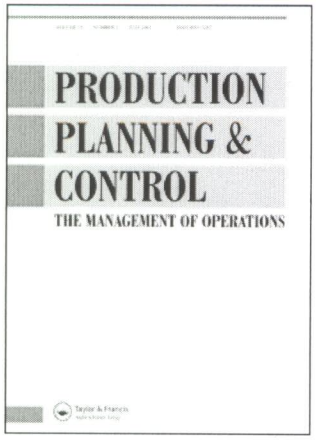

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An empirical study of quality management practices in the petroleum industry

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An empirical study of quality management practices in the petroleum industry

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The purpose of this paper is to empirically study quality management practices in the petroleum industry in Iran. A reliable and valid survey instrument has been used for data gathering from managers in the petroleum industry in Iran. The instrument has been developed based on the criteria of the Malcolm Baldrige National Quality Award (MBNQA), which consists of 13 dimensions of quality management. Correlation analysis has been used to test for a relationship between the quality management constructs and quality results (internal quality results and/or external quality results). Most of the linkages within the Baldrige criteria were supported, which indicates the universal applicability of the Baldrige Award criteria. The result of the correlation analysis indicates that top management support is the major driver for quality management implementation which is significantly correlated with most of the quality management constructs. Furthermore, the results indicated that employee training and employee involvement are significantly correlated with internal (operational) quality results. Customer orientation and supplier quality are not significantly correlated with external quality results (business performance).

Keywords: Quality management; Baldrige criteria; Petroleum industry; Performance

1. Introduction

Globalisation and international trade, along with advances in information technology, have dramatically increased competition worldwide. The concept of total quality management (TQM) was developed as the result of intense global competition. Companies with international trade and global competition have paid considerable attention to TQM philosophies, procedures, tools, and techniques. Empirical research shows that quality management practices improve organisational performance and profitability (Hendricks and Singhal 1996, Hendricks and Singhal 2001a, b).

The implementation of quality management has not occurred at the same pace in different regions of the world. Early implementation of TQM started in Japan and was later adopted by the US, Europe, and the South East Asian countries. Countries in the Middle East have been slower in their quality journey. The rise and fall of gas/oil prices in the global market during different periods (late 1982, 1998, early 1999, and 2005) and the dependence of Middle Eastern national economies on revenue from the petroleum industry have forced these countries to evaluate quality initiatives as a way of improving their products and services (Al-Khalifa and Aspinwall 2000).

Despite the number of publications and quantity of research on TQM, little empirical work has been carried out in developing countries, particularly in the Middle East. The lack of research leaves us with the following questions. What are the implications of quality management in the Middle East? How is quality management being implemented in the Middle East? Do quality

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management practices affect operational and/or business performance?

The paper makes several contributions to the literature. First, the paper investigates the linkages among different constructs of quality management (through emphasis on the Baldrige criteria) in an international context. Second, the paper adds to the body of knowledge in quality management in the international context, specifically in the Middle East. Third, the paper advances the literature on the practice of quality management in process industries, specifically in the petroleum industry. Research on quality management in process-based industries is surprisingly rare (*Journal of Operations Management*, 2003); therefore this study advances the knowledge on quality management in the petroleum industry.

2. Literature review

The importance of global quality management, its definition, components and essentials first appeared in a special issue on global quality management in the *Journal of Decision Sciences* (1995, Vol. 26, No. 5). Kim and Chang (1995) argued that international/global quality management should be researched systematically. They conceptualised global quality management (GQM) as the next generation of TQM and defined it as:

> The strategic planning and integration of products and processes to achieve high customer acceptance and low organisational disfunctionality across country market.

The emergence of GQM serves as a motivation for the development of a standard for evaluating quality management practices between countries (Rao *et al.* 1999). A standard of this nature will enhance the practice of quality management, from the national to the global level (Kim and Chang 1995), which helps firms to compete globally and gain a competitive edge in the global market (Fawcett *et al.* 2000, Liu and Kleiner 2001). The study of global quality management serves as a benchmarking tool for achieving this competitive advantage and a basis for international language and business performance in the global context (Feigenbaum 1997). As Sila and Ebrahimpour (2003) indicated, the question regarding the universality of quality management practices has not yet been answered, and more empirical, cross-country and industry-specific research is needed on quality management.

