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QUALITY PAPER

Does interaction between TQM practices and knowledge management processes enhance the innovation performance?

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Abstract

Purpose – The purpose of this paper is to investigate the effect of applying total quality management (TQM) on enhancing knowledge management processes. It also examine the relationship between knowledge management and innovation performance in the Malaysian manufacturing sector.

Design/methodology/approach – This study used a survey method to test the formulated hypotheses. Therefore, the adopted questionnaire was used as an instrument to collect the needed data. The population of the study consisted of 800 big and medium manufacturing companies listed in Federation of Malaysian Manufacturers (2012).

Findings – The results of this paper support a positive and significant impact of TQM practice on knowledge management processes. Furthermore, the relationship between knowledge management and innovation performance has been a proved. However, further analysis on dimension level indicates that knowledge acquisition failed to show significant relationship with innovation performance.

Originality/value – This study addresses one of the recent issues within the Malaysian context of becoming a developed nation, which is innovation performance, specifically for manufacturing companies. To do so, the overlapping relationships among TQM practices, knowledge management, and innovation performance have been tested.

Keywords Innovation performance, Knowledge management processes, Partial least square, TQM practices

Paper type Research paper

Introduction

Due to several factors such as the rapid technological development, change in the customers' preferences and needs, ever-increasing competition, it has become a hard task for organizations to maintain competitive advantages. As a result, organizations seek to adopt and adapt several strategies (e.g. total quality management (TQM), knowledge management, and innovation) whose effectiveness in achieving high rates of performance has been proven (Chen *et al.*, 2009; Liebowitz, 1999). Among those strategies, innovation is considered by several studies as the key source of organizations' competitive advantage (Bigliardi and Dormio, 2009; Rosenbusch *et al.*, 2011; Sandvik and Sandvik, 2003). Furthermore, the ability to leverage innovation constitutes a main engine and driver of economic growth (EPU, 2010; Rosenberg, 2006; Torun and Cicekci, 2007). According to Torun and Cicekei (2007), modern economies are built with ideas that are translated into creative outputs. Therefore, enhancing innovation performance has become an unavoidable choice for organizations in such a competitive environment.

By looking at the Malaysian scenery, Malaysia aspires to become a developed nation by the year 2020 through achieving Vision 2020. This ambitious vision which includes several plans to transfer Malaysia to be a developed nation has been the main driver of Malaysian economic policies. According to Vision 2020, the productivity is the new and current issue of the Malaysian strategies which focus on the intensive knowledge and

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innovation-led economy integrated with human capital (10th Malaysia Plan 2011-2015, 2010). Since the old Malaysian strategy represented in the competition via low costs of production is not suitable any more to meet the requirements to be a developed country, therefore, competing via innovation is considered as an important step (10th Malaysia Plan 2011-2015, 2010).Thus, within the 10th Malaysia Plan, a special confirmation is given to catalysts of productivity. For that, Malaysia has launched on April 19, 2010 Malaysia Economic Monitor Growth through Innovation (The World Bank, 2010) as one of the sub-plans within the 10th Malaysia plan 2011-2015, 2010. In fact, Malaysia has started to concern about innovation since 1990, where it has carried out five surveys through its National Survey of Innovation (NSI) in the manufacturing sector to determine the position of innovation performance in Malaysia. Table I shows the percentage of innovation in the Malaysian manufacturing sector throughout different years.

From Table I, it can be noted that the rate of innovation is higher for the period of NSI-4 compared to those recorded in the periods of NSI-2, NSI-3, and NSI-5. However, the higher rate of innovation during the period of NSI-4 does not necessarily mean that the overall incidents of innovation has increased at that certain period (National Survey of Innovation 2002-2004, 2006). Including big organizations in NSI-4 compared to other periods could be one of the reasons behind the obtained result (National Survey of Innovation 2002-2004, 2006). Moreover, NSI-4 used a longer time frame which is three years compared to NSI-3 that used two years only (National Survey of Innovation 2002-2004, 2006). Besides, it is also noticeable that innovation performance of the Malaysian manufacturing companies was unstable for all the periods covered by the surveys. According to National Survey of Innovation, 2005-2008 (2011), the main factors that hinder innovation activities of the Malaysian manufacturing companies can be grouped into five factors, i.e. cost factor, knowledge factor, market factor, regulatory factor, and organizational factor. These factors affect innovation in different manners. While in certain cases they prevent the project from being started at all or cause it to be abandoned in the concept stage, the other factors burden the firm with other serious problems which lead to abandon the activity or project after it has begun.

Lack of knowledge as a hindering factor of innovation is the concern of this study as it impedes innovation performance of Malaysian manufacturing companies through different forms such as lack of a qualified personnel, lack of information on technology, lack of information on markets, and difficulties in finding cooperation partners for innovation (National Survey of Innovation 2005-2008, 2011). Thus, the important role of knowledge management requires researchers to investigate "how" and "which" strategies, among others, enhance the processes of knowledge management (Gold *et al.*, 2001). Empirically, TQM as a strategy has proven its effectiveness in improving the organizational performance in different aspects (e.g. customer satisfaction, finance, productivity, and the like) (Flynn *et al.*, 1995; Flynn, 1994; Martínez-Costa and Jiménez-Jiménez, 2008; Prajogo and Hong, 2008; Prajogo and Sohal, 2006; Sadikoglu and Zehir, 2010). However, the studies that investigate the relationship between TQM practices and knowledge management processes

Items	NSI-1[a]	NSI-2	NSI-3	NSI-4	NSI-5
Period	1990-1994	1997-1999	2000-2001	2002-2004	2005-2008
Number of innovation firms	270	217	263	261	524
Number of non-innovation firms	142	827	486	224	493
Total number of firms	412	1,044	749	485	1,017
Percentage of innovating firms	66	21	35	54	52

