shows the strength and direction of causal influence on each category of the TNQA. In Fig. 3, the influence of Leadership on Information Management is much stronger than that on other system categories. This quite makes sense. Many companies in Taiwan today face more vigorous competition than ever before. To be successful against such competition, top management has to make good use of information to respond quickly and appropriately to customers' demands. In other words, building a good information system is critical to successful leadership. Information Management also has an influence on other categories within the TNQA system. It shows strong relationships with Innovation and Strategic Management, Customer/Market Development and Process Management. For Innovation and Strategic Management, good quality of information enables managers to

focus their attention on creative thinking, enhancing the quality of communications and decisions, integrating horizontal relationships among divisions, and increasing the power of action for organizations. For Customer/Market Development, companies must communicate continuously with customers to build up a learning relationship in which a company can acquire useful information by appreciating customers' behaviours and offering appropriate products and services at the right time through the right channel, thus satisfying customers' demands and developing new markets. For Process Management, the operating efficiency of a process is a critical factor in obtaining better business results. In general, there are several indicators by which to measure the operating efficiency of companies including inventory level, inventory turnover rate, and manufacturing cycle. For example, if companies want to get a lower inventory level, they must catch any change in customer demand, and follow a well-designed process of information flow to integrate production planning, material management, procurement function, and manufacturing management. Simultaneously, such information (for example, daily demand) must be shared with suppliers to ensure that production lines balance with demand. Therefore, 'Information Management' is an internal driver of the TNQA to make the system run more effectively.

Other interesting findings of this research are the path coefficients between Leadership and Business Result, and between Innovation and Strategic Management and Business Result. The statistical results in Table 4 for two hypothetical paths show significance. This is different from Wilson & Collier's (2000) research on the MBNQA. In Wilson & Collier's research (2000), there were no direct influences from Leadership to Result and from Strategic Planning to Result. In the present study, most of the sampled companies were medium-sized

Table 4. *Path estimates for Taiwan National Quality Award final casual model*

Hypotheses	Path	Point estimate	95% C.I	*P*-value	Hypothesis Significance
H_1	1.0 → 5.0	0.824	(0.765, 0.829)	0.015	*
H_2	1.0 → 2.0	0.386	(0.256, 0.521)	0.011	*
H_3	1.0 → 3.0	0.209	(0.092, 0.363)	0.007	**
H_4	1.0 → 4.0	0.198	(0.029, 0.334)	0.016	*
H_5	1.0 → 6.0	0.154	(0.080, 0.239)	0.008	**
H_6	1.0 → 7.0	0.155	(0.087, 0.244)	0.006	**
H_7	2.0 → 3.0	0.241	(0.090, 0.410)	0.013	*
H_8	2.0 → 4.0	0.145	(0.040, 0.284)	0.007	**
H_9	2.0 → 7.0	0.363	(0.219, 0.515)	0.016	*
H_{10}	3.0 → 4.0	0.387	(0.211, 0.523)	0.030	*
H_{11}	3.0 → 6.0	−0.046	(−0.02, 0.114)	0.583	
H_{12}	3.0 → 7.0	0.104	(−0.026, 0.23)	0.138	
H_{13}	4.0 → 6.0	0.215	(0.050, 0.404)	0.015	*
H_{14}	4.0 → 7.0	0.013	(−0.12, 0.142)	0.821	
H_{15}	5.0 → 2.0	0.527	(0.364, 0.638)	0.018	*
H_{16}	5.0 → 3.0	0.517	(0.381, 0.650)	0.018	*
H_{17}	5.0 → 4.0	0.267	(0.106, 0.427)	0.011	*
H_{18}	5.0 → 6.0	0.617	(0.388, 0.743)	0.013	*
H_{19}	5.0 → 7.0	0.153	(0.085, 0.245)	0.007	**
H_{20}	6.0 → 7.0	0.222	(0.020, 0.337)	0.039	*

Notes: *: $\alpha \leqslant 0.05$, **: $\alpha \leqslant 0.01$
CI: Confidence Interval
Category Number in Second column.

and small-sized, in terms of assets. Over the past ten years, many small Taiwanese companies have shifted to Mainland China to seek much lower labour costs. In such cases, the number of employees does not represent the actual company size (in terms of Taiwan) because the plants in Mainland China are included. In Taiwan, the top management of many medium and small companies is composed of family members, and the main stockholders are therefore also the management leaders. Strong personal wills and views (derived from a background of Chinese culture) can thus control the whole direction of a company development. Similarly, in most small companies, the policy-makers are also the executors of policy, and it is easy for these people to make their companies into what they want them to be. For these reasons, Leadership and Innovation and Strategic Management have direct influences on Business Result.

