

Research framework for the impact of total quality management on competitive advantage

Impact of total
quality
management

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The mediating role of innovation performance

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Abstract

Purpose – The purpose of this paper is to apply a more accurate competitive advantage construct to study the impact of total quality management on firms' competitive advantage in the context of the weakening of the competitive advantage of firms that are renowned for the excellent quality management. It also aims to find a better explanation for the source of competitive advantage through mediating constructs.

Design/methodology/approach – The authors use iterative methodology by reviewing, analyzing, synthesizing and refining the current state of the literature and propose a research framework which allows for overcoming the limitation encountered in previous empirical research.

Findings – The use of two second-order constructs including the incremental innovation performance and radical innovation performance which enable the researchers to have a better explanation about the mediating role of innovation performance.

Practical implications – This study is seeking to contribute to the practice of total quality management area of research. Specifically, this study applies two second-order measurement scales of innovation in use, actualize the use of the new measurement scale of competitive advantage and explain clearly the role of total quality management on competitive advantage in the current context.

Originality/value – This is one of the few papers investigating the impact of total quality management on competitive advantage, developing the conceptual model that examines the mediating role of innovation performance.

Keywords Competitive advantage, Total quality management, Radical innovation, Incremental innovation

Paper type Research paper

1. Introduction

The weakening of many Japanese firms that are well-known worldwide because of their excellent quality management, along with the strong rise of Korean and Chinese firms that tend to innovate rapidly, is currently shaking the confidence in the philosophy of total quality management (TQM). The success of global companies such as BMW, LG Electronics, Nintendo, Nokia, Samsung, Tata and Toyota has often been attributed to their innovative product offerings and systematized approach to use R&D for product development (Colvin, 2009). Innovation is an important source of competitive advantage in the knowledge economy era (Daghfous, 2004; Prajogo and Ahmed, 2006). Numerous companies which have benefited from innovation increased their profits and market share, but the important point is that, a firm cannot be successful with innovation if it cannot produce products that meet acceptable quality standards (Nowak, 1997).



A review of the literature shows that positive effects of TQM on competitive advantage were supported by many scholars and experimental studies. However, few definitions in the literature define competitive advantage in a rather fuzzy manner (South, 1981), while that other statements define competitive advantage implicitly (Sigalas and Economou, 2013). Moreover, previous studies have not distinguished concepts of competitive advantage and performance. As a consequence, the scale of competitive advantage in these studies has not accurately reflected competitive advantage.

Moreover, most previous studies have not clearly separated incremental innovation performance and radical innovation performance, in which, incremental innovation performance is said to be the strength of TQM and radical innovation performance is just a consequence of TQM. Therefore, such studies have not really clarified the role of TQM on innovation performance. Only the study by Kim *et al.* (2012) has separated incremental innovation performance and radical innovation performance. However, the innovation performance in this study has been subdivided into five dimensions. This subdivision can result in the weaker reflection of innovation performance on each dimension. As a result, the conclusion of tests on the impact of TQM on competitive advantage could diminish its strength.

On the other hand, many scholars have emphasized that the role of an innovation bridge between TQM and competitive advantage is becoming increasingly important. TQM is a good way of improving quality while facilitating the innovation process (Martínez-Costa and Martínez-Lorente (2008). TQM can be one of the prerequisites of innovation (Hoang *et al.*, 2006; Perdomo-Ortiz *et al.*, 2006). A recent study by Dervitsiotis (2011) pointed that the innovation process should be carried out under the TQM for the maximum beneficial impact on performance. This bridging role of innovation has not been shown in the previous experimental studies.

There are three research questions that are needed to answer in the above context: (1) Has TQM still maintained an active role of creating competitive advantage? (2) Has TQM positively contributed to a type of today's important performance – innovation performance? And (3) How do the various types of innovation performance play as the mediating role in the causal relationships between quality management and competitive advantage?

