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The relationship between total quality management practices and operational performance

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Abstract

Total quality management (TQM) has been a widely applied process for improving competitiveness around the world, but with mixed success. A review of the literature revealed gaps in research in this area of quality/operations management, particularly in the area of empirical testing of the effectiveness of TQM implementation. The aim of this study was to examine the total quality management practices and operational performance of a large number of manufacturing companies in order to determine the relationships between these practices, individually and collectively, and firm performance. We used a large data base of 1200 Australian and New Zealand manufacturing organisations. The reliability and validity (construct, content, criterion) of the practice and performance measures were evaluated. Our study showed that the relationship between TQM practice and organisational performance is significant in a cross-sectional sense, in that TQM practice intensity explains a significant proportion of variance in performance. Some but not all of the categories of TQM practice were particularly strong predictors of performance. The categories of leadership, management of people and customer focus were the strongest significant predictors of operational performance. This is consistent with literature findings that behavioural factors such as executive commitment, employee empowerment and an open culture can produce competitive advantage more strongly than TQM tools and techniques such as process improvement, benchmarking, and information and analysis.

Keywords: Quality; Operations management; Performance; Human resource/OM interface; Empirical research

1. Introduction

This article contributes, via a large field study, to our understanding of an important practical problem, namely the effectiveness and validity of quality management systems, in explaining the variance in operational performance of manufacturing companies. Total quality management (TQM) has been a popular intervention all around the world, but particularly so in industrialised countries (Garvin, 1991; Dean and Bowen, 1994; Evans and Lindsay, 1995).

Whether under a TQM or similar banner, most manufacturing companies in Europe, the USA, Japan and Australia have tried working in some way on improving the following key components of TQM:

- Leadership
- Management of people
- Customer focus
- Use of information and analysis

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- Process improvement
- Strategic and quality planning

Many well known companies which were experiencing decline in their fortunes, have experienced wonderful revitalizations, and have restored their market share and profitability based on TQM. These include Xerox, Harley Davidson and Ford. Thousands of less well known companies have done similar to some extent or other. Very few manufacturing companies have been able to ignore the elements of TQM and still prosper. Although the original impetus came from Japanese companies, for putting the elements listed above together as a focussed improvement strategy, Western companies have intensely pursued these ideas and practices since just before 1980. After twenty years of experience with TQM practices, it is clear that the performance improvements resulting from these fine-sounding ideals, listed above, are indeed not clear but are very mixed! Some companies, indeed more than enough to justify the huge interest in TQM, have achieved major improvements. At the pinnacle of lists of those which have accomplished great improvements are the winners of the various quality awards around the world. However, for each successful implementation of TQM there are many which have not been able to translate their efforts into operational or business improvement. As a result, there is now widespread disillusionment with TQM, and many are saying that 'the bubble has burst'. How does this evidence fit with the intrinsic attractiveness of the elements of TQM, and with the significant number of successes? Many Japanese and Western companies did indeed build or rebuild their competitiveness based on the principles of TQM.

This study provides a contribution to the literature through the analysis of a large database of TQM practices and performance in companies in two countries, Australia and New Zealand. Reliability and validity of the empirically based model are computed and conclusions are drawn on the explanatory and predictive power of the TQM elements. Issues are raised about each of the seven elements.

The following research questions are empirically investigated in this study:

1. Are the elements of TQM reliable and valid for measuring and predicting organisational performance?
2. Which elements of TQM are best predictors of organisational performance?

Answering the above questions will contribute to a deeper understanding of the business value and the strategic role of each of the elements of TQM. This would help managers with the allocation of resources to those categories that have the most significant effect on organisational performance.

2. Literature review and research problem background

2.1. Purpose of the literature review

In the last several years, influential media such as the Harvard Business Review (Debate, 1992) have published many articles on TQM. Even more recently, researchers have begun empirical verification on answering the simple questions: ''What works?'' and ''How does it work?'' (Flynn et al., 1994; Powell, 1995). Our literature review identified over 1000 articles on the TQM philosophy and methods. Only a small percentage of these articles attempted to test the strength of the relationship between TQM and organisational performance.

2.2. The development of TQM

One of the most influential individuals in the quality revolution was Dr. Edwards Deming. In 1980, NBC television produced a special program entitled *If Japan Can. Why Can't We?* The widely viewed program revealed Deming's key role in the development of Japanese quality. As business and industry began to focus on quality, the US government recognised that quality is critical to the nation's economic health. In 1987, the Malcolm Baldrige National Quality Award (MBNQA) was established as a statement of national intent to provide quality leadership. Similar quality awards and frameworks were created in other industrialised countries. Other key influencers in the early days, who made significant contributions to the development of both the conceptual and practical sides of quality management, were Crosby (1979) and Juran (1989).

The quality awards criteria are the most commonly used method for categorising TQM elements, hence our work was guided by what is rapidly

becoming the 'universal' awards structure. A number of research studies of TQM and quality awards systems have been conducted, and led to a debate about the effectiveness of such awards and of the various TQM elements. Many of these studies have been either perceptual studies or small-scale empirical works. The present study is a large cross-sectional examination of the quality-related practices and performance of over 1200 manufacturing organisations. In this section we examine some of the key existing empirical studies and their limitations.

