
Original Article

A study of the relationships between quality management practices and organizational performance in the shipping industry

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Abstract It is generally accepted that firms that pursue sound quality management practices will become more competitive due to enhanced business excellence and performance. However, relatively little research has studied the relationships between quality management practices and organizational performance in the shipping industry. We conduct this study to plug this gap in the literature. We conduct a large-scale industry survey to collect data and develop three measures of organizational performance, namely *operational performance*, *financial performance* and *customer satisfaction*. From the literature we identify four key quality management practices, namely *top management commitment and participation*, *quality information and performance measurement*, *employee training and empowerment*, and *customer focus*. Through regression analysis, we find that all four quality management practices are positively associated with the three empirically developed organizational performance measures. This study contributes to research by establishing the links between quality management practices and organizational performance in the shipping industry, and provides managerial insights on how shipping firms should plan, tailor and implement their quality management efforts to attain their desired organizational performance measures.

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Introduction

Shipping is often the least costly way of moving large quantities of goods over long distances. The existence of reliable water transportation has been a key to the economic and political well-being of most nations throughout history. Shipping, or carriage of goods by water, has played a significant role in the development of human society over time (Lun *et al*, 2010). Shipping provides a crucial link between widely separated parts of the world. The international shipping industry is responsible for the carriage of as large as 90 per cent of world trade and is the lynchpin of the global economy. Without shipping, intercontinental trade, the bulk transport of raw materials and the import/export of affordable food and manufactured goods would simply not be possible. Regulated by the International Maritime Organisation (IMO), shipping today is also considered one of the safest and most environmentally benign forms of commercial transport. Like many other industries, the shipping industry faces the common challenges of involving significant amounts of capital investments, long pay-back and investment periods, and bearing a wide range of substantial maritime and investment risks. At the same time, the shipping industry also faces such new challenges as increasing legislative requirements, migration of manning resources, increasing expectations to preserve the environment, shifting of skill requirements arising from changes in ship technology, and increasing customer expectations. All these challenges, traditional and new, have prompted shipping firms to seek continuous improvement in their core processes and services in order to remain competitive and profitable.

In general, quality management encompasses continuous improvement, meeting customer requirements, reducing re-work, long-range thinking, increased employee involvement and teamwork, process re-design, competitive benchmarking, team-based problem-solving, constant measurement of results, and closer relationships with suppliers (see, for example, Ross, 1993; Willborn and Cheng, 1994; Powell, 1995; Ahire and Golhar, 1996; Agus, 2000). Temtime and Solomon (2002) state that quality management focuses on continuously improving the quality of goods and services through the participation of all organization members. Walton (1986) points out that quality management can be implemented in any organization and that it leads to improved products and services, reduced costs, more satisfied customers and employees, and improved performance. In short, it is generally accepted that firms that pursue sound quality management practices will become more competitive due to enhanced business excellence and performance (Lee, 2002). So it is conceivable that shipping firms can stay competitive and profitable through pursuing quality management.

Although there have been many studies examining the relationship between quality management and organizational performance (see, for example,



Ittner and Larcker, 1996; Hendricks and Singhal, 1997b; Lemak *et al*, 1997), relatively little research has studied the relationship between quality management and organizational performance in the shipping industry. We conduct this study to fill this research gap by examining the relationships between the key quality management practices in the shipping industry identified by Cheng and Choy (2007) and the organizational performance measures pertinent to the shipping industry developed in this study.

We organize the article as follows: In the next section we review the pertinent literature on the relationship between quality management and organizational performance. In the third section we discuss the identification of the organizational performance measures cognate with the shipping industry and detail the development of the measurement scales. We describe and justify the research methodology, followed by analysis and discussion of the empirical results in the fourth section. In the fifth section we discuss the results of multiple regression analyses, which establish the links between quality management practices and organizational performance in the shipping industry. In the sixth section we discuss the research findings and their theoretical and managerial implications. Finally, we conclude the article in the last section.

Literature Review

Over the last two decades, the volume of survey-based research on quality management practices and their relationships with organizational performance has expanded exponentially. Sila and Ebrahimpour (2002) reviewed 347 quality management survey studies published between 1989 and 2000 and found that a total of 116 of them examined the impact of one or more quality management practices on organizational performance in various contexts. It is widely accepted that the benefits of quality management towards business excellence and performance inevitably depend on its effective implementation. Lemak *et al* (2002) state that there is a growing body of empirical research supporting the direct links between quality management practices and organizational performance. A considerable amount of empirical evidence shows that the effective implementation of quality management leads to improvement in organizational performance in terms of both productivity and profitability (see, for example, American Quality Foundation and Ernst and Young, 1991; GAO, 1991; Sohal *et al*, 1992; Manni *et al*, 1994; Gordon and Wiseman, 1995). The empirical evidence from these studies also suggests that quality management is significantly associated with increased quality and productivity, along with improved customer and employee satisfaction (Sohal and Terziowski, 2000; Yee *et al*, 2008). According to the quality management advocates, quality management



does create value through a variety of benefits, including improved understanding of customer needs, improved internal communication, better problem-solving capability, greater employee commitment and motivation, stronger relationships with suppliers, fewer errors, and reduced waste (Juran, 1988; Spechler, 1991; Schmidt and Finnigan, 1992; Yee *et al.*, 2008; Yee *et al.*, 2009).

In 1989, the Conference Board, a New York business research group, reported that over 30 per cent of the respondents to their survey reported that quality management had improved their performance, with less than 1 per cent reporting performance declines as a result of quality management implementation. However, this study did not control for industry type, did not include medium-sized and small firms, and did not track the performance of comparable 'non-quality' firms. In 1992, the Arthur D. Little Corporation produced an in-house report based on a survey of 500 large US firms, which stated that 93 per cent of the respondents claimed to have some form of quality management implementation, with 35 per cent reporting that their efforts had had significant performance impacts, while 62 per cent expecting significant impacts over the next three years. However, the study did not investigate the performance of 'non-quality' firms. The most widely cited empirical study on quality management is the International Quality Study conducted by the American Quality Foundation and Ernst & Young (Adam, 1994) to identify quality management practices that have a significant impact on organizational performance, as discussed by Bemowski (1991). The project studied quality management practices of over 500 organizations in the United States, Canada, Germany and Japan. It concluded that three quality management practices (process improvement methods, strategic plan deployment and supplier certification programs) have a significant impact on performance (Adam, 1994). However, the report provided neither the scores of the measures nor the correlated measures with actual profitability, productivity and quality.