In spite of the extant research on quality management, there is still little literature available on the quality system implementation in developing countries. The generalisability of quality management practices in the global context requires studying quality management practices in other parts of the world that have not been studied empirically, including the Middle East.

2.1 *The Baldrige criteria*

The Malcolm Baldrige National Quality Award (MBNQA) has evolved from a means of recognising the best quality management practices to a comprehensive framework for world class performance, where it is widely used as a model for (process) improvement (Flynn and Saladin 2001).

Despite being described as 'badge of honor' (Dow *et al.* 1999), the MBNQA is much more than a quality award for an organisation. Garvin (1991) described it as: 'The most important catalyst for transforming American business.' Furthermore, Juran (1994) argues that the MBNQA is a helpful model for getting into world class quality. MBNQA has been primarily used as a framework for business improvement rather than as an award for quality. The application of MBNQA is not just limited to the US. In fact, most national and international quality awards have been influenced by Malcolm Baldrige criteria (Ettore 1996, DeBaylo 1999), including the European Quality Award, the Mexican National Quality Award, the Brazilian National Quality Award, the Egyptian Quality Award and the Japanese Quality Award. The Baldrige model consists of seven criteria, as follows:

1. Leadership.
2. Strategic planning.
3. Measurement, analysis and knowledge management.
4. Customer and market focus.
5. Human resource focus.
6. Process management.
7. Business results.

Despite the wide application of the Baldrige model in practice, few theoretical or empirical studies have been reported in the literature. The Baldrige model has been used as a framework for putting quality management into operation (Samson and Terziovski 1999, Dow *et al.* 1999, Handfield *et al.* 1998, Lee *et al.* 2003, Evans and Jack 2003). The universality of MBNQA and its relationship to many quality management constructs has made the Baldrige model a useful framework for studying quality management practices. Samson and Terziovski (1999) state that:

> Although there are always going to be debates about how to categorise elements of a holistic

process and framework like 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.

In addition, MBNQA criteria has been used for studying quality management practices in different regions in the world (Rao *et al.* 1999). Studies using the Baldrige model as a framework for quality management in the global context show some convergence in quality management practice (Rao *et al.* 1997, 1999). MBNQA is not only used as a model for international quality management comparison, but it also could help as a self-assessment tool, providing a framework for continuous business process improvement.

3. Variables and measures

For the purpose of this study, the 13 constructs identified by Rao *et al.* (1999) were considered to serve as a framework for quality management. These constructs have been evolved from the Baldrige model. While the Baldrige model consists of seven constructs, the survey instrument in this study consists of 13 constructs for quality management. Through implementation, verification, and empirical analysis of the original instrument new constructs have been added so that the survey instrument can capture all aspects of quality management (Rao *et al.* 1999). The constructs have been explained below. The abbreviation in parentheses refers to the variable in the data analysis section.

1. *Top management support* (tms) addresses the critical role of management in driving company-wide quality management efforts.
2. *Strategic quality planning* (spqm) incorporates the integration of quality and customer satisfaction issues into strategic and operational plans, which allow firms to set clear priorities, establish clear target goals, and allocate resources for the most important things.
3. *Quality information availability* (qia) refers to the availability of quality information for effective and efficient quality management practices.
4. *Quality information usage* (qiu) indicates how much quality information is used by managers when making decisions.
5. *Employee training* (et) explains the level of continuous and intensive training as an essential part of quality management.
6. *Employee involvement* (ei) relates to the involvement of employees in problem solving, and decision making at all levels in the organisation.
7. *Product/process design* (pd) indicates the implementation of product/process management techniques that reduce process variation and affect internal quality performance.
8. *Supplier quality* (sq) acknowledges the importance of suppliers in achieving higher levels of quality in an organisation.
9. *Customer orientation* (cfs) refers to the extent the company evaluates the feedback from its customers in improving quality.
10. *Quality citizenship* (qc) stresses the practice of company responsibility and its social role in society, such as improvement of education, safety, and health care in the community.
11. *Benchmarking* (b) is defined as the search for industry best practices that lead to superior performance.
12. *Internal quality results* (iqr) determines how much quality management practices have affected internal quality measures, such as defect rates, reprocessing rate, production lead time, and productivity.
13. *External quality results* (eqr) refers to the improvement of external performance of the firm, which is measured by competitive market position, profitability and customer satisfaction.