Bemowski and Stratton (1995) investigated the usefulness of the MBNQA criteria. Surveys were sent to a randomly selected sample of 3000 people worldwide. A response rate of 28% was achieved. The study found that the usefulness of the MBNQA criteria, overall, has met or exceeded users' expectations and that the criteria were being used primarily to obtain information on how to achieve business excellence. However, that study failed to establish a link between the MBNQA and organisational performance. Helton (1995) attempts to demonstrate that the MBNQA winners in the US achieved more than double the wealth creation rate of the average market increase, as measured by stock price movements. Helton concluded that: ''An investment of US$1000 in each publicly owned quality award winner has increased by 99% through September 1, 1994. This correspond favourably to a 41.9% gain on principal if the same dollars had been invested in the Dow Jones Industrials or a 34.1% gain if invested in Standards and Poor's 500 stocks on the award dates''.

Black and Porter (1996) conducted factor analysis on a questionnaire administered to quality manager practitioners. From this they established a list of ten factors that are described as critical to TQM. Although their approach is sound, and indeed is similar to ours, it like ours suffers from the general weakness of factor analysis, that relates to the absence of prescriptive rules about how many factors are sensible. Black and Porter sensibly use Eigenvalues and 'variance explained' criteria to justify their choice of 10 factors, whereas we have chosen to stay with the six categories of TQM practices common to quality award systems. We then test these for significance and predictive power.

In a similar study, Saraph et al. (1989) established eight factors, some of which are similar to those of Black and Porter, and to the quality award categories. However, there is certainly not a clear agreement as to what the 'real' factors of TQM are, and there will always be disagreements as to 'how to best cut the TQM cake' into factors or elements. Noting that the differences exist and are generally not major, we prefer to use a well established factor set, the awards framework categories, and move on to test the correspondence of these factors, individually and collectively, with organisational performance measures, which is an additional step from Black and Porter's contribution.

Our motivation is based on wishing to contribute to knowledge about 'What works?' This means using methods similar to those of Saraph et al. (1989) and Black and Porter (1996), but also using matched performance data, to test linkages of the established factors to a performance factor.

Ahire et al. (1996) also developed a model using similar techniques to Black and Porter. Their list of factors is, as expected, similar to both Saraph et al. and Black and Porter's, and while Ahire did include 'product quality' as a factor, they did not include aspects of organisational performance in their study.

A qualitative study by Easton (1993) provides assessment of the MBNQA based on his experience as an Examiner and Senior Examiner with the Baldrige Award for four years, involving 22 companies. Easton (1993) states: ''TQM in the US is far from mature. It is important that TQM approaches continue to be developed, refined, and expanded, even in companies that have already achieved considerable success. Otherwise the competitive advantage that TQM promises will not be realised and many companies will be left struggling against competitive decline without and unified or coherent start for revitalisation.'' Although these qualitative views based on practical experience are of substantial value, empirical evidence is also needed based on what Black and Porter (1996) referred to as ''scientifically based'' frameworks.

Rigorous statistical analysis is required in order to meet professional standards of reliability and validity. This approach would enable items to be retained or removed based on multivariate statistical analysis such as Principal Components/Factor Analysis procedures. To our knowledge, this has not been done with any statistical rigour based on a large

($N > 1000$) and randomly selected sample. Previous studies have been generally based on between about 20 and 200 observations.

3. Theoretical framework and research hypotheses

3.1. TQM elements

Although there are always going to be debates about how to categorise elements of a holistic process and framework such as TQM, it is necessary to decompose it in some way to facilitate analysis. Since the most pervasive and universal method has been awards criteria such as the MBNQA, we have chosen to follow that framework. Our empirical constructs are guided by the main criteria of these quality awards frameworks, particularly the best known of them, the MBNQA.

There are seven award criteria, each assigned a number of points, such that the total for all criteria leads to a score out of a possible total of 1000. In this section we describe the seven criteria, which we have adopted as TQM model elements. Our empirical work aims to validate these seven elements as constructs and determine the relationships between the six practice elements and the seventh, which is performance outcomes.

3.1.1. Leadership

This element is considered the major 'driver' of TQM which examines senior executives' leadership and personal involvement in setting strategic directions and building and maintaining a leadership system that will facilitate high organisational performance, individual development, and organisational learning. TQM advocates emphasise the activities of senior leadership much like transformational leadership theory (Burns, 1978; Bass, 1985). The core issues in our leadership construct (see Appendix A) included the creation of unity of purpose, encouragement of change, management of the environment, and use of operator's ideas in improving the business.

3.1.2. People management

The main issue addressed in this category is how well the human resource practices tie into and are aligned with the organisation's strategic directions. Excellence in this category, according to Garvin (1991) comes down to a simple test: the voice of the people. Our survey questions focussed on training, development, communication, safety, multi-skilling and employee flexibility, employee responsibility and measurement of employee satisfaction. The answers to these types of questions are the bottom line on human resource management because they capture the combined impact of TQM training, communication, and involvement programs. Commonly heard statements by CEO's such as ''People are really everything'' and ''People are our critical resource'' lead to an expectation that this variable will have significant explanatory power on performance.

