NEW RESEARCH

The relationship between TQM practices, quality performance, and innovation performance
An empirical examination

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Abstract This empirical study examines the relationship between total quality management (TQM) and innovation performance and compares the nature of this relationship against quality performance. The empirical data were obtained from a survey of 194 managers in Australian industry encompassing both manufacturing and non-manufacturing sectors. The structural equation modeling technique was used to examine the relationships between TQM and quality performance as well as innovation performance, simultaneously. The findings suggest that TQM significantly and positively relates to both product quality and product innovation performance although it appears that the magnitude of the relationship is greater against product quality. In addition, significant causal relationships between quality performance and innovation performance were found, suggesting that achievement of one aspect of performance could impact the other.

1. Introduction
The emergence of total quality management (TQM) has been one of the major developments in management practice. The recognition of TQM as a competitive advantage is widespread around the world, especially in Western countries, and today very few (especially manufacturing) companies can afford to ignore the term TQM (Dean and Bowen, 1994). Despite numerous stories about TQM failures, previous empirical studies on the relationship between TQM and organizational performance, and in particular, quality, have indicated strong and positive results (Ahire et al., 1996; Flynn et al., 1994; Samson and Terziovski, 1999). On the other hand, innovation has also received considerable attention as having a crucial role in securing sustainable competitive advantage in the current market (Tushman and Nadler, 1986).
Given these two facts, there is a need to re-assess the role of TQM in determining innovation performance. Several rationales behind this need are as follows. First, as argued by several scholars (Bolwijn and Kumpe, 1990; Hamel and Prahalad, 1994; Tidd et al., 1997), market conditions have changed, and so has the basis of competition with quality being considered more as a “qualifying criterion” – a term suggested by Hill (1985) – and has been replaced by other aspects such as flexibility, responsiveness, and particularly innovation, which function as “winning order criteria”. As a result, TQM as the primary resource behind quality has also received a similar challenge in the sense that organizations would ask: should we continue to implement TQM as a management model in the future, particularly if we want to pursue a higher level of innovation performance? Second, the need to address this inquiry is further substantiated by the fact that there are conflicting theoretical arguments appearing in the literature with regard to the relationship between TQM and innovation with one group of arguments affirming that TQM is not compatible with innovation because managing innovation is fundamentally different from managing quality, as asserted below (Maguire and Hagen, 1999, p. 30):

For quality practitioners, this explosion of innovation activity represents significant challenges. While they can expect to see increased demand for some of their specialized knowledge and skills, they must be prepared to master new tools and techniques while also giving serious consideration to how quality may be redefined in this environment of rapid change and rising customer expectations.

The extension of this claim is that organizations may need to choose between quality and innovation as they could not be successful with both. Finally, despite the fact that a number of studies have been conducted on TQM, only very few of these (Flynn, 1994; Gustafson and Hundt, 1995; McAdam et al., 1998) have been focused on testing the relationship between TQM and innovation performance. This provides further opportunities for examining this relationship.

Given the above reasons, this paper presents an empirical study with the following objectives: to examine the nature of the relationship between TQM and innovation performance; to compare the strength of this relationship with that between TQM and quality performance; and to examine the relationship between quality and innovation performance.

The remainder of this paper is structured as follows. Section 2 discusses the theoretical arguments concerning the relationship between TQM and innovation. Both positive and negative arguments in this respect are presented. Section 3 presents the research framework and research questions. Section 4 describes the empirical research design and the development of the research instrument. Section 5 presents the quantitative analysis, followed by Section 6 which presents the discussion of the findings. Section 7 concludes this paper with several major conclusions drawn from the research.
2. Literature review on the relationship between TQM and innovation

A review of the literature discussing the relationship between TQM and innovation suggests that there are conflicting arguments concerning the relationship between TQM and innovation (Prajogo and Sohal, 2001). Arguments that support a positive relationship between TQM and innovation contend that companies embracing TQM in their system and culture will provide a fertile environment for innovation because TQM embodies principles that are congruent with innovation (Dean and Evans, 1994; Kanji, 1996; Mahesh, 1993; Roffe, 1999; Tang, 1998). The principle of customer focus encourages organizations to consistently search for new customer needs and expectations, and therefore, leads organizations to be innovative in terms of developing and introducing new products as a continual adaptation to the market’s changing needs (Juran, 1988). Likewise, continuous improvement encourages change and creative thinking in how work is being organized and conducted. Finally, the principles of empowerment, involvement, and teamwork are also substantial in determining the success of organizational innovation.