The US General Government Accounting Office Study (GAO, 1991) was commissioned by the US Congress to examine the impact of formal quality management improvement strategies on the performance of 20 companies that scored well in the 1988/89 Malcolm Baldrige National Quality Award. The study reported that there is a strong association between quality management practices and corporate performance, and firms that have adopted quality management experience overall improvement in corporate performance. In addition, companies that use quality management achieve greater customer satisfaction, increased market share and improved profitability. From the employees' perspectives, the primary responses were: increased suggestions (15 per cent average annual improvement), lowered staff turnover (6 per cent annually), improved operating gains in terms of average annual order-processing time



(12 per cent), improved performance reliability (12 per cent), reduced errors or defects (10 per cent), decreased cost of quality (9 per cent), enhanced customer satisfaction as reflected by decreased complaints (12 per cent per year), improved financial performance in terms of annual market share (14 per cent), increased sales per employee (9 per cent), increased return-on-asset (2 per cent) and improved return-on-sales (1 per cent). However, Garvin (1991) cautioned that the GAO study was not performed scientifically using statistical methods, the 20 companies surveyed did not answer all the survey questions, and a larger and more diverse sample of companies was required.

Easton (1993) studies the state of quality management implementation in the United States, and concludes that US companies that are committed to quality are likely to yield clear results in terms of customer satisfaction, operational improvement and employee involvement. Becker and Golomski (1993) show that 30 companies practicing quality management for an average of $6\frac{1}{2}$ years achieve higher revenues (8.3 per cent versus 4.2 per cent on average) and better productivity (a decrease in payroll by 6.5 per cent versus an 8.5 per cent increase on average). The Australian Manufacturing Council (AMC Study, 1994) also concludes that quality management implementation is likely to lead to overall improvement in organizational performance. However, the AMC study suffered from statistical shortcomings.

Zairi *et al* (1994) examine 29 companies that have implemented quality management, and report that 22 of these companies outperform their industry averages with respect to profit margin, return on total assets, turnover per employee, profit per employee, total assets per employee, fixed assets trend and average remuneration. Wisner and Eakins (1994) also find a strong positive relationship between quality improvement programs and financial performance. Manni *et al*'s (1994) research is considered one of the most complete empirical studies that rigorously tests and validates the strength of the relationships between quality management practices and organizational performance. The study shows that process output as measured by labour volume, labour cost and hourly output is significantly related to four measures of business performance, namely sales variant, return on assets, sales volume and market share. The study further shows that manufacturing performance is significantly related to four business performance measures, namely return on assets, return on sales, sales volume and market share. Quality management practices also have significant positive impacts on performance measures concerning process utilization, process output, production output, production cost, work-in-progress, inventory level and on-time delivery. One of the most rigorous studies on the relationships between quality management practices and organizational performance was conducted by Powell (1995). The study examines quality management implementation as a potential source of



sustainable competitive advantage. Madu *et al* (1995) also discovered associations between quality measures (customer satisfaction, employee satisfaction and employee service quality) and organizational performance. Helton (1995) similarly presented the impressive financial gains made by the majority of the Malcolm Baldrige Award winners. A fictitious portfolio of shares of the 1988 and 1993 award winners shows a return on principal far greater than the major indices in the United States. Fox (1995) and Oakland (1996) observe that better organizational synergy, removal of non-productive activities, better competitor understanding through benchmarking and a more reliable communication system can be achieved through quality management implementation. Jeffries *et al* (1996) claim that quality management leads to such benefits as enhanced profitability, reduced costs, creating an innovation approach, improved accountability and a more enjoyable working environment. Studying 235 companies that have implemented quality management, Radovilski *et al* (1996) find that they achieve an increase in profit (21 per cent), market share (9 per cent) and productivity (20 per cent) with reductions in defects (24 per cent), and a reduction in cost of achieving quality (20 per cent). Forker (1996) examines the contribution of quality management on business performance and concludes that quality management helps a firm gain competitive advantage.

In 2000, the US National Institute for Standards and Technology (NIST, 2000) looked into the performance of Malcolm Baldrige Award winners by tracking a hypothetical sum in each of the 1991–2000 publicly traded Award recipient's common stock. The 21 companies as a group outperformed the Standard and Poors 500 Index by 2.94 to 1.00 and achieved a 322.78 per cent return compared with a 109.68 per cent return for the Standard and Poors 500 Index. However, the study focused on Malcolm Baldrige Award winners only. Terziovski and Samson (2000) conclude that quality management implementation does have a significant positive effect on business performance, operational performance, employee relations and customer satisfaction, and it is more likely to achieve higher organizational performance with the implementation of quality management than without. However, the authors acknowledge that a longitudinal design is required to support a causal inference of the study. Sun (2000) finds that quality management enablers contribute to an increase in customer satisfaction and business performance. Human resource development, quality strategy and quality leadership are predominant in terms of the contributions to performance. Sharma and Gadenne (2001) observe that there is a marked difference in organizational performance between firms that make a commitment to quality management compared with those that do not. Similarly, Lee (2002) considers that the principles of quality management are sound and, when applied correctly and consistently, will



increase a firm's competitive position. He further states that many of today's successful companies that embrace quality management implementation effectively can attest to its valuable contribution. Huang and Lin (2002) reported that most companies believed that quality management helped them stand apart from the financial crisis in the Asia-Pacific area in 1997. This argument can be explained by the fact that quality management can actually improve the physical and financial status of a company. Quality management enables the development of a more efficient, effective, flexible and reliable organization.

The above studies suggest that an organization that uses quality management has a better chance of achieving organizational performance (Vora, 2002), and there is a consensus that implementation of quality management leads to better financial and operational performance, improved communication, increased customer satisfaction, and teamwork (Boon and Ram, 1998; van der Wiele and Brown, 1998; Chandler and McEvoy, 2000; Reed *et al*, 2000; Lee *et al*, 2011).

Organizational Performance Measures

For the purpose of this study, we need to first identify and develop the measurement constructs for organizational performance (performance measures), which are based on an extensive review of previous studies and the literature, and are consistent with the performance measurements of relevant studies on the relationships between quality management practices and organizational performance. We summarize the results of the extensive review of previous major studies on the measurement of organizational performance and on the relationships between quality management practices and organizational performances in Table 1.