Globalization and rapid development of technology have made competition increasingly fierce in the international business. Porter and Van der Linde (1995) argue that there is a new paradigm of international competitiveness, which is dynamic in nature and based on innovation. The resulting competitive advantage of companies that have succeed in business rests on the capacity for innovation and improvement. Therefore, this paper helps companies, especially companies in the field of international business, effectively apply TQM to enhance their competitive advantage and achieve success in their business.

2. Theoretical background and hypotheses

2.1 Theoretical background

According to Kaynak (2003), TQM can be defined as a holistic management philosophy that strives for continuous improvement in all functions of an organization, and it can be achieved only if the total quality concept is utilized from the acquisition of resources to customer services after the sale. The perspective of considering TQM as a complete body, which affects the performance of a company, has been used by many scholars such as Prajogo and Sohal (2003, 2006), Martínez-Costa and Martínez-Lorente (2008), Prajogo and Hong (2008), Sadikoglu and Zehir (2010).

The previous literature on innovation has shown the importance of having a clear definition of innovation by distinguishing radical innovation and incremental innovation

(Abernathy and Clark, 1985; Cooper, 1998). Some scholars argue that there is a negative relationship between TQM and innovation performance, while most others insist that there is a positive relationship between them. Furthermore, the literature review also shows the different roles of TQM for incremental innovation and radical innovation. Most scholars believed that while TQM mainly affects incremental innovation performance, it has a little or indirect impact on radical innovation performance.

Crosby (1996), Demming (1986), Feigenbaum (1991), Ishikawa and Lu (1985) and Juran (1992) emphasized that customers define quality, and in turn, the quality itself creates customer satisfaction that leads to an improvement of competitive position. Scholars believed that innovation enables companies to quickly adapt changes and discover new products and markets, thereby protect them against the unstable business environment (Martínez-Costa and Martínez-Lorente, 2008). Successful innovation can make external imitation more difficult and allow firms maintain their competitive advantage effectively (García-Morales *et al.*, 2007).

Research concepts on behavioral science in general and on business in particular are often latent variables that cannot be measured directly (Ahire *et al.*, 1996). As a result, latent variables that were tested from previous experimental studies should be used to ensure their validity and reliability (Tata *et al.*, 1999).

2.2 Proposed research model

Based on the review of the literature, a research model is proposed as shown in Figure 1 that supports to answer three posed research questions. In this model, TQM is considered as a complete body of quality management that affects their innovation performance and competitive advantage of firms.

To have clear explanation about the different roles of incremental innovation performance and radical innovation performance, two second-order constructs of innovation performance were used, including incremental innovation performance and radical innovation performance. These two second-order constructs were developed based on the first-order constructs of innovation performance, derived from empirical research of Kim *et al.* (2012) to ensure their reliability and validity.