4. Hypotheses

The following hypotheses (table 1) have been developed based on the theoretical framework and previous research in the Malcolm Baldrige quality award (Evans and Jack 2003, Lee *et al.* 2003).

5. Methodology

5.1 *Survey instrument*

A survey instrument was used to gather information on quality management practices. The quality management instrument developed by Rao *et al.* (1999) was based on the MBNQA. This instrument was selected after a careful review of the literature. It solicits information from the participants about their perceptions of quality management practices. A 5-point Likert system scale (an interval scale) was used on the instrument. The scale ranged from 1 to 5; indicating 1 = very low, 2 = low, 3 = medium, 4 = high, and 5 = very high.

Table 1. Proposed hypotheses and relevant justification.

Hypothesis	Justification
H_{1a}: Top management support for quality is positively correlated with external quality results. H_{1b}: Quality citizenship is positively correlated with external quality results. H_{1c}: Quality information availability is positively correlated with external quality results.	Research in quality management emphasises the critical role of top management in driving overall quality management systems in the organisation (Anderson *et al.* 1995, Flynn *et al.* 1995). In the Malcolm Baldrige model, top management is the major driver of a quality system where it affects organisational performance and profitability (Wilson and Collier 2000). On the other hand, top management enhances an organisation's role in the society (Rao *et al.* 1999). Furthermore, the development of necessary infrastructures for quality management such as access to and availability of information systems is enhanced by top management support (Flynn *et al.* 1995).
H_2: Strategic quality planning is positively correlated with quality information usage.	In the Malcolm Baldrige model, it has been stated that there is a positive link between strategic planning for quality and quality information and analysis (Lee *et al.* 2003).
H_{3a}: Quality information usage is positively correlated with product/process design.	Lee *et al.* (2003) empirically showed that quality information and analysis have a significant effect on process management.
H_{3b}: Benchmarking is positively correlated with product/process design.	
H_4: Product/process design is positively correlated with internal quality results.	Foolproof process design reduces variation in the process by building quality into the product during the production stage (Handfield *et al.* 1998). Variance reduction in the process should result in increased output, reduced rework and waste (Forza and Flippini 1998). This is due to the fact that quality problems have been identified and corrected immediately (Ahire and Dreyfus 2000). According to Flynn *et al.* (1995), effective process management results in an increased percentage of output passing final inspection with no rework.
H_5: Employee involvement is positively correlated with internal quality results.	According to Lee *et al.* (2003) human resource management is significantly correlated with quality results.
H_6: Top management support is positively correlated with employee training.	Kaynak (2003) empirically showed that employee training is positively correlated with top management support.
H_7: Customer orientation is positively correlated with product/process design.	Lee *et al.* (2003) justified that customer orientation is positively related to process improvement.
H_8: Supplier quality is positively correlated with internal quality results.	Previous studies show that product quality and process improvement are enhanced when interaction between buyer and supplier has been increased (Ansari and Modarress 1990, Trent and Monczka 1999). Supplier involvement in the firm's design of products/services increases process efficiency (Flynn *et al.* 1995, Forza and Flipinni 1998).
H_9: Internal quality results are positively correlated with external quality results.	Through process improvement, operating and financial performance will be improved (Garvin 1988). In the Malcolm Baldrige model, it has been shown that improving internal management practices leads to improvement in external results (Evans and Jack 2003).