The construction of the measurement constructs for organizational performance in this study is accomplished from a thorough review of previous studies and the literature, based on which we identify the following organizational performance measures, namely (1) financial performance, (2) marketing performance, (3) employee performance (shore-based staff/seafarer performance in the case of the shipping industry) and (4) operational performance. These measures are reliable, tested and validated, and are frequently used in previous research that studies the main benefits of quality management and its relationship with organizational performance (Escrig-Tena, 2003). In addition, these measures particularly cover the key organizational performance indicators relevant to the shipping industry. The measurement indicators for financial and marketing performance, which

**Table 1:** Summary of major studies on measurement constructs for organizational performance

Anderson <i>et al</i> (1995) ● Customer satisfaction	Flynn <i>et al</i> (1995) ● Quality market outcomes, %-passed final inspection with no rework, competitive advantage(unit cost, fast, delivery, volume, flexibility, inventory, cycle time)	Mohrman <i>et al</i> (1995) ● ROE, ROI, ROS, ROA, perceived profitability and competitiveness ● Market share ● Cost of manufacturing, inventory turnover, perceived productivity, customer satisfaction, quality and speed
Powell (1995) ● Sales growth, profitability, revenue growth ● Productivity, competitive position, profitability, revenues, overall performance	Hendricks and Singhal (1996, 1997a, 2001) ● Market returns, percentage changes in operating income, in sales, in the ratio of sales to number of employees, in the ratio of capital expenditure to assets, in number of employees, in assets	Adam <i>et al</i> (1997) ● Net profit as percent of sales, ROA, sales growth ● Percent defectives, cost of quality, and customer satisfaction
Chenhall (1997) ● Growth in sales, in ROS, in ROA, overall growth in profitability	Choi and Eboch (1998) ● Quality (plant performance), customer satisfaction	Ahire and O'Shaughnessy (1998) ● Product quality
Grandzol and Gershon (1997) ● ROI, market share, capital investment ratio ● Product/service quality, productivity, scrap/waste, energy/efficiency/, material usage	Dow <i>et al</i> (1999), Terziovski and Samson (1999) ● Product quality, customer satisfaction, employee morale, productivity, delivery performance	Easton and Jarrell (1998) ● Net income to sales and to assets, operating income to sales and to assets, sales to assets, net income and operating income per employee, sales per employee, total inventory to sales and to costs of goods sold, cumulative daily stock returns
Forza and Flippini (1998) ● Quality conformance, customer satisfaction	Das <i>et al</i> (2000) ● Market share, ROA, market share increase ● Customer satisfaction	Wilson and Collier (2000) ● Market share, market share growth, ROI, growth in ROI, ROS, growth in ROS ● Customer focus and satisfaction
Lee <i>et al</i> (1999) ● Performance quality – Percentage of item defective – Waste and rework – Return on warranty – Rework as a percentage of sales – Training and development ● Operating performance – Employee turnover rate – Net profit as percentage of sales ● Financial performance – ROA – Sales growth	Douglas and Judge (2001) ● Growth in earnings, growth in revenue, changes in market share, return on assets, long-run level of profitability, industry expert ratings	Ho <i>et al</i> (2001) ● Product quality

are considered as common for any industry, are identified in accordance with the extensive review of previous studies and the literature presented above. As for the measurement indicators for shore-based staff/seafarers and operational performance, which are industry-specific, they are identified



Table 2: Four measurement constructs and initial 35 measurement indicators for organizational performance

Financial performance

1. Improve in overall financial performance
2. Increase in overall turnover volume
3. Increase in operating incomes
4. Decrease in vessel operating costs
5. Decrease in shore-based operating expenses
6. Increase in profit margin in terms of gross and net profits
7. Improve in return on investments

Marketing performance

8. Improve in overall customer satisfaction/relationship
9. Increase in market share
10. Enhance in customer retention/customer loyalty
11. Improve in handling customers' complaints/inquiries
12. Enhance in competitive position
13. Increase in capability to stay in business

Shore-based staff/seafarer performance

14. Improve in overall shore-based staff/seafarer satisfaction and well-being
15. Increase in shore-based staff/seafarer productivity
16. Improve in shore-based staff/seafarer morale
17. Reduce in shore-based staff turnover rate
18. Improve in seafarer return/retention rate
19. Reduce in shore-based staff/seafarer grievances
20. Reduce in shore-based staff absenteeism
21. Reduce in number seafarer's deaths/injuries/insurance claims
22. Improve in shore-based staff/seafarer training and development

Operational performance

23. Improve in overall operational performance
24. Improve in overall service quality to customers
25. Improve in conformance and compliance to rules, regulations and procedures
26. Improve in sense of safety awareness and compliance
27. Improve in sense of environmental awareness and protection
28. Improve in on-time delivery of services
29. Reduce in cargo damage and loss claims
30. Reduce in loss of hire
31. Increase in volume of tonnage shipped
32. Reduce in vessel repairs and maintenance time and costs
33. Reduce in average shipping time
34. Improve in suppliers/vendors quality
35. Reduce in number of accident/near miss case

with reference to those measurement indicators (in particular, those performance indicators presented in Wisner (1999) in connection with the transportation industry) that are most appropriate, relevant and compatible with the purpose of this study in the context of the shipping industry and that fit the scope of the constructs. Table 2 presents the detailed descriptions of the four organizational performance measures and their corresponding initial 35 measurement indicators for measuring organizational performance in the shipping industry.



Data Collection and Analysis

Organizational performance

Content validity

Following Cheng and Choy (2007), we developed a survey instrument based on the identified organizational performance measures and their measurement indicators. Before conducting a survey using the instrument, we checked the content validity of the measurement indicators to ensure that they adequately cover the organizational performance of the shipping industry and that the proposed survey instrument as a whole is well understood and worded, and is able to collect the data for the purpose of this study (Kerlinger, 1978). We proceeded in two critical steps to check content validity. In the first step we invited a panel of experts, comprising two independent experts – an academic with research expertise in quality management and organizational performance, and an experienced shipping executive – to conduct an initial assessment. In the second step we invited a larger panel of experts, all of whom were senior shipping industry practitioners, to conduct a detailed assessment. They were asked to judge how well the survey instrument meets the common questionnaire design standards (Malhotra and Grover, 1998) and the expected requirements in terms of its coverage and the degree to which the statements in the survey instrument are unambiguously worded (Rao *et al.*, 1999). Based on the feedback from the two panels of experts, we modified the proposed survey instrument in order to (1) improve its content, ease of understanding and texts; (2) eliminate ambiguity; (3) delete duplicated and unnecessary measurement indicators as appropriate in the case of the shipping industry – as a result, the number of measurement indicators was reduced from the initial 35 to 28 items; and (4) obtain all the experts' agreement that the instrument possesses content validity. Table 3 presents the finalized survey instrument that includes 28 measurement indicators.