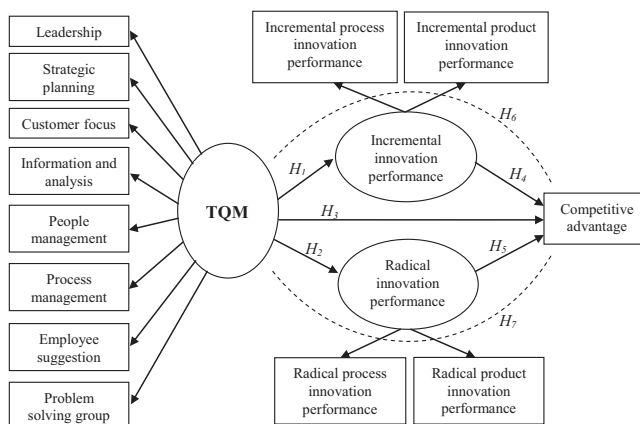


Figure 1.
Proposed research
model

2.3 Constructs in proposed research model

2.3.1 TQM: second-order construct. In this study, the measurement model for TQM used by Samson and Terziovski (1999) is accepted as the core model. The elements of this construct constitute the criteria of the Malcolm Baldrige National Quality Award (MBNQA) that has been accepted by many scholars such as Curkovic *et al.* (2000) and Juran (1995) as matching with the content of TQM practices. Second, the MBNQA criteria can be applied to firms both in the areas of manufacturing and non-manufacturing, and so it can be used in this study. Third, this TQM construct has been used in experimental studies of many scholars such as Prajogo and Sohal (2003, 2004, 2006) in Australia, Feng *et al.* (2006) in Australia and Singapore, Prajogo and Hong (2008) in Korea, so its reliability and validity have been tested. Finally, Vietnam – where this research framework will be experimented – has the quality award based on criteria that are similar to the MBNQA criteria. Observed variables for six elements (leadership, strategic planning, customer focus, information and analysis, people management and process management) are taken from Prajogo and Sohal (2006). This is the scale of Samson and Terziovski (1999) that was adjusted and tested by Prajogo and Sohal in 2003, 2004 and 2006 to ensure reliability.

Schroeder and Flynn (2002) have made comparisons about quality management practices among 164 firms at the USA, Japan, Germany, Italy and the UK in the 1990s and have found that Japanese manufacturers achieved an outstanding performance in quality management in comparison with other countries on a variety of activities such as process control, information feedback and small group activities. Therefore, to reflect its own characteristics of TQM, Japan, based on the study of Phan *et al.* (2011) on Japanese firms, two elements are added to TQM measurement models of Samson and Terziovski. They are employee suggestion element and problem-solving group element.

The employee suggestion element measures how a firm respects, responds to and uses the employee suggestions. Creativity and innovation are the necessary requirements to meet the needs and to exceed the expectations of customers. In Japan, “soikufu” is an important concept that means creative thinking, focusing on employees’ proposals and suggestions or new ideas. The measurement scale for employee suggestion element is taken from Phan *et al.* (2011). However, in this scale, the authors have used reversed items for the fifth observed variable. This can create fake factors that cannot be explained (Swain *et al.*, 2008; Woods, 2006). On the other hand, if the content of the fifth observed variable was changed into a normal variable, its content was repeated in the first observed variable, so the fifth observed variable was deleted in this research.

The problem-solving group element is demonstrated by the establishment of problem-solving groups, which are actively used to solve arising problems quickly and in place. The Japanese model seeks to complement the lean production system with coordinated human effort (Fuxman, 1999). The measurement scale for problem-solving group element is taken from Phan *et al.* (2011). However, in this scale, the authors have used reversed items for the fourth observed variable. This can create fake factors that cannot be explained (Swain *et al.*, 2008; Woods, 2006). As a result, the fourth observed variable was adjusted into a normal variable by replacing the phrase “not use” with the word “use”.

Therefore, TQM is a second-order construct, including eight first-order elements as shown in Figure 1. We operationalized a single composite TQM construct, followed in Hendricks and Singhal (1996), Easton and Jarrell (1998), Douglas and Judge (2001), Rungtusanatham (2001) and Sadikoglu and Zehir (2010). The TQM index, which equals the aggregate of the means of eight TQM elements, can be formulated as follows:

$$TQM = \sum_{i=1}^8 \frac{\sum_{j=1}^{m_i} item_{ij}}{m_i} \quad (1)$$

Where $item_{ij}$ is the j^{th} measurement item of the i^{th} element's measurement scale, and m_i is the number of measurement items in the i^{th} element's measurement scale.

2.3.2 Incremental innovation performance: second-order construct. Incremental innovation mentions minor changes of existing technologies in terms of design, function, price, quantity and features to meet the needs of existing customers (Garcia and Calantone, 2002; Propriis, 2002). Incremental innovation focuses on refining, expanding, improving and exploiting existing knowledge, skills and technical cycles (Gatignon *et al.*, 2002). Although incremental innovation requires a low level of risk, it generates little benefit (Koberg *et al.*, 2003). The incremental innovation is the second-order construct that includes incremental product innovation performance and incremental process innovation performance, as shown in Figure 1.