Another difference between the MBNQA model (Wilson & Collier, 2000) and the TNQA model is concerned with Customer/Market Development. In Wilson & Collier's research, Customer and Market Focus was extracted as Result (customer satisfaction). It disappeared from the original MBNQA system categories. However, in the present research, Customer/Market Development is listed as one of the TNQA system categories. In the TNQA, the dimension of customer satisfaction is already included in Business Result. To maintain the content of the original TNQA criteria, we did not change the position of Customer/Market Development. Actually, OEM (Original Equipment Manufacturing) and OEM (Original Design Manufacturing) production strategies are very popular in Taiwanese companies. Providing products and services of good quality at lower price for customers is emphasized. It is necessary to focus the attention of more companies on Customer/Market Development. In a sense, the role of Customer/Market Development in the TNQA is a function of strategic planning focused on customers. Thus, it follows the same path (along with Innovation and Strategic Management) from Human Resource and Knowledge Management to Process Management, and then to an influence on Business Result. In addition, the path from Innovation and Strategic Management to Human Resource and Knowledge Management, and then to Process Management is in accordance with Wilson & Collier's (2000) MBNQA model. It is an important system path to identify.

Conclusions

This study uses SEM to establish a measurement and structural model for TNQA criteria. The assumption of the TNQA model being recursive is supported by the statistical results of the study. In addition, the prior theory of this causal model that Leadership is the driver of the system, which creates results, is justified. The framework of the TNQA causal model is shown in Fig. 3. This model also represents an excellent model for business performance, which can predict results expected through various system paths. It points out the directions likely to lead to success in achieving company goals. It demonstrates that merely being a quality-driven leader is not enough to produce a good business result unless a good quality-management system is also employed. Furthermore, the TNQA criteria are also a good guide for companies to make an appropriate self-inspection while implementing a TQM programme. They point out the right directions to improve the quality system in detail in each dimension.

As noted above, this study used questionnaires, which were modified from the original TNQA Criteria Handbook to ensure content validity and reliability. These questionnaires were subsequently mailed to various manufacturing companies, and the proposed TNQA causal model has therefore been extensively studied in manufacturing industry. However, since 2001, the TNQA has also been open to non-manufacturing industry (such as public

organizations, hospitals, and military groups) using the same criteria. In our opinion, other industries should not be included in the proposed TNQA model unless the criteria are modified. The TNQA criteria should be customized for different industries.

Future research on the TNQA could take various forms. First, it might be useful to study other samples to test whether the same modelling procedure is appropriate to another sample. As a corollary, it would be interesting to ascertain whether the model is affected bysample size. Secondly, samples could be taken from various specific industries with a view toerepeating the same modelling procedure in each industry, followed by a comparison of each specific model. Thirdly, an evaluation could be made of the distribution of scores of the various TNQA categories according to weighted importance, followed by a discussion of the adequacy of the scores as currently distributed among the various categories. Finally, of course, all of the findings of the current research should be checked by different sampling methods and different analytical approaches.

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APPENDIX A: Questionnaire scale items

Please indicate your level of agreement or disagreement with the following statements:

Scale Anchors: Strongly Disagree (1), Disagree (2), No Opinion (3), Agree (4), Strongly Agree (5).

1.1. Business Concepts/Values

a. The business concepts/values are established on Total Quality Management.
b. Top management is able to visualize the business concepts of company.
c. The business concepts are acknowledged with employees.
d. The business concepts of company can be fulfilled through various processes and procedures.

1.2. Organization Mission/Vision

a. Top management is able to well describe the company missions.
b. The company vision is to run for excellent business performance.
c. Most employees fully understand the company vision.

1.3. Senior Executive Leadership

a. The top management creates a learning environment for employee.
b. The first priority of responsibility for top management is to create the value for stakeholder.
c. Top management led the company to use PDCA for working improvement.
d. Top management seeks innovation through performance measurement.
e. The management effectiveness of top management positively relates to organization performance.

1.4. Total Quality Culture
a. Top management takes the lead to join quality activities of company.
b. Employee recognizes the importance of good quality products for company existence.
c. Employee initiatively solves their problems of work.
d. Plant management provides personal leadership for quality products and improvements.

1.5. Corporate Citizenship
a. A responsive mechanism is installed against the plant accidents.
b. Any contamination from production is treated and controlled by full-time staff.
c. The responsibility for product/services is a basic requirement to quality enhancement.
d. Employee is encouraged to participate in community activities.

2.1. Innovation Values
a. The innovative activities are conducted based on feasibility of cost, market and technology.
b. There are good interactions between R&D department and others.
c. The values created by innovative activities are measurable.

2.2. Business Model and Strategic Planning
a. The decision making process is well organized into the business model.
b. Some indices are designed and constructed to measure the performances of business model.
c. The strategic goals are clear-cut in company.
d. Customer satisfaction is the most important topics for long term strategic planning.
e. Both certainty and uncertainty condition are involved in strategy making.