Data collection

This organizational-level study is based on empirical data collected through a questionnaire survey administered to shipping industry executives. We invited respondents to participate in our survey by randomly sampling shipowner members of the world's two major international maritime associations, namely the Baltic and International Maritime Council (BIMCO) and the International Association of Independent Tanker Owners (INTERTANKO). We mailed 1028 survey packages to 803 owner members of BIMCO, 152 owner members of INTERTANKO and 73 joint owner members of both BIMCO and INTERTANKO. Fourteen survey packages were returned due to wrong addresses or incorrect



Table 3: 28 Measurement indicators for organizational performance after content validity and included in the survey questionnaire

Financial performance

- V1. Turnover volume and value
- V2. Operating incomes
- V3. Vessel and shore-based operating costs
- V4. Margin in terms of gross and net profits
- V5. Return on investments and assets
- V6. Overall financial performance

Marketing performance

- V7. Market share
- V8. Customer retention/customer loyalty
- V9. Handling of customers' complaints/inquiries
- V10. Competitive position
- V11. Overall marketing performance

Shore-based staff/seafarer performance

- V12. Shore-based staff/seafarer productivity
- V13. Shore-based staff/seafarer morale
- V14. Shore-based staff turnover rate and seafarer return/retention rate
- V15. Shore-based staff/seafarer grievances and complaints
- V16. Number of seafarer's deaths/injuries/insurance claims
- V17. Shore-based staff/seafarer training and development
- V18. Overall shore-based staff/seafarer performance

Operational performance

- V19. Conformance and compliance with rules, regulations and procedures
- V20. Sense of safety awareness and compliance
- V21. Sense of environmental awareness and protection
- V22. On-time delivery of services
- V23. Minimum cargo damage and loss claims
- V24. Minimum loss of hire
- V25. Maximum volume of cargo shipped
- V26. Minimum vessel repairs and maintenance time and costs
- V27. Number of accident/near miss case
- V28. Overall operational performance

contact details in the databases of BIMCO and INTERTANKO. As a result, 1014 survey packages, which made up the sample for this study, were received by the targeted respondents. In the end, 166 responses were returned, of which four declined to respond and one return was incomplete. In other words, a total of 161 usable returns were obtained for analysis, yielding an effective response rate of 15.88 per cent, which is considered as reasonable and adequate for an organizational-level study.

Respondent profiles

We analyze the demographic data and salient profiles of the valid respondents and summarize the results as follows: In all, 71.4 per cent of the respondents



have been in business for more than 20 years, while 9.9 per cent of the respondents have a company history of over 100 years. In terms of revenues, 81.4 and 20 per cent of the respondents record annual revenues of over US\$5 million and over US\$100 million, respectively. Of the respondents, 67.7 per cent have been awarded quality certificates, out of which 37.3 per cent have received two or more quality certificates. The majority of the respondents (92.5 per cent) have implemented quality management practices to some extent; however, only 9.3 per cent of the respondents have adopted quality award criteria to assess and evaluate their quality management implementation. Of the respondents, 59.6 per cent state that their customers require them to implement a certain degree of quality assurance measures and/or improvement programs. As a result, 68.4 per cent of the respondents receive very great or great support from their shareholders and/or top management to implement quality management. Of the respondents, 68.2 per cent report that they have implemented quality management, and 78.0 per cent of those with no implementation of quality management have planned to do so in the near future. Only 7 per cent of the respondents (or 22.0 per cent of those without implementing quality management) have neither implemented quality management nor have any plan to do so.

Non-response bias

To test for potential non-response bias, we performed a series of *t*-tests on the mean values of the responses to a sample of the organizational performance measures and the relationships between quality management practices and organizational performance, between the early respondents group and the late respondents group, that is, those who responded on or before and after a cutoff date, respectively (Oppenheim, 1996; Malhotra and Grover, 1998). The test result indicates that the mean values between the two groups do not differ significantly, suggesting that non-response bias did not seem to be a problem in this study.

Purification of items

The measurement items need to be purified before a *factor analysis* can be conducted on them. Conducting a factor analysis without item purification will produce many more dimensions than can be conceptually identified, confounding the interpretation of the factor analysis (Churchill, 1979). We adopted two criteria to purify (eliminate) items before conducting a factor analysis. First, items for a given factor exhibiting a corrected item-total correlation (that is, the correlation of each item with the sum of all other items) less than 0.50 are usually candidates for elimination (Robinson *et al.*, 1991; Hair *et al.*, 1998; Koufteros, 1998; Malhotra and Grover, 1998; Torkzadeh and Dhillon, 2002).



Second, items are also eliminated based on internal consistency reliability. The reliability of the items comprising each factor is examined using Cronbach's alpha (α), and items are eliminated if the reliability of the remaining items is at least 0.90, or items are retained for further analysis if the reliability of the remaining items is less than 0.90 (Torkzadeh and Dhillon, 2002). The corrected item-total correlation eliminated six measurement indicators, namely V1, V5, V16, V19, V25 and V26, out of the original 28 measurement indicators. All the eliminated measurement indicators have a corrected item-total correlation below 0.50. Thus, 22 measurement indicators were retained for the reliability test. The reliability test did not eliminate any measurement indicators. As a result, 22 measurement indicators of organizational performances were retained for the subsequent factor analysis.

Kaiser–Meyer–Olkin (KMO) measure and Bartlett's test

Before conducting the factor analysis, we further performed two tests to check the possible presence of multicollinearity or correlation among the items and the appropriateness of performing a factor analysis. First, KMO quantifies the degree of intercorrelations among the variables and the appropriateness of factor analysis (Norusis, 1999) with a value above 0.50 for either the entire matrix or an individual variable indicating appropriateness (Hair *et al*, 1998). Second, Bartlett's test of sphericity tests for the presence of correlations among the variables, which provides the probability that the correlation matrix has a significant correlation among at least some of the variables (Hair *et al*, 1998; Norusis, 1999). The KMO values, which are all greater than the 0.50 threshold value, and the results of the Bartlett's test, which are all significant beyond the 0.000 level for the retained measurement indicators of organizational performance, suggest that the correlation matrix is not an identity matrix and that the intercorrelation matrix contains enough common variance to make a factor analysis of the 22 retained measurement indicators worth performing (Hair *et al*, 1998; Torkzadeh and Dhillon, 2002).