5.2 *Instrument development and validation*

The following steps were taken to develop and validate the measurement instrument. The theoretical dimensions underlying quality practices were conceptualised and a questionnaire developed to measure them. Data was collected in multiple countries using the questionnaire. The sample was divided randomly into two. Testing and purification of the constructs were done using the first half, while the second half was used as a hold-out sample to confirm the validity of the constructs. Structural equation modelling (LISREL) methodology was used in the analysis and validation (Rao *et al.* 1999).

The construct reliability was reported as 0.83, indicating good construct reliability. Convergent validity was reported 0.93, indicating strong convergent validity. Requirements for discriminant validity and predictive validity were also satisfied. The instrument has been administrated to multiple industries in multiple countries, and it has the highest external validity (Rao *et al.* 1999).

For this study, the original questionnaire was translated into Persian using the following process: First, the researcher, who has sufficient knowledge of the subject and command of both English and Persian languages, translated the English version of the questionnaire into Persian. Another native of Iran, who has sufficient knowledge of both English and Persian, also translated the English version into Persian. The two Persian versions of the questionnaire were compared with each other. Over 95% of the translation in the two versions was the same. Finally, a third person, a professor at a university, whose area of research was quality management and who had a good command of both English and Persian, evaluated the translation and provided comments on the translation. The final version was used for the survey.

5.3 *Sample*

The participants in the study were 31 consultants/project managers from different companies that have projects in the petroleum industry in Iran. These individuals have knowledge and familiarity with a variety of functions/processes in the petroleum industry in Iran, notably production and exploration. Iran was selected as the representative country in the Middle East because of the major role it plays in the petroleum industry in the world. Iran is the fourth oil producer in the world, has the second largest reservoirs of oil and gas in the world and is a major power in the international oil and gas market.

6. Data analysis and results

6.1 *Demographic information*

In the sample 100% of the participants were male. This gender homogeneity was not unusual since most managers and consultants at that level in Iran are male. The average age for the respondents was 49 years. All respondents have been in the oil/gas industry for at least five years. The lowest educational level of the participants was a Bachelor's degree.

6.2 *Descriptive statistics*

The mean and standard deviations for each variable have been calculated and the results are provided in table 2. To calculate the averages for each variable (construct), first the total values for all questions for a given construct were calculated. Then, the average was calculated by dividing the total values by the number of questions.

'Minimum' and 'maximum' refer to the minimum and maximum score received in response to the questions on a particular construct (for a given person). For example, there are seven questions for top management support. The sum of the values that one respondent gave to all of questions was 10 (the minimum score), and another respondent gave a total value of 23 (the maximum score).

6.3 *Reliability*

Table 3 shows Cronbach's coefficient alpha for the 13 constructs considered in the study. Cronbach's alpha

Table 2. Descriptive statistics.

Variable	*N*	Number of questions	Minimum	Maximum	Mean	Standard deviation
tms	31	7	10.0	23.0	18.058	3.2266
spqm	31	4	6.0	13.0	9.935	1.8062
qia	31	3	3.0	10.0	5.097	1.6804
qiu	31	3	4.0	11.0	6.645	1.4271
et	31	4	7.0	15.0	10.581	2.0940
ei	31	5	9.0	18.0	12.581	2.0780
pd	31	5	8.0	15.0	11.129	1.7077
sq	31	6	9.0	22.0	14.581	3.2739
cfs	31	8	12.0	23.0	17.710	2.5716
qc	31	4	6.0	16.0	8.871	2.1563
b	31	4	4.0	14.0	8.419	2.1099
iqr	31	5	7.0	21.0	14.581	2.7052
eqr	31	4	6.0	15.0	11.355	2.0904

is used to measure the internal consistency (reliability) of the instrument. Reliability of an instrument shows the degree of consistency or repeatability of the measurement (Streiner 2003). Most of the constructs have a coefficient value of 0.7 which is an acceptable value for survey research (Nunally and Bernstein 1994, Streiner 2003). Only one construct (product/process design) has a relatively low reliability (0.496). In total, the instrument has an acceptable reliability, indicating a high level of internal consistency. Thus, items assigned to each construct measured the same factor.