In contrast to the above arguments, several scholars reject the positive relationship between TQM and innovation for the reason that it possesses principles and practices that could hinder innovation. Slater and Narver (1998) and Wind and Mahajan (1997) agree that a customer focus philosophy could easily lead organizations to focus only on incremental improvements in their current products and service activities rather than trying to create novel solutions. Consequently, this leads to the development of uncompetitive “me-too” products rather than the development of real innovation. Customer focus, therefore, could build a “tyranny of the served market” in which managers see the world only through their current customers’ eyes. In this way, such firms could fail to explore customers’ latent needs. As a result, they fail to drive generative learning through the search for the unserved, untapped potential in markets. Similarly, continuous improvement requires regulatory standards and activities that are sufficiently routine to be well understood. Hence, control and stability is the core of the continuous improvement process (Imai, 1986; Jha et al., 1996). Whilst standardization is necessary for conformance and error reduction, from the innovation point of view, it could trap people into staying with what is workable; resulting in rigidity (Glynn, 1996; Kanter, 1983). In addition, Lawler (1994) and Samaha (1996) suggest that the concept of continuous improvement is basically aimed at simplifying or streamlining a process and carrying it out in a better or faster manner. Such an approach could be detrimental to innovation because companies may continually work upon, and improve, processes that are already fundamentally flawed.

The contest of these opposing arguments can also be extended to address the relationship between quality performance and innovation performance;
whether they are positively associated with each other or not. The implication is that one can question whether organizations can excel in both types of performance, or they have to prioritize one over the other. Flynn (1994) notes that the conventional wisdom suggests that fast product innovation and quality cannot be simultaneously achieved. Williams (1992) argues that organizations that focus their strategy on making frequent and fast innovations would not have time to learn about the processes in order to statistically control them to achieve a high level of conformance.

While it is difficult to accept that a company can be successful with innovation if it cannot produce products that meet acceptable quality standards, it is argued here that in certain situations, companies have to prioritize quality over innovation or vice versa. This is particularly true when industry and market conditions are taken into consideration (Nowak, 1997).

3. Research framework and questions
Based on the above literature review, a research framework is developed to simultaneously examine the relationship between TQM practices and quality performance as well as innovation performance. The framework is presented in Figure 1.

The primary research questions of this study can be articulated as follows:

*RQ1*. Do TQM practices – that have been successfully proven as significantly and positively related to quality performance – have a similar predictive power against innovation performance?

*RQ2*. Is there any significant relationship between quality performance and innovation performance? If yes, what is the nature of this relationship?

4. Research instrument
In designing a survey instrument, the use of constructs has played an important role in management research. Constructs or scales are defined as latent variables that cannot be measured directly (Ahire *et al.*, 1996). In any

![Research Framework](image-url)
research concerning behavioral elements, there is no device that can precisely produce measurement through a single metric unit. Therefore, researchers usually employ two or more measures to gauge a construct or scale. Working with constructs or scales of measurement, however, is a complex task, moving from development to final validation. Following a suggestion made by Tata et al. (1999), this study attempted, wherever possible, to use pre-tested constructs from previous empirical studies to ensure their validity and reliability.

The instrument developed in this study consists of two major parts. The first part comprises six constructs measuring TQM practices and the second part comprises three constructs measuring three different types of performance: quality, product innovation, and process innovation performances (details can be found in the Data Reduction Process section). The instrument used is a five-point Likert scale, representing a range of attitudes from strongly disagree to strongly agree.