Exploratory factor analysis

We performed an exploratory factor analysis (EFA) of the retained items using the *principal component analysis* as the extraction method and the *varimax criterion* as the rotation method of the retained items to assess the unidimensionality of the retained items and, where appropriate, eliminate items that are not factorially pure (Weiss, 1970). The main objective of using EFA is to summarize the identified (retained) items into a new and smaller set of uncorrelated dimensions (that is, organizational performance measures) with a minimum loss of information (Ngai *et al*, 2004). The unidimensionality of each success factor is assessed by examining the factor loadings. Items with factor



loadings greater than 0.50 on the factor that they are hypothesized to load on are considered adequate indicators for that factor (Hair *et al.*, 1998). In addition, the use of imprecise and ambiguous terms to label the factors should be avoided (Bagozzi, 1981). The items in each category are assumed to be measures of the same factor. Items that are not factorially pure and/or cross-load on multiple factors are deleted. We used 0.4 as the cutoff value to delete items that cross-load on multiple factor(s) (Ngai *et al.*, 2004). After extracting the factors by EFA and appropriately labeling them, we conducted a reliability assessment by calculating the Cronbach's α for the extracted factor model in order to ensure that the items comprising each factor are highly reliable and internally consistent (Hair *et al.*, 1998). If the calculated Cronbach's α is greater than the critical point of 0.70 (Nunnally, 1978), the proposed factor is said to be highly reliable and internally consistent.

After four iterations of the EFA, 13 measurement indicators were eliminated and the remaining nine measurement indicators were organized under three factors. In other words, the EFA produces a three-factor model with nine measurement indicators for the three factors (measures) of organizational performance, whereby all the factor loadings meet the threshold value of 0.50 or above and all the eigenvalues are greater than 1, which explains 73.084 per cent of the variance. Table 4 presents the final EFA results. We then interpret the results of the EFA by assigning labels to the extracted factors. In view of the nature and semantics of the measurement indicator descriptions for the respective factors, it is theoretically acceptable to group them under the same factors and label them accordingly:

- Factor 1: Operational Performance (OP) with four measurement indicators comprising V12, V20, V21 and V28;
- Factor 2: Financial Performance (FP) with three measurement indicators comprising V2, V4 and V6; and
- Factor 3: Customer Satisfaction (CS) with two measurement indicators comprising V8 and V9.

As for the reliability assessment of the factor model extracted by the EFA, the results in Table 4 show that the values of the respective factors and the overall Cronbach's α 's for the three factors of organizational performances are all above the recommended critical point of 0.70 (Nunnally, 1978). There is clear evidence that the factor model extracted by the EFA is highly reliable and internally consistent.

Construct validity

Having confirmed that the extracted factors are unidimensional and meet the necessary levels of reliability, we conducted a final assessment of the validity of the constructs, which addresses the issues of convergent, discriminant and

**Table 4:** Results of exploratory factor analysis – Three factors measuring organizational performance

	Factor			Corrected item-total correlation
	1	2	3	
<i>Operational performance (OP)</i>				
V12	0.603	—	—	0.567
V20	0.819	—	—	0.663
V21	0.866	—	—	0.675
V28	0.752	—	—	0.680
<i>Financial performance (FP)</i>				
V2	—	0.822	—	0.690
V4	—	0.840	—	0.682
V6	—	0.841	—	0.690
<i>Customer satisfaction (CS)</i>				
V8	—	—	0.874	0.681
V9	—	—	0.893	0.681
Mean (scale)	8.263	6.520	4.204	—
Standard deviation	2.421	2.076	1.334	—
Eigenvalue	4.045	1.468	1.065	—
% of variance	44.941	16.310	11.833	—
Cumulative % of variance explained	44.941	61.251	73.084	—
Cronbach's α	0.822	0.824	0.808	—
Overall Cronbach's α :	0.837	—	—	—

Results obtained after four iterations of the EFA.

Only indicators with factor loadings greater than 0.50 and without cross-loaded on multiple factors with factor loading of greater than 0.40 are reported.

content validity (Hair *et al.*, 1998), in order to assess the extent to which a measure or a set of measures correctly and accurately represents what it is supposed to, that is, the degree to which it is free from any systematic or non-random error (Carmines and Zeller, 1979). Convergent validity assesses the degree to which two measures of the same construct are correlated (Hair *et al.*, 1998). If the *t*-value of the measurement scale is greater than $|2|$ or $|2.576|$, it is considered as significant at the 0.05 and 0.01 levels, respectively, which indicates that the scale is measuring its intended concept (Koufteros, 1998). Discriminant validity is the degree to which two conceptually similar constructs are distinct (Hair *et al.*, 1998). We tested discriminant validity by comparing the Average Variance Extracted (AVE) of a construct with its squared correlations with other constructs (Koufteros, 1998). Discriminant validity is established if the AVE of a construct is substantially higher than the squared correlations between this construct and all other constructs (Koufteros, 1998). Regarding content validity, we assessed the degree of correspondence between the items selected to constitute a summated scale and its conceptual definitions (Hair *et al.*, 1998) by conducting interviews with a panel of experts, comprising one



academic and three senior executives from international shipping companies, to judge and assess how well the measurement instrument meets the standards (Emory and Copper, 1991). As for the results of convergent validity, the t -values of all the items in all the performance measures are higher than 2 or 2.576, which are significant at the 0.05 and 0.01 levels, respectively, indicating that the items are measuring the intended performance measures. In addition, the results show that all the performance measures possess discriminant validity. Finally, content validity reveals that the retained measurement indicators in the respective performance measures are confirmed to be adequately covering all the relevant dimensions of organizational performance in the shipping industry. Overall, the results support the construct validity of the retained measurement indicators for the three measures of organizational performance. Based on the results of the EFA, reliability assessment and tests of construct validity, we have developed a reliable, empirically tested and rigorously validated instrument to measure the organizational performance in the shipping industry.