Note: [a]National Survey of Innovation (NSI)
Sources: NSI-1, NSI-2, NSI-3, NSI-4, NSI-5

Table I.
Innovation in the Malaysian manufacturing sector (1990-2008)

are scant (Ooi, 2009; Zwain *et al.*, 2011a, b). Furthermore, It is noticeable from the literature reviewed that although the previous studies try to figure out the effect of TQM on knowledge management and then organization's performance, these studies provide a partial view of this relationship as they only focus on one of the knowledge management processes (i.e. knowledge transfer and knowledge sharing) (Ju *et al.*, 2006; Molina *et al.*, 2007; Ooi *et al.*, 2009, 2010). Accordingly, this study aims to provide an overview of this relationship by investigating the influence of TQM practices on knowledge management processes. On the other hand, although the effect of knowledge management on performance exists in the relevant literature, this effect is still weak and cannot be concluded yet (Hung *et al.*, 2010). Therefore, re-examining the effect of knowledge management on innovation performance provides a solid basis that helps the decision makers to answer this critical question: "how" our company can be innovative?

The aforementioned issues and literature gaps motivated this study to investigate the effects of applying TQM practices to enhance knowledge management processes which affirmatively affect innovation performance of the firms. Furthermore, providing empirical evidence in respect of the effect of knowledge management on innovation performance is another objective of this study, which hopes to reduce the uncertainty regarding this relation.

As result, the main research questions in the present study are:

RQ1. To what extent does applying TQM practices enhance knowledge management processes?

RQ2. Do knowledge management processes influence innovation performance?

By answering theses research questions, it is hoped that this study will contribute to both academics and practitioners, as they will reduce the gap in the relevant literature which has been identified above (Ooi, 2009; Prajogo and Sohal, 2001; Singh and Smith, 2004). Furthermore, the result of the study will assist the manufacturing managers to overcome one of the main hindering factors of innovation performance, represented by lack of knowledge, as stated in the fifth National Survey of Innovation's report (National Survey of Innovation 2005-2008, 2011). Moreover, this study will enable the managers to integrate the two vital strategies (i.e. TQM practices and knowledge management processes) to enhance innovation performance. In addition, by conducting this study, the literature of TQM will be extended to clarify the role of TQM practices in promoting other aspects of organizations beside quality, financial performance, customer satisfaction, and the like, to cover a different and important side which is quality of knowledge. To do so, TQM practices have been identified through six main practices based on several past studies. These six practices are represented by top management commitment, customer focus (CF), people management (PEM), processes management, supplier management and quality data reporting (QDR) (Antony *et al.*, 2004; Fuentes *et al.*, 2006; Prajogo and Sohal, 2006; Rahman and Bullock, 2005). Knowledge management, on the other hand, has been recognized through three processes as stated by Darroch (2005) which are knowledge acquisition (KAC), knowledge dissemination (KD), knowledge application (KAP).

This study is organized as follows: it starts with a discussion of the relationship among the variables, and then the hypotheses of the study are introduced. The subsequent sections describe the research's methodology, data analysis, and results, while the last section presents conclusions, limitations of the study and recommendations for future researches.

Literature review

TQM practices and knowledge management processes

During the past few decades, TQM has been among the important topics in management and business research due to its potential role on the growth of management practices

(Prajogo and Sohal, 2003). Just as TQM enjoyed a great popularity during the 1980s (Martínez-Costa and Martínez-Lorente, 2008), knowledge management has also attracted great attention of business and academic community (Ju *et al.*, 2006). Organizations are viewing knowledge management as a critical success factor of dynamic environment. Consequently, knowledge managers and knowledge creation teams are created in many organizations (Ju *et al.*, 2006). According to Hsu and Shen (2005), the relationship between TQM and knowledge management as management practices seems to be close, as they share some processes such as result orientation, people-based management, leadership, and delight the customer. These similarities form an interactive relationship between the two practices (Leonard and Mcadam, 2001).

The main reason that attracts the scholars' attention is that both TQM practices and knowledge management processes have a great influence on the organization strategic competences. However, most of the related research lacks empirical evidence of this relationship, and the results are not practical enough (Ju *et al.*, 2006). By using mixed methods of research (qualitative and quantitative) Ju *et al.* (2006) examined the relationship between TQM and knowledge management based on a framework that adopted ten dimensions as critical success factors of TQM and four dimensions represented knowledge management. They obtained several results regarding this relationship, the main of which are: emphasizing the important role of the top management in implementing knowledge management in terms of supporting, sitting the goals and allocating the resources; applying process management (PRM) practices and improvement is suitable to establish knowledge management; and focusing on customers provides a solid basic to build knowledge management. However, even Ju *et al.* (2006) used mixed research methods in their study, the limited sample for both qualitative and quantitative methods (two cases for the qualitative and only 30 respondents for quantitative) has made it difficult for the results to be generalized.

Ooi (2009) presented a conceptual model to address the effect of TQM practices on knowledge management processes. This model contributed to the literature concerned with the relationship between TQM and knowledge management processes, which help both the practitioners and the academicians to better comprehend the link between TQM practices and knowledge management processes. However, this model is still conceptual and needs to be supported by empirical studies for more reliability. In another conceptual study conducted by Ooi *et al.* (2009), the effect of human resource management (HRM) and TQM practices on knowledge management has been addressed through integrating a model that combines these three variables in order to come up with desirable knowledge management processes. Though Ooi's *et al.* (2009) study is also still conceptual, the dimensions of their study is not comprehensive. Moreover, TQM emphasizes on HRM as one of the main practices, so both TQM and HRM can be one entity.

Molina *et al.* (2007) study analyzed the relationship between TQM and knowledge transfers. The study reported that PRM, as one of quality management factors, helps and facilitates internal knowledge to be transferred. Findings also showed that quality management highlights the differences in efficiency among the different processes that organization performs based on the data rather than on intuition. It was also found that quality management maintains and builds the effectual cooperation with suppliers and customers which will improve the transfer of external knowledge from them to the organization.