3.1.3. Customer focus

This element addresses how and how well the organisation determines current and emerging customer requirements and expectations, provides effective customer relationship management, and determines customer satisfaction (Evans and Lindsay, 1995). We also measured the extent to which customer related information is disseminated through the organisation and the extent of customer complaint resolution. Customer focus is the underpinning principle in the TQM philosophy.

3.1.4. Strategic planning

This element focuses on the organisation's strategic and business planning and deployment of plans, along with the organisation's attention to customer and operational performance requirements (Evans and Lindsay, 1995). The emphasis is on customer-driven quality and operational performance excellence as key strategic business issues that need to be an integral part of overall business planning. It is appropriate to distinguish between the TQM perspective of strategy and corporate strategy. The TQM perspective deals extensively with business unit strategy in the sense of 'how to compete for a set of customers.' On the other hand, corporate strategy deals with 'how to decide which customers to compete for.' The extent of a defined central purpose and mission in the organisation was also a part of this construct.

3.1.5. Information and analysis

This element is concerned with the ''scope, management, and use of data and information to maintain a customer focus, to drive quality excellence, and to improve . . . performance'' (Malcolm Baldrige National Award Criteria, 1995). The TQM philosophy emphasises *Decision making based on fact* involving analysis of information about customer needs, operational problems, and the success of improvement attempts. Many popular TQM techniques (e.g., cause-and-effect analysis, Pareto charts) are aimed at helping organisations to process information effectively (Dean and Bowen, 1994). The TQM literature suggests that organisations that consistently collect and analyse information will be more successful than those that do not. However, empirical studies in the literature suggest that the sort of information and analysis advocated by the TQM philosophy can actually inhibit organisational performance. For example, Fredrickson (1984) found that although comprehensive decision making was positively related to organisational performance in the highly stable paint industry, it was negatively related to organisational performance in the highly unstable forest product industry. Dean and Bowen (1994) conclude that management theorists see information processing as useful in general but potentially irrelevant or even hazardous in specific situations. As TQM moves from the original domain of application, manufacturing, towards use in research, marketing, and customer service activities, such uncertain conditions are more likely. Our survey questions on information and analysis focussed on the extent of benchmarking conducted throughout the organisation, over most of the categories that determine business competitiveness.

3.1.6. Process management

This element of TQM is concerned with how the organisation designs and introduces products and services, integrates production and delivery requirements and manages the performance of suppliers (Evans and Lindsay, 1995). The core idea behind this principle of TQM is that organisations are sets of interlinked processes, and that improvement of these processes is the foundation of performance improvement (Deming, 1986). Deming saw sets of interlinked processes as systems, and his treatment of organisational systems is generally consistent with the use of this term in management theory. According to Dean and Bowen (1994) the intellectual turf represented by this category has been abandoned by management theorists and is currently occupied by industrial engineers. Some organisations have experienced dramatic performance improvements through process redesign and reengineering (Hammer and Champy, 1993; Stewart, 1993).

3.1.7. Performance

The performance element of TQM focuses on quality performance, operational and business performance indicators. We have given this construct separate status in our study, as the 'dependent' variable to which we fit the other categories as independent variables. Our measures were of customer satisfaction, employee morale, productivity, quality of output and delivery performance.

3.2. Research hypotheses

Our first hypothesis is concerned with the validity and reliability of the TQM construct and its elements, while the second hypothesis deals with the predictive power of these elements.

3.2.1. Hypothesis H1

The TQM elements individually and collectively comprise a reliable and valid instrument for measuring TQM practice and performance.

3.2.2. Hypothesis H2

There is a significantly positive relationship between TQM element strength and operational performance.

4. Methodology

4.1. Background

The stated hypotheses were tested using a mail survey of manufacturing site managers that was conducted in 1994 by the Australian Manufacturing Council (AMC) in conjunction with the Australian Bureau of Statistics, and the Manufacturing Advisory Group (New Zealand). The various factor analyses, multiple regressions, and other statistical calculations

Table 1
Factor analysis: independent variable constructs

Variables	Descriptions	Initial factor loadings	Revised factor loadings	Reliability of revised construct
F1:	Leadership			
LE1		0.756	0.758	
LE2		0.651	0.670	
LE3		0.657	0.656	
LE4		0.784	0.788	
LE5		0.756	0.760	
LE6		0.535	0.534	
Ln_BM3a		0.354	–	
				$\alpha = 0.783$
F2:	People Management			
PE1		0.658	0.658	
PE2		0.700	0.700	
PE3		0.698	0.698	
PE4		0.671	0.671	
PE5		0.579	0.579	
PE6		0.666	0.666	
QP8		0.602	0.602	
				$\alpha = 0.776$
F3:	Customer Focus			
CF1		0.644	0.662	
CF2		0.687	0.701	
CF3a		0.531	0.511	
CF3b		0.422	–	
CF4		0.367	–	
CF5		0.699	0.717	
CF6		0.636	0.650	
CF7		0.588	0.622	
				$\alpha = 0.715$
F4:	Strategic Planning			
PL1		0.721	0.734	
PL2		0.777	0.788	
PL3		0.745	0.750	
PL4		0.673	0.670	
PL5		0.735	0.748	
PL6		0.676	0.665	
PL7		0.397	–	
				$\alpha = 0.820$
F5:	Information and Analysis			
BM21		0.826	0.826	
BM22		0.883	0.883	
BM23		0.822	0.822	
BM24		0.834	0.834	
BM25		0.780	0.780	
BM5c		0.932	0.932	
BM5d		0.878	0.878	
BM5h		0.888	0.888	
				$\alpha = 0.898$