Relationships between Quality Management Practices and Organizational Performance

Next, we conducted a series of multiple regression analyses to examine and predict the relationship between quality management and organizational performance in the shipping industry. The independent variables (exogenous constructs – predictors) of quality management practices are the four key quality management practices in the shipping industry found by Cheng and Choy (2007), which are *top management commitment and participation* (MCP), *quality information and performance measurement* (QIM), *employee training and empowerment* (ETE), and *customer focus* (CUF); and the dependent variables (endogenous constructs) of organizational performance are the three performance measures developed in this study, which are *operational performance* (OP), *financial performance* (FP) and *customer satisfaction* (CS). Table 5 summarizes the independent variables and dependent variables with their corresponding measurement indicators. We hypothesize that the four independent variables are positively related to each of the three dependent variables in the shipping industry as follows:

- Hypothesis 1:** MCP, QIM, ETE and CUF are positively related to OP in the shipping industry;
- Hypothesis 2:** MCP, QIM, ETE and CUF are positively related to FP in the shipping industry;
- Hypothesis 3:** MCP, QIM, ETE and CUF are positively related to CS in the shipping industry.

**Table 5:** Summary of independent variables and dependent variables with their measurement indicators

Independent variables – Quality management practice and its measurement indicators (Cheng and Choy, 2007)

Top Management Commitment and Participation (MCP)	<ul style="list-style-type: none"> ● Acceptance of responsibility for quality by top management within your organization ● Support of top management to long-term quality improvement process ● Participation by top management in the quality improvement process ● Need for top management to have clear objectives and specific goals for quality performance ● Understanding of quality goals and policy within your organization ● Top management's perception of quality improvement as a way to increase profits
Quality Information and Performance Measurement (QIM)	<ul style="list-style-type: none"> ● Inclusion of quality measurements in the processes used ● Availability of quality data in your organization to all levels of shore-based staff/seafarer ● Timeliness of producing and providing quality data ● Use of quality data as tools to manage quality
Employee Training and Empowerment (ETE)	<ul style="list-style-type: none"> ● Development of an environment, helping towards on-the-job training, by the higher management ● Participation of managers and supervisors in specialist training ● Implementation of shore-based staff/seafarer involvement type programs in your organization ● Participation in quality decisions by the shore-based staff/seafarer
Customer Focus (CUF)	<ul style="list-style-type: none"> ● Personal and regular contacts with your customers ● Use of customers' requirements as the basis for quality

Dependent variables – Organizational performance and its measurement indicators

Operational performance (OP)	V12 Shore-based staff/seafarer productivity V20 Sense of safety awareness and compliance V21 Sense of environmental awareness and protection V28 Overall operational performance
Financial performance (FP)	V2 Operating incomes V4 Margin in terms of gross and net profits V6 Overall financial performance
Customer satisfaction (CS)	V8 Customer retention/customer loyalty V9 Handling of customers' complaints/inquiries



We applied the following logical procedures to conduct the multiple regression analysis and analyze the data.

Prediction assessment

We examined the R^2 value, which measures the proportion of the variance of the dependent variable about its mean that is explained by the set of independent variables or predictors (Hair *et al.*, 1998).

Regression

Based on the results of the multiple regression analysis, each independent variable was then weighted to ensure maximal prediction from the set of independent variables. The weights facilitate interpretation as to the influence of the independent variable on making the prediction of the dependent variables, and denote the relative contribution of the independent variable to the overall prediction of the dependent variables (Hair *et al.*, 1998). The set of weighted independent variables forms the regression variate, a linear combination of the independent variables that best predicts the dependent variable. The regression variate, also referred to as the regression equation or regression model, is the most widely known example of a variate among the multivariate techniques. We also examined the value of the unstandardized beta (β) of the independent variable, which calculates the predicted value for each observation and expresses the expected change in the dependent variable for each unit change in the set of independent variables (Hair *et al.*, 1998). The greater the value of the unstandardized β of an independent variable is, the greater is its influence on the value of the dependent variable (George and Mallery, 2003). In addition, we also assessed the value of the standardized β (beta coefficient) to compare and measure the relative strength, impact and explanatory power of each of the independent variables on the dependent variable (Hair *et al.*, 1998; George and Mallery, 2003). The greater the value of the standardized β of an independent variable is as compared with the other independent variables in a regression model, the greater is its influence on the value of the dependent variable as compared with the other independent variables in the regression model.

Hypothesis testing

To test the hypotheses of this study, we adopt the following criteria:

- The values of the unstandardized β of the independent variables in a regression equation must all be positive with respect to the hypothesis of this study that the set of independent variables are positively related to the respective dependent variables.



- The predictive ability of the regression model is assessed by its significance level, which determines whether the regression model is statistically significant, indicating that the additional independent variable is substantial in adding to the regression model's predictive ability (Hair *et al*, 1998). The *F* value and its associated *P*-value reflect the strength of the overall relationship between the set of independent variables and the dependent variable (George and Mallery, 2003). In this study a hypothesis is said to be supported if the regression model is statistically significant at a *P*-value less than 0.001.

Multicollinearity assessment

Before the regression results are accepted, we adopt two common measures for assessing multiple variable collinearity, namely (1) the tolerance value and (2) its inverse – the variance inflation index (VIF). These measures provide the degree to which each independent variable is explained by the other independent variables (Hair *et al*, 1998). A common cut-off threshold is a tolerance value of 0.10, which corresponds to a VIF value of 10.0 (Hair *et al*, 1998).

Regression model by backward elimination

We also examined the set of independent variables that predicts the respective dependent variable reasonably well, which results in a 'good' regression model. A simpler model is better because the standard errors of the coefficients increase without improving prediction ability if insignificant variables are included in the regression model (Norusis, 1999). In this study we adopt backward elimination to identify the 'good' regression model. Backward elimination is a method of selecting variables for inclusion in the regression model that starts by including all the independent variables in the model and then eliminating those variables not making a significant contribution to the prediction (Hair *et al*, 1998). In other words, this method enters all the independent variables one at a time and then removes variables one at a time based on a preset significance value to remove. The default value by SPSS® to remove a variable is $P > 0.10$ (Norusis, 1999; George and Mallery, 2003). When there are no more variables that meet the requirement for removal (that is, $P \leq 0.10$), the backward elimination process terminates and a 'good' regression model is identified.