Ooi *et al.* (2010) conduct an empirical study to measure the effect of TQM on knowledge management. The findings revealed that TQM is significantly associated with knowledge sharing. Moreover, the results showed that training, teamwork, and CF is positively related to knowledge sharing among middle management employees. Zwain, Lim and Othman (2011), assess the relationship between core TQM elements and knowledge sharing. They confirm a

positive relationship between TQM elements and knowledge sharing, and indicate that TQM core elements should be implemented holistically rather than individually to get best results on knowledge sharing. The previous discussion leads this study to formulate the following main hypothesis:

H1. TQM practices have a significant effect on knowledge management processes.

Consequently, the following sub-hypotheses have been introduced:

H1a. TQM practices have a significant effect on KAC processes.

H1b. TQM practices have a significant effect on KD processes.

H1c. TQM practices have a significant effect on KAP processes.

Knowledge management processes and innovation performance

Effective knowledge management has been identified in the literature as one of the methods for improving innovation performance (Darroch and McNaughton, 2002). Carneiro (2001) emphasize that knowledge management emerges as an important concept that has been considered as an antecedent of innovation performance. According to Plessis (2007), there are three main drivers of the application of knowledge management in innovation.

The first driving force of knowledge management in innovation today is to create, build and maintain competitive advantage. This can be done through the utilization of knowledge and collaborative practices. However, this has become increasingly complex and difficult because of changing customer needs, competitive pressure and extremely rapid technological changes (Cavusgil *et al.*, 2003). Therefore, many organizations have started working collaboratively across organizational boundaries to ensure sustained innovation and competitive advantage (Cavusgil *et al.*, 2003). Knowledge management can facilitate such collaboration, whereby knowledge and skills acquisition through collaboration is deemed an effective and efficient way toward successful innovation (Plessis, 2007).

The second driving force of knowledge management's role in innovation is that knowledge is a resource which can be utilized to reduce complexity in the innovation performance. Therefore, managing knowledge as a resource is very vital (Plessis, 2007). Innovation is very much dependent on knowledge availability; hence, the complexity created by the wealth of knowledge must be recognized and managed (Adams and Lamont, 2003; Darroch and McNaughton, 2002). Several authors have agreed that knowledge management is a mechanism through which innovation complexity can be addressed (Cavusgil *et al.*, 2003; Shani *et al.*, 2003). It helps not only in managing new knowledge created through the innovation process, but it also assists to manage existing knowledge as a resource that is used as an input to the innovation process (Plessis, 2007).

The third driving force of knowledge management's role in innovation performance is the integration of both internal and external knowledge, which becomes more available and accessible to the organization (Plessis, 2007). This implies that knowledge can be exchanged, shared, evolved, refined and made available where and when it is needed. Hence, this integration of knowledge via knowledge management platforms, tools and processes must facilitate reflection and dialogue so as to enable personal and organizational learning and innovation. This requires to link the ability, adaptability and dynamic representation of business information with knowledge. Thus, it is vital that knowledge integration is effectively driven by information and knowledge management which in turn underpins innovation; otherwise, organizations may be under-utilizing knowledge as a source of innovation (Baddi and Sharif, 2003; Chen *et al.*, 2004; Plessis, 2007).

Knowledge management process (which is represented by processes of acquiring the valuable information, disseminating this knowledge during the organization and making it

available to the users on time, and applying this knowledge in commercial way) have been considered as the critical antecedents that contribute to providing a necessary foundation to improve the innovation performance of the organization (Cohen and Levinthal, 1990). In line with the discussion above, the present study proposes the following main hypothesis:

H2. Knowledge management processes have a significant effect on innovation performance.

Accordingly, the following sub-hypotheses have been developed:

H2a. KAC processes have a significant effect on innovation performance.

H2b. KD processes have a significant effect on innovation performance.

H2c. KAP processes have a significant effect on innovation performance.

Based on the previous discussion, a theoretical framework was introduced as shown in Figure 1. Guided by this framework, the current research examined the relationship between TQM practices and knowledge management processes, and investigated the effect of knowledge management on innovation performance.

Research methodology

Data collection

According to Creswell (2003), if the aim of the study is to identify the influence relationship among the variables under investigation, then a quantitative approach is the best. Quantitative research method is suitable in testing theories and hypotheses through using a set of statistical tools (Creswell, 2003). Accordingly, this study used a survey method to test the formulated hypotheses. Therefore, the adopted questionnaire was used as an instrument to collect the needed data. The population of the study consisted of 800 big and medium manufacturing companies listed in Federation of Malaysian Manufacturers (2012). As suggested and adopted by previous research, the suitable respondents of such studies are the top management managers, as they hold a critical position in the organization that enables them to provide reliable information regarding the basic environmental and organizational characteristics of their organizations (Hung *et al.*, 2010; Yusr *et al.*, 2013). By using a simple random sampling, 600 questionnaires were e-mailed to the managing directors or chief executive officers of selected companies in the population. To increase the response rate, following-up telephone calls to managers in sample were performed. In total,