4.1 TQM measures
A review of the previous empirical studies on TQM suggests that researchers have defined TQM construct in numerous ways although they are complementary to each other. In this study, we decided to use one of these models as a skeleton or framework for the TQM construct and supplemented by several other models. The framework used by Samson and Terziovski (1999) was selected as representing the core of TQM construct in this study for the reason that it has been used in the largest study of Australian companies conducted so far. Moreover, Samson and Terziovski argue that their model constitutes the criteria of the Malcolm Baldrige National Quality Award (MBNQA) that is accepted as representing TQM practices by several scholars such as Ahire et al. (1995), Dean and Bowen (1994), Evans and Lindsay (1999), and Juran (1995). The MBNQA consists of six criteria of organizational practices and one criterion of organizational performance. The TQM practices embodied in these six criteria are leadership, strategy and planning, customer focus, information and analysis, people management, and process management. Most of the contents of our instrument for measuring TQM practices are similar to those used by Samson and Terziovski (1999), except in the case of the criteria of information and analysis. Their scale only addressed benchmarking issues, whilst the criteria set out on the MBNQA guideline covers wider issues than benchmarking. Based on the three elements of the information and analysis criteria (Brown, 1997), three items were added into this scale in addition to one item addressing benchmarking, namely the company’s strategy in measuring performance, the availability of data and information about performance, and the use of information in decision-making processes conducted by senior management.
4.2 Quality performance measures

Similar to TQM, quality performance has been reflected and measured in various ways in past empirical studies on TQM (Ahire et al., 1996; Dow et al., 1999; Flynn et al., 1994; Saraph et al., 1989). However, most of the typical dependent variables used in these studies are associated with a model focused on quality by conformance, such as the percentage of defects and the cost of quality. Among this variation, the construct for measuring quality performance developed by Ahire et al. (1996) was the one that most closely matched to our purpose. This construct showed good validity and reliability and it defined quality performance as composed of four indicators: reliability, performance, durability, and conformance to specification.

4.3 Innovation performance measures

A review of past research on organizational innovation also indicates that there has been variations in measuring innovation performance in organizations. For the purpose of comprehensively capturing the aspects of innovation performance, this study built the construct for measuring product and process innovation on the basis of several criteria which are conceptualized and used in previous empirical studies of innovation, such as Avlonitis et al. (1994), Karagozoglu and Brown (1998), Cohn (1980), Deshpande et al. (1993), Hollenstein (1996), Kleinschmidt and Cooper (1991), Miller and Friesen (1982), and Subramanian and Nilakanta (1996). These criteria are the number of innovations, speed of innovation, level of innovativeness (novelty or newness of the technological aspect), and being the “first” in the market. By including the last two criteria, the scope of the innovation performance measures captured areas that could be considered as “radical” innovation. These four characteristics of innovation were applied in two major areas of innovation, namely product and process innovations. The distinction between these two areas of innovation has been articulated in the literature on innovation (Gobeli and Brown, 1994; Yamin et al., 1997). The scales to gauge both product and process innovation performance are summarized in Table I.

<table>
<thead>
<tr>
<th>Product innovation</th>
<th>Process innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The level of newness (novelty) of new products</td>
<td>The technological competitiveness</td>
</tr>
<tr>
<td>The use of latest technological innovations in</td>
<td>The updated-ness or novelty of technology used in processes</td>
</tr>
<tr>
<td>new product development</td>
<td>The speed of adoption of the latest technological innovations in processes</td>
</tr>
<tr>
<td>The speed of new product development</td>
<td>The rate of change in processes, techniques and technology</td>
</tr>
<tr>
<td>The number of new products introduced to the</td>
<td></td>
</tr>
<tr>
<td>market</td>
<td></td>
</tr>
<tr>
<td>The number of new products that is</td>
<td></td>
</tr>
<tr>
<td>first-to-market (early market entrants)</td>
<td></td>
</tr>
</tbody>
</table>

Table I.
The scales to measure product innovation and process innovation performance
Regarding the measurement approach, perceptual data were used in which respondents were asked to evaluate the company’s innovation performance against the major competitor in the industry in order to minimize industry effects. The advantages of this approach were discussed in detail by Kraft (1990).