Table 1 (continued)

Variables	Descriptions	Initial factor loadings	Revised factor loadings	Reliability of revised construct
F6:	Process Management			
QP2		0.690	0.690	
QP3		0.753	0.753	
QP4		0.672	0.672	
QP5		0.656	0.656	
QP6		0.603	0.603	
				$\alpha = 0.697$

were conducted using the SPSS Windows v6.0 software. Our sample was purposefully a truly random sample of manufacturing companies.

Whereas the GAO study and that of Helton (1995) were of 'superior quality' companies, and there is much attention given to quality award winners around the globe, the largely 'unstudied' companies, that are not quality leaders, but that comprise most of the manufacturing sector of an economy, merit further investigation in terms of their quality practices and operational performance.

4.2. Sample

The sample population is a stratified random sample drawn from manufacturing sites that employ more than twenty people and were registered with the Australian Bureau of Statistics, or Statistics New Zealand in 1993. For each country, the sample was stratified using twelve industry codes (ASIC and NZIC) and three size categories. This stratification ensured that for the Australian sample, each cell contains a minimum of 15 respondents. A total of approximately 4000 manufacturing sites (3000 in Australia and 1000 in New Zealand) were sent the questionnaire. Responses were received from 1289 sites, 962 in Australia and 327 in New Zealand; yielding response rates of 32% and 38%, respectively. A telephone survey of 108 non-respondents was conducted by the AMC. These non-respondents were asked a sub-set of questions that had a high predictive validity for the rest of the questionnaire, and were examined for other differences such as scale and location. No significant response bias was detected (AMC, 1994). As will be discussed later in the section on data preparation, 265 respondents of the original 1289 have been dropped from the sample due to an excessive number of unanswered questions. This left a total of 1024 useable responses that formed the data set for all analyses in this study.

4.3. Survey instrument

The survey instrument was a 17-page survey mailed to site managers. A total of 246 questions were included in the questionnaire. All responses were returned within a 10-week period. The questions in the survey were developed by a committee of academics (including one of the authors), site managers, and the chairman of the Australian Quality Awards Foundation. This committee used a variety of sources in developing the questions, including the Malcolm Baldrige National Quality Award Criteria (1994), the Deming Prize Criteria, the European Quality Award Criteria, the Australian Quality Award Criteria, 1994 (Australian Quality Council, 1994), and Made in Britain (1992). The questionnaire was pilot tested on six sites in Australia, and subsequently revised. Given the length and complexity of the instrument, Ergas and Wright (1994) tested the data for 'respondent fatigue' and 'awareness' of changes in the tone and/or measurement scale of the questions. They found little or no evidence of these types of bias. Further details of the survey method and the profile of companies involved are given in a recent article by Terziovski et al. (1997) in which an examination of the efficacy of quality management systems certification was made.

4.4. Data preparation

Three distinct stages of data preparation are performed prior to conducting the main analyses.

4.4.1. Selection of questions

The first stage involves the selection of questions to include in the final data set. Many of the questions in the survey instrument were not directly concerned with TQM and organisational performance. For example there was a series of questions on the extent of use of advanced manufacturing technology and manufacturing process and strategy, which are relevant to other analyses but not to this investigation of TQM implementation. We used the 53 variables in this analysis that were TQM related and allocated them to seven constructs based on the 1995 MBNQA examination criteria (Evans and Lindsay, 1995) and existing literature on the issues of quality management and TQM (Deming, 1986; Saraph et al., 1989; Garvin, 1991; Adam, 1994; Flynn et al., 1994; Powell, 1995). The seven constructs have been assigned the labels in accordance with the theoretical constructs discussed in Section 3.1 of this paper: Leadership; People Management; Customer Focus; Strategic Planning; Information and Analysis; Process Management; Performance. These constructs were tested for construct validity after having been nominated because of their close fit with the intended meaning of the generally accepted quality management elements and the various international quality award frameworks such as the MBNQA categories. Our choice of questions was driven by previous empirical studies, particularly Adam (1994) and the content analysis of the literature base of TQM, and validated through the statistical analysis described below.