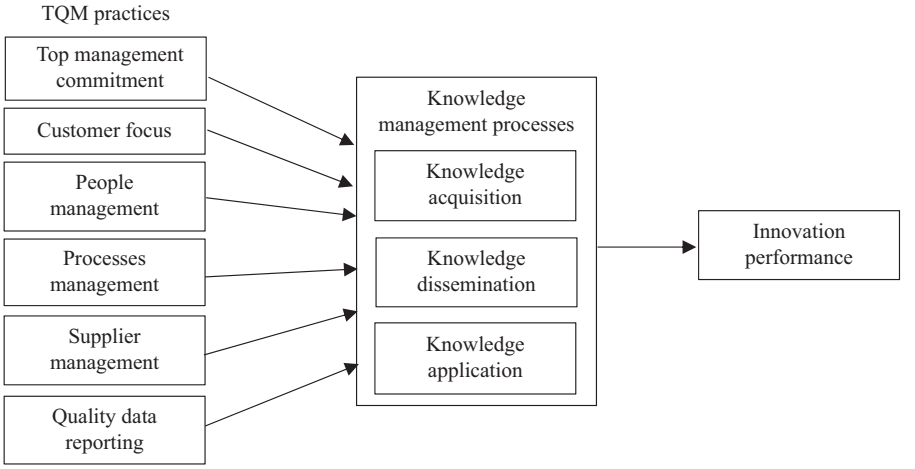

Figure 1.
Research framework

161 questionnaires were returned, which formed a response rate of 26 percent. Generally, such a response rate is acceptable compared to other surveys in the management fields which obtained response ranging between 10 and 32 percent (Cavusgil *et al.*, 2003; Gold *et al.*, 2001; Hung *et al.*, 2010). Moreover, according to Roscoe's (1975) rule of thumb suggesting that the sample size which is larger than 30 and less than 500 is appropriate for majority of research, therefore, the obtained sample size for this study is considered appropriate. In addition, because of the nature of online survey which can be designed to reject submitting incomplete questionnaires, all the returned forms were valid.

Measurement and scale

Due to the nature of this study that involves the dependent effect between the latent construct and the manifest variables, a reflective measurement model was suitable for this study (Gudergan *et al.*, 2008). All the adopted items were rated on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree). The innovation performance was measured using eight items from Calantone *et al.* (2002) and Prajogo and Sohal (2006). To assess knowledge management processes within the organization, 16 items were adapted from Darroch (2003) and Gold *et al.* (2001). The 16 items were distributed into three dimensions as suggested by Darroch (2003). To measure TQM practices, the study adapted 35 items developed and used by several studies such as Ahire *et al.* (1996), Fuentes *et al.* (2006), Prajogo and Sohal (2006), Rahman and Bullock (2005).

A pilot study with 53 companies was conducted to ensure the reliability and validity of the measurement within the Malaysian context. The results of the pilot study indicated that the internal consistency of the main constructs ranged from 0.88 to 0.93, which exceeded the threshold of 0.70 as suggested by Hair *et al.* (2010).

Data analysis

The most popular statistical techniques under structural equation model (SEM) are covariance-based approach (CB-SEM) and variance-based partial least squares technique (PLS-SEM) (Jr *et al.*, 2014). However, PLS-SEM has lately gained wide attention in many disciplines like marketing (Hair, Sarstedt, Ringle, and Mena, 2012), strategic management (Hair, Sarstedt, Pieper, and Ringle, 2012), management information systems (Ringle *et al.*, 2012), and other areas. The ability of PLS-SEM to handle problematic modeling issues that usually happen in the social sciences such as unusual data characteristics (e.g. non-normal data) and highly complex models is the substantial reason behind increasing the usage of this approach.

Given the advantage of this approach, the present study used PLS-SEM to thoroughly test the proposed hypotheses. SmartPLS software was carried out to evaluate both the outer and inner models, respectively. Testing the outer model allowed for ensuring the goodness of the measurement in terms of reliability and validity, while the introduced hypotheses were examined through the inner model.

Assessing the outer model

As Hair *et al.* (2014) state, assessing the outer model is carried out through verifying both reliability and validity. To test the reliability, Hair *et al.* (2014) recommend using composite reliability to evaluate the internal consistency reliability as it provides a more appropriate measure of internal consistency compared to the other traditional assessment, i.e., Cronbach's α, for two main reasons. First, Cronbach's α assumes that all items loadings are equal in the population, however, this assumption is rarely true. Second, Cronbach's α is also sensitive to the number of indicators in the scale and generally tends to underestimate internal consistency reliability. Accordingly, using composite reliability helps to accommodate different item reliabilities, and also avoids the underestimation

associated with Cronbach's α. As recommended by many researchers (e.g. Hair *et al.*, 2011; Henseler *et al.*, 2009), the acceptable threshold for composite reliability is 0.70.

The following step was to evaluate the validity of the outer model. To do so, constructs' convergent validity and discriminant validity should meet the minimum requirement value. The convergent validity is supported when each indicators has an outer loading more than 0.70, while the constructs' average variance extracted (AVE) should be 0.50 or above (Henseler *et al.*, 2009; Hair *et al.*, 2014). An AVE of 0.50 showed that the construct explained more than half of the variance of its indicators (Hair *et al.*, 2014). Table II shows the results of testing the reliability and validity of the outer model, where all the included items meet the requested threshold.

Table II statistically proved the reliability and validity of the outer model of this study. After checking and verifying the reliability and validity of the constructs, the discriminant validity was examined. Discriminant validity indicates to which extent the construct is empirically distinct from other constructs (Hair *et al.*, 2014). Fornell and Larcker (1981) criterion is one of the approaches that has been used to evaluate the discriminant validity. According to this approach, the construct must share more variance with its indicators than with any other constructs. Basically, if a specific construct is more correlated with another construct than with its own measures, there is the possibility that the two constructs share the same types of measures and are not conceptually distinct (Chin, 2010). Substantiation of discriminant validity occurs when square root of AVE estimation goes over the correlations between the indicators making each pair (Fornell and Larcker, 1981). Table III indicates that the AVE square root value exceeds the values of all correlations.

Table III demonstrates the discriminant validity of the constructs. It can be confidently concluded that the model meets the requirements of goodness and the measurement is reliable and valid to test the hypotheses formulated by this study. Testing the hypotheses requires to move to the second step of analysis, i.e., assessing the inner model. The next section discusses the relationships involved in the structural model.

Assessing the inner model

There are many steps that need to be taken to assess the hypothesized relationships within the inner model (Chin, 2010; Hair *et al.*, 2014). Hair *et al.* (2014) state that the assessment of the model's quality lies on its ability to predict the endogenous constructs. Therefore, the following criteria facilitate this assessment: Coefficient of determination (R^2), cross-validated redundancy (Q^2), path coefficients, and the effect size (f^2).