4.4 Source of empirical data
Empirical data were obtained through a random survey of 1,000 managers, most of whom were senior managers who had knowledge of past and present organizational practices relating to continuous improvement and innovation in the organization. The sample was selected randomly Australian-wide and encompassed various industry sectors, including both manufacturing and non-manufacturing sectors. The focus of this study was limited to one site (or plant) per organization. A total of 194 managers responded, whilst 150 questionnaires were returned to the researchers with return to sender (RTS) messages, indicating that the addresses were no longer valid. By discounting the number of RTS mails, the final response rate accounted for 22.8 percent. The proportion of the respondents was nearly equal between manufacturing and non-manufacturing sectors (52.5 and 47.5 percent, respectively). Regarding the position of the respondent in the organization, half of the respondents were quality managers and/or production/operations managers, one-third of them were senior managers (general manager or managing director), and the rest were managers from other areas, such as marketing, finance, human resource, and administration. Out of 194 companies, 190 companies which responded to the survey were certified ISO 9000.

5. Data analysis
Data analysis for this study involved two major steps: the data reduction process and the structural relationship analysis. The data reduction process aimed to reduce the number of variables and parameters in the research model to a manageable number in terms of the ratio between sample size and parameters estimated in the structural equation modeling (SEM). The structural relationship analysis was used to examine the simultaneous relationship between TQM and product quality performance, product innovation performance, and process innovation performance, as well as assessing the relationships among those three performance variables.

5.1 Data reduction process
The data reduction process was conducted in order to collapse the nine constructs – each consisting of four to six items – employed in this study into composite variables. Six constructs (leadership, strategic planning, customer focus, information and analysis, people management, and process management) constituted TQM latent variables, and three constructs (product quality, product innovation, and process innovation) constituted
three organizational performance measures. These nine constructs were subjected to validity and reliability tests before a single score can be calculated to represent each construct. Confirmatory factor analysis (CFA) using LISREL 8.30 was employed for examining construct validity of each scale by assessing how well the individual item measured the scale. During this process, only one item in customer focus scale was deleted due to poor loading on its latent variable. The goodness of fit indices (GFI) of the nine constructs exceeded the 0.9 criterion suggested by Kelloway (1998), hence, establishing the construct validity. The reliability analysis was conducted by calculating the Cronbach’s alpha for each scale. The result shows that the Cronbach’s alpha measure for the nine constructs exceed the threshold point of 0.7 suggested by Nunnally (1967), and this is very encouraging given that the product innovation and process innovation constructs are still in the exploratory stage. The final results of construct validity and reliability tests of the nine constructs are reported in Table II.

Having met the requirement of construct validity and reliability, the composite measure of each construct can be measured by calculating their mean values (Hair et al., 1998). The results are presented in Table II.

### 5.2 Structural relationship analysis

#### 5.2.1 The relationship between TQM and organization performance

SEM using LISREL 8.30 was employed for examining the relationship between a set of TQM practices and three types of organizational performance (i.e. product quality, product innovation and process innovation) simultaneously, as shown in Figure 2. In this model, TQM is represented as a single latent construct composed of six variables, regressed against three latent constructs of organization performance, each measured by a single variable.

The path coefficient between TQM and each of the five variables \( \lambda_{x2,1}, \lambda_{x3,1}, \lambda_{x4,1}, \lambda_{x5,1}, \) and \( \lambda_{x6,1} \) and the respective error variances were estimated, except that between TQM and leadership variable \( \lambda_{x1,1} \) that was fixed to 1. On the other hand, none of the paths of the endogenous variables (i.e. organizational

<table>
<thead>
<tr>
<th>Construct</th>
<th>No. of items (final)</th>
<th>Goodness of fit index</th>
<th>Means</th>
<th>Standard deviation</th>
<th>Cronbach's alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>4</td>
<td>0.980</td>
<td>3.756</td>
<td>0.825</td>
<td>0.8580</td>
</tr>
<tr>
<td>Strategic planning</td>
<td>4</td>
<td>0.998</td>
<td>3.567</td>
<td>0.901</td>
<td>0.8242</td>
</tr>
<tr>
<td>Customer focus</td>
<td>5</td>
<td>0.976</td>
<td>3.918</td>
<td>0.684</td>
<td>0.7853</td>
</tr>
<tr>
<td>Information and analysis</td>
<td>4</td>
<td>0.991</td>
<td>3.543</td>
<td>0.878</td>
<td>0.7992</td>
</tr>
<tr>
<td>People management</td>
<td>5</td>
<td>0.974</td>
<td>3.431</td>
<td>0.802</td>
<td>0.8303</td>
</tr>
<tr>
<td>Process management</td>
<td>6</td>
<td>0.978</td>
<td>3.601</td>
<td>0.707</td>
<td>0.7922</td>
</tr>
<tr>
<td>Product quality</td>
<td>4</td>
<td>0.983</td>
<td>4.197</td>
<td>0.547</td>
<td>0.8839</td>
</tr>
<tr>
<td>Product innovation</td>
<td>5</td>
<td>0.970</td>
<td>3.377</td>
<td>0.697</td>
<td>0.8684</td>
</tr>
<tr>
<td>Process innovation</td>
<td>4</td>
<td>0.953</td>
<td>3.533</td>
<td>0.676</td>
<td>0.8909</td>
</tr>
</tbody>
</table>