4.4.2. Screening of outliers

The second stage of data preparation was the screening for outliers, and checking the normality of the data. Four of the variables are based on continuous scales. All of these required a natural logarithm transformation to correct for excessive skew and kurtosis. In addition, three data points were identified as outliers (z-scores all > 10) and have been deleted. All of the remaining variables utilise interval scales; predominantly five point Likert-type scales. Only one of the interval scale variables required a transformation to correct for excessive skew and kurtosis. After appropriate transformations and deletions, six of the 53 variables still suffer skew in the range of 1.00 to 1.60. These variables have been retained. One other variable is heavily skewed (skew $= 3.65$), and has been dropped from the analysis. A summary of the wording, and scales for each of the 53 variables can be found in Appendix A.

4.4.3. Treatment of incomplete responses

The third and final stage of data preparation was treatment of incomplete responses. Factor Analysis and Multiple Regression Analysis require all cells in the data set be complete. Only 352 of the original 1289 responses are complete. Thus, the researcher is faced with dropping almost three quarters of the responses, or using a technique such as imputing missing cells with the variable mean. The latter of these two options, substituting the variable mean, is only advisable when the proportion of blank cells is low (Bentler, 1993, pp. 46–47). For the purposes of the analyses reported in this paper, a compromise approach has been adopted. If any response has more than 6 empty cells among the 53 variables, then the entire response has been deleted from the data set. This approach yields 1024 responses with only 1.2% missing cells. Within this sample of 1024, the variable means have been substituted for missing cells.

4.5. Analysis procedures

The variables assigned to each of the seven TQM constructs have been subjected to factor analysis to ensure that they are reliable indicators of those constructs (Nunnally, 1967). A cutoff loading of 0.450 has been used to screen out variables that are weak indicators of the constructs (Tables 1 and 2). Eight variables failed to make this cutoff, leaving a total of 45 variables constituting the seven constructs. The composite reliabilities of five of the seven constructs meet Nunnally's recommended standard (Cronbach Alpha ≥ 0.70) for early stage research (Nunnally, 1967, p. 245). The reliabilities of the remaining two constructs: 'Process Management' and 'Organisational Performance', both fall mildly short of this standard (0.697 and 0.674, respectively). However, further culling of variables will not improve this situation, as the reduction in the number of indicators outweighs the benefits of shedding the less reliable

Table 2
Factor analysis: dependent variable construct

Variables	Descriptions	Initial factor loadings	Revised factor loadings	Reliability of revised construct
F7:	Performance			
PO7a		0.654	0.677	
PO7c		0.612	0.598	
PO7d		0.535	0.524	
PO7e		0.381	–	
PO8a		0.618	0.643	
PO8b		0.457	0.494	
PO8c		0.574	0.580	
PO8j		0.554	0.586	
Ln_Sales_Gr		0.169	–	
Ln_Emp_Gr		0.128	–	
Ln_PCBD		0.399	–	
				$\alpha = 0.674$

indicators. Our factor loadings are broadly similar to those of Black and Porter (1996).

Once the factor analysis was completed, factor scores were calculated from the remaining variables to provide estimates for each of the seven constructs. The factor scores for the first six constructs were used as independent variables in a multiple regression analysis. A correlation matrix of the factor scores for these six constructs was produced. The factor scores for the seventh construct, Performance, were used as the dependent variable in the regression analysis.

5. Results

Table 1 shows the construct 'strengths' for the six independent variable TQM element factors. The variables are identified by their code names that are explained in Appendix A.

Table 2 shows the factor loadings for the seventh element of our survey, which was to be our dependent variable, Performance.

The slightly lower than standard acceptable value of α for F7, Performance, is interpreted such that performance is indeed composed of multiple dimensions or elements. Such disparate measures as quality, productivity, employee morale, customer satisfaction and delivery performance contributed to this construct, and we know from scanning and cutting the data set and from the literature (see Samson et al., 1993) that firms often specialise or focus to excel in only a subset of these performance dimensions.

Table 3 shows the bivariate correlation of the six independent variable factors. There is clearly some significant multicollinearity. This reflects, as would

Table 3
Correlation matrix of independent variable construct factor scores

	F1: Leadership	F2: People management	F3: Customer focus	F4: Strategic planning	F5: Information and analysis	F6: Process management
F1	1.000					
F2	0.694[a]	1.000				
F3	0.520[a]	0.565[a]	1.000			
F4	0.569[a]	0.580[a]	0.488[a]	1.000		
F5	0.268[a]	0.257[a]	0.245[a]	0.320[a]	1.000	
F6	0.392[a]	0.450[a]	0.472[a]	0.374[a]	0.222[a]	1.000

[a] Significant to 0.01, one-tailed.

Table 4
Multiple regression analysis

Dependent variable	F7: Performance			
Multiple *R*	0.463			
R-square	**0.214**			
Adjusted *R*-square	0.210			
Standard error	0.889			
Analysis of variance				
	df	Sum of squares	Mean square	
Regression	6	219.3	36.55	
Residual	1017	803.7	0.79	
$F = 46.2$	Significant $F = 0.000$			
	Variables	Beta	*T*	Significant *T*
F1	Leadership	0.158	3.86	0.000
F2	People Management	0.259	6.07	0.000
F3	Customer Focus	0.120	3.31	0.001
F4	Planning	0.047	1.27	0.203
F5	Information and Analysis	−0.145	−4.89	0.000
F6	Process Management	−0.026	−0.80	0.423

be expected, that firms which are advanced in their practices on some factors tend generally to be more advanced on others.