Table 3. Reliability of the constructs.

Variable	Number of items	Cronbach's alpha
Top management support (tms)	7	0.792
Strategic quality planning (spqm)	4	0.667
Quality information availability (qia)	3	0.869
Quality information usage (qiu)	3	0.667
Employee training (et)	4	0.752
Employee involvement (ei)	5	0.665
Product/process design (pd)	5	0.496
Supplier quality (sq)	6	0.802
Customer orientation (cfs)	8	0.645
Quality citizenship (qc)	4	0.805
Benchmarking (b)	4	0.788
Internal quality results (iqr)	5	0.811
External quality results (eqr)	4	0.771

6.4 *Correlation between variables*

The correlation between the variables is presented in table 4. The results from the correlation analysis (table 4) show that employee training has the highest correlation with internal quality results ($r = 0.615$), top management support has the highest correlation with external quality results ($r = 0.493$), and internal quality results has the highest correlation with customer orientation ($r = 0.557$). Referring to the correlation matrix, the highest correlation between variables is between quality information availability (qia) and quality information usage (qiu) ($r = 0.654$). This was expected since the usage of quality information is dependent upon the availability of quality information.

The second highest correlation is between employee training (et) and internal quality results (iqr) ($r = 0.615$). This supports the fact that employee training is the most important factor for achieving higher internal quality results, such as process improvement and cost reduction. And finally, the third highest correlation is between strategic quality planning (spqm) and quality

Table 4. Correlation between variables.

	tms	spqm	qia	qiu	et	ei	pd	sq	cfs	qc	b	iqr	eqr
tms	1	0.388*	0.400*	0.571**	0.427*	0.352	0.472*	0.287	0.413*	0.386*	0.401*	0.52*	0.493*
		0.031	0.026	0.001	0.017	0.052	0.007	0.117	0.021	0.032	0.025	0.003	0.005
spqm		1	0.562**	0.612**	0.01	0.170	0.057	0.570**	−0.291	0.178	0.305	−0.108	0.306
			0.001	0.0001	0.956	0.360	0.761	0.001	0.112	0.339	0.096	0.563	0.094
qia			1	0.654**	0.220	0.461**	0.425*	0.535**	−0.063	0.427*	0.317	0.229	0.218
				0.0001	0.234	0.009	0.017	0.002	0.738	0.017	0.082	0.215	0.240
qiu				1	0.361*	0.398*	0.443*	0.602**	−0.056	0.515**	0.538**	0.141	0.379*
					0.046	0.027	0.012	0.0001	0.764	0.003	0.002	0.448	0.036
et					1	0.372*	0.286	−0.133	0.478**	0.453*	0.169	0.615**	0.317
						0.039	0.119	0.474	0.007	0.011	0.362	0.0001	0.082
ei						1	0.551**	0.292	0.320	0.419*	0.505**	0.549**	0.150
							0.001	0.111	0.080	0.019	0.004	0.001	0.419
pd							1	0.457**	0.206	0.340	0.595**	0.373*	0.286
								0.010	0.266	0.062	0.0001	0.039	0.119
sq								1	−0.308	0.337	0.490**	−0.133	0.125
									0.092	0.064	0.005	0.474	0.504
cfs									1	−0.031	−0.137	0.557**	0.144
										0.868	0.464	0.001	0.440
qc										1	0.591**	0.396*	0.121
											0.0001	0.027	0.515
b											1	0.265	0.199
												0.149	0.282
iqr												1	0.487**
													0.005
eqr													1

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 5. Summary of the results.