Table II. Construct validity and reliability and the values for composite measures
performance) were estimated since each of the organizational performance constructs was explained by a single observed variable. As such, the path coefficients between observed and latent variables in organization performance ($\lambda_{y_{1,1}}$, $\lambda_{y_{2,2}}$, and $\lambda_{y_{3,3}}$) were set at a fixed value using the square root of the construct reliability (presented in Table II), and their error variances were calculated using the formula: error variance = (1 - construct reliability) × the variance of the variable (Germain and Spears, 1999, p. 380). In addition, three error correlations (\(\psi\)) were also estimated: between product quality and product innovation, between product quality and process innovation, and between product innovation and process innovation constructs in order to examine the causal relationship among these three performance measures.

Table III presents a summary of the standardized values of estimation as well as GFI. The three GFI justify the robustness of the overall model with the GFI well exceeding 0.9, and both RSMEA and SRMR are well below 0.05. The path coefficients between the six variables and the TQM latent variable are all highly significant as well as being reasonably high, thus validating the measurement model of TQM practices. This indicates that TQM is normally implemented as a set of practices instead of loosely, as concluded in previous studies (Ahire et al., 1996; Grandzol and Gershon, 1998; Samson and Terziovski, 1999).

The most important result in this model is the significant relationship between TQM and the three performance constructs (all \(t\)-values > 2.581), suggesting that TQM significantly and positively relates to quality performance as well as innovation performance. This provides a criterion validity on the relationship between TQM and the three organization performance measures as well as supporting the positive arguments on the relationship between TQM and innovation performance as discussed in the literature. It is important to note, however, that the results also indicate that the strengths of the relationship between TQM and quality performance and those between TQM and innovation performance are different. The path coefficient between TQM and product quality ($\gamma_{11} = 0.572$) has the highest value, followed by that between

![Figure 2. LISREL model of the relationship between TQM practices and organizational performance](image-url)
TQM and process innovation ($\gamma_{31} = 0.466$), and finally between TQM and product innovation ($\gamma_{21} = 0.449$), suggesting that TQM has a higher explanatory power on quality performance than on innovation performance.

5.2.2 The relationship between quality and innovation performance. Regarding the relationship between quality performance and innovation performance, it is necessary to verify whether the causal relationship among these organizational performance measures was a genuine connection, or whether it was spurious due to the influence of TQM as their common antecedent. This test was conducted using partial correlation among the three types of performance when TQM was controlled (Bagozzi, 1980). The results, as presented in Table IV, yield significant values at 0.05 level or better,
suggesting that the causal relationships among the organizational performance measures are genuine. However, the result also indicates that the correlation between product quality and product innovation is weaker than the other two correlations.

The strengths of the three causal relationships among the three performance variables are examined by observing the value of error correlations (ψ) identified in the result of SEM. The result in Table III shows that the three correlations are significant at 0.05 or better, indicating that the variance in each of the performance variables is explained by the other type of performance, in addition to what is contributed by their common antecedent (i.e. TQM). The results also indicate that the causal relationship between product quality and product innovation (t-value = 1.965 and ψ_{12} = 0.130) is weaker compared to the other two relationships between product quality and process innovation (t-value = 5.573 and ψ_{13} = 0.394) and between product innovation and process innovation (t-value = 5.608 and ψ_{23} = 0.425), and therefore confirms the previous finding of the partial correlation.