Due to the nature of the prediction-oriented PLS-SEM method that aims to clarify the endogenous latent variables' variance, the coefficient of determination (R^2) of endogenous latent variables is one of the crucial criteria in the process of assessing the inner model (Hair *et al.*, 2014; Henseler *et al.*, 2009). The R^2 is a measure of the model's predictive accuracy. Therefore, the R^2 level of the main target constructs has to be high. Basically, classifying the R^2 level depends on the kind of research discipline (Hair *et al.*, 2011). However, researchers have to depend on a "rough" rule of thumb regarding an acceptable R^2, i.e., 0.75, 0.50, and 0.25, respectively, describing substantial, moderate, or weak levels of predictive accuracy (Hair *et al.*, 2011; Henseler *et al.*, 2009).

Based on the research model, there are two endogenous constructs represented by knowledge management and innovation performance. The results obtained from PLS algorithm indicated that the R^2 value of knowledge management was 0.647, referring that 65 percent of the variance in knowledge management was explained by TQM practices. Further, R^2 was in the substantial range demonstrating that TQM practices had a substantial effect on knowledge management. On the other hand, the R^2 value of innovation performance was 0.419, which suggested that 42 percent of the variance in innovation performance could be captured by knowledge management, as a result, R^2 was in the

Construct and items (item code)	Internal reliability Composite reliability	Convergent validity Factor loading	AVE
Leadership and management commitment (LMC)			
Senior managers in our company actively encourage involvement and commitment in moving toward "best practice"	0.926	0.851	0.806
Top management in our company allocates adequate resources toward effort to improve quality		0.918	
Our company has clear quality goals identified by top management		0.922	
Customer focus (CF)			
Our company seriously investigates and fix all customer complaints	0.923	0.875	0.749
Our company knows our external customers' current and future requirements (both in terms of volume and products characteristics)		0.886	
In our company customers' requirements are effectively understood throughout the workforce		0.881	
Our company regularly measures customer satisfaction		0.819	
People management (PEM)			
Our company has wide training and development process, including career path planning, for all our employees	0.941	0.803	0.728
Our company has an effective team rewards to motivate the employees		0.895	
Our company has maintained both "top-down" and "bottom-up" communication processes		0.864	
In our company employees satisfaction is regularly measured		0.875	
In our company, everyone participates in improving our product (s) /process(es)		0.850	
We believe that all employees take quality as their responsibility		0.827	
Processes management (PRM)			
Preventing defective products from occurring is our strong attitude in our company	0.938	0.856	0.750
The processes for designing new products in our company ensure quality		0.885	
Our company evaluates and improves business process continuously		0.880	
Our company has a program to find wasted time in all internal processes		0.848	
Our company evaluates and improves the individual employee's performance continuously		0.861	
Supplier quality management (SQM)			
Our company maintains long-term relationship with the suppliers	0.905	0.793	0.705
Our company selects its suppliers based on quality		0.798	
Our company selects its suppliers based on delivery schedule		0.885	
Our company provides relevant information to the suppliers		0.835	
Quality data reporting (QDR)			
The information about the cost to implement quality is available in our company	0.939	0.816	0.754
In our company the data of quality (e g., error rates, defects rates, scrap, defects, etc.) is made available to managers and supervisors		0.847	
Our company uses data of quality as tools to manage quality		0.887	
Our company uses data of quality to evaluate supervisor performance		0.877	
Our company uses data of quality to evaluate managerial performance		0.911	

(*continued*)

Table II.
The reliability and validity of constructs

Construct and items (item code)	Internal reliability Composite reliability	Convergent validity Factor loading	AVE
Knowledge acquisition (KAC)			
Our company has processes for generating new knowledge from existing knowledge	0.867	0.883	0.686
Our company has processes for acquiring knowledge about new products within our industry		0.846	
Our company rewards its employees who present new information and knowledge		0.750	
Knowledge dissemination (KD)			
Our company has mechanism for filtering, cross-listing and integrating different sources and type of knowledge	0.909	0.845	0.667
Our company utilizes databases, repositories and information technology application to store knowledge for easy access by all employees		0.868	
In our company market information is freely distributed		0.692	
Our company sends out timely reports with appropriate information to the functional department		0.820	
Our company has a considerable of documented information about the successes and failures of product development		0.847	
Knowledge application (KAP)			
Our company responds quickly to customers' requirements	0.900	0.752	0.692
Our company responds quickly to changing technology		0.867	
Our company responds quickly to competitors actions		0.855	
Our company is flexible and opportunistic by readily changing our products, processes and strategies		0.844	
Innovation performance (IP)			
Number of new product introductions is high compared to other competitors	0.941	0.853	0.697
Compared to other competitors, our company is faster in bringing new product(s) into the market		0.887	
Our company encourages the new ideas presented to develop the performance		0.823	
Our new product introductions has increased over the last 5 years		0.837	
Our company changes production methods at a great speed compared to other competitors		0.848	
The technological competitiveness of our company is high		0.746	
During the past five years, our company has developed many new management approaches		0.842	

Table II.

Constructs	CF	IP	KAC	KAP	KD	LMC	PEM	PRM	QDR	SQM
CF	*0.866*[a]									
IP	0.479	*0.835*[a]								
KAC	0.596	0.519	*0.828*[a]							
KAP	0.672	0.611	0.637	*0.832*[a]						
KD	0.560	0.594	0.762	0.700	*0.817*[a]					
LMC	0.791	0.471	0.598	0.529	0.538	*0.898*[a]				
PEM	0.682	0.590	0.672	0.620	0.661	0.671	*0.853*[a]			
PRM	0.759	0.586	0.653	0.633	0.652	0.716	0.805	*0.866*[a]		
QDR	0.654	0.557	0.696	0.627	0.699	0.677	0.716	0.741	*0.868*[a]	
SQM	0.688	0.547	0.612	0.628	0.626	0.661	0.688	0.751	0.725	*0.840*[a]

Note: [a]AVE square root values

Table III.
The discriminant validity of the constructs

moderate range indicating that knowledge management had a moderate effect on innovation performance.