Incremental process innovation is identified as innovation associated with the application of minor or incrementally improved elements into an organization's production or service operations with the purpose of achieving lower costs and/or higher product quality (Ettlie, 1983; Gatignon *et al.*, 2002; Reichstein and Salter, 2006). Three observed variables of incremental process innovation performance are taken from Kim *et al.* (2012). This scale was selected from many empirical studies such as Huergo and Jaumandreu (2004), Reichstein and Salter (2006), Jansen *et al.* (2006), Martinez-Costa and Martinez-Lorente (2008) and Akgün *et al.* (2009); thus, its validity and reliability are ensured.

The incremental product innovation mentions the innovation, which involves the introduction of the products (or services) that offer new features, improvements or the benefits associated with the technology available on the existing market (Chandy and Tellis, 1998; Herrmann *et al.*, 2007; Valle and Vázquez-Bustelo, 2009). Five observed variables of incremental product innovation performance are taken from Kim *et al.* (2012). This scale was selected from many empirical studies such as Atuahene-Gima (2005), Subramaniam and Youndt (2005), Jansen *et al.* (2006), Herrmann *et al.* (2007) and Valle and Vázquez-Bustelo (2009); thus, its validity and reliability are ensured.

We operationalized a single composite incremental innovation performance construct (IIP). The IIP index, which equals the aggregate of the means of two incremental innovation elements, can be formulated as follows:

$$IIP = \sum_{i=1}^2 \frac{\sum_{j=1}^{m_i} item_{ij}}{m_i} \quad (2)$$

Where $item_{ij}$ is the j^{th} measurement item of the i^{th} element's measurement scale, and m_i is the number of measurement items in the i^{th} element's measurement scale.

2.3.3 Radical innovation performance: second-order construct. Radical innovation is defined as the adoption of new technologies to create a demand not yet recognized by customers and markets (Jansen *et al.*, 2006). Radical innovation, regarded as competence-destroying (Teece *et al.*, 1997), concentrates on market pull or technology push strategies (Li *et al.*, 2008). Radical innovation requires greater uncertainty and a high level of risk (Moguilnaia *et al.*, 2005). The radical innovation performance is the second-order

construct that includes radical product innovation performance and radical process innovation performance, as shown in Figure 1.

Radical process innovation involves the application of the new or significantly improved elements for production activities or services of an organization with the aim for achieving lower costs and/or higher-quality products (Ettlie, 1983; Gatignon *et al.*, 2002; Reichstein and Salter, 2006). Three observed variables of radical process innovation performance are taken from Kim *et al.* (2012). This scale was selected from many empirical studies such as Huergo and Jaumandreu (2004), Reichstein and Salter (2006), Martínez-Costa and Martínez-Lorente (2008), Valle and Vázquez-Bustelo (2009) and Lau *et al.* (2010); thus, its validity and reliability are ensured.

Radical product innovation is defined as innovation that involves the introduction of products or services that are associated with new technologies, which are different from existing ones used in existing products or services (Chandy and Tellis, 1998; Herrmann *et al.*, 2007; Valle and Vázquez-Bustelo, 2009). Five observed variables of radical product innovation performance are taken from Kim *et al.* (2012). This scale was selected from many empirical studies such as Chandy and Tellis (1998), Atuahene-Gima (2005), Subramaniam and Youndt (2005), Herrmann *et al.* (2007) and Valle and Vázquez-Bustelo (2009); thus, its validity and reliability are ensured.

We operationalized a single composite radical innovation performance construct (RIP). The RIP index, which equals the aggregate of the means of two incremental innovation elements, can be formulated as follows:

$$RIP = \sum_{i=1}^2 \frac{\sum_{j=1}^{m_i} item_{ij}}{m_i} \quad (3)$$

Where $item_{ij}$ is the j^{th} measurement item of the i^{th} element's measurement scale, and m_i is the number of measurement items in the i^{th} element's measurement scale.