These findings of significant causal relationships among the three performance variables not only negate the theoretical proposition suggesting a negative relationship between quality and innovation performance, but also indicates cross-fertilization between quality and innovation performance, particularly that involves process innovation. This means that achievement in quality performance impacts on innovation performance, and vice versa. Whilst the strong and positive association between product and process innovation confirms the findings of the study by Kraft (1990). The overall result in this section indicates that process innovation is strongly related to both product quality and product innovation performance and therefore it could be inferred that process innovation mediates the relationship between the other two performance variables.

6. Discussion

Overall, the results of the SEM indicate that TQM significantly and positively relates to quality performance as well as innovation performance, hence supporting the positive argument for the relationship between TQM and innovation performance outlined in the literature review section. This result also confirms the findings of several previous studies in this area, such as Baldwin and Johnson (1996), Flynn (1994), Gustafson and Hundt (1995), and McAdam et al. (1998). The SEM result, however also indicates that the explanatory power of TQM is higher toward quality performance than innovation performance. This is plausible as TQM was originally intended by its advocates (e.g. Deming, Juran, Crosby, and Ishikawa) for achieving quality performance (in terms of conformance) rather than innovation (novelty or newness), as asserted by Wilkinson et al. (1998, p. 8):

In terms of TQM, however, it is essential to appreciate that the quality gurus’ conception of quality is meeting reliable and consistent standards in line with customer requirements.
Although Bounds et al. (1994) argue that TQM has evolved from being focused on quality control to capturing more comprehensive and wider organizational aspects, it seems that its principal course remains on quality control and assurance. Focusing on quality by conformance means that organizations need to emphasize the use of certain techniques (e.g. SPC) and standards to reduce or eliminate variation, something that cannot be applied in innovation with a similar fashion (Kanter, 1983; Morgan, 1993). Therefore, while the results have demonstrated that TQM has a positive and significant relationship with innovation performance, it also implies that TQM in its own right is less effective for organizations to maximize their innovation performance.

From the innovation point of view, the positive result on the relationship between TQM and innovation also provides an important confirmation. Under the context of innovation studies, TQM is considered as one form of innovation (Cooper, 1998; Westphal et al., 1997; Yamin et al., 1997), and innovation scholars have expressed their interest in examining the impact of adoption and implementation of particular innovation. This is because they suggest that a successful adoption of innovation in terms of implementation of a set of practices will result in a wide range of consequences, the intended or anticipated ones as well as the unintended ones (Tornazky and Flischer, 1990). Given the fact that TQM was initially intended more for achieving quality (by conformance) performance, innovation performance can be considered as the intended result or a secondary effect resulting from the adoption of TQM.

The positive result on the relationship between TQM and innovation performance is augmented by the finding responding to the RQ2 that shows a causal relationship between quality performance and innovation performance. This suggests that the variance in both product innovation and process innovation performance is also explained by product quality performance on top of what is contributed by their common antecedent, TQM. This result therefore rejects the proposition suggesting that organizations need to choose between quality and innovation, and even focusing on one at the expense of the other; instead, it implies that organizations that excel in quality are likely to also excel in innovation, as Nowak (1997, p. 132) suggests:

Division of quality and innovation is, to some substantial extent, largely theoretical, not practical. In practice, because of self-reinforcing and dual-direction character of the impact quality management and innovation have on one another, firms seek quality through innovation or innovate through quality improvement.

Finally, we attempt to build a link between the two parts of this study by analyzing the difference in the degree of relationships between TQM and organizational performance as well as the associations among the three types of organizational performance. As identified by the results, TQM has a strongest relationship with product quality, followed by process innovation, and finally product innovation. At the same time, product quality demonstrates a stronger association with process innovation rather than with product innovation.
Particularly, the weakest relationship between TQM and product innovation is consistent with the weakest association between product quality and product innovation. Therefore, it can be concluded that product is the area where TQM provides least support for innovation. In their literature review, Prajogo and Sohal (2001) note that the major difference between TQM and innovation in terms of behavioral traits, ways of thinking, approaches, and principles is concerned with the area of product innovation with TQM being more market-pull whilst innovation is more product-push. More specifically, it can be argued that the more radical the product innovation, the less the contribution which can be expected from TQM. As mentioned in the earlier section, the scope of product innovation in our study captures several characteristics of radical innovation, for example, the early entrant market that reflects the first-mover strategy. Such strategy cannot fit to the philosophy of TQM, particularly customer focus, as well as the principle of quality by conformance.