Cross-validated redundancy (Q^2) is another criterion which is used to assess the inner model's predictive relevance (Hair *et al.*, 2014). Through running blindfolding procedures, which depend on a sample re-use technique, the Q^2 can be evaluated (Henseler *et al.*, 2009). Hair *et al.* (2011) recommend the number of cases in the data must not be a multiple integer number of the omission distance d in order for the blindfolding procedure to avoid producing erroneous results. Furthermore, Hair *et al.* (2011) stress on choosing a value of d between 5 and 10. Therefore, this study used 7 as a value for d to obtain cross-validated redundancy measures for the endogenous variable. As stated by Hair *et al.* (2014), the smaller the difference between predicted and original values the greater the Q^2 and thus the model's predictive accuracy. In other words, a Q^2 value larger than zero for a specific endogenous construct points out to the path model's predictive relevance for this exact construct. Based on the result attained from PLS-SEM, the cross-validated redundancy Q^2 for knowledge management construct was 0.353 while the Q^2 of innovation performance construct was 0.281. Consequently, the obtained output supported the claim that the model had an adequate predictive relevance.

On the other hand, it is useless to carry out the effect size because running the effect size is more applicable when the interaction relationship among the variables exists; otherwise, the value of R^2 would remain the same. Therefore, the current study will proceed to the final step of assessing the inner model which tested the hypothesized relationships by means of running PLS algorithm to identify the path coefficient and bootstrapping algorithm to determine the significance level of the obtained coefficients. The critical t-values for a two-tailed test were 1.65 (with a significance level of 10 percent), 1.96 (with a significance level of 5 percent), and 2.58 (with a significance level of 1 percent). Table IV presents the path coefficient and the bootstrapping result.

As shown in Table IV, all the formulated hypotheses were supported by the result of the study. However, the hypothesis that addresses the relationship between KAC and innovation performance was not supported. To extend our understanding regarding the relationship between TQM practices and each of knowledge management processes and also to identify which of the TQM practices is more effective in enhancing knowledge management processes, this study examine the significance of each practices belong to TQM with the three main processes of knowledge management. Table V displays the result of this relationship between TQM practices and knowledge management processes.

As seen in Table V, eight out of the 19 sub-hypotheses were found to have relationships among TQM practices and knowledge management processes. However, results also revealed that certain practices of TQM were reported not to have any impact on all knowledge management processes equally.

Hypotheses	Path coefficients	SE	t-value	p-value	Decisions
H1: TQM → KM	0.804	0.033	24.374***	0.000	Supported
H1a: TQM → KAC	0.738	0.040	18.620***	0.000	Supported
H1b: TQM → KAP	0.712	0.038	18.680***	0.000	Supported
H1c: TQM → KD	0.733	0.034	21.344***	0.000	Supported
H2: KM → IP	0.648	0.062	10.425***	0.000	Supported
H2a: KAC → IP	0.059	0.093	0.637	0.262	Not supported
H2b: KAP → IP	0.364	0.077	4.727***	0.000	Supported
H2c: KD → IP	0.299	0.111	2.687***	0.004	Supported

Note: ***$p < 0.01$

Table IV. Result of testing hypotheses

Constructs	Path coefficients	SE	*t*-value	*p*-value	Decision
CF → KAC	0.066	0.104	0.636	0.263	Not supported
CF → KAP	0.457	0.101	4.507***	0.000	Supported
CF → KD	0.044	0.097	0.448	0.327	Not supported
LMC → KAC	0.060	0.105	0.574	0.283	Not supported
LMC → KAP	−0.222	0.104	2.125**	0.017	Supported
LMC → KD	−0.068	0.099	0.689	0.245	Not supported
PEM → KAC	0.265	0.095	2.789***	0.003	Supported
PEM → KAP	0.164	0.104	1.586	0.056	Not supported
PEM → KD	0.233	0.108	2.162**	0.015	Supported
PRM → KAC	0.046	0.112	0.409	0.341	Not supported
PRM → KAP	0.015	0.138	0.109	0.457	Not supported
PRM → KD	0.106	0.134	0.790	0.215	Not supported
QDR → KAC	0.345	0.101	3.407***	0.000	Supported
QDR → KAP	0.224	0.119	1.885**	0.030	Supported
QDR → KD	0.387	0.101	3.848***	0.000	Supported
SQM → KAC	0.060	0.089	0.669	0.252	Not supported
SQM → KAP	0.177	0.104	1.710*	0.044	Supported
SQM → KD	0.127	0.104	1.217	0.112	Not supported

Notes: *$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table V.
Result of the relationship between TQM's practices and knowledge management processes

Discussion

Based on a comprehensive review of the relevant literature, the present study proposed a structural model of relationships among a number of the distinct domains in the business world nowadays, i.e., TQM practices, knowledge management processes, and innovation performance. Essentially, this study attempted to investigate how much TQM practices are effective in enhancing knowledge management processes, and to clarify the role of knowledge management processes in improving innovation performance. The perceptions of the managers of the manufacturing companies in Malaysia were the source of the information for testing the hypotheses and the model involved in the study. The results of the hypotheses testing showed that a well-established TQM (as one set of practices) within the organization leads to a better performance of knowledge management processes. This result is compatible with several previous studies that have examined this relationship between TQM practices and knowledge management (e.g. Ooi, 2009; Skyrme and Amidon, 1997; Wong, 2005; Zwain, Lim and Othman, 2011). In addition, it could be argued that the basis of this positive relationship relies on the infrastructure provided by TQM practices, which (i.e. the infrastructure) represents an antecedence of knowledge management processes. Furthermore, TQM concept, as a set of practices, ultimately aims to satisfy customers through continuous improvement processes (Hackman and Wageman, 1995; Kumar *et al.*, 2011). To achieve this goal, several processes and practices should be performed. Applying these processes and practices helps to make the organization more open and close to its environment (Chourides *et al.*, 2003; Skyrme and Amidon, 1997). This, in turn, drives the process of knowledge management.