2.3.4 Competitive advantage: first-order construct. In this research, the definition of competitive advantage from Newbert (2008) that was modified by Sigalas *et al.* (2013, p. 335) is selected: "Competitive advantage is the above industry average manifested exploitation of market opportunities and neutralization of competitive threats". This selection is based on several reasons. First, this competitive advantage definition meets the criterion that it does not contain any judgments about its own's value or company's performance (Sigalas and Economou, 2013). Second, this definition has been formulated in consultation with senior executives, who participate in the process of strategic management at firms, within a tight process of developing the measurement scale.

Four observed variables of competitive advantage are taken from Sigalas *et al.* (2013). The reason we choose this measurement scale for competitive advantage is that it was developed scientifically and rigorously to meet all the requirements of the construction process for a new scale. This scale also meets the requirement of distinguishing competitive advantages with superior performance that was admitted by the majority of scholars.

In essence, this is the competitiveness scale of Sigalas *et al.* (2013) that was based on a five-point Likert scale. However, the conversion from the competitiveness scale to the competitive advantage scale based on Sigalas *et al.* (2013) is really difficult to apply in practice. The reason is that data from experimental studies are often not sufficient to determine the industry average competitiveness. On the other hand, the competitive advantage scale of Sigalas *et al.* (2013) only takes two values (a firm either has competitive

advantage or not). This scale is essentially ordinal scale, unable to meet the measuring demands in scientific research – the interval scale or ratio scale.

Based on the argument that three points on the competitiveness scale of Sigalas *et al.* (2013) are equivalent to the industry average competitiveness, the competitiveness scale of Sigalas *et al.* (2013) can be used as the competitive advantage scale if the average competitiveness points of all or most of the surveyed firms are greater than or equal to three points. Points that are less than three in this scale can be considered to measure competitive disadvantage.

If the experimental sample does not meet this requirement, we can treat as follows: eliminate 50 per cent of firms having average competitiveness points less than three points, from lowest to highest, and test the hypothesis for the entire remaining experimental sample to ensure that the majority of firms in the sample have competitive advantages (reject the null hypothesis that average points are equal to or less than three).

2.4 Hypotheses

TQM proponents (i.e. Deming, Juran and Crosby) have not connected quality management with radical product innovation. They stressed on the importance of continuous improvement of product quality to meet the demands and expectations from customers. Some authors like Prajogo and Sohal (2001) and Weirauch (2006) have reported that the staffs of TQM firms have worked for gradually improving the existing system by focusing on the details of the existing quality process rather than new ideas changing an existing system. The customer focus leads the organization to incremental improvement in current products and services that can satisfy the current needs of the existing customers, rather than to breakthrough (radical) improvement that will satisfy the latent needs of current and future customers (Sadikoglu and Zehir, 2010). Nowak (1997) argued that TQM and quality seem to be attached to the existing technology because they mainly focus on the incremental improvement of the product or existing processes. Hung *et al.* (2011) argued that TQM is not simply a management tool for promoting and improving quality, but it can also promote a culture of sharing, trust, openness and innovation when supported by top management, employee involvement, continuous improvement and customer focus. This stimulates employees to enhance products, processes and organizational innovation performance. These lead us to the following hypothesis:

H1. TQM has a positive impact on incremental innovation performance.

On the other hand, continuous improvement (stressed by TQM) provides a solid background on which more radical innovation can be successfully implemented (Jha *et al.*, 1996). When pursuing the quality performance, organizations may need to deal with process innovation, even in a radical way (Prajogo and Sohal, 2006). This is because, in certain situations, the resources needed to meet a new quality standard (e.g. specification) cannot be achieved through incremental improvements of existing processes, even though how many resources are pumped into this effort. That can only be achieved through resetting these processes and innovating radically, more or less (Grossi, 1990). The experimental research of Hung *et al.* (2011) on 223 Taiwanese high-tech companies showed that TQM had a significant and positive effect on innovation performance. The innovation in high-tech companies is often rather rapid and the content of innovation performance in this study includes radical innovation performance. Thus, the following hypothesis is proposed:

H2. TQM has a positive impact on radical innovation performance.