2.3. Strategic Development and Deployment
a. Employee understands business strategies of company.
b. The personal target in the company is established on the base of strategic goals.
c. The strategic development of the company involves the customer participation.
d. The evaluation indices of performance are established with each strategic target.

3.1. Product/Service and Market Strategy
a. Under market segment, the company is able to satisfy customers' demands.
b. The ongoing R&D is in accordance with the future customers' demands.
c. A responsive mechanism is installed toward the changes of customers' demands.

3.2. Customers and Business Information Management
a. The customers' data are systematically collected.
b. The customers' data are well organized into business information.
c. The process of customer service satisfies the customers' demands.
d. The customers' satisfactions are routinely discussed in the business meeting.

3.3. Customer Relationship Management
a. The standards of customer service are well established.
b. The customer options are quickly responded to through a customer service response mechanism.
c. The company initiatively detects the customers' complains as early as possible.
d. The customers' complaints are systematically analyzed and discussed.
e. The customers' satisfaction surveys are routinely made.
f. The auditing for customer relationship improvement is routinely proceeded.

4.1. Human Resource Planning
a. The career planning of an employee is based on individual performance evaluation.

b. The strategies of human resource management are routinely evaluated.
c. The human resource structure is often adjusted to meet the business requirements.
d. The prediction of human resource demand is based on the future development of company.

4.2. Human Resource Development
a. The training programmes are designed on the basis of employees' demands on jobs.
b. The results of training programmes are often reviewed and evaluated.
c. The training programmes are designed toward the enhancement of employee working ability.
d. The employee productivity gets higher through the long-term training programmes.

4.3. Human Resource Usage
a. Employee is hired and promoted under the regular and formal personnel system.
b. The employee hiring and promotion are met with the goal of company development.
c. The employee promoted depends on the personal contribution and ability on jobs.
d. The career planning for employee follows the route of enhancement of working ability.

4.4. Employee Relationship Management
a. The employee performance is increased because of the rewarding system.
b. The welfare system of an employee is ideally designed.
c. There are workable communication channels between top management and employee.
d. There are several indices to measure employee satisfaction.
e. The employees are aware of improved well-being factor such as health, safety and ergonomics.
f. The health inspection for employees is routinely made.
g. A good mechanism for employee safety on the job is installed to eliminate the chance of accidents.

4.5. Knowledge Management
a. The knowledge on the job is accessible to any employee within the company.
b. Personal professional knowledge is accessible to others.
c. On the job training inside or outside the company for employees is encouraged.
d. Part of profit increase is owing to effective knowledge management.
e. Part of investment reducible is owing to effective knowledge management.
f. The teamwork performance is the key index under the performance evaluation system.

5.1. Information Strategic Planning
a. The collected data about customer satisfaction are diverted to performance improvement.
b. The quality information collected about product/service is diverted to performance improvement.
c. The computer information system meet users' demands.
d. The performance evaluation of product/service is in accordance with the strategy goal by information system.
e. The various methods are used to ensure the reliability of data collected.
f. The information from each department is integrated to proceed business planning.

5.2. Information Application
a. The result of information analysis is fast transmiffed to individuals.
b. Employees understand the meaning of the result of performance evaluation on jobs.
c. The control standards for each member are set according to the result of performance analysis.

6.1. Product Process Management
a. The product/service development is conducted with a systematic approach.
b. The operation and distribution process are conducted with a systematic approach.
c. Customer demands are analysed before beginning a new product design.
d. The new product design is conducted with concurrent engineering orientation.
e. The process of new product design involves customer participations.
f. A good quality management system is implemented for quality management.
g. The process variation is decreased by statistical quality approach.
h. The quality information from competitors is involved in quality improvement.
i. The process analysis is extensively used in quality improvement.

6.2. Organizational Relationship Management
a. The first priority of attributes for vendor selection is quality.
b. Vendors are allowed to join the setting of performance standard) for vendor evaluation.
c. The design of the production processg involves vendor participation.
d. The company is able to help vendors promoting their quality level.
e. The ideal mechanism is established to evaluate vendors' performances.

7.1. Customer Satisfaction
a. Several specialists are invited to measure customer satisfaction.
b. The customer satisfactions are increasing.
c. The customer complaints are quickly dealt with.
d. The customer retention rate is increasing.
e. The company's products have a good reputation in the customers' view.
f. The quality performance of products is above the average level of the industry.

7.2. Company Financial Result
a. The market share is better than that of competitors'.
b. Market share growth.
c. Positive return on investment (ROI).
d. Growth in ROI.
e. Growth in sales.
f. Growth in productivity.