These correlations between factor elements of TQM are broadly similar to those of Ahire et al. (1996), who established 12 TQM factors that had correlations generally in the range of 0.2 to 0.7 between them.

Although the correlation coefficients were generally above 0.2, and were therefore highly significant as one would expect with over 1000 observations, it is interesting to note that F5: Information and Analysis did not seem so closely related to the rest of the group.

Table 4 shows the multiple regression of all six factors regressed on the dependent variable F7: Organisational Performance. From this analysis, our intent was to test the hypothesis stated earlier and hence contribute to knowledge about the relationship between the six driving TQM practice elements and performance.

6. Discussion of results and findings

6.1. Tests of hypothesis H1

Information about validity and reliability were needed in order to determine whether the seven elements of TQM are stable and accurate and whether they truly measure what they set out to measure (Saraph et al., 1989; Flynn et al., 1994, Black and Porter, 1996). This provides assurance that the findings reflect an accurate measure of the underlying constructs (leadership, people, customer focus, strategic planning, information and analysis, process management, and performance) and that the results are believable.

6.1.1. Validity

Three different types of validity were considered in this study: content, construct and criterion validity (Hair et al., 1992).

6.1.1.1. Content validity. A category was considered to have content validity if there was general agreement from the literature that the TQM model had measurement items that cover all aspects of the variable being measured. Since selection of the initial measurement items was based on the extensive review of international literature and the evaluation criteria of major international quality awards from Australia, the United States, Japan and Europe, our measures were generally considered to have content validity. They generally do measure the key fields of the TQM elements.

6.1.1.2. Construct validity. A measure has construct validity if it measures the theoretical construct that it was designed to measure. The construct validity of each category was evaluated by using Principal Components Factor Analysis (Hair et al., 1992). The measurement items for each of the categories were factor analysed as discussed in the Analysis Procedure in the Methodology section. The results are shown in Table 1. Items that had a factor loading less than 0.450 were eliminated (e.g., item Ln_bm3a in the Leadership construct, which is shown in Table 1). All factors loaded acceptably well.

6.1.1.3. Criterion validity. This is also known as predictive validity or external validity. It is concerned with the extent to which the model is related to independent measures of organisational performance. The criterion related validity of the model was determined by examining the Multiple *R* coefficient computed for the six categories and the measure of performance (0.463 as shown in Table 4). This indicates that the six categories have a reasonably high degree of criterion-related validity when taken together.

6.1.2. Reliability

Reliability is frequently defined as the degree of consistency of a measure. The internal consistency of a set of measurement items, therefore, refers to the degree to which items in the set are homogeneous. Reliability analysis is a correlation-based procedure. Internal consistency for the seven elements was estimated using the reliability coefficient, Chronbach Alpha ranging between the values 0.00 and 1.00 (Nunnally, 1967). Using the SPSS for Windows reliability test program, an internal consistency analysis was performed separately for each of the model elements shown in Table 1. The analysis revealed that maximisation of the Chronbach Alpha coefficient would require eliminating items for each category. Table 1 reports the original sets of measurement items associated with the relevant TQM elements, the items dropped from the original sets to achieve maximisation of alpha, and the reliability coefficient associated with the resulting categories. The reliabilities shown in Table 1 generally meet or exceed prevailing standards of reliability for survey instruments. Considering the above findings, hypothesis H1 on reliability and validity and is supported. Each of the seven categories did form a 'solid' construct, from both a theoretical and statistical perspective.

6.2. Test for hypothesis H2

The results of the regression analysis of the six TQM elements on Performance provide some insights and challenges from both a practical and research perspective. Three of the factors, Leadership, Human Resources Management and Customer Focus proved to be strongly significant and positively related to Performance. The other three factors were shown (Table 4) to be either not significantly related (Planning and Process Management) or negatively related (Information and analysis). All of the independent variable constructs had significant positive correlation with each other, explaining why the least squares algorithm produced the regression results reported in Table 4. Overall, the multiple *R*-value of 0.463 is interpreted as indicating a relatively strong relationship, accompanied by an *F*-statistic for the regression which is highly significant.

6.3. Findings

It is interesting that the strong predictors of performance were the so-called 'soft' factors of leadership, human resources management and customer focus, and the more systems and analytic oriented criteria (information and analysis, strategic planning, process analysis) were not strongly and positively related to performance in the regression.

It is important to note that from these results, we cannot suggest that for a single company, strategic management and process management should not be the focus of improvement because they are not related to performance, nor that better information and analysis in a company leads to worse performance. Nor can we directly say that the world's quality awards systems are 'wrong' because some of the related TQM elements do not contribute positively to explain performance variance in a multiple regression. Our study was cross-sectional and descriptive of a given sample at a given point in time, whereas

the quality awards are being used to measure and suggest dimensions of improvement in order to increase organisational practices, quality and performance. Quality awards frameworks are often usefully interpreted as a set of values through which to pursue improvement for a given company or site, longitudinally.