In order to get more insight regarding this relationship between TQM practices and knowledge management, this study performed further exploration to evaluate the path coefficients of each of TQM practices with each of the knowledge management processes. The comprehensive understanding concerning the relative contribution of each of TQM critical factors toward successful TQM initiative can help a manufacturing company to better utilize its available resources to enhance the outcome quality of the knowledge management processes. Therefore, determining which factors of TQM contribute more and which of them contribute less toward a successful quality initiative will help the managers of manufacturing companies to know which factors should be paid more

attention and given more investment compared with the less contributing factors. As reported in Table V, the outcome of PLS-SEM indicated that only one out of six TQM's factors was found to be predictors of the three knowledge management processes, while the rest factors were found to be partially related to knowledge management, i.e., with one or two processes of knowledge management. The reason behind this result can be attributed to the nature of this factor, namely, QDR. QDR is about providing necessary information regarding the processes to the right department at the right time to help decision makers take the right action. Definitely from the nature of QDR, it can be noticed the association of QDR with all knowledge management processes (e.g. acquisition knowledge, disseminating knowledge, and application knowledge). Therefore, the result of this study was compatible with our expectation.

Furthermore, this study revealed that leadership management and commitment (LMC) was a significant determinant of only KAP. However, the association of LMC with KAC and KD was not significant, which contradicts the findings of some previous studies (e.g. Daud and Yusoff, 2011; Zwain *et al.*, 2011a, b). This contradiction can be attributed to the fact that these studies examine the relationship of each of TQM's factors with only one of knowledge management processes. Moreover, the obtained result leads to discuss the nature of the relationship between LMC and KAP. LMC as a TQM practice focuses the majority of its efforts on controlling and applying the concept of TQM to achieve several goals. Therefore, the main concern of LMC is to take decisions, i.e., how and what is the right decision that LMC should take in order to improve the organization's processes (i.e. KAP). To this end, the managers allocate the efforts and the resources to create and acquire the knowledge that helps to make the best decision. Hence, knowledge management should be established in order to achieve this aim. To sum up, the managers' need of knowledge that enables them to respond quickly and effectively is the key concern of LMC with knowledge management processes. In other words, KAP processes are performed by managers.

In contrast to our expectation, the finding showed that CF was reported to be a significant predictor of only one of knowledge management processes which is KAP. On the other hand, the association of CF with the other two processes of knowledge management, i.e., KAC and KD, was found to be not significant. This result is inconsistent with the finding of Ooi *et al.* (2010) and Zwain *et al.* (2011a) who confirm that CF has a significant positive association with KAC and KD.

However, the nature of the manufacturing companies leads to spend the major efforts in satisfying their customers through responding to their needs and desires in terms of the quality of the product, new features of product, several services/multi uses of the product, or new products that meet some aspects of latent needs of customers. To do this, the feedback from the customers is a critical issue in order to get a clear view as to their needs and desires. Therefore, this obtained feedback represents the main input of the manufacturing companies' processes to improve the quality of product, or even create a new product. Thus, the ability of the organization to respond to the outside changes (e.g. customers, competitors, technology, opportunities and so on) by using the provided knowledge (customers' feedback) is considered as one of the main indicators of success of knowledge management processes. Focusing on customers in TQM concept is achieved by responding properly to the customers' feedback and applying the obtained knowledge (i.e. KAP). Therefore, the significant association between CF and KAP is reasonable.

As for the effect of PEM on knowledge management processes, the result of this study showed that PEM is significantly associated with knowledge management. However, this association was found to be related to KAC and KD processes. This result is consistent with the past studies (e.g. Daud and Yusoff, 2011; Ooi, 2009; Zwain *et al.*, 2011a). Furthermore, that PEM is associated with KAC and KD is a logical result. This logical conclusion can be explained within Nonaka's (1994) classification of knowledge, where knowledge can be

explicit and tacit. Explicit form of knowledge can be in manual, roles, and instructions, and it can be also outside the organization. Tacit form of knowledge, however, resides in the mind and experiences of the individuals. PEM as one of TQM's practice applies several activities that help the organization to extract the tacit knowledge from the individuals to share it with other employees. Training programs is one of these activities that help the individuals to acquire the experience and skills of the experts whether inside or outside the organization (e.g. consultants, competitors, customers, suppliers, and prior employers of the organization's new employees) to improve and supports the individuals' performance (Becerra-Fernandez *et al.*, 2004). Moreover, one of PEM tasks is to provide and facilitate top-down and bottom-up communication, which helps and accelerates acquiring the concerned parties with the necessary information in the right time for making decision. Finally, the way that TQM manages people stresses on sharing responsibility of achieving quality among all employees, which provides an environment that encourages disseminating the information and knowledge whether explicit, tacit or even from outside.

The findings of this study also reveals that supplier quality management (SQM) has a significant relationship with KAP. This result is compatible with Daud and Yusoff's (2011) result, where the authors concluded that soft components of TQM (e.g. CF, SQM, and top management leadership), are more important in enhancing the organization's ability to apply the acquired knowledge from different sources. Furthermore, the nature of the SQM as a TQM practice makes this result acceptable and logical as these practices consist of different aspects such as maintaining long-term relationships with the suppliers and providing them with the technical assistance and relevant information, and also involving the suppliers in the product development processes. Thus, it can be concluded that in some aspects the organization may not be able to apply the acquired knowledge without helping the supplier. In other words, suppliers play an important role in activating certain knowledge. Therefore, cooperative relationships with suppliers help the organization to make use of the valuable information, especially the suppliers who provide some of the specialized raw materials (such as microchips, optical cells, organic products, chemical products, and medical equipment) which the organization sometimes cannot produce or provide on its own.