TQM practices have significantly affected quality performance, especially with regard to customer satisfaction, company's image, employee quality awareness and employee

satisfaction. All TQM efforts will be geared toward the end result of increasing the organization's efficiency and effectiveness, thus increasing quality performance and enhancing the organizational competitiveness level (Abu-Doleh, 2012). After examining the relationship between TQM and firm performance in a sample of US firms, experimental results from the study of Powell (1995) indicated that TQM can create competitive advantage. Richard *et al.* (2000) argued that an effective product design will reduce costs by eliminating parts that do not add value, and so make the manufacture of product easier. The improvement of process effectiveness coming from experience curve effects and learning also reduces costs. Therefore, it can be concluded that TQM has the potential to create competitive advantage. The studies by Matsui (2002) and Phan *et al.* (2011) on the Japanese manufacturing enterprises showed that TQM had influence on competitive advantages in several ways. These theoretical and empirical bases lead to the following hypothesis:

H3. TQM has a positive impact on competitive advantage.

To achieve competitive advantage in a changing market, firms must improve both the quality and innovation (Feng *et al.*, 2006; Hung, 2007; Irani *et al.*, 2004). Normally, a specific innovation offers particular advantages that can support only strategies that benefit from those capabilities (Congden and Schroeder, 1996). Process innovation offers many competitive advantages. It can reduce costs, improve quality, shorten delivery times, reduce inventories, minimize plant and equipment investments, shift scale economies and allow greater flexibility (Lauenstein and Skinner, 1980). Tech-innovation is positively associated with economic and strategic export performance, suggesting that competitive advantage comes from technological advances (Silva *et al.*, 2017). The experimental research of Chen *et al.* (2009) on 106 manufacturing firms in Taiwan showed that innovation performance has a positive impact on competitive advantage. Experimental research of Aziz and Samad (2016) on 220 small and medium sized enterprises producing food in Malaysia showed that innovation has a positive impact on competitive advantage. These theoretical and empirical bases lead to the following hypotheses:

H4. Incremental innovation performance has a positive impact on competitive advantage.

H5. Radical innovation performance has a positive impact on competitive advantage.

In today's business environment, the basis of competitive advantage has shifted from quality to innovation (Prajogo and Brown, 2004). One of the core values and concepts that have emerged in recent versions of MBNQA is related to innovation management (Prajogo and Sohal, 2006). Therefore, to achieve competitive advantage in today's business context, firms that are implementing TQM would have to emphasize innovation activities, and they would use not only incremental innovation performance but also radical innovation performance as a basis to create competitive advantage for their firms. In other words, innovation performance is increasingly important and has become the mediator between TQM and competitive advantage. Therefore, the following hypotheses are proposed:

H6. Incremental innovation performance has the role of mediator between TQM and competitive advantage.

H7. Radical innovation performance has the role of mediator between TQM and competitive advantage.

3. Methodology

Based on an iterative methodology, the paper reviews, analyzes, synthesizes and refines the current state of the literature and proposes a research framework which allows for overcoming the limitations encountered in previous empirical researches and satisfactorily answering three research questions posed in the context of attenuate TQM.

To ensure the generalizability, the probability sampling method should be used to provide the data for the analysis of the proposed research model. The partial least squares path modeling (Hair *et al.*, 2014) method to structural equation modeling would be appropriate to test the measurement model and structural model based on the proposed research model. The Sobel test (Sobel, 1982) should be used to test the role of mediator of innovation performance between TQM and competitive advantage.

4. Discussion and conclusion

The importance of TQM has been confirmed by many scholars in previous studies. Although no longer being appreciated as before, the role of TQM for innovation and competitive advantage is still being emphasized. It is unable to maintain a competitive advantage if the product quality is not respected. The battery explosion incident of Galaxy Note 7 and the recent issue with Samsung washer causing injury to users are the realistic evidences to support this view. As a result, to achieve competitive advantage, firms that are implementing TQM would have to emphasize innovation activities, and they would use not only incremental innovation performance but also radical innovation performance as a basis to create competitive advantage for their firms.