We do claim, however, that the relative strengths and significance of the regression coefficients in Table 4 coupled with the correlations between these factors are instructive in understanding the underlying differences between high-performance and low-performance firms. So in respect of H2, three of the criteria proved to be strongly positively and independently related to organisational performance and although there were strong inter-correlations among all six practice elements of TQM, multivariate regression certainly sorted out the less important (weaker) factors that had little or no additional positive explanatory power over the powerful three. A managerial insight which can be deduced from this is that in 'fighting the good fight' of improving organisational performance, concentrate mostly on people management, leadership and customer focus. This is not to say that the other three factors should be ignored but rather to note that in our cross-sectional study, these weaker factors did not powerfully distinguish the high from the low performers whereas the first three factors clearly did appear as differentiators.

Ahire et al. concluded that of their eleven factors cutting across all areas of TQM, product quality is most closely affected by ''quality-oriented human resource management'' (1996, p. 43). Our finding is consistent with this and indeed goes further, in that performance of the organisation is related more to these 'soft' factors than quality systems and structural factors.

Adam (1994) reported *R*-squared values for quality elements in terms of their explanatory power on various performance factors ranging from 0.05 to 0.5. Based on his low *R*-squared value of Training and Development on Sales (0.1632) and other similar relationships, Adam poses the case for ''TQM as a Failure'' (1994, p. 41). We believe this argument to be a strawman, and that *R*-squared values such as ours (0.21) are indeed significant. Certainly there is substantial unexplained variance in our performance construct, some of which would presumably be explained by a myriad of other factors including technology, scale, business structure and focus, and luck. However any management methods that explain over 20% of performance variance as in this study and that of Ahire et al. (1996) do not merit the label 'failure'. Based on much fieldwork and close observation of how TQM is implemented, we have strongly concluded that TQM is substantially composed of 'the right stuff' for management. If there is widespread or general failure, and there is, our belief is that it is not so much in the content of TQM and its elements, but in how it is implemented. Failure to explain higher proportions of variance in performance may come from the variance in implementation effectiveness, as much as anything else. Cross-sectional studies such as Adam (1994), Ahire et al. (1996), Black and Porter (1996) and ours also suffer from not being able to account for the lag that exists between the time that new practices are introduced and performance improvements are observed. We suspect that this contributes to values of *R*-squared that are lower than would be the case if such lags could be properly accounted for.

7. Conclusions, limitations and further research

The central finding of this study is that the TQM model, as we modelled it in a cross-sectional study, is a reliable and valid instrument for predicting performance. Three of the elements of TQM, leadership, people management and customer focus have a significantly positive effect, but the other three categories in our study (strategic quality planning, information and analysis and process management) did not.

In a large random survey study such as ours, there was a good deal of variance in performance not explained by our TQM elements, as tested by the regression analysis. This was across a set of companies that varied in size from 20 to 3000 employees, across all manufacturing industries. The great strength of the TQM model and construct elements occurs in our view when companies use the approach to audit their TQM practices and performance, then set targets and strategic improvement plans for im-

provement based on these drivers of performance. Our research does cast a strong light on these practical issues in terms of which three of the six 'practice' elements are likely to be the most important influencers of the organisational performance measure. Our research, which accords well with practical experience, suggests to us that efforts in improved leadership, human resources management and customer focus are more likely to be fruitful than efforts in improving information and analysis, strategic planning and process management.

Despite the fact that our study is one of the largest, most comprehensive in the field, it does suffer from limitations, and these give rise to a number of suggestions for further research. The internal validity of our variables is acceptably strong, but far from perfect. Further empirical research could become tighter than the present study by pre-testing the factors that more closely represent the TQM elements, which would hopefully achieve higher validity scores. Further research on refining the constructs and their elements is warranted.

The research reported here is of a purely cross-sectional snapshot. We were unable to test and account for the lags between the existence of practices and performance changes, nor to trace the progress of particular companies in our study, which is a limitation of all such studies. Therefore we suggest that two further streams of field research are needed. The first is a set of longitudinal studies that would measure TQM elements across a three to five year period, examining the relationships and their development through time. These should be structured studies using statistically credible samples and multivariate methods. This implies a need for reasonably large and random samples like ours, rather than the quite small studies that have often been reported on, and the use of 'convenience' samples, which do not permit proper extrapolation of results from the sample to a population.

In addition, in depth case studies are needed which detail the impact of TQM elements and improvement initiatives on these factors, which many firms are now using internally, to determine the rich fabric of how these initiatives lead to performance changes. Structured interview processes would also be able to investigate what other systematic factors relate to performance changes apart from those presently measured by the TQM elements, which might lead to an improvement in the definition of those measures in the quest for better answering the question: 'What works?'