Importantly, the attained result shows that PRM has no relationship with any of knowledge management processes. By looking at PRM practices, it can be argued that they are limited practices that focus more on operation activities for a short term to accomplish certain aims within the processes of producing the products, while knowledge management depends on accumulating processes for a long term. Thus, the result indicated by this study is acceptable. Consequently, this study stressed on the importance of TQM as a determinant of knowledge management based on the data collected from manufacturing companies operating in Malaysia. This result is consistent with the results of many previous studies (e.g. Daud and Yusoff, 2011; Ooi, 2009, Zwain *et al.*, 2014; Wong, 2005). Furthermore, applying TQM successfully requires organizations to combine all the TQM practices and should not be selective about TQM practices (Al-Swidi, 2012). Additionally, applying TQM as a combination of practices positively affects the knowledge management processes rather than implementing those practices separately.

Regarding the influence of knowledge management on innovation performance, this study provided an empirical evidence that knowledge management processes have a significantly positive effect on innovation performance. Such a result is supported by Darroch (2005) who considers knowledge management as necessary processes for achieving the desired innovation performance. Further analysis conducted by the present study determined two processes of knowledge management (i.e. KAP and KD) to be associated with innovation performance, while there was no relationship between KAC and innovation performance. This obtained result is logic where having knowledge without taking the steps

to provide all facilities to apply it will not achieve a superior performance. Furthermore, the ability to utilize knowledge is the critical factor in achieving the target performance. This conclusion, furthermore, is in line with Hung's *et al.* (2010) argument that the main output of knowledge management processes is knowledge, and that this output is not the targeted end; rather, it is a tool to achieve the desired goal which is improving the overall performance of the company. Therefore, providing this knowledge to the right person at the right time so that he or she makes right decisions is the main reason behind the vital role of knowledge management in enhancing performance.

Implications of study

From a theoretical perspective, the results of this study provide empirical evidence of the positive role of TQM practices in enhancing knowledge management processes. Additionally, knowledge management processes were found to be influential processes to boost innovation performance of the manufacturing companies. On the other hand, from a managerial perspective, the outcomes of this study provide the decision maker in manufacturing companies with a better understanding of how TQM practices can go beyond enhancing the quality of the manufacturing processes or quality improvement by facilitating knowledge management processes too. Obviously, the findings of this study indicate that in order to effectively enhance the processes of knowledge management, TQM practices must be taken as one set of practices that can complement each other starting from top management commitment to the detailed processes to report the necessary data among the divisions. Moreover, the decision makers should enhance applying TQM practices at the strategic level of the manufacturing company, which means giving more attention to soft practices of TQM rather than hard practices. To do so, the managers should emphasize the role of HRM and all behavioral aspects to improve the employees' skills, management leadership, teamwork, organizational culture, supplier relationship and management, and create value to the customers. Such practices by management will ensure the flow and update of the cutting-edge of knowledge throughout the organization. Moreover, it is highly recommended that managers allocate some extra efforts and financial supports to enhance PEM and QDR practices to reinforce and establish effective knowledge management processes. Therefore, further studies are needed to clarify the best way and strategies in this regard.

On the other hand, based on these logical and reasonable findings, managers should focus on establishing the system through which the gained knowledge can be accessed and applied by the different departments in order to enhance the innovation performance. Although the attained results did not detect a direct relationship between KAC and innovation performance, this result should not lead us to ignore the important role of gaining knowledge. The processes of acquiring knowledge is one of the necessary antecedents of enhancing innovation performance. Accordingly, the attention should be paid to build and improve the organizations' capabilities to acquire knowledge and update it.

Conclusion

Innovation performance seems to be one of the critical indicators of success of the organizations through which companies can ensure their sustainability in the market. In this regards, gaining and managing knowledge have been recognized as one of the essential requirements to reinforce innovation performance. Therefore, the main purpose of this study is to empirically investigate the effect of applying TQM practices as a strategic option on knowledge management processes, which, in turn, leads to desired innovation performance. The findings of this study emphasize two main issues. The first issue is the influence of TQM practices on knowledge management processes. More specifically, the outcomes of this paper suggest that soft practices of TQM are more

essential to knowledge management processes. However, this result does not mean that hard practices of TQM are not necessary. TQM practices should be applied as one set of practices (i.e. soft and hard practices) with an emphasis on soft practices. Second, the direct impact of knowledge management processes on innovation performance has been proved. Furthermore, the ability of the organization to gain the knowledge and use it has been determined as the main determinant of innovation performance. Accordingly, our findings recommend that TQM as one set of practices plays an indirect role to enhance innovation performance through providing the necessary antecedences (i.e. knowledge). This obtained conclusion has significant consequences for decision makers in manufacturing companies.

Undoubtedly, this present research has some limitations that should be highlighted. First, this study has only examined the direct relationships among the investigated variables (i.e. the relationship between TQM practices and knowledge management processes, and on the other hand, the relationship between knowledge management processes and innovation performance). Therefore, it is recommended to extend this study by investigating the interaction relationships among all these variables. It is also suggested to examine the moderating or mediating role of other related variables (such as organizational capabilities) to provide more sight regarding this issue. It is also recommended to investigate the relationship between knowledge management processes and different aspects of innovation instead of testing innovation performance in general, which will help to extend our understanding regarding this relationship. Moreover, it is important to examine the mediating role of knowledge management in the relationship between TQM practices and innovation performance. Second, this study was limited to manufacturing companies in the Malaysian context. Thus, re-testing the model in different context will enhance the generalizability of the gained results in this study.

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