Hypothesis	Result
H_{1a}: Top management support for quality is positively correlated with external quality results.	Accept
H_{1b}: Quality citizenship is positively correlated with external quality results.	Reject
H_{1c}: Quality information availability is positively correlated with external quality results.	Reject
H_2: Strategic quality planning is positively correlated with quality information usage.	Accept
H_{3a}: Quality information usage is positively correlated with product/process design.	Accept
H_{3b}: Benchmarking is positively correlated with product/process design.	Accept
H_4: Product/process design is positively correlated with internal quality results.	Accept
H_5: Employee involvement is positively correlated with internal quality results.	Accept
H_6: Top management support is positively correlated with employee training.	Accept
H_7: Customer orientation is positively correlated with process/product design.	Reject
H_8: Supplier quality is positively correlated with internal quality results.	Reject
H_9: Internal quality results are positively correlated with external quality results.	Accept

information usage (qiu) ($r=0.612$). Planning for quality requires that managers use information as the primary source for making strategic decision. The previous research supports these results (Lee *et al.* 2003).

The results of the correlation analysis can be used to support the hypotheses developed. Regarding the effects of leadership (top management support, quality citizenship, and quality information availability), the correlation matrix shows that top management support is significantly correlated with external quality results ($r=0.493$, $p=0.005$). This supports H_{1a}. However, there is not enough evidence to show that quality citizenship and quality information availability are significantly correlated with external quality results. Accordingly, $H1_a$ and $H1_b$ are not supported. The correlation matrix indicates that there is a significant correlation between strategic quality planning and quality information usage ($r=0.612$, $p=0.0001$). This supports H_2. From the correlation matrix it is found that there is a significant correlation between benchmarking and process/product design ($r=0.595$, $p=0.0001$). The same result is found between quality information usage and product/process design ($r=0.443$, $p=0.012$). Accordingly, H_{3a} and H_{3b} are supported. Alpha (the level of significance) is set at 0.05.

Looking at the correlation matrix, in table 4, it is found that there is a significant correlation product/process design and internal quality results ($r=0.373$, $p=0.039$). Accordingly, H_4 is supported. The correlation matrix indicates that there is a significant correlation between employee involvement and internal quality results ($r=0.549$, $p=0.001$). Accordingly, H_5 is supported. The correlation matrix shows that there is a significant correlation between top management support and employee training ($r=0.427$, $p=0.017$). Accordingly, H_6 is supported. No significant correlation is found between customer orientation and product/process design ($r=0.206$, $p=0.266$). Accordingly, H_7 is not supported. The correlation matrix indicates that there is not a significant correlation between supplier quality and internal quality results ($r=-0.133$, $p=0.474$). Accordingly, H_8 is not accepted. Looking at the correlation matrix it is found that there is a significant correlation between internal quality results (operational performance) and external quality results (business performance) ($r=0.487$, $p=0.005$). Accordingly, H_9 is supported.

While most of the linkages among the Baldrige criteria have been proven, surprisingly no significant correlation was found between customer orientation and supplier quality with external quality results. Table 5 shows a summary of the results.

7. Summary and limitations

The results from the correlation matrix reveal that top management support is significantly correlated with both internal quality results and external quality results. It has been significantly correlated with other constructs such as strategic quality planning, quality information availability, quality information usage, employee training, product/process design, customer orientation, quality citizenship, and benchmarking. This shows that top management plays a critical role in promoting quality management implementation in the company. This finding agrees with the Malcolm Baldrige award criteria where top management is considered the driving force for quality management implementation (Wilson and Collier 2000).

The correlation between top management support and employee involvement was not found to be statistically significant. This is surprising since it is the

management's responsibility and commitment to empower employees and involve them in the organisation-wide decision-making process (Rao *et al.* 1999). The same relationship was found between top management support and supplier quality; top management support was not significantly correlated with supplier quality. While previous empirical research validates such a link (Kaynak 2003) it would be interesting to investigate why top management support is not correlated with employee involvement and supplier quality.

The results of this research are consistent with previous studies on quality management. As evidenced by Powel (1995) the soft side of quality management such as leadership, organisational culture, and empowerment affect firm performance. Our findings are consistent with previous studies on quality management. We found that human resource management (employee training and employee involvement) is the key to effective implementation of quality management in the petroleum industry. In other words, oil and gas companies can gain higher level of operational performance through focusing on employee training and employee involvement. As a result of that, higher level of operational performance leads to higher profitability.