Appendix A

A.1. Survey questions

Please circle the number which accurately reflects your site's PRESENT position, where: 1 = Strongly Disagree; 2 = Disagree; 3 = Neither Agree nor Disagree; 4 = Agree; 5 = Strongly Agree

A.1.1. Leadership

le1	Senior Managers actively encourage change and implement a culture of trust, involvement and commitment in moving towards 'Best Practice'	1	2	3	4	5
le2	There is a high degree of unity of purpose throughout our site, and we have eliminated barriers between individuals and/or departments	1	2	3	4	5
le3	'Champion(s) of change' are effectively used to drive 'Best Practice' at this site	1	2	3	4	5
le4	At this site we proactively pursue continuous improvement rather than reacting to crisis' 'fire-fighting'	1	2	3	4	5
le5	Ideas from production operators are actively used in assisting management	1	2	3	4	5
le6	environmental ('green') protection issues are proactively managed at this site	1	2	3	4	5

A.1.2. People management

pe1	The concept of the 'internal customer' (i.e., the next person or process down the line and including all employees) is well understood at this site	1	2	3	4	5
pe2	We have an organisation-wide training and development process, including career path planning, for all our employees	1	2	3	4	5
pe3	Our site has effective 'top–down' and 'bottom–up' communication processes	1	2	3	4	5
pe4	Employee satisfaction is formally and regularly measured	1	2	3	4	5
pe5	Our Occupational Health and Safety practices are excellent	1	2	3	4	5
pe6	Employee flexibility, multi-skilling and training are actively used to support improved performance	1	2	3	4	5
p8	All employees believe that quality is their responsibility	1	2	3	4	5

A.1.3. Customer focus

cf1	We know our external customers' current and future requirements (both in terms of volume and product characteristics)	1	2	3	4	5
cf2	These customer requirements are effectively disseminated and understood throughout the workforce	1	2	3	4	5
cf3(a)	In designing new products and services we use the requirements of domestic customers	1	2	3	4	5
cf5	We have an effective process for resolving external customers' complaints	1	2	3	4	5
cf6	Customer complaints are used as a method to initiate improvements in our current processes	1	2	3	4	5
cf7	We systematically and regularly measure external customer satisfaction	1	2	3	4	5

A.1.4. Planning

pl1	We have a mission statement which has been communicated throughout the company and is supported by our employees	1	2	3	4	5
pl2	We have a comprehensive and structured planning process which regularly sets and reviews short and long-term goals	1	2	3	4	5
pl3	Our plans focus on achievement of 'Best Practice'	1	2	3	4	5
pl4	When we develop our plans, policies and objectives we always incorporate customer requirements, supplier capabilities, and needs of other stakeholders, including the community	1	2	3	4	5
pl5	We have a written statement of strategy covering all manufacturing operations which is clearly articulated and agreed to by our Senior Managers	1	2	3	4	5
pl6	Our site's manufacturing operations are effectively aligned with the central business mission	1	2	3	4	5

A.1.5. Process management

qp2	Our suppliers work closely with us in product development	1	2	3	4	5
qp3	We work closely with our suppliers to improve each others' processes	1	2	3	4	5
qp4	Our suppliers have an effective system for measuring the quality of the materials they send to us	1	2	3	4	5
qp5	We have well established methods to measure the quality of our products and services	1	2	3	4	5
qp6	We have site-wide standardised and documented operating procedures	1	2	3	4	5

A.1.6. Information and analysis

At this site we have undertaken benchmarking in the following areas:

Please circle as many numbers as are appropriate		Yes	No
@bm21	Relative Cost Position	1	2
@bm22	Operating Processes	1	2
@bm23	Technology	1	2
@bm24	Quality Procedures	1	2
@bm25	Customer Service	1	2

Estimate the total number of business days your site invests per year in reviewing the following information relating to other firms in your industry, where: 1 = None; 2 = Less than three business days; 3 = Between three and five business days; 4 = Between six and twenty business days.

Please circle one number against each factor						
bm5c	Other firms' product quality and procedures	1	2	3	4	5
bm5d	Other firms' human resource practices and policies	1	2	3	4	5
bm5h	Other firms' processes in bringing new products to market	1	2	3	4	5

A.1.7. Organisational performance

Please indicate (by writing a single number, ranging from one through to five, in the vacant end column) your site's current performance level for EACH of the listed attributes.

Dependent variable (performance outcome)	1	2	3	4	5	(1–5) score
po7a Customer Satisfaction	Sometimes meets expectations	Generally meet expectations	Consistently meet expectations	Always meet expectations	Expectat's exceeded delighted customers	

po7c Employee Morale	Very low	Low	Satisfactory	High	Very High
po7d Productivity	Decreasing	Static	Moderate Improvement	Consistently improving	Major and significant gains
po8a Defects as a % of production volume	Less than 0.1%	0.1–0.49%	0.5–1.99%	2.0–5.0%	More than 5.0%
po8b Warranty claims cost as a % of total sales	Less than 0.1%	0.1–0.99%	1.0–1.49%	1.5–3.0%	More than 3.0%
po8c Cost of quality (error,scrap, rework and inspection) as a % of total sales)	Less than 1.0%	1.0–4.9%	5.0–9.9%	10.0–15.0%	more than 15.0%
Delivery in full on time to our customer	Less than 50%	50–80%	81–90%	91–96%	97–100%

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