Residual analysis

In regression analyses, one or more predictor variables predict a criterion or dependent variable. The regression analysis procedure examines whether or not



each predictor variable significantly relates to the dependent variable. Thus, a model of predictor variables is developed as follows: dependent variable = effects of predictor variables + residual. In order to examine how well a model of a set of independent variables predicts the respective dependent variable, we assess the residual values for all of the cases to see if there is any pattern in the residuals by looking at the (1) histogram, (2) normal probability plot and (3) scatterplot (George and Mallery, 2003). The histogram displays the standardized residuals (the residuals divided by the estimate of the standard error) across the horizontal axis, and the number of subjects within each range of standardized residuals along the vertical axis. We examine the pattern in the relationship between the histogram bars and the normal curve in order to assess whether the residuals are normally distributed. The normal distribution indicates a linear relationship between the set of independent variables and the respective dependent variable (George and Mallery, 2003). The normal probability plot places the observed cumulative probability along the horizontal axis and the expected cumulative probability along the vertical axis (George and Mallery, 2003). The normal distribution makes a straight diagonal line, and the plotted residuals are compared with the diagonal. If a distribution is normal, the residual line closely follows the diagonal (Hair *et al*, 1998). The scatterplot places the standardized residuals against the standardized predicted value. If the residuals appear to be randomly scattered around the horizontal line and show no obvious pattern, the assumptions of linearity and homogeneity of variance are met.

Given the results of the multiple regression analysis above, we predict the relationships between four key quality management practices and three organizational performance measures in the shipping industry. Table 6 summarizes the results of all of the above steps of multiple regression analysis for hypothesis testing and predictions of the exogenous constructs for the endogenous constructs. Table 7 presents the relative influences and significance of the various quality management practices on the respective organizational performance measures.

Discussions

Quality management has been shown to lead to improved performance and greater competitiveness (Powell, 1995; Andersen and Sohal, 1999; Lee *et al*, 1999; Terziovski and Samson, 1999; Zhang, 2000; Yeung *et al*, 2004; Yeung *et al*, 2006). Lee (2004) observes that many studies find that quality management practices are positively associated with superior organizational performance (see, for example, Mann and Kehoe, 1994; Fredenhall and Robbins, 1995;



Table 6: Summary of results of hypothesis testing and predictions of exogenous constructs for endogenous constructs

<i>Hypothesis</i>	<i>Statistical support</i>
Hypothesis – H ₁	Support
Hypothesis – H ₂	Support
Hypothesis – H ₃	Support
<i>Endogenous constructs</i>	<i>Exogenous constructs – predictors</i>
Operational performance	Top Management Commitment and Participation Quality Information and Performance Measurement Employee Training and Empowerment Customer Focus
Financial performance	Top Management Commitment and Participation Quality Information and Performance Measurement Customer Focus
Customer satisfaction	Top Management Commitment and Participation Employee Training and Empowerment Customer Focus

Table 7: Summary of influences and significance of quality management practices on organizational performance in the shipping industry

<i>Organizational performance</i>	<i>Quality management practice – Order of influence on and significance to organizational performance</i>
Operational performance	<ul style="list-style-type: none"> ● Top Management Commitment and Participation ● Customer Focus ● Employee Training and Empowerment ● Quality Information and Performance Measurement
Financial performance	<ul style="list-style-type: none"> ● Customer Focus ● Top Management Commitment and Participation ● Quality Information and Performance Measurement ● Employee Training and Empowerment is not regarded as a significant practice at all in generating financial performance
Customer satisfaction	<ul style="list-style-type: none"> ● Top Management Commitment and Participation ● Customer Focus ● Employee Training and Empowerment ● Quality Information and Performance Measurement is not regarded as a significant practice at all in yielding customer satisfaction

Ahire *et al*, 1996; Emery *et al*, 1996; Lee and Crouch, 1996; Hendricks and Singhal, 1997a; Terziovski and Samson, 1999; Zhang, 2000; Kaynak, 2003; Yeung *et al*, 2005). Escrig-Tena (2003) emphasizes that quality management practices focusing on customers and people are all related to operational and financial results. Lai *et al* (2004) provide empirical evidence that quality



management leads to improvement in organizational performance in terms of increased productivity and profits (Hendricks and Singhal, 1997a; Douglas and Judge, 2001).

We wish to point out two important aspects in this study. First, the handsome values of the squared correlation coefficients (R^2) in the relationships between the set of independent variables and the respective dependent variables show the ability of the set of independent variables in explaining the variations in the respective dependent variables. The statistical findings also show that the set of independent variables (representing the quality management practices of top management commitment and participation, quality information and performance measurement, employee training and empowerment, and customer focus) are all positively related to the respective dependent variables (representing the organizational performance measures of operational performance, financial performance and customer satisfaction). Second, the relatively larger unstandardized and standardized beta (β) coefficients associated with top management commitment and participation, and customer focus imply that both top management commitment and participation, and customer focus exert relatively stronger influences on and are statistically more significant to organizational performance.

Top management commitment and participation, and customer focus and organizational performance

The findings of this study rank both top management commitment and participation, and customer focus as the most critical and important quality management practices in yielding organizational performance in terms of operational performance, financial performance and customer satisfaction in the shipping industry, which are consistent with all relevant previous studies and the literature. The relative effects of top management commitment and participation, and customer focus on the respective organizational performance measures are somehow different. As such, it is worth noting the following findings in relation to the relative relationships between top management commitment and participation, and customer focus and the respective organizational performance measures.

First, customer focus leads to a greater increase in all organizational performance measures than top management commitment and participant. Chong and Rundus (2004) obtain similar results that there is a more positive relationship between the quality management practice of customer focus and organizational performance. Second, the influences of top management commitment and participation on operational performance and customer satisfaction are relatively higher than customer focus. Williams *et al* (2004) also find



that top management commitment and participation is important to reach operational excellence (Deming, 1986; Juran, 1989). However, customer focus has a relatively greater influence on financial performance than top management commitment and participation. Third, customer focus is relatively more significant in yielding business results in terms of operational performance and financial performance than top management commitment and participation on one hand, and top management commitment and participation is relatively more important in generating customer satisfaction on the other, which agrees with the findings of Ugboro and Obeng (2000) that the goal of customer satisfaction is achieved through top management commitment.