The proposed research model allows researchers to test the impact of TQM as a complete body, including eight elements of quality management practices on two types of innovation performance and on competitive advantage. The proposed research model also allows researchers to test the mediating role of two types of innovation performance. The mediating role of incremental innovation performance will help to explain the importance of incremental innovation performance (stressed by TQM) toward competitive advantage. The mediating role of radical innovation performance will help to explain the impact of TQM or other agents (e.g. technology management/R&D) on competitive advantage through radical innovation performance. The competitive advantage construct from Sigalas *et al.* (2013) used in the proposed research model has met the requirements of distinguishing competitive advantages and superior performance. The problem that arises when converting the competitiveness scale of Sigalas *et al.* (2013) to the competitive advantage scale has been resolved satisfactorily. Two second-order constructs including incremental innovation performance and radical innovation performance enable researchers to have a better explanation about the mediating role of innovation performance. Therefore, the proposed research model will help researchers answer satisfactorily three mentioned research questions. The model is a good theoretical framework for empirical studies.

To survive in the business battlefield, product quality has become a critical factor in maintaining a competitive edge, to outperform competitors. This is especially true if manufacturers in developing countries would like to participate in the international market (Chan *et al.*, 2000). Galperin and Lituchy (1999) also suggested that, if firms whose cultures are more congruent with the TQM philosophy implement TQM, they will be more likely to improve the quality of their products and services, and therefore be competitive in the global marketplace.

Globalization and the rapid development of technology have made innovation become the key factor of international business success. Innovation is a source of competitive advantage in international markets, which is a crucial antecedent of firm export performance (Azar and

Ciabuschi, 2017; Pla-Barber and Alegre, 2007; Singh, 2009). Innovation is critical for creating competitive advantage in international markets, which allows firms to benefit from economies of scale (Fernández-Mesa and Alegre, 2015), as well as overcome the size constraint of domestic markets (Kyläheiko *et al.*, 2011). Therefore, empirical research results based on this research framework will be a reliable information source for firms, especially firms in the field of international business, applying effectively TQM to enhance their competitive advantage in today's context.

There are limitations to this study that should be noted. First, this study is just at the stage of building a framework of research. Hence, it is needed to have subsequent experimental studies to test the proposed research model in the context of today's global competition. Second, the proposed research model does not allow studying TQM under the perspective of partial TQM (including some of elements) that can have different impacts on competitive advantage. This research approach can help firms have the best way applying TQM according to its versions to enhance their competitive advantage. This is the next research direction in the efforts for improving TQM so that it can be consistent with the strategy for today's international competition.

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Construct	Variable descriptions	Reference sources
Leadership	Senior executives share similar beliefs about the future direction of this organization Senior managers actively encourage change and implement a culture of improvement, learning, and innovation toward “excellence” Employees have the opportunity to share in and are encouraged to help the organization implement changes There is a high degree of unity of purpose in our company, and we have eliminated barriers between individuals and/or departments	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)
Strategic planning	We have a mission statement which has been communicated throughout the company and is supported by our employees We have a comprehensive and structured planning process which regularly sets and reviews short- and long-term goals When we develop our plans, policies and objectives, we always incorporate the needs of all stakeholders, including the community We have a written statement of strategy covering all business operations which is articulated and agreed by our senior manager	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)
Customer focus	We actively and regularly seek customer inputs to identify their needs and expectations Customer needs and expectations are effectively disseminated and understood throughout the workforce We involve customers in our product design processes We always maintain a close relationship with our customers and provide them an easy channel for communicating with us We have an effective process for resolving customers' complaints We systematically and regularly measure customer satisfaction	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)
Information and analysis	Our company has an effective performance measurement system to track overall organizational performance Up-to-date data and information of company's performance is always readily available for those who need it Senior management regularly has a meeting to review company's performance and uses it as a basis for decision-making We are engaged in an active competitive benchmarking program to measure our performance against the “best practice” in the industry	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)