On the other hand, the link between TQM, product quality, and process innovation indicates a better coherence. This suggests that a strategy focusing on improving processes to enhance the performance of product quality (i.e. conformance to specification) could lead companies to the adoption and implementation of process innovation, even the radical ones, in terms of new technology in the purpose of enhancing process capability. Although emphasizing the importance of incremental improvement on processes, Imai (1986) suggests the combination between incremental and breakthrough improvement. Similarly, Jha et al. (1996) also suggest that continuous improvement provides a solid foundation on which radical innovations can be successfully implemented. Smed (1997) even argues that the accumulation of systematic and incremental steps of innovations would eventually result in radical innovations. From an innovation point of view, in order to yield a significant benefit, the implementation of an innovation must consider the fit of the innovation to the organizational values and objectives (Klein and Sorra, 1996). In this context, we argue that quality can serve such a fit to ensure that process innovation, for example, the adoption of new technology, is implemented within a clear context of organizational strategic objectives.

The combination of these results supports the proposition suggested by Gobeli and Brown (1994) that from an innovation point of view TQM principles fits into the category of value-leader which places high emphasis on process innovation and low emphasis on product innovation. This notion is also plausible when viewed from a value-chain perspective, particularly between upstream (design and development) and downstream (production) processes. As mentioned earlier, TQM is closely related to process control as its origin was rooted in the principle of statistical process control (SPC) which is mostly applied at production process although this does not necessarily imply that TQM ignores upstream processes. At the same time, process innovation is also closely related to downstream processes with the aim being to enhance its
effectiveness and efficiency. On the other hand, product innovation is more related to design and development processes where ideas and creativity are accumulated. However, given that the result has indicated that process innovation is strongly related to both product quality and product innovation, this closely binds the overall link between TQM, quality and innovation, and therefore reinforces the positive relationship between TQM and innovation.

7. Conclusion
In response to RQ1, the findings provide empirical evidence that TQM significantly and positively contributes to innovation performance, in terms of both product and process. Its contribution to innovation performance, however, seems to be inferior to that of quality performance. Therefore, while the result rejected the arguments suggesting that TQM could hinder innovation performance, care needs to be taken before claiming that TQM in its own right is sufficient for achieving high innovation performance. In response to RQ2, the findings indicate a positive and significant relationship between quality performance and innovation performance, particularly process innovation. This suggests that the achievement of quality performance as a result of the implementation of TQM practices does, to certain degree, lead to realization of innovation performance. Given that TQM was originally intended for realizing quality performance, innovation performance could then be considered as the “unintended” result of the implementation of TQM practices, thus providing further support to the positive notion of the relationship between TQM and innovation performance. Combining the two sections of the above analysis provides a plausible evidence and explanation on the positive and significant relationship between TQM practices and innovation performance because not only TQM itself would lead to innovation performance, but the quality performance resulting from TQM practices also contributes to innovation performance.

Even for those who are still skeptical as to whether TQM could directly lead to innovation performance, the result of this study strongly suggests that TQM, at least, establishes a “precondition” for innovation in order to achieve a real competitive advantage. This means that although quality management does not directly result in innovation, organizations that want to pursue a high innovation performance must have the capability to manage quality requirements of their products before hand, as asserted by Bolwijn and Kumpe (1990) and Ferdows and DeMeyer (1990). In other words, quality management is a prerequisite for innovation management, and, therefore, TQM is necessary although not sufficient for innovation. As such, we strongly argue that organizations should not decline TQM even though in their industry quality is no longer considered as a winning order criterion.

The overall implication is that TQM certainly provides a sound systemic foundation for managing quality on which organizations can further build their
competence and capabilities as well as other strategies to achieve multidimensional competitive advantage, including innovation. From a practical point of view, organizations that want to pursue innovation performance are recommended to adopt TQM and co-align it with other practices and techniques relating to research and development (R&D) and technology management. Future studies in this area therefore should be focused on investigating the compatibility of TQM with those practices in determining innovation performance.

References
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