We need to be cautious in interpreting the result of the correlation analysis. While correlation between variables does not necessarily mean causation, we should be aware of this issue. However, previous studies in the link between quality management and firm performance indicates that leadership is the major force behind quality management implementation (Kaynak 2003), which indirectly affects firm performance through the quality management infrastructure (*e.g.* information systems, process improvement, human resource management). In that regard, our findings suggest that the main infrastructure for effective quality management is employee training and employee involvement.

One possible limitation of the results of this study might be related to the cultural differences in the perception of quality (Yavas *et al.* 2004). In this paper, a culture free approach towards quality was employed. While the selection of a culture free perceptive of quality is well established in the literature (Haire *et al.* 1966, Rao *et al.* 1997, Corbett *et al.* 1998) there is a need to look at the effect of culture on the perception of quality. Therefore, future research in quality management needs to address the effect of culture in quality. Another limitation of the study might be the small sample size ($N = 31$). This sample size prevents us from performing more complex analysis on the data set. It is highly recommended that the future research be conducted with a larger sample size.

While most constructs of the instrument showed acceptable level of reliability, the relatively low reliability for process/product design needs to be addressed. Such a relatively low reliability (0.49) might be because of the nature of the petroleum industry (as a process industry). It is recommended that this construct be revisited and validated. It is also possible to decompose process/product design into two or more constructs. One possible construct is safety management in the process design.

The focus of this paper was on production and exploration. While production and exploration constitutes a considerable portion of the petroleum industry, the result does not, in general, apply to other sections of the industry. Accordingly, more research is needed to generalise the result to other sections of the petroleum industry, such as petrochemicals, transportation and distribution.

References

Ahire, S.L. and Dreyfus, P., The impact of design management and process management on quality: an empirical examination. *J. Op. Manage.*, 2000, **18**(5), 549–575.

Al-Khalifa, N. and Aspinwall, E.M., The development of total quality management in Qatar. *TQM Magazine*, 2000, **12**(3), 194–204.

Anderson, J.C., Rungtusanatham, M., Schroeder, R.G. and Devaraj, S., A path analytic model for a theory of quality management underlying Deming Management Method: Preliminary empirical findings. *Decision Sci.*, 1995, **26**(5), 637–658.

Ansari, A. and Modarress, B., *Just-in-Time Purchasing*, 1990 (The Free Press: New York, NY).

Corbett, L.M., Adam, E.E, Harrison, N.J, Lee, T.S., Rho, B.H. and Samson, D., A study of quality management practices and performance in Asia and the South Pacific. *Int. J. Prod. Res.*, 1998, **36**(9), 2597–2607.

DeBaylo, P.W., Ten reasons why the Baldrige model works. *J. Qual. & Partici.*, 1999, **22**(1), 24–28.

Dow, D., Samson, D. and Ford, S., Exploding the myth: do all quality management practices contribute to superior quality performance?. *Prod. & Op. Manage.*, 1999, **8**(1), 1–27.

Ettore, B., Is the Baldrige still meaningful? *Manage. Rev.*, 1996, **85**(3), 28–31.

Evans, J.R. and Jack, E.P., Validating key results linkages in the Baldrige performance excellence model. *Qual. Manage. J.*, 2003, **10**(2), 7–24.

Fawcett, S.E., Calantone, R.J. and Roath, A, Meeting quality and cost imperatives in a global market. *Int. J. Phys. Distrib. & Logist.*, 2000, **30**(6), 472–499.

Feigenbaum, A.V., Changing concepts and management of quality worldwide. *Qual. Prog.*, 1997, **30**(12), 45–48.

Flynn, B.B., Schroeder, R.G. and Sakakibara, S., The impact of quality management practices on performance and competitive advantage. *Decision Sci.*, 1995, **26**(5), 659–691.