(continued)

Table AI.
Scale of measures

Construct	Variable descriptions	Reference sources
People management	We have an organization-wide training and development process, including career path planning, for all our employees Our company has maintained both “top-down” and “bottom-up” communication processes Employee satisfaction is formally and regularly measured Employee flexibility, multi-skilling and training are actively used to support performance improvement We always maintain a work environment that contributes to the health, safety and well-being of all employees	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)
Process management	The concept of the “internal customer” (i.e. the next process down the line) is well understood in our company We design processes in our plant to be “fool-proof” (preventive-oriented) We have clear, standardized and documented process instructions which are well understood by our employees We make an extensive use of statistical techniques (e.g. SPC) to improve the processes and to reduce variation We strive to establish long-term relationships with suppliers We use a supplier rating system to select our suppliers and monitor their performance	Adapted from Samson and Terziovski (1999) and Prajogo and Sohal (2006)
Employee suggestion	Management takes all product and process improvement suggestions seriously We are encouraged to make suggestions for improving performance at this plant Management tells us why our suggestions are implemented or not used Many useful suggestions are implemented at this plant	Adapted from Phan <i>et al.</i> (2011) and adjusted by the authors
Group problem-solving	Our plant forms teams to solve problems In the last three years, many problems have been solved through small group sessions Problem-solving teams have helped improve manufacturing processes at this plant We use problem-solving teams much, in this plant	Adapted from Phan <i>et al.</i> (2011) and adjusted by the authors

Table AI. (continued)

Construct	Variable descriptions	Reference sources
Incremental process innovation	Our organization introduced minor or incrementally improved machinery and equipment for producing products or services Our organization introduced minor or incrementally modified productive processes for producing products or services Our organization introduced minor or incrementally improved information technologies for producing products or services	Adapted from Akgün <i>et al.</i> (2009), Huerdo and Jaumandreu (2004), Jansen <i>et al.</i> (2006), Kim <i>et al.</i> (2012), Marínez-Costa and Marínez-Lorente (2008), and Reichstein and Salter (2006)
Incremental product innovation	Our new products differ slightly from our existing products We introduce incremental product innovations into the market more frequently than our competitors Our percentage of incremental product innovations in the product range is significantly higher compared to the competition The percentage of total sales from incremental product innovations is up substantially We are well known by our customers for incremental product innovations	Adapted from Atuahene-Gima (2005), Herrmann <i>et al.</i> (2007), Jansen <i>et al.</i> (2006), Kim <i>et al.</i> (2012), Subramaniam and Youndt (2005), and Valle and Vázquez-Bustelo (2009)
Radical process innovation	Our organization has introduced new or significantly improved machinery and equipment for producing products or services Our organization has introduced new or significantly modified productive processes for producing products or services Our organization has introduced new or significantly improved information technologies for producing products or services	Adapted from Huerdo and Jaumandreu (2004), Reichstein and Salter (2006), Marínez-Costa and Marínez-Lorente (2008), Valle and Vázquez-Bustelo (2009), and Kim <i>et al.</i> (2012)
Radical product innovation	Our new products differ substantially from our existing products We introduce radical product innovations into the market more frequently than our competitors Our percentage of radical product innovations in the product range is significantly higher compared to the competition The percentage of total sales from radical product innovations is up substantially We are well known by our customers for radical product innovations	Adapted from Chandy and Tellis (1998), Atuahene-Gima (2005), Subramaniam and Youndt (2005), Huerdo and Jaumandreu (2004), Valle and Vázquez-Bustelo (2009), and Kim <i>et al.</i> (2012)
Competitive advantage	Your firm exploited all market opportunities that have been presented to your industry Your firm fully exploited the market opportunities that have been presented to your industry Your firm neutralized all competitive threats from rival firms in your industry Your firm fully neutralized the competitive threats from rival firms in your industry	Adapted from Sigalas <i>et al.</i> (2013)

Table AI.

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