Employee training and empowerment and organizational performance

After top management commitment and participation, and customer focus, employee training and empowerment is the next most crucial and important factor in producing both operational performance and customer satisfaction. As compared with quality information and performance measurement, employee training and empowerment: (1) leads to a greater increase in operational performance, (2) has a relatively greater influence on operational performance, and (3) is relatively more significant in generating operational performance. Regarding customer satisfaction, we find that employee training and empowerment leads to customer satisfaction. Ugboro and Obeng (2000) also find that the primary focus of customer satisfaction is facilitated by empowered and highly motivated employees. However, though it is positively related to financial performance, employee training and empowerment is not regarded as a significant practice in improving financial performance. It makes sense that, although employee training and empowerment assists shipping companies in yielding organizational performance (except it is not so significant to financial performance), both the direct and indirect costs associated with the training and empowerment of employees do not significantly and directly improve the margin and the overall financial performance of shipping firms.

Quality information and performance measurement and organizational performance

With respect to quality information and performance measurement, its influence on and significance to operational performance is the weakest as compared with the other three quality management practices. In the case of financial performance, quality information and performance measurement, though ranks after top management commitment and participation and customer focus, does significantly contribute to financial performance. Although



quality information and performance measurement is positively related to customer satisfaction, it is not considered a practice that significantly yields customer satisfaction. Lai and Cheng (2005) find that it is possible that quality improvement efforts with inward focus alone cannot deliver the desired results, which should be complemented with market orientation that focuses on market needs to drive performance. As such, quality information and performance measurement (the quality management practice with an inward focus) may not significantly and directly lead to the desired results of customer satisfaction, which may have to be supplemented with market orientation focusing on the market for identifying customer needs before the customers are satisfied.

Conclusions

We develop in this article reliable, empirically tested, and rigorously validated measurement instruments for organizational performance, which are critically important and applicable to the shipping industry. We also identify the quality management practices that are able to generate various desirable organizational performance outcomes in the shipping industry.

Theoretically, the findings of this study lend further support to the commonly accepted notion that quality management practices are associated with improved organizational performance in firms that implement them. In addition, the organizational performance measures developed in this study capture most of the profound facets of organizational performance recommended by leading researchers and practitioners. The measurement instruments developed in this study are expected to bring similar benefits to both general and industry-specific quality management research. More importantly, the developed set of measurements, which hardly exists in the shipping industry, can be adopted for future research. Furthermore, our research findings should encourage further research on the link between quality management and organizational performance in the shipping industry and on developing unique sets of measurement instruments for other industries (for example, banking, telecommunications, information technology, insurance and so on). In short, this study helps enrich the knowledge base of the global quality improvement movement concerning the impacts of quality management practices on organizational performance, and also broaden the understanding of the topic in the related industry-specific literature (Lun *et al.*, 2011).

From the managerial perspective, our findings establish that quality management practices are positively related to organizational performance, suggesting that quality management is an effective management approach to improve organizational performance in practice. More specifically, this study is



relevant to the shipping industry in that we identify the most critical and important organizational performance measures and the quality management practices that can yield these performance outcomes in the shipping industry. Specifically, this study provides useful guidance to senior management and quality management practitioners in shipping firms as follows: (1) fine-tune or revise their attention and focus on the quality management programs, (2) design and/or refine their systems of quality management and control, (3) reinforce their plans to implement quality management and (4) encourage the implementation of appropriate quality management practices to shoot for the desired organizational performance outcome.

This study is subject to several limitations, which we leave as potential topics for future research. First, the sample of this study was drawn from the owner members of BIMCO and INTERTANKO. As such, the results may be generalizable only to that population. Future research should study the results and implications or replicate the work of this study by analyzing and focusing on the behaviors of various sectoral areas of the shipping industry (such as owner members of other international maritime associations and/or other shipping participants and so on). It is likely that the impacts of quality management practices on organizational performance may vary among sectors. It would also be worth conducting further studies to evaluate and compare the results of sectoral differences and how sectoral differences would affect the links and the strengths of the relationships between quality management practices and organizational performance. In addition, the use of a larger sample size should provide higher levels of assessment rigor and validity of the measurement instrument. Second, we used cross-sectional data, which are collected at one point in time from a sample chosen to represent the population of the shipping industry (Malhotra and Grover, 1998), to test the research model and the hypotheses that reflect the perceptions of the respondents at a point in time. Cross-sectional data do not capture any continuous transformations that might affect the hypothesized relationships. Organizational performance measures and their relationships with quality management practices are constructs that are dynamic in nature, which involve the time element and might be better examined and reviewed over an extended period. As such, longitudinal studies should be conducted in future research to assess the phenomenon that changes over time by collecting data at two or more points over time, which can provide greater confidence in causality and would strengthen the underlying theory. Third, this study examines the relationship between quality management and organizational performance by considering only four key quality management practices (that is, top management commitment and participation, quality information and performance measurement, employee training and empowerment, and customer focus) and three organizational performance measures



(that is, operational performance, financial performance and customer satisfaction). Future research should include additional important quality management practices (for example, continuous improvement, strategic planning, employee motivation and reward, innovation and technology, quality award criteria etc) and other relevant organizational performance measures (for example, employee performance, quality performance and so on) to evaluate how these alternative quality management practices help shipping companies enhance their overall performance. In addition, future research can also be conducted to examine the factors and the underlying reasons that lead to the success (or failure) of quality management implementation, and also the obstacles and the underlying reasons that hinder the implementation of quality management in the shipping industry. Fourth, this study does not consider variables that mediate the relationships between quality management practices and organizational performance. Future studies may examine potential macro variables that include organizational size (Libby and Waterhouse, 1996; Lee *et al*, 1999; Hoque and James, 2000; Hendricks and Singhal, 2001; Lau *et al*, 2004), organizational context (Benson *et al*, 1991), degree of capital intensity and diversification (Hendricks and Singhal, 2001), level of commitment and degree of implementation (Madu *et al*, 1996; Westphal *et al*, 1997; Sun, 1999; Escrig-Tena, 2003), and national culture (Lai and Cheng, 2005; Lu *et al*, 2012). Inclusion of these moderating variables may provide further insights into and measure the extent of the effect of these variables on the relationship between quality management and organizational performance. Last, this study is only able to demonstrate the relationships among the constructs studied. While existing empirical and theoretical research suggests that an independent variable (representing a quality management practice) precedes a dependent variable (representing an organizational performance measure), such an assumption is entirely theory-driven and cannot be imputed from the cross-sectional survey method (Chong and Rundus, 2004). Therefore, the potential of reverse causality cannot be ruled out (Nouri *et al*, 1999). Future research may employ different research methods to investigate more systematically and ascertain the causal relationships implicit assumed in this study.

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