Flynn, B.B. and Saladin, B., Further evidence on the validity of the theoretical models underlying the Baldrige criteria. *J. Op. Manage.*, 2001, **19**(3), 617–652.

Forza, C. and Flippini, R., TQM impact on quality conformance and customer satisfaction: A casual model. *Int. J. Prod. Econ.*, 1998, **55**(1), 1–20.

Garvin, D.A., *Managing Quality*, 1988 (The Free Press: New York, NY).

Garvin, D.A., How the Baldrige award really works. *Harv. Business Rev.*, 1991, **69**(6), 80–93.

Haire, M., Ghiselli, E.E. and Porter, L.W., *Managerial Thinking: An International Study*, 1966 (John Wiley & Sons: New York, NY).

Handfield, R.B., Ghosh, S. and Fawcett, S., Quality-driven change and its effects on financial performance. *Qual. Manage. J.*, 1998, **5**(3), 13–30.

Hendricks, K.B. and Singhal, V.R., Does implementing an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards. *Manage. Sci.*, 1996, **43**(9), 1258–1274.

Hendricks, K.B. and Singhal, V.R., Firms characteristics, total quality management, and financial performance. *J. Op. Manage.*, 2001a, **19**(3), 269–285.

Hendricks, K.B. and Singhal, V.R., The long-term stock price performance of firm with effective TQM programs. *Manage. Sci.*, 2001b, **47**(3), 359–368.

Juran, J.M., The upcoming century for quality. *Qual. Prog.*, 1994, **27**(8), 29–37.

Kaynak, H., The relationship between total quality management practices and their effects on firm performance. *J. Op. Manage.*, 2003, **21**(4), 405–435.

Kim, K.Y. and Chang, D. R., Global quality management: a research focus. *Decision Sci.*, 1995, **26**(5), 561–568.

Lee, S.M., Rho, B.H. and Lee, S.G., Impact of Malcolm Baldrige National Quality criteria on organisational quality performance. *Int. J. Prod. Res.*, 2003, **41**(9), 2003–2020.

Liu, V.C. and Kleiner, B.H., Global trends in managing innovation and quality. *Manage. Res. News*, 2001, **24**(3/4), 13–16.

Nunally, J.C. and Bernstein, J. H., *Psychometric Theory*, , 3rd ed., 1994 (McGraw-Hill: New York, NY).

Powel, T., Total quality management as competitive advantage: A review and empirical study. *Strat. Manage. J.*, 1995, **16**(1), 15–37.

Rao, S.S., Raghu-Nathan, T.S. and Solis, L.E., A comparative study of quality practices and results in India, China and Mexico. *J. Qual Manage*, 1997, **2**(2), 235–250.

Rao, S.S., Solis, L.E. and Raghu-Nathan, T.S., A framework for international quality management research: Development and validation of a measurement instrument. *Total Qual. Manage.*, 1999, **10**(7), 1047–1075.

Samson, D. and Terziovski, M., The relationship between total quality management practices and operational performance. *J. Op. Manage.*, 1999, **17**(4), 393–409.

Sila, I. and Ebrahimpour, M., Examination and comparison of the critical factors of total quality management (TQM) across countries. *Int. J. Prod. Res.*, 2003, **41**(2), 235–268.

Streiner, D.L., Starting at the beginning: an introduction to coefficient alpha and internal consistency. *J. Personal. Assess.*, 2003, **80**(1), 99–103.

Trent, R.J. and Monczka, R.M., Achieving world-class supplier quality. *Total Qual. Manage.*, 1999, **10**(1), 927–938.

Wilson, D.D. and Collier, D.A., An empirical investigation of the Malcolm Baldrige National Quality award casual model. *Decision Sci.*, 2000, **31**(2), 361–390.

Yavas, B.F., Janda, S and Marcoulides, G.A., Cross-national stability of a quality management model: A comparative study of the United States and Turkey. *J. Appl. Math. & Decision Sci.*, 2004, **8**(1), 43–65.

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